Aug. 28, 1962 L. H. MAYER 3,051,804

ELECTROMAGNETIC RELAYS

Filed Dec. 28, 1960

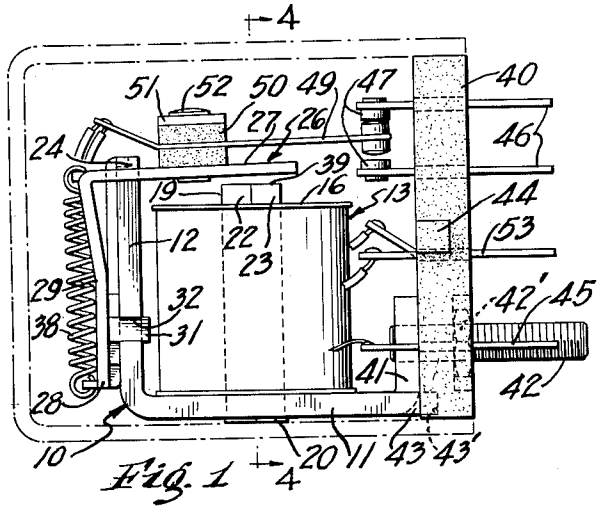


Fig. 1

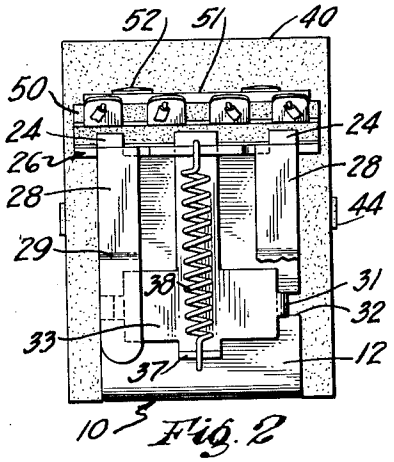


Fig. 2

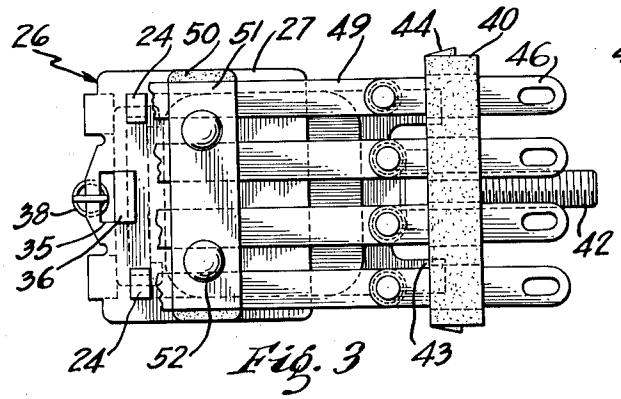


Fig. 3

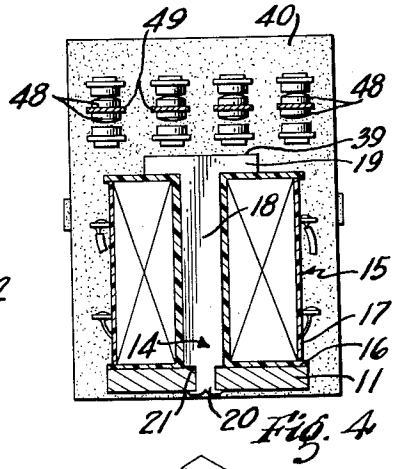


Fig. 4

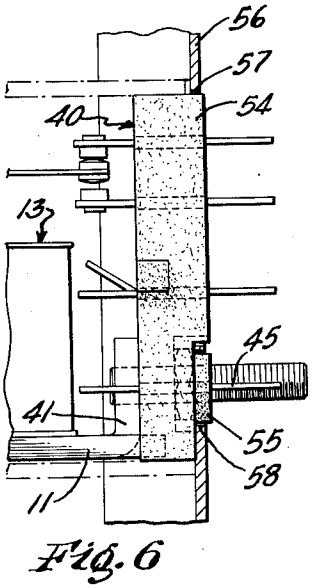


Fig. 6

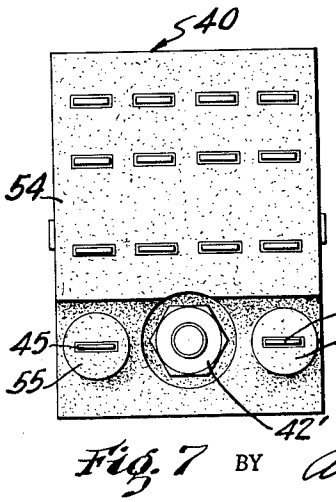


Fig. 7

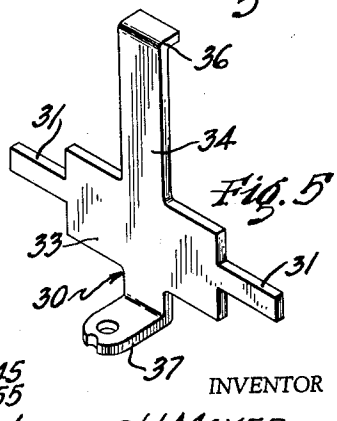


Fig. 5

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ELECTROMAGNETIC RELAYS

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This invention relates to relays and, more particularly, to electromagnetic relays of the type having a restoring spring which, when the relay is de-energized, moves the armature to and holds it in normal position.

One of the objects of this invention is to provide an improved relay which is compact, efficient in operation and simple and inexpensive to manufacture.

Another object is to provide a compact relay embodying an improved core structure, contact assembly and spring retainer bracket.

A further object is to provide an electromagnetic relay with a multi-purpose bracket which anchors one end of the restoring spring, limits pivotal movement of the armature, prevents armature sticking and prevents the armature from being accidentally dislocated from engagement with a fulcrum edge.

Still another object is to provide a relay, of the class described, with improved means by which the relay can be keyed to a supporting member.

Another object is to provide an improved pole face and armature arrangement providing a relatively great holding force regardless of variations in manufacturing tolerances.

In order that the manner in which these and other objects are attained, in accordance with the invention, can be understood in detail, reference is had to the accompanying drawings, which form a part of this specification, and wherein:

FIG. 1 is a side elevational view of a relay constructed in accordance with one embodiment of the invention;

FIG. 2 is an end elevational view (from the left, as viewed in FIG. 1) of the relay of FIG. 1, with parts broken away for clarity;

FIG. 3 is a top plan view (from the top, as viewed in FIG. 1) of the relay of FIG. 1;

FIG. 4 is a sectional view taken on line 4—4, FIG. 1;

FIG. 5 is a perspective view, on an enlarged scale for clarity, of a bracket member employed in the relay of FIG. 1;

FIG. 6 is an elevational view, similar to FIG. 1, illustrating a modification of a portion of the relay, and

FIG. 7 is an elevational view of the right end of the relay as viewed in FIG. 6.

Referring now to the drawings in detail, and first to FIGS. 1–5 thereof, there is shown a relay including an L-shaped field member or frame 10 of magnetizable material. Frame 10 has a pair of mutually perpendicular legs 11 and 12, leg 11 serving as a support or base on which an electromagnet 13 is mounted.

Electromagnet 13 includes a core 14 and a coil 15 wound on a bobbin or spool 16, the coil being covered by a layer 17 of insulating material. Core 14 is T-shaped, comprising a body portion 18 and a cross bar or pole piece 19 which is integral with and extends transversely to body portion 18 at one end thereof. Body portion 18 has a square transverse cross-section and extends through a square axial bore in spool 16 along the axis of coil 15. Body portion 18 terminates in an end portion 20, of reduced cross-section, which extends through a rectangular aperture in leg 11. End portion 20 is upset, as shown in FIG. 4, to cause the shoulder 21, which is formed at the intersection of the end portion and the body portion, to abut leg 11 and rigidly secure

the core thereto so that coil 15 and core 14 are parallel to leg 12.

Although the spool can be mounted in any one of several different ways, it is particularly advantageous to make the spool slightly longer than the distance between pole piece 19 and leg 11 and shoulder 21, so that the spool is compressed between the pole piece and leg 11 in the final assembly. Also, the core can be a single piece or, as shown in the drawing, it advantageously can be of two identical T-shaped punchings 22 and 23 disposed in face-to-face contact.

The free end of leg 12 is recessed to provide a pair of parallel ears 24 and a bearing edge 25 extending between the ears, the edge being suitably bevelled or sharpened to provide a fulcrum or knife edge on which the armature 26 is pivoted.

Armature 26 is in the form of an integral magnetic member including a flat body portion 27 which is wider than leg 12 and has a pair of spaced apertures located adjacent to one end thereof and through which ears 24 extend. The length of each of ears 24 is greater than the thickness of body portion 27, so that the armature is prevented from moving laterally of leg 12. Furthermore, the ears and apertures are suitably shaped so that the armature can pivot about the edge 25, the body portion engaging the edge along a line which extends between the apertures therein. Armature 26 has a pair of parallel arms or stop tails 28 which extend transversely to and at one end of body portion 27 along the face of leg 12 opposite electromagnet 13. Arms 28 are bent, as indicated at 29, so that the lower portions thereof are parallel to leg 12 when the armature is in the position shown in FIG. 1.

A T-shaped bracket 30 is mounted on the side of leg 12 opposite electromagnet 13 and is secured thereto by a pair of tabs 31 which are bent into engagement with leg 12 and extend through a pair of notches 32 formed in the side edges of the leg. Bracket 30 has a cross bar 33 extending transversely of leg 12, tabs 31 being connected to the ends of the cross bar and extending outwardly therefrom prior to the bracket being secured to the leg, as shown in FIG. 5. Cross bar 33 is parallel to edge 25 but lies closer to the other end of leg 12 than to edge 25, being near base leg 11.

Bracket 30 also includes a shank 34 extending longitudinally of leg 12 and through an aperture 35 formed in armature 26. The end of shank 34 is bent, as indicated at 36, and overlies armature 26 to retain the armature in operative engagement with the frame member. To accomplish this, the distance between the end of shank 34 and the adjacent surface of the armature, when the armature engages edge 25, is made less than the length of ears 24 so that the ears cannot be withdrawn from their cooperating apertures. In other words, the end portion of shank 34 limits movement of armature 26 in a direction longitudinally of leg 12.

In some instances, it is desirable to permit the armature to be disassembled. To accomplish this, bracket 30 can be constructed from a relatively thin, resilient material so that shank 34 can be bent to allow the end portion thereof to pass through aperture 35. Thus, although the armature is normally retained in operative engagement with the frame member, it can nevertheless be removed.

Bracket 30 also includes a lug 37 which projects from the side of cross bar 33 opposite to that from which shank 34 extends, in a direction perpendicular to leg 12, the lug having a suitable aperture and a groove for retaining and fastening one hooked end of a restoring spring 38.

Restoring spring 38 is a conventional tension spring having a pair of end hooks or loops, the lower one of

which is attached to lug 37 and the upper one of which passes through aperture 35 and biases the armature in a counterclockwise direction, as viewed in FIG. 1. Spring 38 also exerts a force along a line which is essentially parallel to leg 12 and biases body portion 27 towards engagement with edge 25.

Cross bar 33 and arms 28 are arranged to be engageable with each other so that restoring spring 38 biases the arms into engagement with the cross bar and limits the pivotal movement of the armature in a counterclockwise direction, which direction, as pointed out hereinafter, is away from engagement with the pole face 39 of the pole piece 19. The bracket is of a nonmagnetic material and accordingly prevents arms 28 from sticking to the cross bar and thereby interfering with the operation of the relay.

Frame 10, core 14 and armature 26 are so dimensioned and assembled that, under ideal circumstances, energization of coil 15, and resulting pivotal movement of the armature about edge 25, will bring the armature into flush, face-to-face engagement with the flat pole face 39. Tolerances in the normal manufacturing procedures employed for relays are such, however, that it often happens that edge 25 and pole face 39 are not spaced from frame leg 11 by precisely the same distances required for such flush face-to-face engagement between the armature and the pole face. If these distances are not precisely correct, the result is that the body portion 27 of the armature will lie at an angle to pole face 39 when the armature is in fully energized position. Thus, if edge 25 is spaced from leg 11 by a greater distance than is pole face 39, the armature will pivot into engagement with the edge of the pole face most distant from edge 25. If, on the other hand, pole face 39 is spaced from leg 11 by a greater distance than is edge 25, energization of coil 15 will cause the armature to pivot into engagement with the edge of the pole face closest to edge 25. In either event, body portion 27 of the armature lies at an angle to the pole face, when the relay is energized, so that there is an air gap between the pole face and body portion 27 which causes a material reduction in the available holding force for the armature below the maximum value established by the design of the relay.

Such reduction in the armature holding force is more severe when the armature engages only the edge of the pole face nearest edge 25. This is so because such engagement of the armature and pole face not only causes an air gap but also reduces the effective torque arm through which the magnetic force is applied to the armature.

Obviously, the difficulties just described can be avoided by requiring that the frame 10, core 14 and armature 26 be made and assembled with absolute preciseness. This would, however, unduly increase the cost of manufacture of the relay. According to the present invention, the possible losses in holding force applied to the armature are minimized by minimizing the width of the pole face 39 in the direction of the longitudinal dimension of body portion 27 of the armature (that is, in a direction at right angles to edge 25). Thus, as will be clear from FIGS. 1 and 4, pole face 39 is in the form of a rectangle which is approximately twice as long as it is wide, the long dimension of the rectangle extending parallel to edge 25 and therefore transverse to body portion 27. In effect, this configuration of pole face 39 allows the pole face to have a minimum dimension longitudinally of body portion 27 and a maximum dimension transversely thereof so that, while the desired total pole face area is provided, the distance between the two edges of the pole face which can be contacted by the armature (when flush face-to-face engagement between the armature and the pole face is not achieved) is minimized. Making this critical distance as small as possible assures that any air gaps existing between the pole face and the armature, when the relay is energized, will be kept to a minimum and that variations in the effective torque arm through which the magnetic effect of the coil 15 is applied will also be minimized.

The relay also includes a terminal board or front plate 40, of suitable electrical insulating material, which is secured to an arm 41 of frame 10 by a stud 42 and nut 42'. The frame also has a pair of ears 43 which extend into apertures or recesses 43' suitably formed in terminal board 40. Terminal board 40 extends parallel to leg 12 and coil 15 on the side of the coil opposite leg 12, arm 41 being parallel to leg 12.

Terminal board 40 is also provided with a pair of tapered lugs 44, as best seen in FIG. 3, which provide edge portions for engaging a cooperating portion of a cover, indicated by the dotted lines in FIG. 1, to detachably secure the cover which encloses the components of the relay.

A pair of terminals 45 extend through board 40 on opposite sides of the mounting stud 42 and are connected electrically to the terminals of the coil 15. Adjacent the other end of the board 40 are mounted a plurality of arms 46 which, at their inner ends, each carry a different one of a plurality of the fixed contacts 47 of the relay.

A plurality of movable contacts 48 are mounted each on the end of a different one of a plurality of spring arms 49, the contacts being arranged, as shown, to form a plurality of single pole, double throw, make-break contact assemblies. The other end of each of the spring arms 49 extends through a block 50 of insulating material, the block being mounted on body portion 27 of armature 26 by a mounting plate 51 and a pair of rivets 52. The fixed ends of the spring arms 49 are connected to a plurality of flexible conductors which are in turn connected to a plurality of terminals 53 mounted on and projecting through board 40.

FIGS. 6 and 7 illustrate a modification of the terminal board 40 which permits the board to be keyed into a suitable supporting member. In this embodiment, board 40 has an enlarged, quadrangular locator portion 54, through which terminals 46 and 53 extend, and a pair of cylindrical locator projections 55, through which terminals 45 extend. Portion 54 and projections 55 extend beyond the edge of the cover, indicated by the dotted lines in FIG. 6, and are adapted to be inserted into similarly shaped apertures in the supporting member so that the relay can be mounted in only one position. The supporting member can be a channel member 56, FIG. 6, the base web of which is provided with openings 57 and 58 of such shape and size as to snugly accommodate portion 54 and projections 55, respectively.

In operation, when the relay is de-energized, the restoring spring 38 holds armature 26 in the position shown in FIG. 1. In this position, arms or tails 28 engage cross bar 33 and movable contacts 48 engage the normally-closed contacts, the spring arms 49 being suitably adjusted to provide the necessary contact pressure. When the relay is energized, a magnetic field is induced in such manner that the flux passes through core 14, frame 10, and armature 26 and thereby attracts the armature into engagement with pole face 39. As the armature moves from the position shown in FIG. 1 into engagement with pole face 39, movable contacts 48 disengage from the normally-closed fixed contacts and move into engagement with the normally-open fixed contacts. The armature is held in engagement with the pole face 39 so long as the force of magnetic attraction exceeds the spring forces acting on the armature. When the relay is de-energized, restoring spring 38 pivots the armature until arms 28 engage the bracket 30, the position of FIG. 1 being thus reestablished.

It will be obvious to those skilled in the art that many changes can be made in the details and arrangement of the parts shown and described without departing from the scope of the invention as defined in the appended claims.

I claim:

1. In an electromagnetic relay, the combination of a magnetic frame member comprising

a flat base, and

a flat leg projecting at right angles from said base and terminating in a free tip presenting a bearing edge spaced from said base;

an electromagnet mounted on said base and extending beside said leg, said electromagnet comprising

a core, and

a bobbin-supported coil,

said core being T-shaped and disposed with the stem of the T extending through said coil and the cross-bar of said T extending across one end of the bobbin supporting the coil, said base being provided with an opening and the end of the stem of the T of said core being mechanically fixed in said opening to rigidly secure said core with said coil being clamped between said base and the cross-bar of the T of said core,

the width of the cross-bar of the T of said core being small as compared to the length thereof and said core being so positioned that the length of the cross-bar of the T thereof extends parallel to said bearing edge;

an armature of magnetic material, said armature comprising

a flat body pivotally engaged with said bearing edge and extending from said leg beyond said cross-bar of the T of said core, said armature body being provided with an opening disposed at the side of said leg opposite said electromagnet;

a generally T-shaped, integral nonmagnetic bracket mounted on the side of said leg opposite said electromagnet, said bracket comprising

a stem portion,

a flat cross-bar portion, and

a spring-retaining lug,

said cross-bar portion of said bracket extending transversely of said leg near said base and said stem portion of said bracket extending longitudinally of said leg and projecting through said opening in said armature body, the tip of said stem portion being located on the side of said armature body opposite said base and extending at an angle to the plane of said leg to retain said armature body in proper location,

said leg being provided with a pair of transversely opposed notches located each in a different edge thereof, and end portions of said cross-bar portion of said bracket being bent each into engagement with a different one of said notches;

a support secured to said base and projecting therefrom on the side of said electromagnet opposite said leg;

a fixed contact mounted on said support and projecting toward said leg;

movable contact means mounted on said armature body and including a spring arm extending to a point adjacent said fixed contact on the side thereof facing said base; and

a tension spring having one end connected to said spring-retaining lug and the other end connected to said armature body on the side of said leg opposite said electromagnet,

said spring being operative to pivot said armature body on said bearing edge in a direction away from said electromagnet to such a degree that said movable contact means is caused to engage said fixed contact,

energization of said electromagnet causing said armature body to pivot on said bearing edge, against the action of said tension spring, into engagement with the cross-bar of the T of said core.

2. A relay in accordance with claim 1 and wherein said core consists of two identical T-shaped punchings disposed in face-to-face contact with each other, the stem portion of each of said punchings having a tip disposed in said opening in said base mechanically deformed to rigidly secure the punching to said base.

3. A relay in accordance with claim 1 and wherein said armature comprises a pair of stop tails integral with said armature body and extending parallel to each other and generally longitudinally of said leg on the side of said bracket opposite said leg, said tails being spaced apart transversely of said leg and each having a free tip disposed to swing into engagement with a different half of the cross-bar portion of said bracket when said armature body is pivoted away from said electromagnet, said spring-retaining lug being centered on said cross-bar portion of said bracket and said tension spring extending between and parallel to said tails,

said stop tails coacting with said cross-bar portion of said bracket to limit pivotal movement of said armature away from said electromagnet.

4. A relay in accordance with claim 1 and wherein

said support is a body of insulating material extending from said base to a point materially beyond the location of said armature, said body of insulating material being of substantial thickness,

said base of said frame member having a projection located on the side of said electromagnet opposite said leg and extending parallel to said leg, said projection engaging the face of said support which is directed toward said electromagnet and being rigidly secured to said support, said projection being narrower than said base and at least generally centered with respect to the width of said support,

said support comprising a pair of cylindrical locator projections disposed each on a different side of the location of said projection on said base, said locator projections extending away from said support on the side thereof opposite said electromagnet, the relay comprising a pair of connector terminals extending each through a different one of said locator projections.

5. A relay in accordance with claim 4 and further comprising a plurality of fixed contacts mounted on said support and a plurality of spring arm type movable contact means mounted on said armature body and each coacting with corresponding ones of said fixed contacts,

said support further comprising a quadrangular locator projection extending from the side of said support opposite said electromagnet, said fixed contacts each comprising a supporting arm and all of said supporting arms extending through said quadrangular locator projection.

6. In an electromagnetic relay, the combination of a magnetic frame member comprising

a flat base, and

a flat leg projecting at right angles from said base and terminating in a free tip presenting a bearing edge spaced from said base;

an electromagnet mounted on said base and extending beside said leg, said electromagnet comprising

a core of magnetic material connected at one end to said base and having an exposed pole portion at the other end, and

a coil surrounding said core between said base and said pole portion;

an armature of magnetic material, said armature comprising

a flat body pivotally engaged with said bearing edge and extending from said leg beyond said pole portion, and

a pair of elongated parallel stop tails integral with said body and projecting therefrom along the side of said leg opposite said electromagnet,

said body having an opening located between said tails;

a generally T-shaped integral nonmagnetic bracket

mounted on said leg of said frame, said bracket comprising

a stem portion,

a flat cross-bar portion, and

a spring-retaining lug projecting away from said stem and cross-bar portions,

said cross-bar portions extending transversely of said leg near said base and being disposed in face-to-face contact with said leg, and said stem portion extending longitudinally of said leg and through said opening in said armature body, the tip of said stem portion being located on the side of said armature body opposite said base and projecting at an angle to the plane of said leg to retain said armature body in proper location,

said frame leg being provided with a pair of transversely opposed notches located each in a different edge thereof and end portions of said cross-bar portion being bent each into engagement with a different one of said notches,

said stop tails extending to a location adjacent said cross-bar portion and each being disposed to swing into engagement with a different half of said cross-bar portion when said armature body is pivoted away from said pole portion;

a support secured to said base on the side of said electromagnet opposite said leg;

a pair of fixed contacts mounted on said support and spaced apart in the direction of movement of said armature body;

movable contact means mounted on said armature body and including a spring arm projecting between said fixed contacts; and

a tension spring having one end connected to said spring-retaining lug and the other end connected to said armature, said spring extending between and parallel to said stop tails,

energization of said electromagnet causing said armature body to pivot on said bearing edge toward said pole portion and thereby causing said movable contact means to engage the one of said fixed contacts nearest said base,

said tension spring being effective, when said electromagnet is deenergized, to cause said armature body to pivot on said bearing edge away from said pole portion and thereby cause said movable contact means to engage the one of said fixed contacts most distant from said base, such pivotal movement of said armature body causing said stop tails to swing toward said frame leg and said cross-bar portion of said bracket serving to prevent magnetic sticking of said tails to said frame leg,

said stop tails coacting with said cross-bar portion of said bracket to limit pivotal movement of said armature in a direction away from said electromagnet.

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