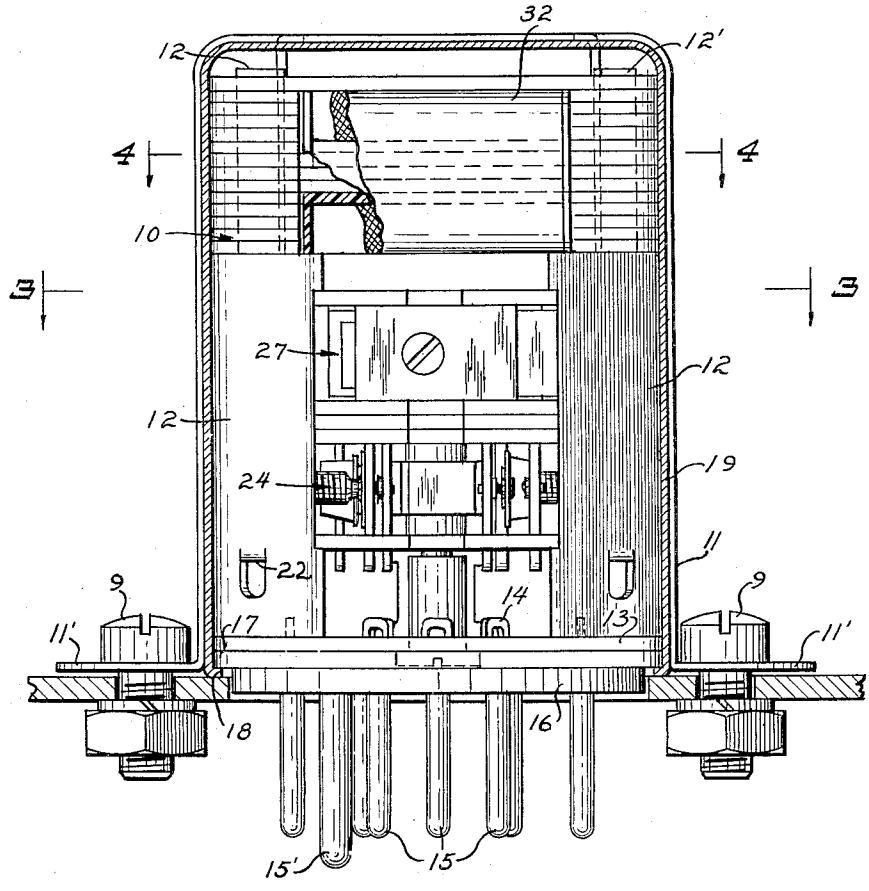
March 4, 1958 B. S. BENGTSSON ET AL 2,825,784

ELECTROMAGNETIC RELAY

Filed April 12, 1955 4 Sheets-Sheet 1

Fig. 1



INVENTORS

BERTIL S. BENGTSSON

ROBERT D. HART

BY Scrivener & Parker

ATTORNEYS

March 4, 1958 B. S. BENGTSSON ET AL 2,825,784

ELECTROMAGNETIC RELAY

Filed April 12, 1955 4 Sheets-Sheet 2

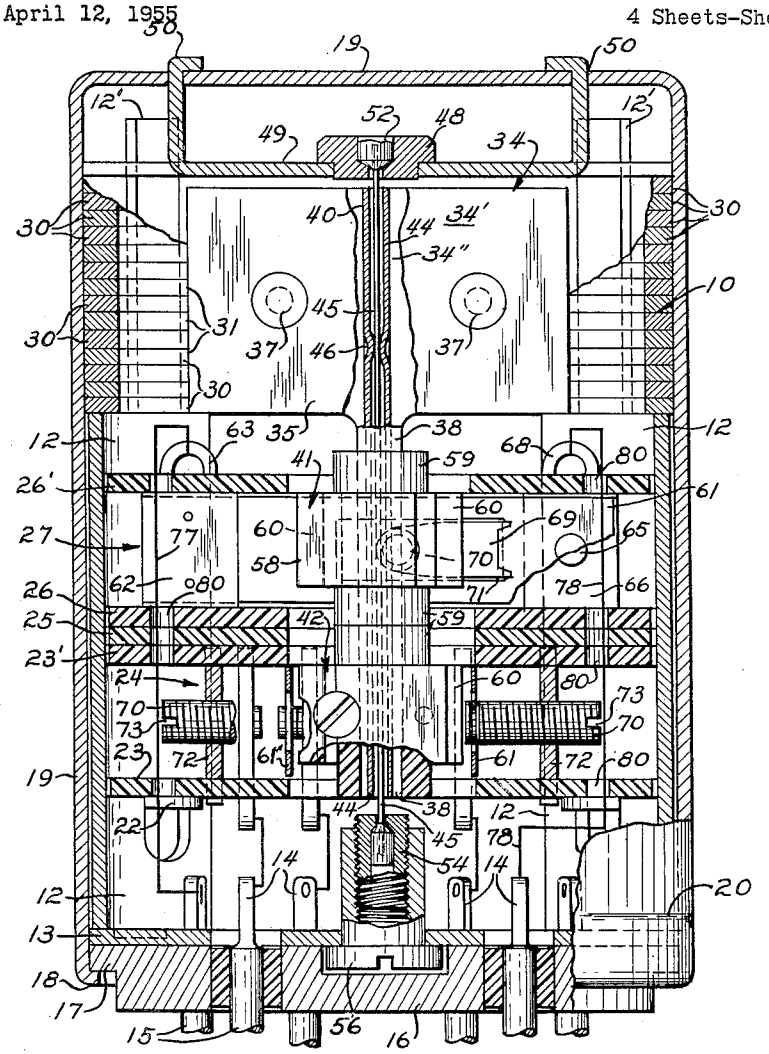


Fig. 2

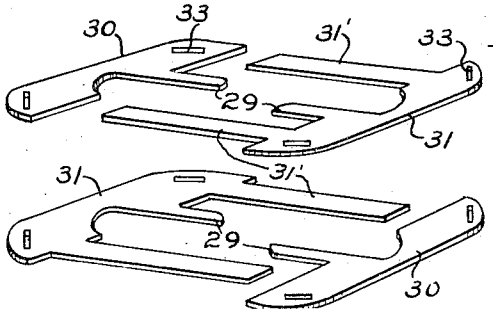


Fig. 5

INVENTORS
BERTIL S. BENGTSSON
ROBERT D. HART

BY Scrivener & Parker

ATTORNEYS

March 4, 1958 B. S. BENGTSSON ET AL 2,825,784

ELECTROMAGNETIC RELAY

Filed April 12, 1955 4 Sheets-Sheet 3

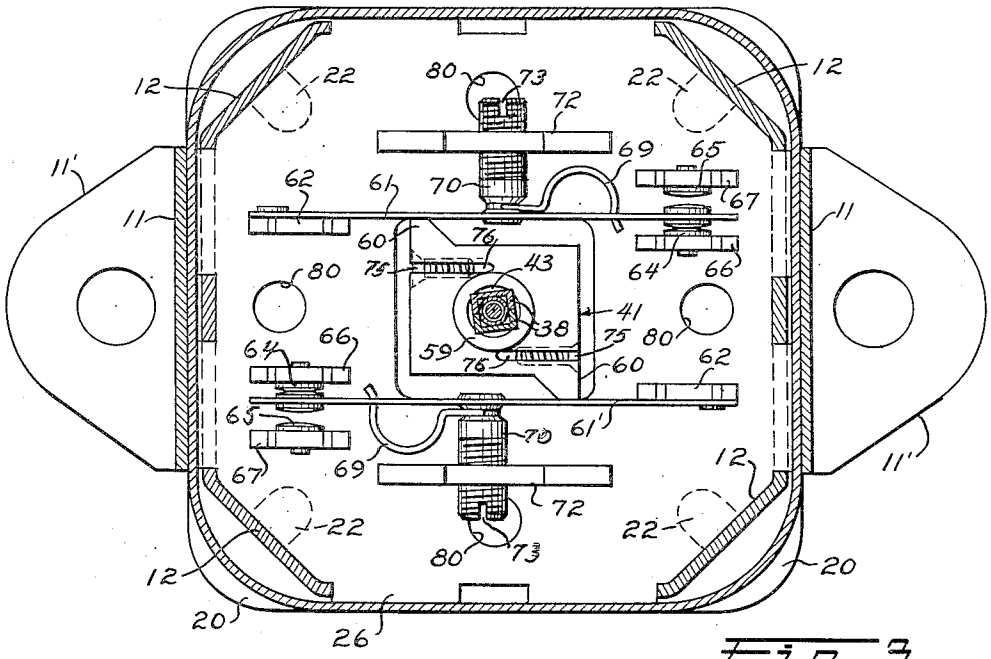


Fig. 3

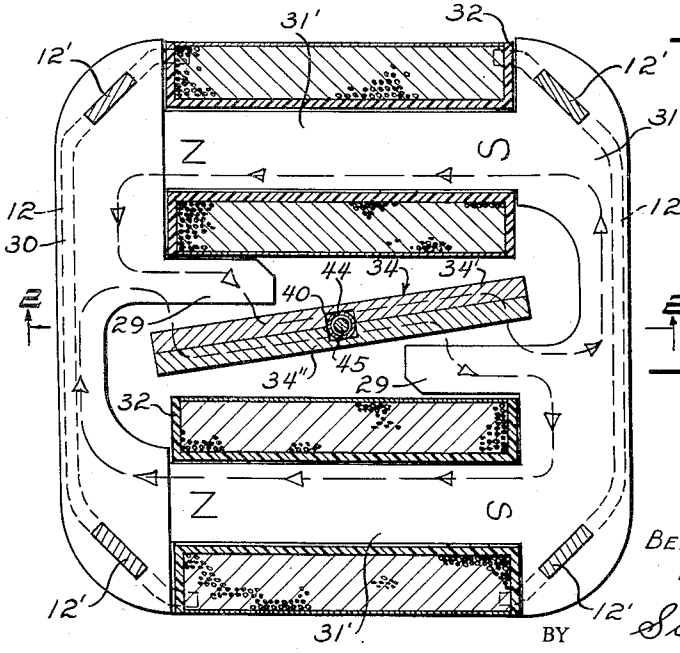


Fig. 4

INVENTORS
BERTIL S. BENGTSSON
ROBERT D. HART

BY Scrivener & Parker

ATTORNEYS

March 4, 1958 B. S. BENGTSSON ET AL 2,825,784

ELECTROMAGNETIC RELAY

Filed April 12, 1955 4 Sheets-Sheet 4

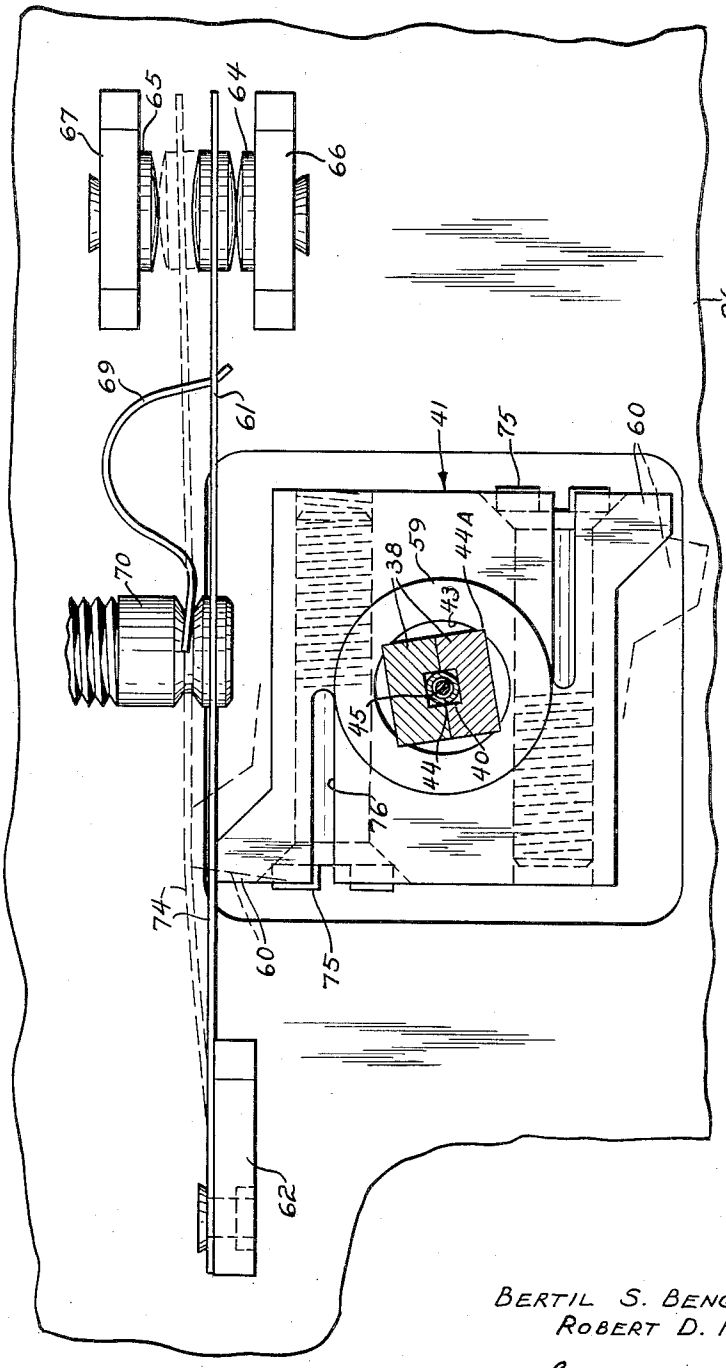


Fig. 6

INVENTORS

BERTIL S. BENGTSSON
ROBERT D. HART

BY Scrivener & Parker

ATTORNEYS

United States Patent Office 2,825,784 Patented Mar. 4, 1958

2,825,784

ELECTROMAGNETIC RELAY

Bertil S. Bengtsson, Plantsville, and Robert D. Hart, Collinsville, Conn., assignors to Barth Engineering and Manufacturing Co., Inc., Milldale, Conn., a corporation of Connecticut

Application April 12, 1955, Serial No. 500,772

5 Claims. (Cl. 200—104)

This invention relates to electromagnetically operated relays and more particularly to a dynamically balanced relay, a prime object of the invention being to provide a relay of this type which is exceptionally stable.

By stability is meant resistance to shock, vibration and high temperatures as well as resistance to acceleration forces having a tendency to prematurely or incorrectly actuate the switching means. Guided missiles and other high acceleration devices depend on electromagnetic relays for controlling flight mechanism or the like and when such relays function incorrectly a missile is almost certain to be destroyed before it accomplishes its mission. It has been found that a major cause of incorrect functioning of missile relays has been caused by premature actuation of the switching means resulting from vibration and the tremendous acceleration forces imposed on the missile particularly during the initial stages of flight. It has been found that a rotary dynamically balanced armature for the electromagnetic means has been effective to overcome the vibration aspects but heretofore the acceleration forces have at times been sufficient to actuate the switching means independently of the armature. One type of switch means which is virtually nonresponsive to acceleration forces is an over-center snap-acting switch of the microswitch variety and one of the objects of this invention is to combine with a dynamically balanced armature a snap-acting switch of the type mentioned to produce an electromagnetic relay which is exceptionally immune to shock, vibration and acceleration forces.

Another object of the invention is to produce an electromagnetic relay which is not only durable but also inexpensive and easily manufactured and assembled.

A more specific object is the provision in the relay of the invention of a novel hinge or suspension means for the rotary armature of the electromagnet.

Other objects and their attendant advantages will become apparent as the following detailed description is read in connection with the accompanying drawings wherein:

Fig. 1 is a vertical side elevation view partly in section of the relay of the present invention;

Fig. 2 is a vertical sectional view taken substantially on the line 2—2 of Fig. 4;

Fig. 3 is a horizontal sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a horizontal sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is an exploded perspective view of two sets of laminations forming part of the electromagnet of the present invention; and

Fig. 6 is an enlarged detail view of a switch and associated actuating mechanism of the present invention.

Referring now to the drawings and particularly Figs. 1 and 2, the relay of the invention is composed of an electromagnet **10** mounted atop opposed vertical support members **12** fixed at their lower ends to the upper surface of a bottom plate **13** which contains a plurality of apertures through which project connectors **14** of plug-in contacts **15** affixed through a terminal plate **16**. It will

be observed that terminal plate **16** is provided with an annular flange **17** which is engaged by the crimped lower edge **18** of a housing **19** enclosing the relay assemblage. The housing **19** as shown at the lower right corner in Fig. 2 is provided with diagonally opposed shoulders **20** near the bottom edge and the bottom plate **13** abuts upwardly against these shoulders and is held thereagainst by the crimping **18** acting on the bottom edge of the terminal plate **16**. When assembled, the relay of the invention is preferably connected to the circuitry of which the relay is a part by insertion of the plugs **15** into suitable registering receptacles in the body of the device, such as a guided missile, for which the relay is intended for use. To insure proper alignment of the relay contacts, a suitable locating plug **15'** may be provided. The entire relay assembly may be rigidly held in place by means of a strap **11** having out-turned toes **11'** engaged by suitable fasteners **9** in the wall of the device as illustrated in Fig. 1.

Vertical members **12** when affixed to the bottom plate **13**, as by the insertion of tangs in registering slots in the bottom plate **13**, provide the skeletal support frame for the entire relay assemblage. As illustrated in Figs. 1, 2 and 3, the support members **12** are pierced to provide inturned projections **22** upon which is supported a switch support wafer **23** made of suitable insulating material. Secured to the wafer **23** is a lower switch assembly designated generally by the numeral **24** and later described in detail. A second upper wafer **23'** identical to the lower, supports the upper ends of the subassembly **24** and immediately above this is an insulating wafer **25** which supports a third wafer **26** identical to the wafer **23** but turned 90° therefrom and having secured thereto an upper switch subassembly **27** which is also provided with a wafer **26'** for supporting the upper ends of the subassembly **27**. The supporting wafers **23**, **23'**, and **26**, **26'** are all fixed in spaced relationship with each other by means of the various parts of the switch subassemblies, all of which will be described in detail hereinafter.

As illustrated in Fig. 2, the upper ends **12'** of the support members **12** are of reduced size to provide shoulders for supporting the electromagnet **10** of the invention in spaced relationship with respect to the upper switch supporting wafer **26'**. The electromagnet is composed of a laminar core piece of hollow-square shape formed of small and large lamination members **30** and **31** respectively which are assembled in alternate relationship as shown in Fig. 5 with the large laminations **31** occupying the central portion of the magnet so that the long arms **31'** thereof may extend through the hollow center of coil supporting bobbins **32** to complete the magnetic circuit. The small laminations **30** are inter-leaved alternately between the large laminations in the usual manner and are also stacked above and below the large laminations at the bobbin ends. After the bobbins and laminations are thus assembled the completed electromagnet is assembled in the relay by registering diagonally disposed slots **33** in the corners of the laminations with the upper ends **12'** of the supporting members. It will be noted that each of the laminations is provided with an inwardly projecting arm **29** which when the magnet is assembled forms oppositely disposed pole pieces with flat active faces facing on opposite sides of a plane through the center of the magnet.

The armature **34** of the electromagnet is of the dynamically balanced type and referring to Figs. 2 and 4, it will be seen that the armature comprises a generally flat rectangular upper portion **35** which resides in the hollow formed by the core of the electromagnet. The armature **34** is preferably formed of two mating members **34'** and **34''** held in face to face relationship by rivets **37** or by other suitable means. Each of the members **34'**,

34'' has an elongated integral stem 38 and centrally milled on the inner faces of the stems and of the upper portions 35 is a groove or slot 40 which when the members 34' and 34'' are joined register to form a passage extending the length of the armature. To retain the stem portion 38 together, switch actuating cams 41 and 42 are provided whose structure and function will be later described in detail but for the present it is sufficient to say that the cams are of suitable insulating material, for example, block nylon, and through the center of the cams there is provided a drilled passageway 43 having a circumference slightly less than the diagonal width of the abutting stems 38. Thus the cam members 41, 42 may be forced onto the stems 38 so that the corners thereof bite slightly as a 44*a* (see Fig. 6) into the inner cylindrical surface of the drilled passages 43. It has been discovered that this forms an exteremely strong connecting means for the armature stems 38 while at the same time enabling the cams to be properly positioned with respect to the switches of the invention as will hereinafter become apparent.

Clamped between the mating armature grooves 40 is a tube 44 which extends the length of the armature and cooperates with the novel armature suspension means of the invention which comprises an elongated wire 45, preferably piano wire or other high grade material, which is contained within the tube 44 and is connected thereto preferably by means of pinching the tube as at 46 so that it is collapsed tightly about the wire for a short distance of its length. Other means, of course, could be employed for joining the tube to the wire but the described pinch has been found entirely satisfactory in practice. The wire 45 is of sufficient length to extend above and below the ends of the armature as shown in Fig. 2 and at the upper end it projects into a drilled passageway in an upper connector anchor 48 seated in a concentric aperture in an upper relay plate 19 resting on the additional small laminations 30 stacked at the ends of the coil bobbins 32. The upper plate 49 in addition to providing a seat for the suspension anchor 48 is provided with two integral upstanding tangs 50 which register with and project through corresponding slots in the housing 19 so that this member may be securely fastened to the relay proper by bending over or twisting the tangs onto the housing as best illustrated in Fig. 2.

The upper end of the wire 45 is connected to anchor 48 by means of solder 52 poured into a suitable recess in the upper side of the anchor. The lower end of the wire 45 is in like manner secured in a lower anchor 54 which is threaded exteriorly to engage interior threads of slotted adjusting member 56 projecting through a concentric aperture in the bottom plate 13. The adjusting member 56 can be turned relative to anchor 54 to draw it downwardly and adjust the tension of wire 45. The armature is normally angularly offset from the plane of the pole faces as shown in Fig. 4 so that when the tension of the wire has been correctly set, it serves as a biased torsion spring which aids in returning the armature to its normal position after actuation thereof by the electromagnet.

Referring now to the cams 41 and 42, these members rotate with the armature to actuate the switches and referring particularly to Figs. 2 and 6, the cams comprise the aforementioned drilled blocks of insulating material having integral with their substantially cubular body portions upper and lower cylindrical portions 59 which serve as spacers between the cams 41 and 42 and provide additional clamp supports for the stems 38 of the armature. Integral with the body portion are diagonally opposed outwardly projecting toes 60 each of which bears against one of a pair of leaf or microtype snap-acting switches 61 and 61' respectively (Fig. 3). The cams 41 and 42 are turned 90° with respect to each other so that the lower cam 42 bears against a pair of switches identical to the members 61 and 61' but turned 90° therefrom. The relationship between the upper and lower switch subassemblies will be apparent from Figs. 1 and 2 and a description of the upper assembly illustrated in Figs. 3 and 6 will suffice for the lower, the subassemblies being turned 90° from each other principally for ease of conductor pass-through from the switch contacts to the plugs 15 though it will be apparent that the pairs of switches could lie in the same plane. The switch members are of the biased type each having one end fixed to a vertical contact post 62 having an integral connector 63 (Fig. 2) which projects through a registering slot in the upper contact wafer 26'. The free end of the switch member 61 operates between two spaced fixed contacts 64 and 65, each respectively mounted on vertical contact posts 66 and 67 each of which is provided with an integral connector 68 similar to the tab 63 of post 62. The switch member 61 is so biased that the end thereof normally bears against the inner contact 64 and is resiliently retained in this position through the action of a biasing spring 69 acting between a grooved end of an adjusting member 70 and the forward end of a window 71 through the central portion of the switch 61. The adjusting member 70 is threaded and mounted in a vertical plate 72 and is provided with a tool receiving slot 73 whereby the stationary end of the biasing spring 69 can be properly located to the outer side of the switch member 61 whereby the spring 69 exerts its biasing effort in a direction forcing the switch into its normal inner position of Fig. 6.

When the cams rotate clockwise in Fig. 6, the toes thereof deflect the switch member 61 as shown in dotted lines at 74 past the biasing position of the stationary end of the spring 69 so that the spring throws the end of the switch 61 against the outer contact 65 with a snap action. The adjusting member 70 permits exact location of the stationary end of the spring 69 so that when the switch is deflected the described snap-action takes place. In order to insure the proper degree of deflection the cam members are adjustable through the means of an adjusting screw 75 which is screwed into a drilled passage adjacent the cam toes 60. A slot 76 enables the conical head of the screw 75 to force the toes outwardly as the screws are advanced into the passage thus varying the throw of the cams. By this adjustment and the above-described adjustment of the biasing spring the switch members 61 can be readily set for accurate and reliable operation.

The mounting posts 62 for the switch member 61 receive electrical energy through a suitable conductor 77 interconnecting an appropriate plug 15 and the connector tab 63 integral with the post. This energy passes through the switch member to either of the fixed contacts 64 or 65 depending on the position of the cam 41 and from the contact the energy flows through the contact post and its connector tab via a conductor 78 to the appropriate plug in the terminal plate 16 to thereby complete the circuit. The conductors pass through the switch wafers by means of registered holes 80 near their outer edges and one reason for having the switch subassembly turned 90° from each other is to limit to approximately three each, the number of conductors passing through any series of holes.

The coils of the electromagnet are wound and connected in such a fashion that upon energization the same polarity is established in the corresponding ends thereof as indicated by the letters N and S in Fig. 4. This prevents short circuiting between the air gaps and the pole pieces 29 so that the magnetic flux will travel the path indicated by the arrows in Fig. 4 and will be forced across the air gaps and through the armature thus causing this to rotate clockwise from its normal position of Fig. 4 until the ends of the armature strike the pole pieces which serve as stops. This rotary motion of the armature is transferred to the cams 41 and 42 causing the intermediate portion of switch members 61 and 61' to bend past the stationary end of the spring 69 whereupon the initial bias thereof is overcome so that this member serves to

throw the switch members against the normally open outer contacts 65 with a snap action.

When the electromagnet is de-energized the armature 34 is returned to its normal position through the combined action of the stressed torsion wire 45 and the deflected switch members acting inwardly on the toes 60 of the cams. The adjusting means previously described are an important feature of the invention since the contact pressure of the switch in the normal position can be increased for any given condition of anticipated vibration or acceleration forces which may be encountered. By moving the stationary ends of the springs 69 outwardly by means of the adjusting member 70 the pressure of the free end of each switch is increased against its inner contact 64. Since the biasing point of the spring 69 is thus moved outwardly the cam toes 60 must deflect the switch elements a greater amount to cause the described snap-action. This additional deflection is produced by merely advancing the cam adjusting screws 75 so that the toes 60 move a sufficient distance outwardly to cause the proper snap-action upon armature rotation. Thus the relay of the invention may be said to have adjustable stability to suit any conditions under which the relay may be expected to operate.

The relay of the invention in addition to being exceptionally stable, is particularly well adapted for use in fields requiring miniature electrical devices. For example, one form of the relay described herein has been manufactured with a height not exceeding one and one-half inches and is widely sought in industry for various uses wherein space limitations require the employment of extremely small devices.

It will be obvious that some of the switch elements of the described device may be of the single throw type wherein the outer contact serves as a stop only while others of the elements are of the double-throw type described. The numbers of switches can be varied as necessary and by suitably elongating the relay frame additional cams and switch elements can be included as desired. The invention is susceptible of these and various other modifications and such modifications are intended to be included within the purview of the invention without departing from the scope and spirit of the appended claims.

What is claimed is:

1. An electromagnetic relay of the plug-in type comprising a housing for enclosing said relay, a plurality of electrical contact plugs at one end of said housing, an elongated frame in said housing, an electromagnetic core mounted at one end of said frame and being in the form of a closed magnetic path normal to the longitudinal axis of the frame, a pair of opposed inwardly projecting pole pieces integral with said core, a pair of coils about said core adjacent said pole pieces, a rotatable armature symmetrically disposed within said core and having its extremities normally angularly displaced from said pole pieces, a lower and an upper plate at the ends of said frame, means for suspending said armature in said frame comprising a tubular passage concentric with the axis of rotation of said armature, an elongated wire extending through said passage and having a length slightly greater than the length of said frame, means in said tubular passageway for connecting the wall thereof at one point of its length to said wire, a fixed anchor in said upper plate concentric with the axis of rotation of said armature for receiving the upper projecting end of said wire, a second anchor for receiving and having secured therein the opposite projecting end of said wire, screw actuated means in said lower plate concentric with the axis of rotation of said armature for receiving said second anchor, means for operating said screw actuating means to draw said anchor and its attached end of wire in the direction of said lower plate to adjust the tension in said wire, a plurality of snap-acting switches in said frame, an operative connection between said snap-acting switches and said armature to actuate the former upon rotation of the latter, and electrical conducting means interconnecting said coils and switches with said contact plugs.

2. The electromagnetic relay of claim 1 wherein said snap-acting switches comprise pairs of spaced fixed inner and outer contacts and a biased over-center leaf spring for each of said pairs having a fixed end connected to an electrical source and the opposite end movable between said contacts said springs being normally biased into electrical engagement with said inner contacts and being snapped therefrom into engagement with said outer contacts upon rotation of said armature.

3. A relay comprising a core having a pair of pole pieces, a flat armature comprising a pair of flat T-shaped members joined in face-to-face relationship to form a composite laminar structure, the adjacent face of each of said members being provided with a groove each registering with the other to form a passage through said armature, a tube clamped between said grooves, a wire extending through said tube and being joined thereto by a pinched portion of said tube clamping said wire, means for anchoring one end of said wire, means for anchoring the opposite end of said wire, adjustable means cooperating with one of said anchoring means for adjusting the tension in said wire, a plurality of cams secured to the stem of the T-shaped armature, each of said cams having a pair of symmetrically opposed camming surfaces, pairs of opposed snap-acting switches each pair symmetrically arranged with respect to said cams, means biasing said snap-acting switches in one direction and against said cams to urge said cams and said armature to a first angular position with respect to said pole pieces, said snap-acting switches being movable to a second position upon movement of said cams and said armature to a second angular position upon energization of said core, said switches serving to return said armature to its first angular position upon de-energization of said core.

4. The electrical relay in accordance with claim 3 wherein said cams are composed of blocks of insulating material having a body portion having camming surfaces comprising outwardly projecting toes.

5. The electrical relay in accordance with claim 4 wherein said toes are adjustable inwardly or outwardly with respect to said body portions.

References Cited in the file of this patent

UNITED STATES PATENTS

1,717,475	Thompson	June 18, 1929
1,737,761	Holte	Dec. 3, 1929
1,839,377	Daly	Jan. 5, 1932
1,858,876	Bossart	May 17, 1932
1,886,372	Bossart	Nov. 8, 1932
2,218,908	Fonseca	Oct. 22, 1940
2,237,705	Kohl	Apr. 8, 1941
2,487,372	Rackley	Nov. 8, 1949
2,546,284	Weisbecker	Mar. 27, 1951
2,553,846	Clemens	May 22, 1951
2,635,155	Barr	Apr. 14, 1953
2,658,573	Harris	Nov. 10, 1953
2,712,763	Horstmann	July 12, 1955
2,718,568	Somers	Sept. 20, 1955
2,767,280	Hall et al.	Oct. 16, 1956

FOREIGN PATENTS

572,686	Great Britain	Oct. 18, 1945