Oct. 15, 1957 D. W. EVERY 2,810,039

SUB-MINIATURE RELAY

Filed March 25, 1955

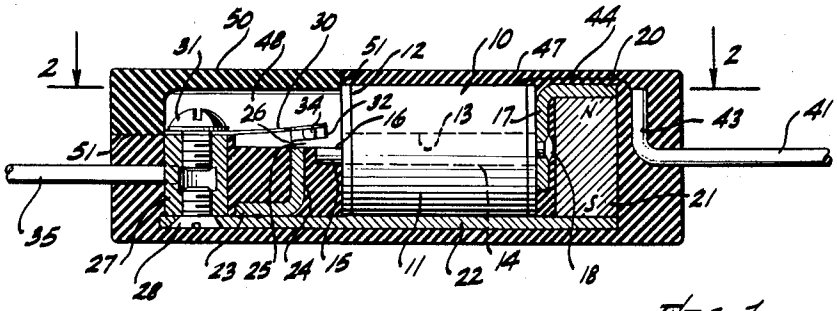


FIG. 1.

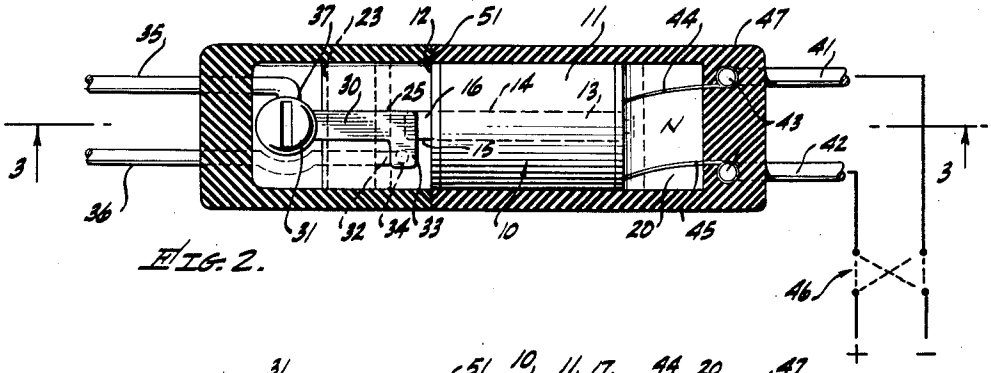


FIG. 2.

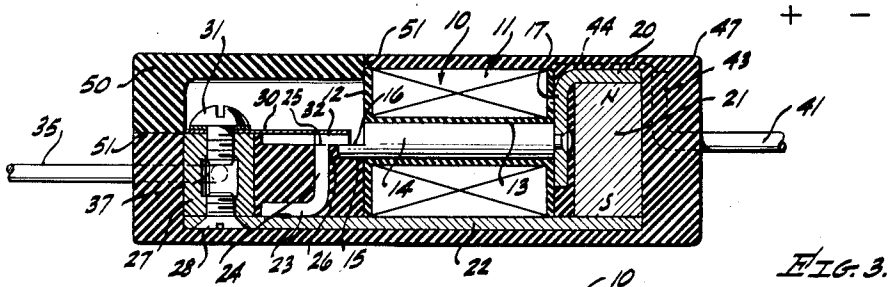
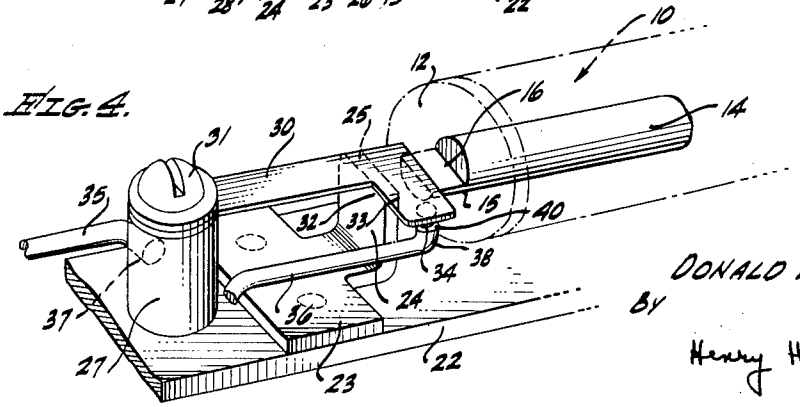


FIG. 3.

FIG. 4.



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United States Patent Office 2,810,039 Patented Oct. 15, 1957

2,810,039

SUB-MINIATURE RELAY

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Application March 25, 1955, Serial No. 496,885

3 Claims. (Cl. 200—93)

The present invention relates generally to a relay and relates more particularly to a sub-miniature type relay including means permitting memory as to the position of operation thereof.

In electromagnetically operated relays, it has become desirable to employ means by which energization thereof may be accomplished by an initial short electrical pulse, with contacts contained within the relay being maintained in a closed condition until another pulse is applied thereto. Additionally, it has also become necessary to employ various relay components in an arrangement enabling disposition in a relatively small space and to provide means whereby the relative positions may accurately be maintained. In electrically or electronically operated devices, as used in aircraft and the like, it is important that the space envelope and weight of various components be maintained as small and as light as possible, commensurate with efficient, effective and reliable operation of the device. Accordingly, in order to satisfy these necessities it is imperative that the individual parts of the relay also be light in weight, incorporate multiple functions and be arranged in a manner permitting the most efficient operating characteristics.

Accordingly, it is one important object of the present invention to provide a sub-miniature relay including a position memory function.

Another important object of the present invention is to provide a sub-miniature relay having construction features of novelty enabling the disposition of components thereof in an extremely small spaced envelope while still maintaining efficient and reliable operational characteristics.

A further important object of the invention is to provide a sub-miniature relay having means for maintaining various components thereof in relative positions in a manner permitting elimination of complex supporting structure.

A still further object of the invention is to provide a subminiature relay employing electromagnetic means and permanent magnetic means arranged in series in a manner enabling electro-magnetic series aiding or series opposing relationships as between the two magnetic sources.

Still another important object of the invention is to provide a novel sub-miniature relay wherein the components thereof are maintained few in number as compared with like prior arrangements.

Other and further important objects of the present invention will become apparent from the disclosures in the following detailed specification, appended claims and accompanying drawing, wherein:

Figure 1 is a longitudinal sectional view through the relay of the present invention with portions thereof being shown in elevation;

Fig. 2 is another longitudinal sectional view taken substantially as indicated by line 2—2, Fig. 1;

Fig. 3 is a sectional view similar to Fig. 1 with components in different positions and taken substantially as indicated by line 3—3 Fig. 2; and

Fig. 4 is a fragmentary perspective view showing the relationships between certain components of the present relay, with the encapsulation being omitted for clarity.

With reference to the drawing, the sub-miniature relay of the present invention is shown as comprising a longitudinally disposed electromagnet indicated generally at 10. The electromagnet 10 comprises a coil 11 that is wound on a bobbin 12 that may be made from any suitable non-conductive material such as, for example, plastic or the like. The bobbin 12 has an axially disposed bore 13 therethrough in which a metallic core member 14 is rigidly disposed. One end of the core member 14 extends beyond the bobbin 12, as at 15, and is cut away to present a flattened surface 16. The other end of the coil member 14 is disposed in co-extensive relationship to the complementary end of the bobbin 12 and has a first conductor 17 secured thereto by means of a riveted portion 18, for example.

The first magnetic conductor 17 extends radially outwardly from the coil member 14, over an end portion of the bobbin 12 and has a portion 20 that is disposed in a plane parallel to and remote from the axis of the coil member 14. This portion 20 of the first conductor 17 is adapted for disposition in contact with one pole (a north pole in the present illustration) of a permanent magnet 21. The permanent magnet 21 is generally rectangular in cross-section and lies in a plane that is substantially normal to the axis of the coil member 14. The other (south) pole of the permanent magnet 21 is positioned in contact with one end of an elongated second magnetic conductor 22. The portion 20 of the first conductor and the one end of the second conductor 22 may be secured to the opposite poles of the permanent magnet 21 as by soldering or the like. The conductor 22 extends from the permanent magnet 21 over the exterior surface of the electromagnet 10 and beyond the end thereof remote from the permanent magnet. A generally L-shaped metallic pole piece 23 is disposed on and in contact with the second conductor 22 in spaced relationship to one end thereof. The pole piece 23 may be secured in position relative to the conductor 22 as by spot welding, soldering or the like. The pole piece 23 has a leg 24 that is disposed normal to the axis of the electromagnet 10, the leg 24 terminating at 25. The surface, defined by the terminus of the leg 24, lies in the plane of the flattened surface 16 of the extension 15 of the core member. A magnetic gap 26 is defined between an axial outer end of the extension 15 and the leg 24.

The end of the second conductor, remote from the permanent magnet 21, has a metallic bushing 27 affixed thereto by means of a screw 28 that threadably engages one end of the bushing. The other end of the bushing 27 is adapted to support a leaf spring member 30, by means of a screw 31 that threadably engages this other end of the bushing. The free end of the leaf spring 30 carries an armature 32 that is adapted to overlie the magnetic gap 26 defined between the core extension 15 and the pole piece leg 24. The armature 32 is normally urged in a direction away from the surfaces 16 and 25 by biasing action of the leaf spring 30, as shown in Fig. 1. The free end of the leaf spring 30 has an angularly disposed portion 33 from which is depended a contact 34 of highly conductive material such as silver or the like, the purpose of which will be later described.

As shown primarily in Figs. 2 and 4, a pair of leads 35 and 36 extend from one end of the relay. The lead 35 is adapted to be suitably affixed, as at 37, to an outer surface of the bushing 27. The lead 36 extends beyond the bushing 27 and has an inner portion 38 bent in sub-

stantially the same direction as the pole piece leg **24**, with a surface **40** defined by the end thereof being disposed in the plane of the core extension surface **16** and leg surface **25**. The surface **40** is adapted for cooperation with the contact member **34**, thus to provide contacts to complete a circuit between the leads **35** and **36**, such a circuit extending through the bushing **27** and leaf spring **30**.

The end of the relay remote from the leads **35** and **36** has extending thereto a second pair of leads **41** and **42** that are bent, as indicated at **43**, in a direction substantially normal to the axis of the electromagnet **10**. The ends of the leads **41** and **42** have smaller coil leads **44** and **45** affixed thereto which extend to the coil **11** of the electromagnet **10**. The leads **41** and **42** may be connected to any suitable source of electrical energy through a switching arrangement **46**. All of the leads **35**, **36**, **41** and **42** are preferably made from highly conductive material, this feature also enabling the use of the end **40** of the lead **36** as one of the contacts for the relay.

As shown in Figs. 1 through 3, the various components of the present relay are maintained in their respective positions by encapsulation in a molded body **47** of non-conductive material such as, for example, plastic or the like. The material of the body **47** is molded in such a manner as to expose the various surfaces **16**, **25** and **40**, with an open area **48** defined above these surfaces being closed by means of a cover **50** which may be fused to the body **47** along the junction lines **51** therebetween.

In operation of the present relay, the armature **32** will initially be in the position shown in Fig. 1, thereby leaving the gap **26** open and the contacts **34** and **40** spaced apart. With the relay in this open condition, the residual force of the permanent magnet **21**, acting through the core member **14** and first and second conductors, is insufficient to effect attraction of the armature **32** into contact with the surfaces **16** and **25**. Upon application of current to the coils **11** of the electromagnet **10** in a direction to create a magnetic series aiding relationship with respect to the permanent magnet **21**, i. e. in such a manner as to create a south pole at the end of the core member **14** adjacent the conductor **17**, the armature **32** will be drawn into engagement with the surfaces **16** and **25**, thus to close the contacts **34** and **40** complete an electrical circuit through the leads **35** and **36**. It may be seen that energization of the electromagnet **10** need only be for a relatively short period of time and that the permanent magnet **21**, upon deenergization of the electromagnet **10**, will serve as a memory establishing means to maintain the armature in position to retain the contacts **34** and **40** in a closed condition. This closed relationship of the various components is shown in detail in Fig. 3.

In order that the contacts **34** and **40** may be separated, the switch mechanism **46** may be operated in order that the coil **11** of the electromagnet **10** may be energized in a direction, opposite from the direction of initial energization, that is in series opposing relationship to the permanent magnet **21**. In this series opposing relationship, the end of the core **14** adjacent the permanent magnet **21** will be, in the present instance, charged as a north pole. The effective magnet force of the electromagnet **10** is only slightly greater than a residual magnetic force of the permanent magnet **21**, with the force differential therebetween being insufficient to overcome the force of the leaf spring **30** and to maintain the contacts **34** and **40** in closed position. Thus, upon such energization of the electromagnet in series opposing relationship to the permanent magnet, the leaf spring **30** will move the armature **32** away from the surfaces **16** and **25**, thus to open the contacts **34** and **40** and interrupt the circuit between the leads **35** and **36**.

It may thus be seen that the present device has detail construction features of novelty and that the various components are arranged in such a manner as to enable a reduction in the number thereof over and above the number of like components associated with prior like devices. Additionally, it is to be noted that the arrangement of the components of the present device is such as to enable simplified, easy and rapid assembly thereof with little possibility of failure due to shifting of the parts and/or misalignment thereof. In practice, it has been found that the entire relay of the present invention may reliably be constructed in a manner wherein the overall length is less than ¾" with the other dimensions being proportional thereto. This extreme miniaturization of components is possible, in part, by the particular arrangement of structural details and the utilization of several components with multiple functions.

Having thus described the invention and the present embodiment thereof, it is desired to emphasize the fact that many modifications may be resorted to in a manner limited only by a just interpretation of the following claims.

What is claimed is:

1. A sub-miniature relay comprising, in combination: a non-conductive bobbin; a coil disposed about said bobbin and defining an electromagnet; a metallic core disposed within said bobbin, one end of said core extending beyond one end of said bobbin; a permanent magnet disposed adjacent said electromagnet; a first conductor having one end secured to the other end of said core, the other end of said conductor being positioned in contact with one pole of said permanent magnet; a second conductor positioned in contact with the other pole of said permanent magnet, said second conductor extending over an outer surface of said electromagnet; a pole piece carried on said second conductor, said pole piece having a portion lying on the axis of and disposed in spaced relationship to said core thus to define a magnetic gap therebetween; a bushing secured to said second conductor remote from said electromagnet; a leaf spring mounted on said bushing; an armature carried by a free end of said leaf spring and adapted to overlie said magnetic gap, said armature being biased in a direction away from said gap by means of said spring; a contact carried by said leaf spring; and a pair of leads, one of said leads being connected to said bushing, one end of the other of said leads forming a contact adapted for cooperation with said spring carried contact, energization of said electromagnet in series aiding relationship with said permanent magnet serving to attract said armature in a direction to close said magnetic gap and said contacts, said permanent magnet acting thereafter to maintain the closed condition of said contacts following de-energization of said electromagnet, energization of said electromagnet in series opposing relationship with said permanent magnet serving to effect separation of said contacts by said leaf spring.

2. A sub-miniature relay comprising, in combination: a non-conductive bobbin; a coil disposed about said bobbin and defining an electromagnet; a metallic core disposed within said bobbin, one end of said core extending beyond one end of said bobbin; a permanent magnet disposed adjacent said electromagnet; a first conductor having one end secured to the other end of said core, the other end of said conductor being positioned in contact with one pole of said permanent magnet; a second conductor positioned in contact with the other pole of said permanent magnet, said second conductor extending over an outer surface of said electromagnet; a pole piece carried on said second conductor, said pole piece having a portion lying on the axis of and disposed in spaced relationship to said core thus to define a magnetic gap therebetween; a bushing secured to said second conductor remote from said electromagnet; a leaf spring mounted on said bushing; an armature carried by a free end of said leaf spring and adapted to overlie said magnetic gap, said armature being biased in a direction away from said gap by means of said spring; a contact carried by said leaf spring; a pair of leads, one of said leads being connected

to said bushing, one end of the other of said leads forming a contact adapted for cooperation with said spring carried contact, energization of said electromagnet in series aiding relationship with said permanent magnet serving to attract said armature in a direction to close said magnetic gap and said contacts, said permanent magnet acting thereafter to maintain the closed condition of said contacts following de-energization of said electromagnet, energization of said electromagnet in series opposing relationship with said permanent magnet serving to effect separation of said contacts by said leaf spring; and a molded non-conductive body of plastic material formed about non-movable elements of said relay, closely to confine such elements and to fix the locations thereof.

3. A sub-miniature relay comprising, in combination: a non-conductive bobbin; a coil disposed about said bobbin and defining an electromagnet; a metallic core disposed within said bobbin, one end of said core having a flattened portion extending beyond one end of said bobbin; a permanent magnet disposed adjacent said electromagnet, the poles thereof lying in a plane normal to an axis of said bobbin; a first conductor having one end secured to the other end of said core, the other end of said conductor being positioned in contact with one pole of said permanent magnet; a second conductor positioned in contact with the other pole of said permanent magnet, said second conductor extending over an outer surface of said electromagnet; a pole piece carried on said second conductor, said pole piece having a portion lying on said axis of and disposed in spaced relationship to said core thus to define a magnetic gap therebetween; a metallic bushing secured to said second conductor

remote from said electromagnet; a leaf spring mounted on said bushing; an armature carried by a free end of said leaf spring and adapted to overlie said magnetic gap, said armature being biased in a direction away from said gap by means of said spring; a contact carried by a laterally displaced portion of said leaf spring; a pair of leads, one of said leads being connected to said bushing, one end of the other of said leads forming a contact adapted for cooperation with said spring carried contact, energization of said electromagnet in series aiding relationship with said permanent magnet serving to attract said armature in a direction to engage said portions of said pole piece and said core, close said magnetic gap and said contacts, said permanent magnet acting thereafter to maintain the closed condition of said contacts following de-energization of said electromagnet, energization of said electromagnet in series opposing relationship with said permanent magnet serving to effect separation of said contacts by said leaf spring; and a molded non-conductive body of plastic material formed about non-movable elements of said relay, closely to confine such elements and to fix the locations thereof.

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