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[54] **MICROMINIATURE POLARIZED RELAY**

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[52] **U.S. Cl.** **335/78,** 335/179, 335/234
[51] **Int. Cl.** **H01h 51/27**
[58] **Field of Search** 335/78, 79, 80, 179, 203, 335/229, 230, 234, 236

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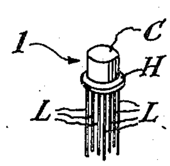
[57] **ABSTRACT**

A microminiature polarized relay for sensing a given polarity of voltage includes an electromagnet and a pivotal armature movable between a first and a second position.

The above change was made only to improve the form of the case. The electromagnet includes a magnetic frame, a core member, an energizable coil, and a magnetic shunt. Normally, the magnetic shunt exhibits a low value of reluctance when the coil of the electromagnet is not energized by the given polarity of voltage so that the armature normally assumes the first position. However, the magnetic shunt exhibits a high value of reluctance when the coil of the electromagnet is energized by the given polarity of voltage so that the armature moves to its second position. The movement of the armature causes the positions of a plurality of movable and stationary contacts to change so that a transfer switching action occurs.

10 Claims, 6 Drawing Figures



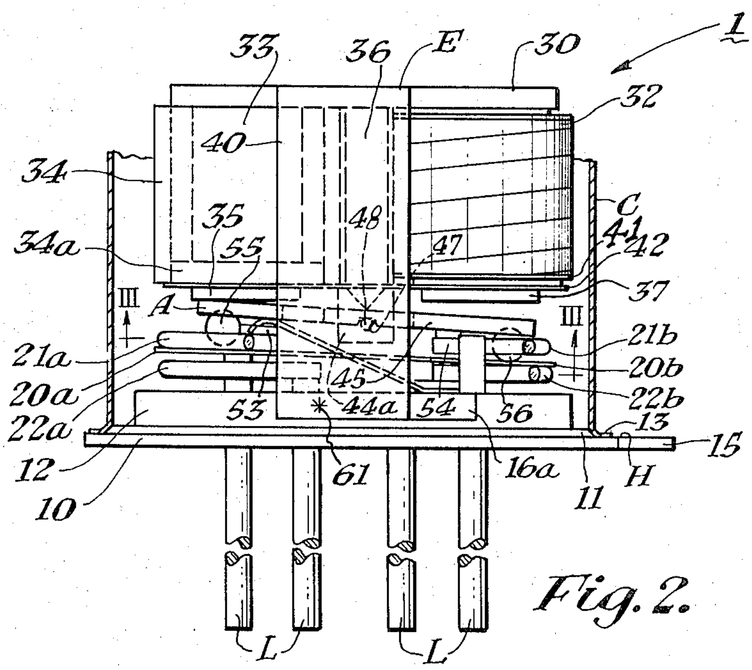


Fig. 2.

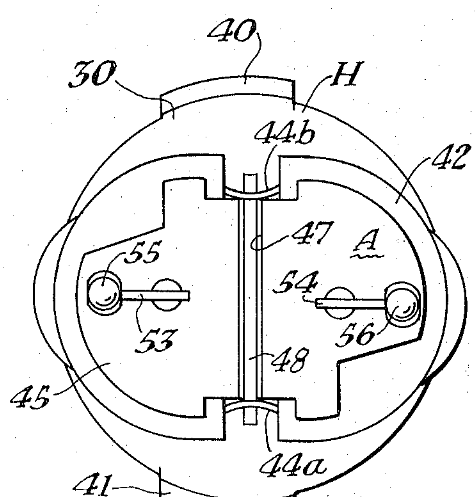


Fig. 3.

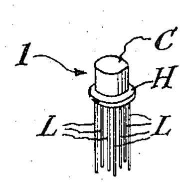


Fig. 1.

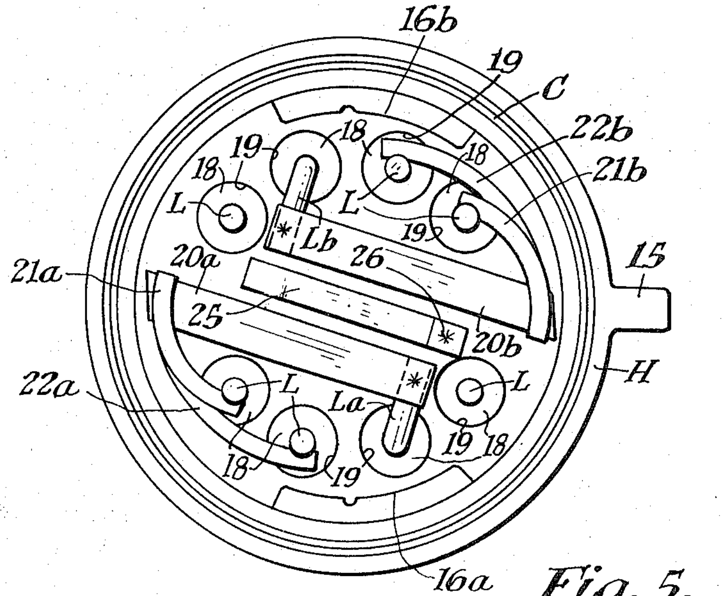


Fig. 5.

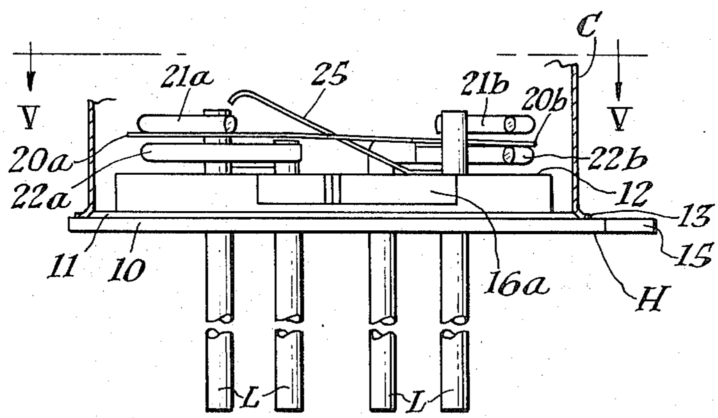


Fig. 4.

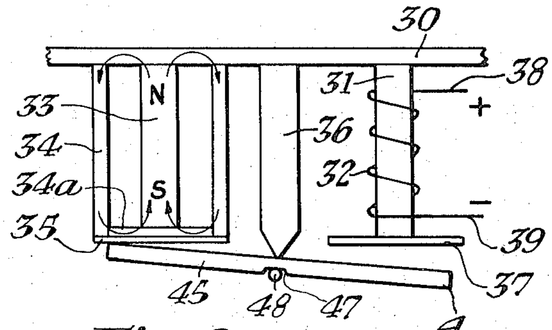


Fig. 6.

MICROMINIATURE POLARIZED RELAY

This invention relates to a microminiature polarized electromagnetic relay and, more particularly, to a hermetically sealed polarized relay having a permanent magnet for causing a pivotal armature to be normally held in a first released position and having an energizable coil of an electromagnet for causing the pivotal armature to be moved to a second picked-up position.

The demand for new and better electronic as well as electromechanical devices is constantly increasing in that suppliers, for example, of signal communication and control equipment require smaller, lighter, less costly, and more efficient apparatus to meet their needs. In certain applications, such as, in aerospace use, the miniaturization of the devices is essential in order to meet the mil-spec. space and weight requirements. The conformance to the requisites of minuteness becomes increasingly more difficult in proportion to the number of components or parts employed in a particular device. For example, in the electromechanical art, such as, electromagnetic relays, it is extremely difficult to design an ordinary miniature neutral relay and especially a miniature permanent magnet polarized relay. A polarized electromagnetic relay has many useful functions, particularly in polarity sensitive circuits that are employed in various electrical systems. For example, the necessary control logic of a data processing network for a signal, communication, or control system must be responsive to a particular polarity of a direct current voltage to permit the transmission and/or reception of information in a digital form. A permanent magnet type of polarized relay is a highly reliable voltage polarity sensitive device in that the operation of the relay is not materially affected by adverse conditions. For example, power line surges, excessive voltage values, and high temperatures have little, if any, effect on the functioning of a permanent magnet type of miniature polarized electromagnetic relay. Further, the armature of the presently described polarized relay is not capable of being operated by the opposite or wrong polarity of direct current voltage. In addition, in aerospace usage the miniature relays are exposed and are subjected to extreme environmental forces, such as, shock, vibrations, acceleration, deceleration, and other gravitational pressures. In order to mitigate the effects of these active adverse forces, it is highly advantageous to employ symmetry in the design of the relays, particularly, the elements or parts of the relay that are capable of moving. Furthermore, the internal components and their construction must be capable of being accommodated within the confines of an improved housing, such as, a standard TO-5 casing. There are other important factors to be considered in the fabrication of microniminiature electromagnetic relays. The mechanical, electrical and magnetic characteristics of the relay must meet or exceed the mil-spec. requirements in order to win the approval and acceptance of the industrial suppliers and, particularly, the governmental agencies.

Accordingly, it is an object of my invention to provide a novel and unique microminiature electromagnetic relay which encompasses all of the abovementioned features and advantages.

A further object of my invention is to provide an improved transistor-case electromagnetic relay which is

spring biased to a deenergized position and is held in said deneergized position by a permanent magnet.

Another object of my invention is to provide an improved electromagnetic relay which will only respond to a given polarity of voltage to move the armature from a first to a second position.

Yet another object of my invention is to provide a unique polarized electromagnetic relay employing a magnetic circuit in the form of a three-legged structure in which a permanent magnet forms one of the outer legs and the electromagnet forms the other outer leg.

Yet a further object of my invention is to provide an improved microminiature polarized relay having a balanced armature to reduce the adverse effects of inertial forces.

Still another object of my invention is to provide a unique microminiature polarized relay which employs a return spring and a permanent magnet for maintaining the armature in a first deenergized position.

Yet an additional object of my invention is to provide a new and improved polarized electromagnetic relay that is extremely small, light, and compact and is capable of fitting within a standard TO-5 transistor type casing.

Still an additional object of my invention is to provide a unique miniaturized electromagnetic relay having a magnetic structure which includes a permanent magnet and a magnetic shunt for ensuring that the electromagnet will only cause the armature to move to its picked-up position when the voltage is of a given polarity.

Yet another object of my invention is to provide a new and improved microminiature polarized electromagnetic relay which is simple in construction, economical in cost, and efficient and reliable in operation.

Further objects, features, and advantages of my invention will become more apparent from the following description, and the ingeniosity which characterizes my invention will be pointed out in the appended claims which form part of my specification.

Generally, my invention relates to a microminiature polarized electromagnetic relay comprising an electromagnetic assembly, a contact and header assembly, an armature assembly, and a cover. The contact and header assembly includes a base plate through which pass a plurality of insulated contact pins which have terminal portions on one side of the base plate and contact switching portions on the other side of the base plate. The interior contact portions cooperate with a plurality of movable contacts secured to selective ones of said insulating connecting pins. In addition, the contact header assembly includes a biasing spring having one end suitably secured to the internal side of the base plate. The electromagnetic assembly includes an electrically energizable coil, a magnetic frame, a magnetic core, a magnetic central pivotal core member, a permanent magnet, and a magnetic shunt. The magnetic frame includes a pair of depending legs which are securely fastened to two opposite sides of the internal portion of the base plate. The magnetic frame forms the backstrap member for a three-legged structure which includes the outer core member of the electromagnet and the permanent magnet, as well as a central pivotal core member. The armature assembly includes a balanced armature member carrying a plurality of contact actuating members for moving the movable contacts. The armature is pivotally mounted about the central depending leg so that the respective ends of the armature are disposed adjacent the pole faces of the magnetic core and the permanent magnet. The upper surface of the armature faces the pivotal edge of the central depending leg while the underside of the armature is held in position by a restraining bracket. The permanent magnet and biasing spring normally urge the armature toward the pole face of the permanent magnet when the energizable coil is deactivated. The contact actuating devices cooperate with the movable contacts to establish a make and brake switching action between the fixed contacts in accordance with the pivotal armature. The cover is suitably attached to the baseplate to provide a hermetical seal for the internally located parts of the relay.

A better and more complete understanding of my invention will be had by reference to the drawings, in which similar characters of reference refer to similar parts throughout the various views and figures and in which:

FIG. 1 is a perspective view of the substantially actual size of a microminiature electromagnetic polarized relay which is constructed in accordance with the present invention.

FIG. 2 is a side elevational view, partly in section, greatly enlarged, of the relay of FIG. 1.

FIG. 3 is a cross-sectional view of FIG. 2, taken substantially along the lines III—III.

FIG. 4 is a side elevational view of the header and contact assembly shown in FIG. 2 with the electromagnetic assembly and a portion of the cover removed.

FIG. 5 is a cross-sectional view of FIG. 4, taken substantially along the lines V—V.

FIG. 6 is a partial schematic illustration of the magnetic circuit details which encompass the concept embodying the present invention.

Referring now to the drawings, there is shown in FIG. 1 the actual size of a transistor-case type of electromagnetic relay, generally characterized by the numeral 1, encompassing the teachings of the present invention. The various internal assemblies which make up the microminiature relay 1 are completely enclosed and hermetically sealed by the cover C which is preferably soldered, brazed, or welded to an associated upper surface of the flanged header assembly H so that the relay 1 is impervious to dust, moisture, and other contaminants which may be present in the operating environment. The required external connections to the relay 1 are made through the electrically conductive connecting pins or leads L, which will be described in greater detail hereinafter.

In viewing FIG. 2, it will be noted that the relay 1 solely consists of four principal components, namely, a header and contact assembly H, an electromagnetic assembly E, an armature actuating assembly A, and a cover C, all of which will now be described in greater detail.

It will be seen in viewing FIGS. 2, 4, and 5 that the header and contact assembly H comprises a circular metallic base or header disk 10 having a flange 11 and an upper central table 12. As best shown in FIGS. 2 and 4, the flange portion 11 is designed to mate and cooperate with the inner inclined surface of the lower edge or rim 13 of the cover C which is telescoped over the internal relay assemblies or components and is preferably suitably secured or sealed in cooperative association therewith, as shown in FIGS. 2 and 4. An indexing or guide tab 15 extends laterally away from the flange portion 11 and provides a convenient method of readily positioning the relay for proper insertion into a suitable plug connector, such as a retainer socket which is connected to the appropriate external circuits. The base or header plate 10 also includes a pair of peripheral notches or depressions 16*a* and 16*b* for receiving a pair of supporting legs of the electromagnetic assembly E, as will be described hereinafter. As shown, the plurality of circularly disposed connecting pins or leads L protrude outwardly from the header 10 and afford electrical connections with the internal contacts of the relay. Each of these connecting pins or leads is secured in place by being embodied in a mass of suitable insulating material 18, such as, glass, which fills each of the openings 19, as best shown in FIG. 5. Hence, a perfect hermetic seal and bond exists between the external terminal portions on the external side of the header and the internal contact assembly which performs the various switching functions on the inner side of the header plate 10. The contact assembly includes a pair of movable contacts or switching blades 20*a* and 20*b*, which are secured to selected ones of the connecting pins or leads L, in this case L*a* and L*b*, respectively. That is, one end of movable 20*a* is secured to connecting pin L*a*, such as by welding, while one end of the contact 20*b* is welded to the internal portion of the contacting pin L*b*. The free ends of the movable contacts or blades 20*a* and 20*b* are suitably disposed and normally biased into cooperative association with a pair of arcuate stationary contact members 21*a* and 21*b*, respectively. Thus the contacts 21*a* and 21*b* are normally closed while a pair of counterparts of arcuate contacts 22*a* and 22*b* are normally open. It will be appreciated that the stationary contacts 21*a* and 21*b* and 22*a* and 22*b* may be integrally formed or may be separate arcuate pieces suitably welded to the upper inner portion of the appropriate connecting pins L, as shown. It will be noted that the contacts are substantially parallel with the upper surface of the central table portion 12. It will also be appreciated that the contacts provide the make and break function for selectively performing the desired completion or interruption to the externally controlled circuits. As shown, the stationary and movable contacts 20*a*, 21*a*, 22*a* and 20*b*, 21*b*, 22*b* form two independent double-throw switches, each having two selective positions. However, it will be appreciated that, while a multiple double-pole double-throw switching arrangement DPDT is illustrated in the drawings, it is readily understood that a single DPDT switching arrangement or a multiple DPST, as well as a single SPST, contact arrangement may be equally employed in practicing the present invention. The remaining two inner contacting portions of the connecting pins L, which are not functionally associated with the movable and stationary contacts, are employed to provide the necessary electrical connections between the electromagnetic coil and a suitable source of electrical power, as will be described in greater detail hereinafter.

Further, the header assembly H is arranged and adapted to carry an elongated upwardly inclined biasing spring 25. As shown in FIGS. 2, 4, and 5, one end of the spring 25 is securely fastened to the upper surface of the header table 12, such as, by spot welding, as indicated by character 26. As will be described hereinafter, the purpose of spring 25 is to engage the armature member and to urge or bias the armature to a particular given position.

The electromagnetic assembly E, which is best shown in FIG. **2,** includes a magnetic frame or backstrap member **30,** a cylindrical core **31** and a pole piece member **37,** and a bobbin supported coil **32,** a solid cylindrical and pole piece **35,** a cylindrical permanent magnet **33,** tubular magnetic shunt **34,** and magnetic keeper member **34***a*, and a central located magnetic member **36.** As shown, the electromagnetic coil and core, the permanent magnet, and the magnetic center member form a substantially E-shaped configuration with the backstrap or frame member **30.** The coil **32** is prewound upon an insulative bobbin member **42** and is electrically connected by wires or leads **38** and **39** to the two appropriate connecting pins L, which, in turn, are selectively connected to the positive and negative terminals of a suitable source of d.c. operating potential, as schematically shown in FIG. **6.**

In viewing FIGS. **2** and **3,** it will be noted that the magnetic frame **30** includes a pair of diametrically opposed depending supporting legs **40** and **41** which, as previously mentioned, are received within the appropriate recesses **16***a* and **16***b* for securing the frame to the base or header plate **10.** The upper end of cylindrical core member **31** is disposed under the backstrap member **30.** The upper extremity of the core **31** is securely fastened to member **30** by welding. As shown, the projecting free end of the core member **31** is formed with a suitable magnetic pole piece **37.** Similarly, the permanent magnet **33** and the central pivotal magnetic member **36** are securely fastened to the underside of the backstrap member by welding. Likewise, the upper peripheral surface of the shunt **34** rests against the underside of backstrap member **30.** The keeper **34***a*, which takes the form of an apertured angular disk, is set flush with the lower peripheral surface of cylindrical shunt **34,** and is held in position by pole piece member **35.** The upper end of the center member **36** is also rigidly secured to the backstrap or frame **30.** The lower end of the centrally located member **36** is formed into a V-shaped or knifelike edge which is used as a bearing for armature **45,** as will be described. The center member **36** is a rectangular element so that the length of the bearing edge is substantially equal to the width of the armature **45.**

As noted above, the projecting end of the core member **31** is provided with a pole face **37** while the free end of the permanent magnet **33** is also provided with an enlarged pole face member **35.** A retaining plate **42** is located between the electromagnet and the permanent magnet shunt structure and the pole pieces to maintain the components in proper relationship, as shown in FIGS. **2** and **3.** The retaining plate also is provided with a pair of diametrically opposed apertured tabs **44***a* and **44***b*. The tabs extend downwardly beyond the armature, the free ends being slightly twisted or bent, as shown, to retain the armature, as will be described in greater detail hereinafter.

As clearly shown in FIGS. **2, 3,** and **6,** the armature assembly A includes a movable armature member **45** formed of a flat piece of suitable magnetic material, such as, sheet iron. The armature member **45** is symmetrically designed about its minor axis so that the effects of inertial, gravitational, and other forces are offset and equalized. As shown, the peripheral edges along the major axis of the armature **45** are rounded to provide a substantially smooth and jagged-free surface. Thus, the free ends of the armature **45** are disposed adjacent to and alternately cooperate with the pole face **37** of the electromagnetic core **31** and the pole face **35** of the permanent magnet **33,** respectively, as will be described in greater detail hereinafter. As shown in FIGS. **2, 3,** and **6,** an elongated groove or notch **47** is formed along the entire breadth of the minor axis of the armature member **45.** The groove or notch **47** is designed to accommodate or receive a suitable pivot rod or pin **49,** as clearly illustrated in FIGS. **2, 3,** and **6.** The free ends of the pivot shaft **48** are inserted within the aligned holes or apertures formed in the tab members **44***a* and **44***b*, respectively. It is understood that other pivotal arrangements, such as, bent in tabs, may be used to secure the armature in its movable position. The V-shaped knife edge of center member **36** provides a low coefficient of friction so that little, if any, energy is used to overcome frictional drag and, therefore, the amount of mechanical wear is greatly reduced. Thus, the magnetic armature member **45** is pivotally mounted to move between a first energized position as shown in the drawings and a second energized position in which the underside of the armature member **45** moves and engages the pole piece **37,** as will be described presently. A pair of actuating members or pusher arms **53** and **54** are suitably secured, such as, by being projection welded, to the respective ends on the underside of the magnetic armature member **45.** The actuating members **53** and **54** take the form of rods or wires, each of which is terminated with suitable nonconducting portions **55** and **56,** respectively, such as, glass balls or different configurations made from other suitable insulating material. As will be described in greater detail hereinafter, the insulating balls are arranged to engage and to transfer the movable contact blades **20***a* and **20***b* from the stationary contacts **21***a* and **21***b* to **22***a* and **22***b*, respectively. It will be appreciated that the glass insulating spheres are employed to provide the necessary isolation and insulation between the various sets of electrical contacts.

As shown in FIGS. **2** and **5,** the supporting leg **40** is received within the notch **16***a* and is secured at a point **61,** such as, by being projection welded to the header **10.** Similarly, the supporting leg **41** is received within the notch **16***b* and is securely attached thereto. Thus, each of the electromagnet, the armature, and the contact header assemblies forms a stable welded type of structure which does not employ screws, bolts, rivets, or other ancillary fastening devices, as previously required in numerous of the types of electromagnetic relays. The entire structure, when assembled, may be completely enclosed within the metallic cover C which, as previously mentioned, has a rim **13** tightly fitted against the flange **11** and preferably welded thereto. It will be appreciated that, if desired, the inside of the relay may be evacuated and charged with suitable inert gas, such as, dry nitrogen, which curtails electrical breakdown and arcing and reduces the possibility of contamination and corrosion.

In operation, the parts of the relay normally assume a first deenergized position, as shown in FIG. **2,** when a preselected given polarity of d.c. voltage is not applied to wires **38** and **39** and, in turn, across the magnetic coil **32.** Under this condition the spring **25** biases the armature member **45** clockwise, namely, the left end of the armature is urged against the pole face **35,** as shown in FIGS. 2 and 6. The biasing effort of the spring 25 is assisted by the attractice force of the permanent magnet 33. That is, as viewed in the schematic of FIG. 6, it will be noted that the permanent magnet 33 is arranged such that a north pole appears at the upper end and a south pole appears at the lower end of the magnetic circuit. Thus, a magnetic circuit path is established from the north pole of magnet 33 through the thin walled cylindrical magnetic shunt 34, the magnetic backstrap or frame 30, the keeper member 35, the pole piece 36, and the left-handed side or end of armature 45 to the south pole of magnet 33. Thus, the armature 45 in effect is a part of the magnetic circuit path so that it is positively retained against pole face 35 by magnetic attraction. With the armature member 45 in its normal position, the insulated contact ball 55 allows the movable contact 20*a* to engage the upper stationary contact 21*a*. However, the insulating contact ball 56 depresses the movable contact 20*b* and causes it to engage the lower stationary contact 22*b*. Thus, the external circuits controlled by movable contacts 20*a* and 20*b* and stationary contacts 21*a* and 21*b* are established while the external circuits connected to stationary contacts 22*a* and 22*b* remain interrupted due to the position of the movable contacts 20*a* and 20*b*.

Now when electromagnetic coil 32 is energized by a selected given polarity of voltage connected between leads 38 and 39, the armature member 45 is attracted and the armature assembly is caused to rotate about its pivotal axis, namely, about knife bearing 48, above noted, in a counterclockwise direction, as viewed in FIGS. 2 and 6. That is, when the upper lead 38 is more positive than the lower lead 39, the right-handed free end or side of the armature 45 is drawn toward the pole face 37, as viewed in FIGS. 2 and 6. The magnetic flux generated by the energized coil causes the magnetic shunt 34 to become highly saturated thereby causing shunt 34 to exhibit a high reluctance. The resultant high reluctance condition of the magnetic shunt 34 effectively blocks passage of the coil flux to pole piece 35. The magnetic polarity of the permanent magnet 33 is in opposition to the magnetic polarity of the coil, further blocking passage of the coil flux to pole piece 35. As a result of these interactions, there is little attraction of the armature member toward pole piece 35. The main portion of the magnetic flux generated by the coil is carried by the central member 36 to and through the armature member 45 to pole piece 37 thus attracting the armature 45 to that pole piece and resulting in counterclockwise motion as viewed in FIGS. 2 and 6.

It will be noted that, if the polarity of the applied voltage is reversed, namely, that the conductor 39 is more positive than the conductor 38, then the magnetic flux established by the coil 32 of the electromagnet has the same polarity as the permanent magnet 33 and the magnetic shunt 34 becomes a low reluctance path. Thus a portion of the electromagnetic flux aids the forces retaining the armature member 45 against pole piece 35. Hence, under no circumstance can the relay assume its second position when the electromagnetic coil 32 is energized by a voltage which is of opposite polarity to that shown in FIG. 6. Accordingly, the presently described electromagnetic relay 1 is polar sensitive and will respond to only one given polarity of d.c. voltage.

Thus, it is apparent that the new and improved polarized relay of the present invention employs new and improved features which result in a more compact, smaller, lighter, more economical, durable, and efficient microminiature relay.

It will be appreciated that the disclosed and illustrated features may be changed and that equivalent structures performing similar operations may be substituted by those having ordinary skills in the art. Hence, the size dimensions of the relay and its parts may vary, the number of coil turns may be varied, the material may be selected in accordance with the use of the relay and the armature may be pivoted in other ways.

Thus, although my invention has been described with reference to a single embodiment thereof, it should be understood that numerous other embodiments and changes and numerous variations may be made by those skilled in the art that will fall within the spirit and scope of my invention. Therefore, it is understood that the invention is not limited to the exact details described herein but it is to be accorded the full scope and protection of the appended claims.

Having thus described my invention, what I claim is:

1. A microminiature polarized relay for sensing a given polarity of voltage comprising, a pivotal armature movable between a first dropped-out and a second picked-up position, a magnetic circuit including a three-legged structure in which a permanent magnet and a magnetic shunt form one of the legs, an energizable electromagnet and magnetic core form a second of the legs, and a magnetic central member forms the third of the legs, said magnetic shunt exhibiting a low value of reluctance when said electromagnet is not energized by said given polarity of voltage so that said armature normally retains said first dropped-out position and said magnetic shunt exhibiting a high value of reluctance when said electromagnetic is energized by said given polarity of voltage so that said armature moves to said second picked-up position.

2. The polarized relay as defined in claim 1, wherein said three-legged structure is formed by having said permanent magnet one of the outer legs and by having said electromagnet the other of the outer legs.

3. The polarized relay as defined in claim 1, wherein the central leg of said three-legged structure includes a low frictional bearing edge about which said armature pivots.

4. The polarized relay as defined in claim 1, wherein said magnetic shunt is a cylinder member which surrounds said permanent magnet.

5. The polarized relay as defined in claim 3, wherein said magnetic circuit includes a magnetic frame which acts as a backstrap member for said three-legged structure and which has depending legs the free ends of which are secured to a header.

6. The polarized relay as defined in claim 3, wherein a retaining plate is disposed adjacent the pole faces of said permanent magnet and said electromagnet, and a restraining means maintains said pivotal armature in position with said low frictional bearing edge.

7. The polarized relay as defined in claim 1, wherein a biasing spring assists in urging said pivotal armature to said first dropped-out position.

8. A relay comprising,

a contact and header assembly, an electromagnetic assembly, an armature assembly, and a cover, said contact and header assembly includes a base plate, a plurality of insulated connecting pins, passing through the base plate so that terminal portions are formed on one side of the base plate and contact portions are formed on the other side of the base plate, a plurality of fixed and movable contacts secured to said contact portions, and a biasing spring secured to said base plate,

said electromagnetic assembly including an electrically energizable coil and a magnetic core, a magnetic frame, a magnetic central member, a permanent magnet and a magnetic shunt, said magnetic frame having depending legs which are securely fastened to said base plate, said magnetic core and said permanent magnet each having one end secured to said magnetic frame and each having the other end forming a pole face, and said magnetic central member securely fastened to said base plate,

said armature assembly including an armature member and contact actuating means, said armature member pivotally mounted about said central

member so that respective ends of said armature member are disposed adjacent the pole faces of said magnetic core and said permanent magnet, said permanent magnet and said biasing spring normally urging said armature member to move toward the pole face of said permanent magnet, said contact actuating means establishing a make and break action between said fixed and said movable contacts,

and said cover hermetically attached to said base plate for providing a sealed enclosure for said assemblies.

9. The relay as defined in claim **8,** wherein said magnetic shunt prevents stray magnetic fields from adversely affecting the operation of the relay.

10. The relay as defined in claim **8,** wherein said central depending leg includes a pivotal edge engaging the upper surface of said armature member and includes a restraining means engaging the lower surface of said armature member.

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