Oct. 29, 1963 J. H. HORMAN 3,109,077

ELECTROMAGNETIC SWITCH APPARATUS

Filed Sept. 18, 1959 2 Sheets-Sheet 1

FIG. 1

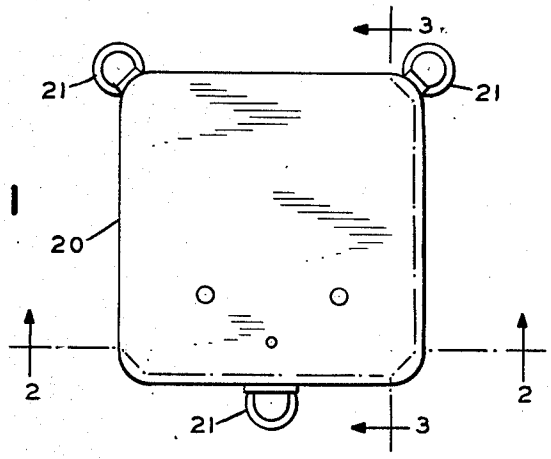


FIG. 2

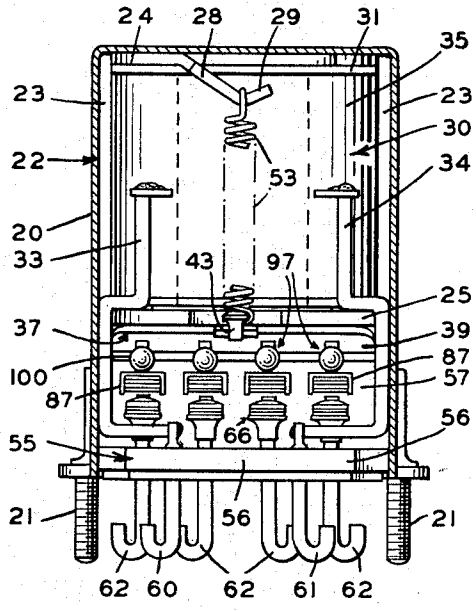


FIG. 3

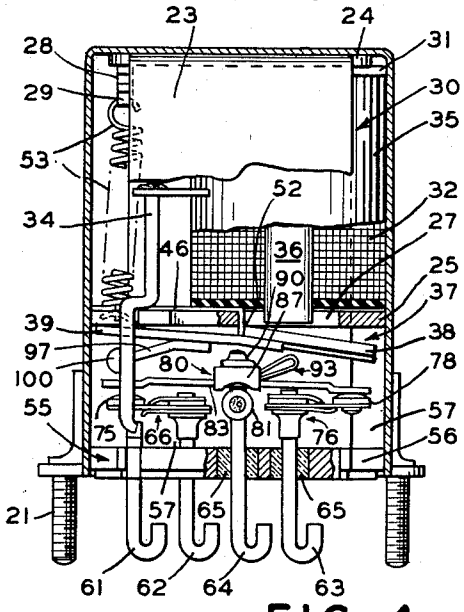


FIG. 5

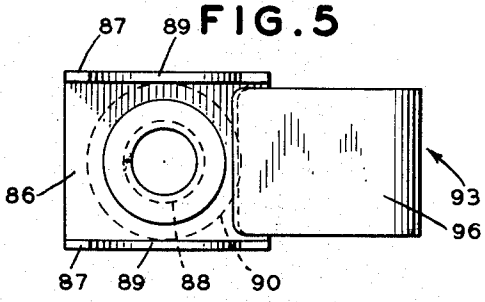
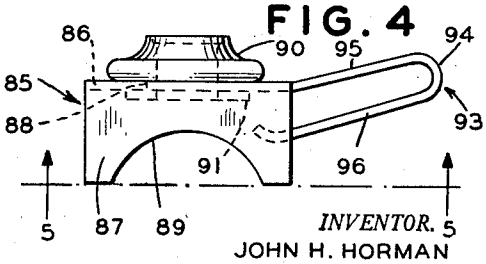


FIG. 4



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Oct. 29, 1963 J. H. HORMAN 3,109,077

ELECTROMAGNETIC SWITCH APPARATUS

Filed Sept. 18, 1959 2 Sheets-Sheet 2

FIG. 6

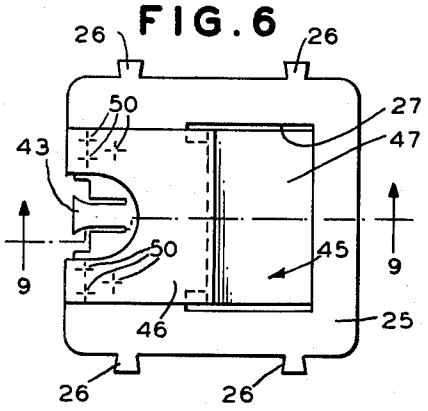


FIG. 10

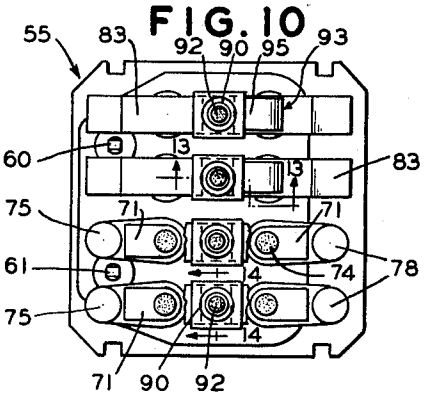


FIG. 7

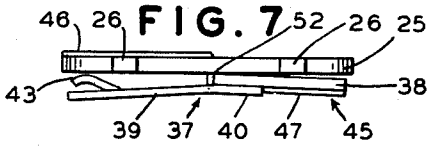


FIG. 11

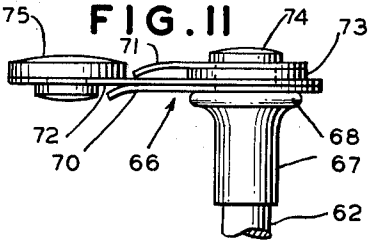


FIG. 8

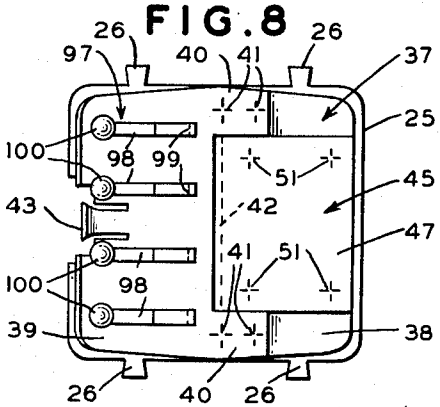


FIG. 12

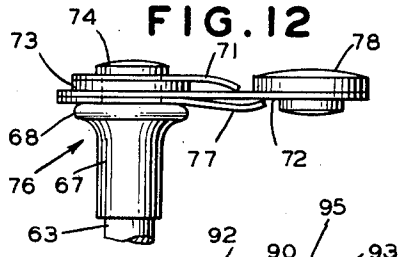


FIG. 9

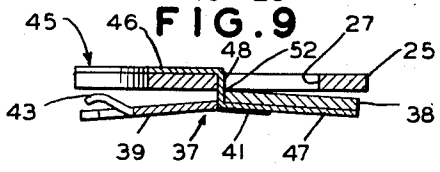


FIG. 13

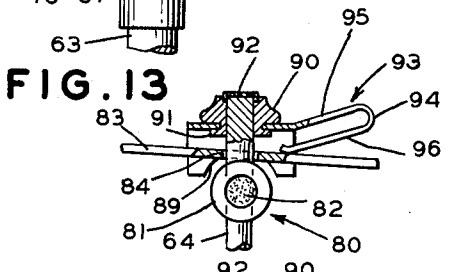


FIG. 15

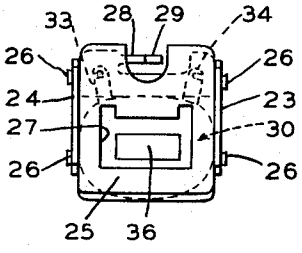
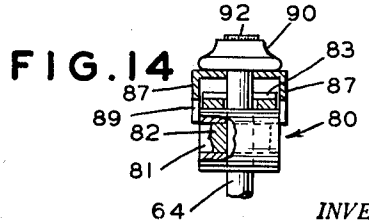


FIG. 14



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3,109,077

ELECTROMAGNETIC SWITCH APPARATUS

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12 Claims. (Cl. 200—87)

This invention relates to the art of electric switch apparatus and pertains, in one of its more specific aspects, to an electromagnetic switch or relay having an improved armature. The invention pertains, in another specific aspect, to an improved contact arrangement for various types of switches, including electromagnetically operated switches.

The apparatus of this invention has wide application. It is especially useful in aircraft and other equipment which are subject to high inertia forces due to shock, vibrations and sudden acceleration or deceleration.

A well-known category of electromagnetic apparatus is one which opens or closes contacts in an electric circuit. An example of such apparatus is a relay which includes a magnetizing coil and an armature that is movable relative to the coil on energization of the coil. A spring-pressed means is actuated by the armature, when the coil is energized, to open or close electric contacts. The armature is normally maintained in inoperative position by a spring, the force of which is overcome by energizing the coil to actuate the armature. If the force of the spring is weak, sudden acceleration or deceleration of the apparatus may actuate the armature and thereby open or close the contacts accidentally. If the force of the spring is strong enough to withstand this tendency, a substantial electrical force is required to operate the apparatus.

One of the features of this invention resides in an improved balanced armature which successfully withstands inertia forces. As a consequence, only a light duty holding spring is needed and a relatively small electrical force is required to actuate the armature against the action of the spring and operate the apparatus.

Another feature of the invention resides in an improved electric contact arrangement for switches. This arrangement includes a stationary contact, a movable contact lever mounted on the stationary contact for pivotal movement about a fixed axis, and a retainer unit including a spring. The spring performs several functions, including:

(1) Maintaining the lever in contact with the stationary contact;

(2) Normally and yieldingly biasing the lever into contact with a second stationary contact, and

(3) Preventing unintentional breaking of contact or arcing between the lever and the second stationary contact due to shock forces, vibrations and the like.

The primary object of the invention is to provide electric switch apparatus which is not adversely affected by vibrations, shock forces, sudden acceleration or sudden deceleration to which it may be subjected in the course of normal use.

Another object of the invention is to provide an electromagnet switch including an improved armature.

Another object of the invention is to provide switch means including a movable contact lever and associated parts of improved design, construction and operation.

A further object of the invention is to provide switch means including a movable contact lever that is devoid of a pigtail or a spring type current-carrying connector.

A still further object of the invention is to provide electric switch apparatus of the character indicated that is small, lightweight and compact in design, that is sturdy and durable in construction, that is reasonable in manufacturing cost and that is capable of performing its intended functions in a dependable manner.

The switch means of this invention is applicable to various types of switches including single pole double throw switches and multi-pole double throw switches. The ensuing detailed description and the accompanying drawings describe and illustrate, by way of example, a relay embodying the invention and including a four pole double throw switch constructed in accordance with the invention.

In the drawings, wherein like reference numerals denote corresponding parts throughout the several views:

FIG. 1 is a top plan view of the relay;

FIG. 2 is a view taken along staggered line 2—2 of FIG. 1;

FIG. 3 is a view taken along staggered line 3—3 of FIG. 1; certain parts being broken away and other parts being shown in cross-section for better illustration;

FIG. 4 is an enlarged side elevation view of a retainer unit assembly which is also shown in other views, including FIGS. 3 and 13;

FIG. 5 is a view taken along line 5—5 of FIG. 4;

FIG. 6 is a top plan view of a support plate and devices carried thereby;

FIG. 7 is a view in side elevation of FIG. 6;

FIG. 8 is a bottom plan view of FIG. 6;

FIG. 9 is a view taken along staggered line 9—9 of FIG. 6;

FIG. 10 is a top plan view of a header assembly, certain parts being broken away for better illustration;

FIG. 11 is a view in side elevation of one stationary contact assembly which is also shown in other views, including FIG. 3;

FIG. 12 is a view in side elevation of another stationary contact assembly which is also shown in other views, including FIG. 3;

FIG. 13 is an enlarged view of a third stationary contact assembly taken along staggered line 13—13 of FIG. 10;

FIG. 14 is another enlarged view of the third contact assembly taken along line 14—14 of FIG. 10; and

FIG. 15 is a bottom plan view on a reduced scale of the armature support plate and parts positioned thereabove.

Referring initially to FIGS. 1, 2 and 3, the illustrated relay includes a housing 20 which is closed at its upper end and open at its lower end. A plurality of spaced threaded connectors 21 is soldered to and projects beyond the open end of the housing. These connectors are utilized in mounting the housing and its contents to a panelboard or other support.

The relay includes a frame 22 which is disposed in the housing and forms a snug fit therewith. The frame includes a pair of parallel side walls 23 and parallel top and bottom walls 24 and 25, respectively. Side walls 23 and top wall 24 are preferably integral. Bottom wall 25 is a separate piece and is provided with lateral ears 26 (FIG. 6) which register with corresponding openings, not shown, in the side walls. Wall 25 has an opening 27 (FIGS. 6 and 15). This wall serves as a support for an armature and other parts which will be described further along herein. A bent finger 28 is struck from a marginal portion of top wall 24. As best shown in FIG. 2, finger 28 projects downwardly and terminates in an upwardly extending free end part 29.

Positioned within frame 22 is an electromagnet 30 which includes a bobbin 31, that is located between and bears against frame walls 24 and 25, and a magnetizing coil 32 that is wound around the bobbin and is provided with a pair of leads 33 and 34. The coil is sheathed in a protective outer wrap 35. A pole piece 36 is positioned in the coil. The upper end of the pole piece is anchored to frame top wall 24, while the lower end of the pole

piece terminates in opening 27 of frame wall 25, as indicated in FIG. 3.

The electromagnet also includes an armature 37 which, as stated earlier herein, constitutes one of the features of the invention. The armature comprises a pair of preferably planar plates 38 and 39 which are made of a magnetic material. Plate 39 is formed with a pair of end extensions 40 which underlie plate 38 and are secured thereto by welds 41 (FIG. 8). As is indicated in this view, the armature is provided with a narrow slot 42 which is defined by adjacent edges of plates 38 and 39 and extensions 40. The free marginal end of plate 39 is cut out and bent to obtain a finger 43.

The armature is pivotally connected to wall 25 by a resilient hinge 45 of the type known to the art as a "reed hinge." Hinge 45 is made of a thin strip of resilient, bendable, magnetic material which is configured as shown in FIGS. 6 through 9 to provide end portions 46 and 47 and a central portion 48. Hinge end portion 46 overlies frame bottom wall 25 (FIG. 9) and is spot welded thereto, as indicated at 50 (FIG. 6). Hinge end portion 47 underlies armature plate 38 (FIG. 9) and is spot welded thereto as indicated at 51 (FIG. 8). Hinge central portion 48 extends through slot 42. It will be evident from an examination of the drawings, particularly FIGS. 7 and 9, that hinge 45 securely anchors the armature to wall 25 and permits limited pivotal movement of the armature relative to that wall about an axis 52. This axis is the line of contact between armature plate 38 and wall 25. That line of contact is also the line of intersection of the left edge of plate 38 and the upper surface of that plate.

A helical spring 53 is connected at its ends to frame finger 28 and armature finger 43. This spring is stressed in tension and, as viewed in FIG. 3, normally and yieldingly urges the armature in a clockwise direction about pivot axis 52 to the extent allowed by frame wall 25. FIG. 3 illustrates the normal position of the armature relative to the other parts when the coil 32 is deenergized.

Referring further to FIG. 3, it will be observed that the lower end of pole piece 36 is positioned in opening 27 and is spaced from armature plate 38. Upon energization of coil 32, the pole piece attracts plate 38 and imparts counter clockwise pivotal movement to the entire armature about pivot axis 52 against the action of spring 53. When the coil is again deenergized, the armature returns to the position shown in FIG. 3 by spring 53. The moment of inertia of the portion of the armature to the right of pivot axis 52 (FIG. 9) is substantially equal to the moment of inertia of the portion of the armature to the left of that axis. As a consequence, such portions counterbalance each other and inertia or gravitational forces will not actuate the armature to operate the apparatus unintentionally. Due to the counterbalanced characteristic of the armature, a relatively light duty spring 53 may be employed.

Reference is next had to FIGS. 2, 3 and 10 which illustrate details of construction of a header assembly 55 that is mounted below armature 37. The header assembly includes a support plate 56 which carries electric connections, switch contacts and other elements that are identified and described below. Plate 56 is affixed to the lower ends of frame side walls 23 in any desired manner known to the art and defines a compartment 57 with frame walls 23 and 25. The armature is positioned in this compartment. Plate 56 carries a plurality of fixed electric terminals, namely a terminal 60, a terminal 61, four terminals 62, four terminals 63 and four terminals 64. These terminals all extend through plate 56 and are anchored thereto by corresponding masses of a suitable, rigid, insulating material, such as glass, as indicated at 65 in FIG. 3. Terminals 60 and 61 are respectively connected to coil leads 33 and 34 and are adapted to be connected to a suitable source of electric energy supply. Terminals 62 are equi-spaced and arranged in a row. Terminals 63 and 64 are also equi-spaced and arranged in like rows which are parallel to the row of terminals 62. Each terminal 64 is positioned midway between a terminal 62 and a corresponding terminal 63.

Each terminal 62 is equipped with an electrically conductive contact arm assembly 66 that is best shown in FIG. 11. This assembly includes a hub 67 having a flange 68 intermediate its ends. Mounted on the hub is a pair of damper springs 70 and 71, a resilient contact arm 72 and a washer 73. The upper end of the hub is riveted over, as indicated at 74, to maintain the parts in the illustrated relative position. A contact button 75 is affixed to the free end of arm 72.

Each terminal 63 is equipped with a contact arm assembly 76 which is best shown in FIG. 12. This assembly is the same as assembly 66 except that it has a damper spring 77 which differs slightly from spring 70. In this connection, the free end of spring 77 is upturned instead of downturned, as in the case of spring 70. The contact button of assembly 76 is identified by numeral 78.

FIGS. 3, 4, 5, 13 and 14 illustrate details of construction of a movable contact assembly 80 that is carried by and makes electric contact with a terminal 64 and that is adapted to make alternate contact with corresponding contact buttons 75 and 78. Assembly 80 comprises a tubular rocker contact 81 having a diametrical opening through which the upper portion of terminal 64 extends. Contact 81 is affixed to its terminal by solder 82 (FIG. 14). Mounted on contact 81 is a rocker lever 83 that has a central opening 84 through which terminal 64 projects. The diameter of opening 84 is larger than that of terminal 64 to permit limited rocking movement of lever 83 about contact 81.

Movable contact assembly 80 also comprises a retainer unit 85 (FIGS. 4 and 5) which includes an inverted U-shaped member consisting of a web 86 and a pair of spaced parallel sides or arms 87. The web has a central opening 88. Each side 87 is cut out at its lower end, as indicated at 89, to accommodate a rocker contact 81. A hub 90 registers with web opening 88 and is riveted over at its lower end to the web, as indicated at 91. The upper end of terminal 64 registers with hub 90 and is affixed thereto, preferably by soldering, as indicated at 92 (FIG. 13). Integral with the retainer web is a spring 93 which is bent at 94 to obtain an upper arm 95 and a lower arm 96. The free end of arm 96 bears against the upper surface of lever 83.

It will be appreciated from an examination of the drawings that retainer unit 85 serves a number of functions. In the first place, sides 87 of the U-shaped member permit rocking movement of lever 83 relative to contact 81 but prevent movement of the lever about the axis of terminal 64. Secondly, spring 93 normally and yieldingly urges the lever in a clockwise direction about contact 81 (FIG. 13) and maintains an end of the lever in contact button with a corresponding contact 78, as shown in FIG. 3.

Referring again to FIGS. 2, 3 and 8, armature 37 is equipped with four equi-spaced actuators 97, each of which is adapted to actuate a corresponding lever 83 against the action of its spring 93 in response to pivotal movement of the armature. Each actuator consists of a rod 98, which is anchored to one end by solder 99 to armature plate 39 (FIG. 8), and an insulating element, such as a glass bead 100, which is formed at its other end.

For the purpose of outlining the operation of the illustrated form of the invention, it is assumed that the apparatus is assembled and that the parts are in the relative position shown in FIGS. 2 and 3. It is also assumed that terminals 60 and 61 are connected to a convenient source of electric energy supply and that magnetizing coil 32 is deenergized. Under these circumstances, each lever 83 is in contact with a corresponding contact button 78 and

completes a circuit which includes corresponding terminals 63 and 64.

Upon energization of the coil, pole piece 36 exerts sufficient attracting force on armature plate 38 to pivot the armature as a whole in a counter-clockwise direction about axis 52 and against the action of spring 53. This causes actuators 97 to move downwardly (FIG. 3), engage the left end portions of levers 83, impart counter-clockwise pivotal movement of levers 83 in unison against the action of corresponding springs 93, and thereby interrupt contact between each lever 83 and its button contact 78 and effect contact between each lever 83 and its button contact 75. This opens each circuit which includes a terminal 63 and a terminal 64 and closes each circuit which includes a terminal 62 and a terminal 64. When the magnetizing coil is again deenergized, the parts return to the position shown in FIG. 3.

From the foregoing, it is believed that the objects, advantages, construction and operation of my present invention will be readily comprehended by persons skilled in the art, without further description. Although the invention has been herein shown and described in a simple and practicable form, it is recognized, that certain parts thereof are representative of other parts which may be used in substantially the same manner to accomplish substantially the same results. Therefore, it is to be understood that the invention is not to be limited to the exact details described herein, but is to be accorded the full scope and protection of the appended claims.

I claim:

1. In an electromagnet which includes an upstanding magnetizing coil and a pole piece, the improvement comprising a support at the lower end of the coil, an armature positioned beneath the support and including a first plate element below the pole piece and a second plate element joined to and extending beyond the first plate element, the portion of the second plate element which is joined to the first plate element being disposed below the first plate element, said plate elements defining an opening which is partly formed by an edge of the first plate element, and a resilient hinge extending through the opening and connected at one end to the armature and at its other end to the support, said hinge maintaining the armature in engagement with the support along the line of intersection of said edge and the upper surface of the first plate element.

2. In an electromagnet which includes an upstanding magnetizing coil and a pole piece, the improvement comprising a support at the lower end of the coil, an armature positioned beneath the support and including a first plate element below the pole piece and a second plate element joined to and extending beyond the first plate element, the portion of the second plate element which is joined to the first plate element being disposed below the first plate element, said plate elements defining an opening which is partly formed by an edge of the first plate element, a resilient hinge extending through the opening and connected at one end to the armature and at its other end to the support, said hinge maintaining the armature in engagement with the support along the line of intersection of said edge and the upper surface of the first plate element, and spring means for normally and yieldingly imparting pivotal movement to the armature about said line and away from the pole piece.

3. In an electromagnet which includes an upstanding magnetizing coil and a pole piece, the improvement comprising a support at the lower end of the coil, an armature positioned beneath the support and including a first plate element below the pole piece and a second plate element joined to and extending beyond the first plate element, the portion of the second plate element which is joined to the first plate element being disposed below the first plate element, said plate elements defining an opening which is partly formed by an edge of the first plate element, and a hinge consisting of a strip of thin, resilient, bendable metal which extends through said opening, one end of the hinge being secured to the support, the other end of the hinge bearing against the lower surface of the first plate element and being secured thereto, said hinge maintaining the armature in engagement with the support along the line of intersection of said edge and the upper surface of the first plate element.

4. In an electromagnet which includes a frame, a magnetizing coil within the frame and a pole piece, the improvement comprising a support plate carried by the frame and positioned below the coil, an armature positioned beneath the support plate and including a first plate below the pole piece and having a first edge and a second plate having a second edge and at least one extension projecting beyond said second edge, said extension bearing against the lower surface of the first plate and being affixed thereto, the first and second plates being so arranged that said edges and extension define a slot, and a resilient hinge extending through the slot and secured at one end to the support and at its other end to the armature, said hinge maintaining the armature in engagement with the support along the line of intersection of said first edge and the upper surface of the first plate.

5. In an electromagnet which includes a frame, a magnetizing coil within the frame and a pole piece, the improvement comprising a support plate carried by the frame and positioned below the coil, an armature positioned beneath the support plate and including a first plate below the pole piece and having a first edge and a second plate having a second edge and at least one extension projecting beyond said second edge, said extension bearing against the lower surface of the first plate and being affixed thereto, the first and second plates being so arranged that said edges and extension define a slot, a resilient hinge extending through the slot and secured at one end to the support and at its other end to the armature, said hinge maintaining the armature in engagement with the support along the line of intersection of said first edge and the upper surface of the first plate, and spring means for normally and yieldingly imparting pivotal movement to the armature about said line and away from the pole piece.

6. In an electromagnet which includes a frame, a magnetizing coil within the frame and a pole piece, the improvement comprising a support plate carried by the frame and positioned below the coil, an armature positioned beneath the support plate and including a first plate below the pole piece and having a first edge and a second plate having a second edge and a pair of spaced extensions projecting beyond said second edge, said extensions bearing against the lower surface of the first plate and being affixed thereto, the first and second plates being so arranged that said edges and extensions define a slot, and a resilient hinge extending through the slot and secured at one end to the support and at its other end to the armature, said hinge maintaining the armature in engagement with the support along the line of intersection of said first edge and the upper surface of the first plate.

7. In an electromagnet which includes a frame, a magnetizing coil within the frame and a pole piece, the improvement comprising a support plate carried by the frame and positioned below the coil, an armature positioned beneath the support plate and including a first plate below the pole piece and having a first edge and a second plate having a second edge and a pair of spaced extensions projecting beyond said second edge, said extensions bearing against the lower surface of the first plate and being affixed thereto, the first and second plates being so arranged that said edges and extensions define a slot, a hinge consisting of a strip of thin, resilient, bendable metal which extends through the slot, one end of the hinge bearing against the upper surface of the support plate and being secured thereto, the other end of the hinge bearing against the lower surface of the

first plate and being secured thereto, said hinge maintaining the armature in engagement with the support plate along the line of intersection of said first edge and the upper surface of the first plate.

8. An electromagnet according to claim 7 including spring means connected to the frame and the second plate for normally and yieldingly imparting pivotal movement to the armature about said line and away from the pole piece.

9. An electromagnet according to claim 4 including switch means comprising a second support plate carried by the frame below the armature, a set of spaced first, second and third electric contacts carried by the second support plate, said third contact being positioned between the first and second contacts, a fixed terminal secured to the support, said third contact being secured to the terminal, an electrically conductive lever having an opening intermediate its ends, said terminal extending through said opening and forming a loose connection with the lever, the lever bearing against and being rockable relative to the third contact, a retainer unit carried by the terminal, spaced from the third contact and engageable by the lever, said retainer unit permitting pivotal movement of the lever relative to the third contact about a fixed axis and preventing such movement about an axis normal to said fixed axis, a spring connected to the retainer unit and engaging the lever to normally and yieldingly bias the lever in one direction about said fixed axis and maintain the lever in contact with the first contact and out of contact with the second contact, said armature being adapted, upon energization of the coil, to be moved about said pivot line in a direction toward the pole piece against the action of the spring means, and actuator means responsive to pivotal movement of the armature in said direction for imparting pivotal movement to the lever in a direction opposite to said one direction against the action of the spring to interrupt contact between the lever and the first contact and effect contact between the lever and the second contact.

10. An electromagnet according to claim 9 wherein the retainer unit comprises a generally U-shaped member consisting of a web and a pair of spaced arms, said lever being positioned between the arms and between the third contact and the web, said terminal being positioned between the arms and connected to the web.

11. An electromagnet according to claim 10 wherein the spring is integral with the web of the U-shaped member and bears against the portion of the lever which is between said fixed axis and the first contact.

12. An electromagnet according to claim 9 including a plurality of sets of contacts, a fixed terminal for each third contact, a lever for each set of contacts, a retainer for each lever, and a spring for each lever, said actuator means imparting said pivotal movement to the levers in unison against the action of the springs to interrupt contact between each lever and corresponding first contact and effect contact between each lever and corresponding second contact.

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