

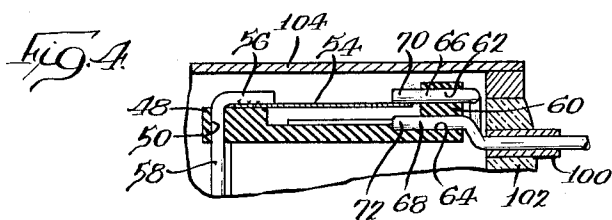
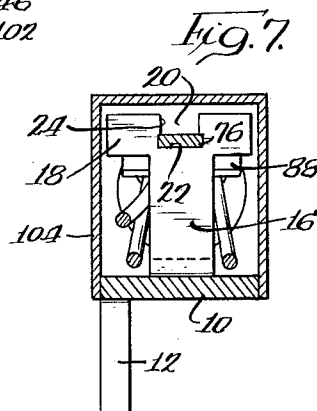
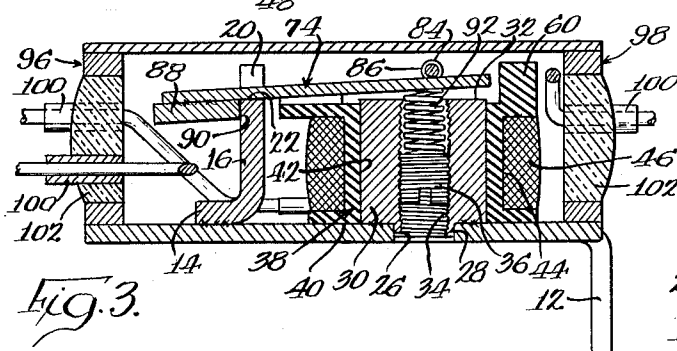
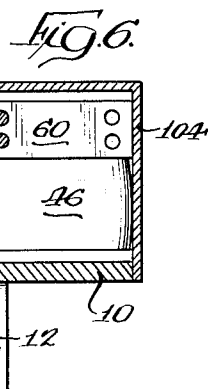
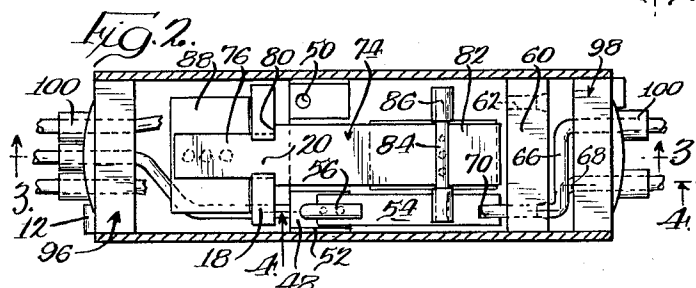
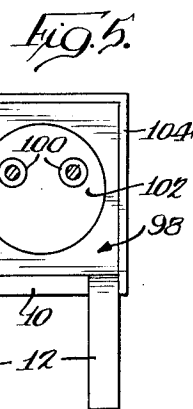
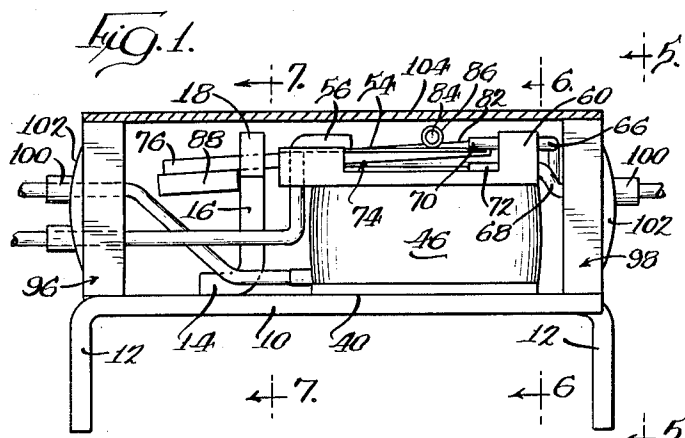
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F. J. SIKORSKI

3,092,701

MINIATURE RELAY

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INVENTOR.
Frank J. Sikorski
BY
B. Gordon Allen *Att'y*

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MINIATURE RELAY

Frank J. Sikorski, Naperville, Ill., assignor to JB Electronic Transformers, Inc., Chicago, Ill., a corporation of Illinois

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This invention relates to electrical relays and more especially to miniature relays, although certain aspects of the invention have a more general utility.

It is the principal object of the present invention to provide a novel miniature relay which may be made at reasonable cost and which has a higher order of reliability under all of the extreme conditions of operation to which a relay of this type may be subjected than other relays with which I am acquainted.

Other objects and advantages will become apparent from the following description of a preferred embodiment of the invention as incorporated in a specific example.

In the drawings in which similar characters of reference refer to similar parts throughout the several views:

FIG. 1 is a longitudinal vertical sectional view taken just inside the relay case so as to illustrate the operating mechanism in side elevation;

FIG. 2 is a horizontal section view taken in a downwardly direction from just inside the top of the relay case so as to provide a top view of the operating mechanism;

FIG. 3 is a longitudinal medial sectional view which may be considered as taken essentially along the line 3—3 of FIG. 2 in the direction indicated by the arrows;

FIG. 4 is a fractional longitudinal sectional view through the contact mechanism and may be considered as taken along the line 4—4 of FIG. 2 in the direction indicated by the arrows;

FIG. 5 is an elevation of the right end of the relay as the relay is oriented in FIGS. 1 to 4;

FIG. 6 is a transverse sectional view which may be considered as taken essentially along the line 6—6 of FIG. 1 in the direction indicated by the arrows; and

FIG. 7 is a transverse sectional view taken in the direction indicated by the arrows substantially along the line 7—7 of FIG. 1.

Miniature relays of the type to which this invention relates are not merely scaled down ordinary relays. Rather, because of the nature of the duty of which they find their major application, they should be extremely precise devices which will operate reliably under extreme environmental circumstances. In general, they are used in guidance systems for rockets and in like applications where they encounter temperature extremes, extremely high orders of vibration and other acceleration forces, widely varying ambient pressures, and universal orientation. Furthermore, the space and weight limitations are very severe.

As an example, the cased relay illustrated has dimensions of no more than .315" high by .272" wide by .90" long excluding the pigtail leads and a pair of mounting prongs which are bent over during installation. This relay is hermetically sealed, operates reliably under temperature extremes, will not malfunction even under enormous shock loadings in any plane, and is insensitive as to its orientation. It operates reliably on low currents, less than 0.1 watt, and its contacts will switch considerably more than one ampere at 28 v. D.C. In fact it easily meets the most extreme specifications customarily encountered which require operation between —65 C. and +170 C. and under vibration conditions of 20 g at frequencies between 5 and 1000 cycles per second and 10 g from 1,000 to 2,000 c.p.s. Additionally, it may be manufactured either as a single pole,

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double throw relay, or, if desired, a second set of contacts may be added so as to provide double pole, double throw operation without change in the major portion of the structure. Furthermore, the relay is adjustable, after assembly, as to the current required for operation, so that identical relays can be adjusted to switch at different current levels if desired. If desirable, this adjustment can be made in the field shortly prior to installation of the relay. In spite of the space and weight limitations, the elements are rugged and trouble free, this being accomplished in part by taking full advantage of the rectangular form in a transverse plane of the cased relay, rectangular elements of this nature incidentally being much preferred since they pack better in the equipment where they find use. Devices of other shape often are penalized by being arbitrarily assigned in effect the dimensions of a circumscribing rectangle. That is, the user of the relay will most often be limited in the overall maximum width he can provide for the device (in the present relay, slightly over ¼ inch), although the height and length are frequently critical dimensions also, and should be kept as small as possible.

The base 10 of the relay illustrated consists of a rectangular piece of magnetic iron having a pair of integral mounting lugs 12 at opposite corners which are bent to extend downwardly. When the relay is installed, these lugs extend through holes in a chassis element or the equivalent and are bent over to secure the relay in place. Other mounting expedients could of course be used, but the one illustrated conforms to quite common practice. The upper surface of the base plate is welded to the bent over foot 14 of an upstanding armature support bracket 16, also made of a strip of magnetic iron. The major plane of the bracket 16 is transverse to the base, and at its upper end the bracket is T-shaped to provide a head 18 which is only slightly narrower than the width across the base 10. At its top center, the head 18 is provided with an armature hinge forming slot 20. This slot is formed so that the bottom surface 22 is flat and parallel to the base. The lower portion of the slot is rectangular, this portion being in the present instance about .070" wide by .022" high. Above this rectangular portion is a second rectangular portion having vertical edges 24 which are spaced inwardly from the vertical edges of the lower portion by about .003".

The vertical portion 16 of the armature bracket is about one third of the way in from one end of the base 10. At a point about one-third of the distance in from the other end, the base has a round hole 26 which receives the turned down lower end 28 of a rectangular coil core 30, also formed of magnetic iron. This coil core, which is about twice as long (longitudinally of the base) as it is wide, is welded to the base and has its top pole face 32 about in the plane of the bottom surface 22 of the slot 20. The core 30 is drilled axially and tapped, as at 34, to receive an adjusting screw 36. After fabrication, the weldment, consisting of the base 10, bracket 16, and coil core 30, is hydrogen annealed and electro tinned.

The coil bobbin 38 is molded of a high temperature resisting, dimensionally stable plastic material. For this purpose I prefer an epoxy resin which is sold under the name diallyl phthalate, but other materials could, of course, be used. It has a flat bottom surface 40 and a rectangular opening 42 through the center to fit the core 30, and a spool space 44 to receive the coil 46 which is wound thereon. The top end of the bobbin is also formed to provide supports for the contacts and is symmetrical from side to side, and therefore only one side needs detailed description. As is best seen in FIGS. 1 and 4, the left end of the bobbin (the end toward the bracket 16) provides a slightly raised platform 48 at one side of the core 30. The top surface of this platform is flat

and parallel to the base 10. Near its left edge the platform is intersected by a small hole 50 which extends vertically in a position such that its lower end is clear of the coil 46. Also the outer edge of the platform is terminated by a slight ridge 52 which extends longitudinally. This platform serves as the base to support a rectangular movable relay contact spring blade 54 made of a thin strip of platinum-plated beryllium copper. The left end of this blade is welded to the short end 56 of an L shaped piece of wire 58, the short end of the wire being disposed against the upper surface of the blade with the long end extending downwardly. The wire is of appropriate size to fit the hole 50 properly and the blade 54 is secured to the platform 48 by passing the wire 58 through the hole 50 and pulling the blade into position against the platform where proper alignment is insured by the ridge 52 which bears against the outer edge of the blade. Temporarily, the blade and wire are cemented in this position, additional support being provided in the complete assembly as will appear presently.

At the opposite end of the bobbin there is an upstanding pillar 60, the inner edge of which is positioned somewhat beyond the free end of the blade 54 so as to avoid interference. This pillar is provided with upper and lower horizontal holes 62 and 64, both of which are approximately aligned vertically with the longitudinal center line of the blade 54. Platinum-plated wire contacts 66 and 68 extend respectively through these holes from the right, so that their free ends 70 and 72 lie respectively above and below the free end of the blade 54. These wire contacts are cemented in place temporarily and are so positioned that when at rest, the upwardly biased end of the blade 54 rests against the lower edge of the upper contact 70 with the blade approximately parallel to the base 10. Downward movement of the blade free end separates the blade from contact 70 and brings the blade end against the upper surface of the lower wire contact 72.

A relay equipped with a set of contacts as so far described will be of the single pole, double throw type, but as previously indicated, the bobbin has provision at the other side for an identical set of contacts to be installed if double pole, double throw action is desired. So as to make the contact elements completely interchangeable from side to side of the bobbin, the wire 58, which serves both as the mechanical support and electrical lead for the blade 54 should be attached to the center of the rear edge of the blade and the blade width should be such that if the wire extends downwardly through the hole 50 on either side of the relay, one or the other edge of the blade will be brought snugly against the adjacent alignment ridge 52.

The blade contact 54 is actuated by the relay armature 74 which is formed from a strip of magnetic iron. As is best seen in FIG. 2, the armature has a rearwardly extending tang 76 which passes through the rectangular portion of the bracket slot 20 with a slightly loose fit. Just ahead of the bracket 16, the armature is wider to provide a shoulder 80 which prevents the armature slipping rearwardly in the slot 20. Ahead of the shoulder 80, the armature main portion 82 has a width and length sufficient to completely cover the pole face 32 of the coil core 30. In the embodiment shown, the armature main portion 82 has the same width as at the shoulder 80.

The contact spring operating mechanism consists of a transverse pin 84, made of a short piece of iron wire, which is welded to the top surface of the armature 74 so as to project an appreciable distance beyond the edges of the armature on each side. Short lengths of capillary glass tubing 86 are slipped over these overhanging ends and are cemented thereto. These small cylindrical glass insulators 86 are against the inside surface of the cover as will appear, so as to be in a position slightly above the spring blade or blades 54 when the armature is released. These act to bend the contact blades 54 downwardly to

engage contacts 68 whenever the armature moves downwardly against the pole face 32.

A rectangular piece of magnetic iron 88 is welded to the bottom surface of the tang 76 and acts as a counterweight for the armature. It is considerably wider than the armature and has a mass, and a mass distribution, such that the portions of the armature system on the two sides of the pivot edge 22 of bracket 16 substantially balance. The face of the counterweight 88 adjacent the bracket 16, particularly the bottom edge 90 of this face, is very close to the bracket head 18 when the armature shoulder 80 is against the opposite face of the bracket, so as to limit movement of the armature relative to its bracket.

The armature is urged in an upwardly direction by a nonmagnetic coil spring 92 which is disposed within the bore 34 and rests upon the upper end of the adjusting screw 36 previously mentioned with its upper end against the lower surface of the armature. The armature upward bias, and hence the relay sensitivity can be adjusted by turning the screw 36 so as to adjust the spring pressure. After adjustment, if the relay is to be sealed as is contemplated, the screw opening can be soldered shut as the last operation before relay installation.

Note that the magnetic circuit is from the pole face 32, through the core 30, through the base 10, through the bracket 16, to the armature 74. Since the surface of the bracket 16 against the armature is flat and in substantially full contact beneath the armature, whereas it is relieved above the armature, the armature will be held downwardly against the surface 22 whenever the coil is energized. Furthermore, in a similar manner, the magnetic circuit, when energized, will insure that the counterweight edge adjacent the bracket 16 will be held against the bracket back face. Because this edge of the counterweight engages the bracket T head 18 over a considerable transverse distance, and because the armature is pulled down, the position and alignment of the armature are precisely established whenever the relay is energized without any necessity for close hinge fits which, in most relays, tend to be too loose at low temperatures and to bind at high temperatures. Also, of course, these several engaging surfaces at the hinge connection between the bracket 16 and armature 74 insure a good magnetic circuit for the transfer of flux from the bracket to the armature, thereby promoting high efficiency of operation.

The relay has a pair of end plates 96 and 98. These plates are rectangular and have the same width as the base 10 to which they are welded. Each is equipped with the necessary number of feed-through tubes 100 sealed in glass 102 which also is sealed into an opening in each of the end plates. These tubes are tinned and the leads from the coil and contacts pass through the tubes and are soldered thereto. This seals around the leads and also provides good physical support for the relay contacts and coil leads.

A U-shaped cover 104, made of sheet nickel silver, encloses the mechanism. It is fitted over the end plates and base edges, and is welded all around its periphery so as to provide a hermetic unit after the screw 36 has been adjusted and its opening soldered shut. When the armature is in the up position, the insulators 86 engage the inside surface of this cover, which thus acts as an armature stop. Nickel silver, of which the cover is made, is a very dead metal (high internal resistance), and it is thus a considerable aid in damping armature vibration.

During manufacture, the coil bobbin is wound and the several contacts are attached thereto as previously described. This subassembly is then secured to the core 30 of the weldment which comprises the base 10, core 30, and bracket 16. The tang 76 of the armature subassembly is then slid through the slot 20, and the counterweight 88 is welded thereto. The end plates 96 and 98 are then brought to such position that the several leads can be passed through their sleeves 100, after which the end plates are brought to final position and welded to the

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base 10. The leads can then be soldered to the sleeves 100, making whatever final adjustment of the leads appears to be advisable during or just prior to the soldering operation. The cover 104 can then be welded in place, the spring 92 dropped into the opening 34, and the adjusting screw 36 entered to complete the assembly, excepting that at some time thereafter the screw 36 will be adjusted to give the relay the proper operating characteristics, after which the screw hole 34 is soldered closed to prepare the article for use.

From the above description of a preferred embodiment of the invention it will be apparent that changes in the structure and the suggested order of assembly may be made without departing from the spirit and scope of the invention, and that, therefore, the scope of the invention is to be determined from the scope of the following claims.

Having described my invention, what I claim as new and useful and desire to secure by Letters Patent is:

1. A relay comprising a base of magnetic material, a coil core of magnetic material secured at one end to the base to provide an exposed end spaced from said base, an armature bracket of magnetic material extending away from the base, a balanced armature blade of magnetic material hinged to said bracket in a position to overlie the exposed end of said core, a coil form of insulated material on said core, a coil on said form, stationary and flexible contact members secured directly to said coil form in a position along at least one side of said armature, an actuator on said armature overlying said flexible contact member and adapted to engage and bend said flexible contact member when said coil is energized, means to limit the movement of said armature blade with respect to said bracket when said coil is deenergized, said core being formed to provide a longitudinally extending passage therethrough and through said base, a spring in said passage bearing with one end against said armature blade, and a member adjustable in said passage to support the opposite end of said spring.

2. A relay comprising a base of magnetic material, a

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coil core of magnetic material secured at one end to the base to provide an exposed end spaced from said base, an armature bracket of magnetic material extending away from said base, an armature blade of magnetic material hinged to said bracket in a position to overlie the exposed end of said core, a coil form of insulating material on said core, a coil on said form, stationary and flexible contact members secured directly to said coil form in a position along at least one side of said armature, an actuator on said armature overlying said flexible contact member and adapted to engage and bend said flexible contact member when said coil is energized, said hinge comprising an edge on said bracket to engage the surface of said armature blade that is toward said core, a counterweight of magnetic material secured to the last said armature blade surface on the side of said bracket away from said core, said counterweight providing an edge adjacent said bracket adapted to engage the surface of said bracket, both said counterweight edge and said bracket edge extending transversely of said armature blade's longitudinal axis, the attraction of said counterweight edge into engagement with said bracket and the attraction of said bracket edge for said armature blade acting to establish the position of said armature blade relative to said bracket when said coil is energized, means to limit the movement of said armature blade with respect to said bracket when said coil is deenergized, a pair of rectangular end plates secured to the ends of said base, said end plates having the same width as said base and providing feedthrough insulators for leads for said coil and said contacts, and a U-shaped cover member welded all around its periphery to said end plates and to said base to seal the operating elements of said relay.

References Cited in the file of this patent

UNITED STATES PATENTS

1,097,160	Balzer	May 19, 1914
2,141,357	Lansing	Dec. 27, 1938
2,716,171	Mekelburg	Aug. 23, 1955
2,798,916	Fisher	July 9, 1957