Nov. 26, 1957 J. S. ZIMMER 2,814,690

ELECTROMAGNETIC RELAY

Filed March 3, 1954

Fig. 1.

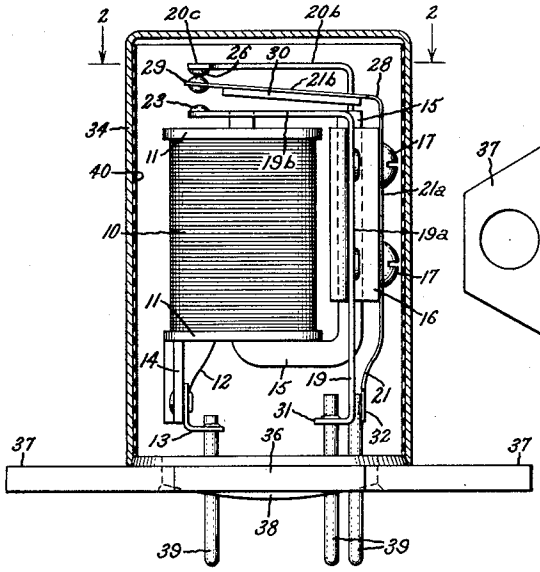


Fig. 2.

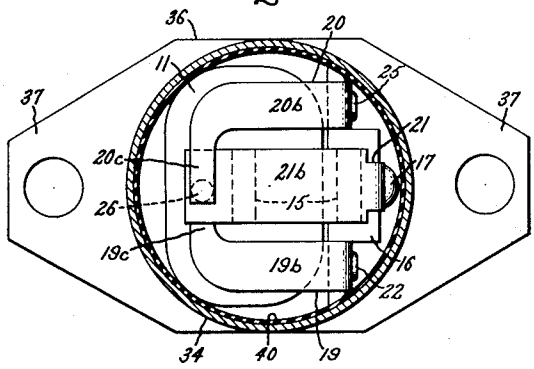


Fig. 3.

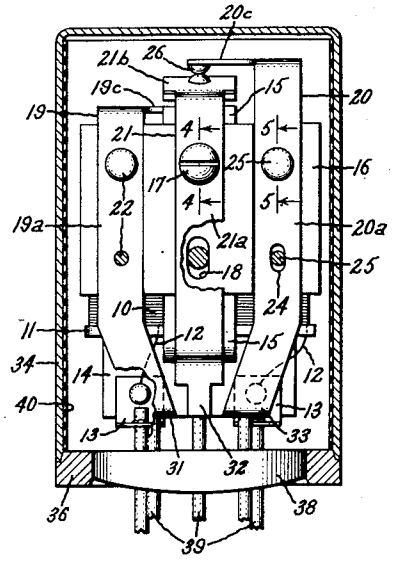


Fig. 4.

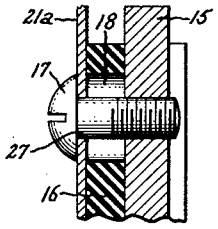
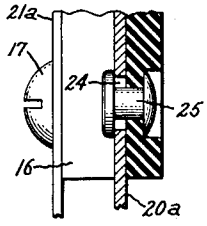


Fig. 5.



Inventor:
John S. Zimmer,
by J. Wesley Saubier
His Attorney.

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ELECTROMAGNETIC RELAY

John S. Zimmer, Scotia, N. Y., assignor to General Electric Company, a corporation of New York

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5 Claims. (Cl. 200—87)

My invention relates to electromagnetic relays, and more particularly to relays of very small physical size that are hermetically sealed in enclosing housings. My invention has for an object the provision of a durable and reliable hermetically sealed miniature electromagnetic relay, yet one that is inexpensive to manufacture and simple to assemble.

Another object of my invention is to provide a relay that is not significantly affected by shock, vibration, bodily acceleration, and extreme conditions of altitude, temperature and humidity.

Still another object of my invention is the provision of a small, lightweight electric relay having a new and improved stationary and movable contact assembly which has very fast response in operation and which facilitates rapid assembly and adjustment in a single operation.

A further object is to provide an improved contact assembly particularly adapted for utilization of a simple and effective method of initial adjustment of the contact clearances and wipe without bending the contact members themselves.

A still further object of my invention is the elimination of parts and the effective utilization of material by the mounting of relay operating parts directly upon rigid terminal pins or connectors extending into a hermetically sealed relay housing.

In carrying out my invention in one form, an electromagnetic relay is provided with an operating coil which is wound on a spool. The spool is axially fixed to one leg of a U-shaped magnetic frame, and an insulating bracket is adjustably fixed to the other leg of the frame to permit an axial adjustment in the position of the bracket on the frame. The contact assembly of the relay is adjustably fixed to the insulating bracket in a manner to permit final adjustment of the space between stationary contact members and of the contact wipe of the movable contact member during assembly of the relay. The movable contact member is a unitary, light weight, resilient arm that serves as armature for the magnetic frame. The relay is particularly adaptable for enclosure within a hermetically sealed housing wherein the relay is supported by rigid terminal connectors that also provide electrical connection to external circuits.

Other objects and advantages of my invention will be apparent from the following description taken in conjunction with the accompanying drawing in which Fig. 1 is an elevational view of the relay with the enclosing housing broken away; Fig. 2 is a sectionalized top view of the relay taken along section line 2—2 of Fig. 1; Fig. 3 is another elevational view of the relay as seen from the right side of Fig. 2 and with the enclosing housing and part of the base plate broken away; Fig. 4 is an enlarged sectional view showing the connection of the movable contact arm, the insulating bracket and the magnetic frame taken along section 4—4 of Fig. 3; and Fig. 5 is an enlarged sectional view of the connection between the long

contact arm and the insulating bracket taken along section 5—5 of Fig. 3.

My hermetically sealed relay includes an operating coil 10 which, as can be seen in the drawing, is wound on a spool 11. The coil 10 is comprised of a plurality of series connected loops of insulated current conducting wire with electrical connection made thereto by a pair of wires 12. The wires 12 connect to a pair of L-shaped current conducting terminal clips 13 which are mounted on a protrusion 14 extending from the flange at one end of the spool 11. As illustrated in Fig. 1, the protrusion 14 extends in a direction parallel to the axis of the spool 11 and the coil 10. Spool 11 closely surrounds and is fixed on one leg of a U-shaped magnetic frame 15 which serves as a core for the coil 10 and provides a path for the magnetic flux produced when the windings of the coil 10 are energized.

The other leg of the frame 15, which is parallel to the first leg and to the axis of the spool 11 but does not extend through spool 11, has fixed thereon an insulating bracket 16. To fasten the bracket 16 onto the frame 15 a pair of screws 17 are employed, each screw 71 extending through a slot 18 in the bracket 16 and threading into an aligned tapped hole in frame 15, as can be seen in Fig. 4. The slots 18 extend in a direction parallel to the legs of magnetic frame 15 to permit axial adjustment of bracket 16 with respect to frame 15 before the screws 17 are tightened.

The insulating bracket 16 provides a common connecting structure for the contact assembly or my relay. The contact assembly comprises a short stationary contact arm 19, a long stationary contact arm 20, and a movable contact arm 21 all fixed to the insulating bracket 16.

The short stationary contact arm 19 is a single, bar-like, current conducting member bent at two points to form three sections. A first section 19*a* is disposed near one edge of the insulating bracket 16, along the far side of the bracket 16 from the coil 10, parallel to the axis of the spool 11. This longitudinal section, 19*a*, of short arm 19 is fixed to bracket 16 by a pair of rivets 22. Arm 19 is bent flatwise substantially at a right angle immediately above the top of bracket 16, as viewed in the drawing, from where a transverse section 19*b* extends across one flange of spool 11 in a plane substantially perpendicular to the axis of the spool 11. An edgewise bend in the arm 19 forms a final, free end section 19*c* which is substantially perpendicular to both sections 19*a* and 19*b* but which lies in the same plane as transverse section 19*b*. Free end section 19*c* extends over the spool 11 at its far side from bracket 16 and terminates with an upward facing contact tip 23.

The long stationary current conducting contact arm 20 is also a single, bar-like member bent at two places to form three sections. A first section 20*a* is disposed in an axial direction parallel to the corresponding section 19*a* of short arm 19. Longitudinal section 20*a* is located near the opposite edge of bracket 16 from section 19*a* and, as can be seen in Fig. 5, contains a pair of oversized apertures 24 for a pair of rivets 25. Because of the oversized apertures 24, the position of long arm 20 can be adjusted with respect to bracket 16 in an axial direction before the longitudinal section 20*a* is fixedly riveted in place on bracket 16. Longitudinal section 20*a* of long arm 20 is longer than the corresponding longitudinal section 19*a* of short arm 19. This additional length appears at the top of the bracket 16, as viewed in the drawing, and a transverse section 20*b* of long arm 20, which is formed by a right angle flatwise bend in arm 20, lies in a plane parallel to but above the plane of the corresponding transverse section 19*b* of short arm

19. Transverse section 20*b* extends across the flange of spool 11 where an edgewise bend in arm 20 forms a final, free end section 20*c* which is disposed substantially perpendicular to both sections 20*a* and 20*b* but which lies in the same plane as section 20*b*. Free end section 20*c* extends over the spool 11 at its far side from bracket 16 and terminates with a downward facing contact tip 26 that is located in axial alignment with but spaced apart from contact tip 23 of short arm 19.

The movable contact member 21 of the contact assembly is disposed between the stationary contact members 19 and 20 for operation with respect to either member. The movable contact member 21 is a thin and light weight, single, resilient, strap-like current conducting arm formed in two generally perpendicular portions. A longitudinal portion 21*a* of resilient arm 21 is parallel to and equidistant between the longitudinal sections 19*a* and 20*a* of short and long contact arms 19 and 20 respectively. Longitudinal portion 21*a* contains a pair of through holes 27 of a size suitable for passing the shank of either of the pair of screws 17. The same screws 17 that connect insulating bracket 16 to one leg of the magnetic frame 15 as described hereinbefore are employed to fixedly clamp longitudinal portion 21*a* of resilient arm 21 to the bracket 16, as shown in Fig. 4. Resilient arm 21 is bent flatwise above spool 11 at 28 to form a resilient portion 21*b*, as can be seen in the drawing. The resilient portion 21*b* is wider than longitudinal portion 21*a* and extends from the bend 28 transversely across the flange of spool 11 defining an angle of slightly greater than 90° with longitudinal portion 21*a*. The resilient portion 21*b* terminates in a contact tip 29 that is disposed in the gap between and axial in line with the spaced apart contact tips 23 and 26 of the stationary contact arms 19 and 20. Being thus disposed, resilient portion 21*b* passes over the open end of the U-shaped magnetic frame 15 and acts as an armature to complete the magnetic circuit set up in frame 15. A relatively thick bar 30 is added to the armature 21*b* to span the gap between the legs of the magnetic frame 15 and thereby to provide increased rigidity and a greater magnetic flux conducting area.

Because of the greater than 90° angle in the resilient contact arm 21, armature 21*b* normally rests in an inclined plane that rises from bend 28 to intersect the plane of section 20*c* of long contact arm 20 at contact tip 26. Thus, as shown in Fig. 1, contact tip 29 of the resilient arm 21 engages contact tip 26 of the long stationary contact arm 20. In this position of the resilient arm 21 there is a space between the armature 21*b* and the magnetic frame 15. The relay is operated in response to energization of the windings of coil 10. Such energization of coil 10 produces a magnetic field in the frame 15 which by electromagnetic attraction pulls armature 21*b* into seating engagement with the magnetic frame 15. Because of the small mass of the resilient arm 21 and its resulting low inertia, the movement of armature 21*b* to its seated position is extremely fast. In the seated position, the plane of armature 21*b* declines from bend 28 and intersects the plane of section 19*c* of short contact arm 19 at contact tip 23. Thus, upon operation of the relay, contact tip 29 of the resilient contact arm 21 disengages from contact tip 26 and makes contact with tip 23 of the short stationary contact arm 19. Because of the lightness in weight of resilient arm 21 and the strong magnetic pull produced by the coil 10, contact bounce and vibration by the armature 21*b* during relay operation is substantially eliminated.

The bend 28 in resilient arm 21, it can be seen, acts as a combination hinge point for armature 21*b* and biasing spring normally holding armature 21*b* firmly in contact with long contact arm 20. By thus combining several functions in one part, this feature of my invention reduces the mass of the movable contact arm 21 of the relay to a minimum and thereby materially contributes to the increased operating speed and resistance to shock.

Each of the contact members 19, 20 and 21, terminates at the lower end of its longitudinal section 19*a*, 20*a* and 21*a* with a suitable terminal extension 31, 32 and 33 respectively.

The elements of my electromagnetic relay described thus far are assembled together to form a single relay unit. Assembly of the relay unit can be performed in a very expedient manner and at the same time adjustment of the contact assembly can be made readily in the following manner:

The coil 10 is wound on the spool 11 which in turn is placed on one leg of the magnetic frame 15. Spool 11 is held in place on the frame 15 by virtue of a snug fit therebetween. The insulating bracket 16 is clamped to the other leg of the frame 15 by means of a suitable fixture which firmly holds bracket 16 in position with respect to the frame 15. The short contact arm 19 is then riveted to the bracket 16. Following this the long contact arm 20 is positioned by virtue of its oversized apertures 24 on bracket 16 to give the desired gap between the axially aligned contact tips 23 and 26, and long arm 20 is then riveted to the bracket 16. Thereafter the pair of screws 17 are passed through the holes 27 in resilient contact arm 21 and through the slots 18 in bracket 16 and are threaded into the magnetic frame 15 but not tightened thereto. The coil 10 is then energized to seat the armature 21*b* of resilient arm 21 on the magnetic frame 15. Owing to the slots 18 in bracket 16, the bracket 16 and its fixed stationary contact arms 19 and 20 can be moved with respect to the frame 15 and its seated resilient arm 21 to obtain the desired wipe between contact tip 29 of resilient arm 21 and contact tip 23 of the short contact arm 19. Screws 17 are then tightened and all necessary final adjustments of the assembled relay unit have been made.

To protect the assembled relay unit from external atmospheric conditions and to permit its operation in a known, constant atmosphere, the relay unit is enclosed in a housing 34. The enclosing housing 34 is cylindrical in shape and is made of non-porous material. One end of the housing 34 is open to admit the relay unit. The open end of the housing 34 is covered by a base plate 36 that is hermetically sealed to the housing 34. The base plate 36 has a pair of mounting ears 37 which can be employed for mounting the hermetically sealed relay upon a chassis or any other desired support. The base plate 36 contains a sealed insulating insert 38 which is pierced by a plurality of sealed current conducting terminal connectors or pins 39. The relay unit is mounted and held in place inside the housing 34 on these terminal pins 39. One end of each terminal pin 39 extends inside housing 34 and is rigidly connected, by solder for example, to one of the terminal extensions 31, 32 or 33 of the contact assembly or to one of the pair of terminal clips 13 mounted on the protrusion 14 of spool 11. This connection not only acts as a current conducting means but also provides a mounting for the assembled relay unit inside the housing 34. The other end of each terminal pin 39 extends to the outside of housing 34 and is arranged for connection to any desired external electrical circuit.

A band of insulating resilient material 40 lines the inside of the cylindrical wall of housing 34 and prevents electrical contact between the relay elements and the housing 34. The insulating band 40 also serves as a vibration damper and shock absorber. The inside diameter of the housing 34 is only slightly greater than the overall diameter of the assembled relay unit and the insulating band 40 fills the resulting small gap. Therefore, cushioned support is furnished to the relay unit by the insulating band 40.

To operate my hermetically sealed electromagnetic relay, a source of electric power must be supplied to two terminal pins 39 connecting to the pair of terminal clips

13. The pair of clips **13** are connected in turn to the pair of wires **12** leading to the windings of coil **10**. The resulting energization of coil **10** will produce a magnetic field in magnetic frame **15** which will pull armature **21***b* of resilient arm **21** from its normal biased position into seating engagement with magnetic frame **15**. The armature **21***b* will move at an extremely fast speed to break contact with the long stationary contact arm **20** and to make contact with the short stationary contact arm **19**. Any external electric circuits connected to the terminal pins connected to the contact assembly of the relay will experience a corresponding opening and closing. Upon de-energization of the coil **10**, armature **21***b* will be self-biased to its original position.

While I have shown and described a preferred form of my invention by way of illustration, many modifications will occur to those skilled in the art. Therefore, I contemplate by the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electromagnetic relay comprising a U-shaped magnetizable frame member having a pair of legs, an operating coil having a spool surrounding and fixed to one leg of said frame, a bracket of insulating material adjustably fixed to the other leg of said frame to provide for variable positioning of said bracket on said other leg, a stationary contact member fixed to said bracket, and a cooperating resilient movable contact member supported on said other leg of said frame, said bracket being axially adjustable relative to said movable contact member, said movable contact member having an armature portion extending across the open end of said U-shaped frame between said legs.

2. An electromagnetic relay comprising a U-shaped magnetizable frame member having a pair of legs, an operating coil having a flanged spool surrounding and fixed to one leg of said frame, a mounting bracket of insulating material adjustably fixed to the other leg of said frame member to provide for variable axial positioning of said bracket on said other leg, a unitary resilient movable contact member supported on said other leg of said frame, said bracket being axially adjustable relative to said movable contact member, said movable contact member having an armature portion extending across the open end of said U-shaped frame between said legs, and a unitary stationary contact member having a longitudinal portion fixed to said bracket and a transverse contact carrying portion extending across the flange of said spool disposed in contact making and breaking relationship with said movable contact member.

3. An electromagnetic relay comprising a U-shaped magnetizable frame member having a pair of legs, an operating coil having a flanged spool surrounding and fixed to one leg of said frame, a mounting bracket of insulating material adjustably fixed to the other leg of said frame to provide for variable positioning of said bracket on said other leg, a first stationary contact member rigidly fixed to said bracket and having a contact carrying portion extending across the flange of said spool, a second stationary contact member adjustably connected to said bracket and having a contact carrying portion disposed in a generally parallel relationship to the contact carrying portion of said first stationary contact member to define a variable space between the contact carrying portions of said first and second stationary contact members, and a cooperating resilient movable contact member adjustably fixed to said bracket and having an armature portion extending across the open end of said U-shaped frame between said legs and disposed in the space between the contact carrying portion of said first and second stationary contact members in contact making and breaking relationship.

4. An electromagnetic relay comprising an open ended enclosing housing, a base plate covering the open end of said housing and hermetically sealed thereto, a plurality of terminal members piercing said base plate, an operating coil inside said housing having a spool rigidly connected to at least one of said terminal members, a magnetizable U-shaped frame member having one leg providing an axis for said spool and fixed thereto, a bracket of insulating material adjustably fixed to the other leg of said frame to provide for variable axial positioning of said bracket on said other leg, a stationary contact member fixed to said bracket and to at least one of said terminal members, and a cooperating resilient movable contact member mounted on said other leg of said frame, said bracket to be axially adjustable relative to said movable contact member, said movable contact member fixed to at least one of said terminal members and having an armature portion extending across the open end of said U-shaped frame between said legs.

5. An hermetically sealed electromagnetic relay having in combination a relay unit comprising a magnetizable U-shaped frame having a pair of legs, an operating coil having a flanged spool axially fixed to one leg of said frame, an insulating bracket adjustably connected to the other leg of said frame to provide for variable axial positioning of said bracket on said other leg, a first unitary stationary contact member including a longitudinal portion rigidly fixed to said bracket and a transverse contact carrying portion extending across a flange of said spool and having a contact tip, a second unitary stationary contact member including a longitudinal portion adjustably fixed to said bracket and a transverse contact carrying portion extending across the flange of said spool and having a contact tip disposed in spaced apart axial alignment with the contact tip of the transverse portion of said first stationary contact member, and a unitary resilient movable contact member including a longitudinal portion fixed to said bracket in axial adjustable relation and an armature portion extending across the open end of said U-shaped frame between said legs and having a contact tip disposed in contact making and breaking relationship between the contact tips of the transverse portions of said first and second stationary contact members; and an enclosure for said relay unit comprising an open ended housing, a base plate covering the open end of said housing and sealed thereto, an insert of insulating material in said base plate, a plurality of terminal connector members piercing said insert and rigidly connected to the longitudinal portions of said stationary and movable contact members and to a flange of said spool to provide support for and electrical connection to said relay unit inside said enclosure, and an insulating band within said enclosure separating said relay unit from the walls of said housing.

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