Oct. 30, 1951

A. B. CHUDYK

2,573,183

POLARIZED ELECTROMAGNET WITH MOVING COIL ARMATURE

Filed June 3, 1948

Fig. 1.

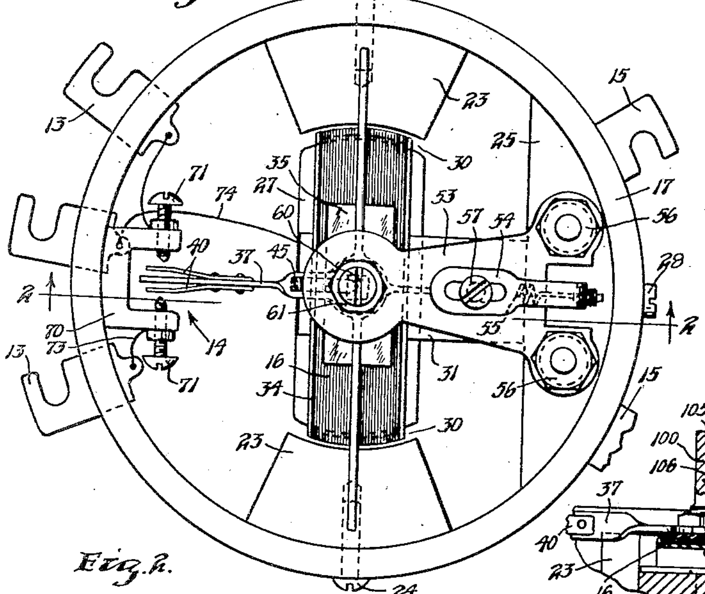


Fig. 3.

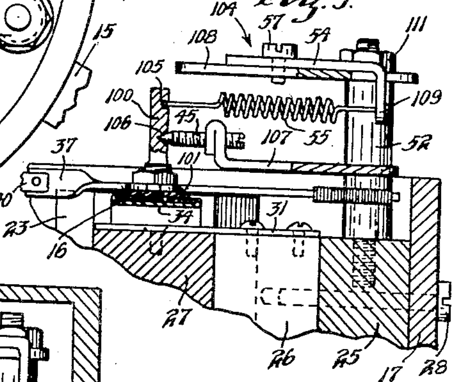
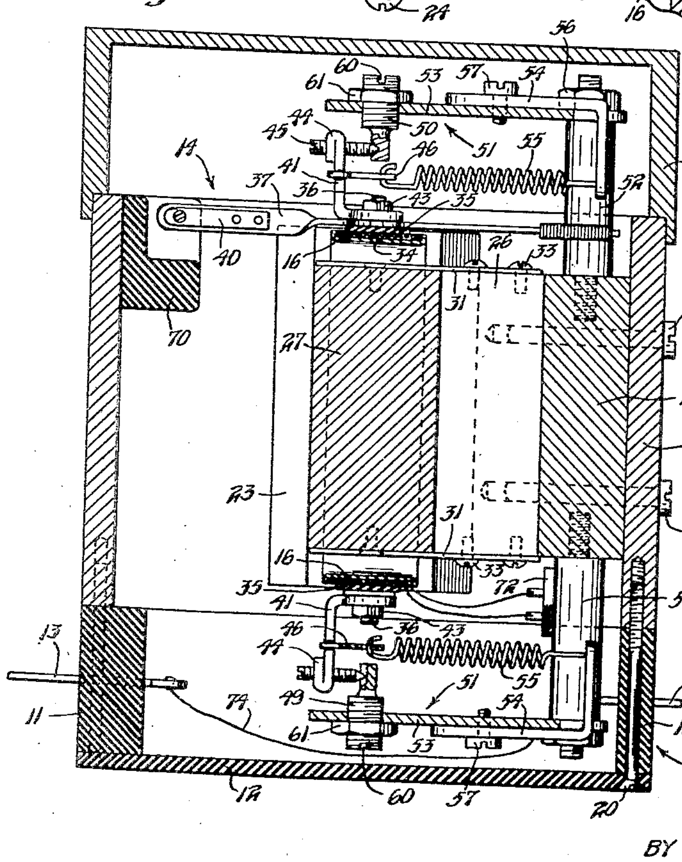


Fig. 2.



Inventor
ALEX B. CHUDYK

BY George N. Fisher
Attorney

Patented Oct. 30, 1951

2,573,183

UNITED STATES PATENT OFFICE

2,573,183

POLARIZED ELECTROMAGNET WITH MOVING COIL ARMATURE

Alex B. Chudyk, St. Louis Park, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

Application June 3, 1948, Serial No. 30,845

3 Claims. (Cl. 175—340)

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This invention relates to electromagnetic devices and more particularly to sensitive relays which respond to small increments of voltage or current. Such devices, because of their inherent sensitivity, are adversely affected by any imposed vibration and therefore cannot be reliably used in a controlling function where such vibration is present. The present invention discloses an improved sensitive relay of the meter type in which an armature or coil is so mounted as to insure its sensitivity and also to bias the coil against external vibrations or oscillations such as might be encountered in an aircraft. It is therefore an object of this invention to provide an improved sensitive relay capable of proper operation without being affected by external vibrations or oscillations.

Another object of this invention is to provide in a sensitive relay an improved mounting structure for its rotating or movable element or coil.

A further object of this invention is to provide in a relay a mounting structure in which a spring biasing means is attached so as to position the armature or coil on a pivot structure and restrain said armature or coil against movement from a predetermined or neutral position in either direction of possible rotation.

A still further object of this invention is to provide a mounting structure in which accurate positioning of the armature or coil is obtained without requiring extremely high tolerances in manufacture.

It is another object of this invention to provide a polarized or sensitive relay in which the magnetic core structure comprises a yoke member with pole pieces mounted thereon, both being of magnetic material, and a centrally disposed permanent magnetic interpole member separated from said pole pieces by arcuate air gaps.

These and other objects will become apparent upon a study of the following specification and drawings wherein:

Figure 1 is a top plan view of the relay with its cover removed.

Figure 2 is an elevational sectional view of the relay of Figure 1 taken along the line 2—2 with the cover element added.

Figure 3 is a sectional view showing a modified pivot structure for the relay.

The electromagnetic device or sensitive relay disclosed in the drawings is a meter type relay or an instrument of the D'Arsonval type. The relay is mounted on a base portion 10 which includes a cylinder 11 of insulating material and an end or bottom plate 12, as can be seen in Figure 2.

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Positioned in the walls of the cylinder 11 are terminals 13 which attach to the relay contact structure 14 and terminals 15 which connect to the coil 16 of the relay. Mounted on base 10 is a cylindrical yoke 17 of magnetic material such as soft iron or nickel iron alloy. It is secured to the base by screws 20 extending through the end plate 12 and cylinder 11. A cover 21 of insulating material fits over the end of yoke 17 opposite base 11.

On the inner surface of yoke 17 are positioned pole shoe portions 23, also made of magnetic material, which extend axially of the yoke and are positioned diametrically opposite one another. They are secured to the yoke 17 by screws 24. Also positioned within the yoke is an axially extending flange 25 of nonmagnetic material. Flange 25 is secured to the yoke by screws 28 and has an inwardly extending raised portion 26. Flange 25 is so positioned that the raised portion 26 is spaced equidistant between pole shoe portions 23. Positioned on the raised portion 26 of flange 25 and between the pole shoes 23 is the interpole or core 27 which also extends axially within the cylindrical yoke 17. Interpole or core 27 is made of a permanent magnet material and has radially extending surfaces positioned in proximity with pole shoes 23 which are curved to conform with the inner surface of said pole shoes 23 and define a uniform arcuate air gap 30 between each pole shoe and the interpole. Interpole 27 is attached to the raised portion 26 of flange 25 by bridging plates 31 secured to the interpole 27 and the raised portion 26 by screws 33. The plates 31 are of a nonmagnetic material similar to the flange 25 and securely positioned interpole 27 thereon. Yoke 17 and pole shoe portions 23 form the outer portion of the core structure of this relay which is positioned or separated from the interpole or core 27 by the arcuate air gaps 30. Interpole 27 is the saturating or energizing source for the magnetic circuits formed by this core structure as will be later noted. With the pole pieces 23 mounted on the yoke 17 or nonpermanent magnet portion of the wire structure and in proximity with the permanent magnet, a concentration of flux through the air gaps 30 is insured.

Within the air gaps 30 is positioned a movable coil 16 which is wound upon a substantially rectangular frame or bobbin 34 of nonmagnetic material, such as aluminum, which is channel shaped and is curved to conform to the air gap. The frame 34 and coil 16 form an armature which surrounds the interpole 27. An insulated plate

35 carrying thereon a shaft 36 is secured to the frame 34 of coil 16 at the extremities thereof along the longitudinal axis of the coil. Each shaft has a threaded end portion by which suitable pivoting structure is mounted for the purpose of positioning the armature. Identical insulating plates and shafts are attached at either end of the frame 34. Positioned on one of the shafts 36 remote from base 10 is the movable contact arm 37 of contact structure 14. The contact arm 37 includes a cross leg structure and a collar which fits over shaft 36. One of the arms of the contact blade 37 carries two flexible contact reeds 40 which engage the fixed portion of the contact structure 14, as will later be described. Mounted on each shaft 36 are bearing brackets 41, L-shaped in form with an aperture in one leg which fits over the shaft 36 to be secured thereto by nuts 43. On the opposite end of the bearing brackets 41 is a bent over portion 44 through which threaded pivot arms 45 are positioned. The pivot arms 45 have a tool receiving head at one extremity and a conically shaped bearing surface at the other extremity and provide a means of adjustment or alignment of the axis of the coil with the axis of rotation of the coil varying the sensitivity of the relay, as will be later noted. Also mounted on bearing brackets 41 are spring mounting plates 46 which are rigidly secured to the bearing brackets 41 in any suitable manner. At the free end of these spring mounting plates is positioned an aperture through which the biasing means for the relay is attached as will be later described. The mounting plate 46 as well as the bearing brackets 41, frame 34 and contact blade 37 are made of non-magnetic but good electrically conductive material for purposes later to be described.

Cooperating with the conically shaped bearing surface of pivot arms 45 are the mating bearing surfaces of arms 50 mounted on the pivot or bearing support frame 51 at either end of flange 25. Each support frame 51 includes a bearing arm 49 or 50, support pins 52 threaded into tapped holes in flange 25, a triangular shaped support bracket 53, a spring anchoring arm 54 and a biasing spring 55. Support pins 52 have reduced diameters at either extremity and threads thereon permit mounting of said pins on said flange and mounting of the remaining frame structure on said pins. In the present relay two such pins are required to mount each support bracket, that is at either end of the coil. Mounting holes in the support bracket fit over the exposed threaded ends of the support pins 52 and the bracket 53 is secured to the pins by nuts 56. The spring anchoring arm 54 is secured to the support bracket 53 in an adjustable type mounting which includes a slot in the anchoring arm 54 and a screw 57 threaded into a tapped hole in the bracket 53. Similarly the bearing arms 49 and 50 are threaded at its outer diameter to fit into tapped holes in the brackets 53 and have a tool receiving end portion 60 opposite the end carrying the bearing surface. A lock nut 61 secures each bearing arm to support bracket 53. Spring 55 is anchored at one extremity to a spring anchoring arm 54 in any suitable manner and is secured at its other extremity through the hole in the spring mounting plate 46. With the exception of the bearing arms 49 and 50, the pivot support structure 51 is identical to both ends of the relay. Spring anchoring arm 54 is adjustable to vary the anchored end of the position of the anchored end of the spring in two directions such as to vary the amount of tension and also the point of application of the same. The bearing arms 49 and 50 are adjustable to locate the point of pivot of the armature since at one extremity the conically shaped bearing surface of pivot arm 45 engages a cooperating conically shaped recess in the bearing arm 50. At the opposite extremity, disposed adjacent to the base portion 10, the cooperating bearing surface of arm 49 is a wedged shaped groove which cooperates with the conically shaped pivot surface of pivot arm 45. This difference in bearing surfaces at either end of the extremity of relay coil 16 permits an accurate positioning of the coil through one bearing engagement and an increased or wider range of tolerances in parts of their associated structure due to the other bearing surface since accurate axial positioning of the pivot surfaces or bearing surfaces is not necessary.

The spring or spring biasing means 55 biases the pivot arms 45 into engagement with the bearing arms 49 and 50 since the surfaces of each are held in cooperating and operating engagement. Such surfaces may be jeweled or of a suitably hard material. The suspension point of spring 55 as determined by the hole in the spring mounting plate 46 is offset from the center line or axis of pivot formed by the engagement of the respective pivots or bearing surfaces in the direction of engagement of the anchored end of spring 55 with arm 54. This offset in the present relay is approximately eight-thousandths of an inch but is adjustable by means of the adjustable pivot arms 45. With this arrangement, the spring mounting plate 46 moves with the bearing bracket 44 as coil 16 is pivoted swinging the suspension point and hence spring 55 from its neutral position. This neutral or initial position is one of alignment in which the pivot point formed by the meeting of the bearing surfaces, the suspension point formed by the engagement of spring 55 with anchoring plate 46 and the anchored end of spring 55 are in alignment. As the spring is offset, it is flexed setting up a component of tension to return the armature or coil to its original position of alignment or bias. This component of tension increases proportionally with displacement of the anchoring plate 46 and the coil 16. Both springs are similarly offset and tend to return the armature in the same direction or to counteract any movement which might be imposed upon the relay other than through its actual operation. Anchoring arm 54, as noted above, is adjustable on bracket 53 through screw 57 to vary the location of the anchoring point of spring 55 on arm 54. By moving arm 54 along the line of alignment, the tension of spring 55 is varied. By pivoting arm 54 about its mounting screw 57 circumferentially along the yoke 17, the anchoring point for spring 55 is pivoted, thereby shifting the neutral position of the coil and the alignment of the pivot point, spring suspension point and the anchoring point. The effect of the offset between the spring and pivot point is unchanged by the latter adjustment, and the coil merely returns or is biased toward a new neutral position.

The stationary portion of contract structure 14 includes an insulating block 70 mounted on the inner surface of cylindrical yoke 17 in any suitable manner. Adjustably mounted in the insulating block 70 are stationary contacts 71 each of which are connected to terminals 13 mounted in base 10 as by connectors 73. The third terminal 13 is connected by means of conductor 74 to one of the support pins 52 being secured thereon by nut 56. An electrical circuit is then obtained between this terminal 13 and the movable contact 37 of contact structure 14 through connector 74, the support pin 52, support bracket 53, spring anchoring arm 54, spring 55, spring mounting plate 46, bearing bracket 41, to contact arm 37. Similarly connections between the coil 16 and the terminals 15 are obtained through conductors, not shown, from an insulating block 75 to which the extremities of the coil 16 are brought. The block 75 may be secured to support pins 52 in any suitable manner.

In the present relay, the permanent magnet interpole provides a saturating or energizing flux for the magnetic circuit of the relay. Since the polarity of the magnet is fixed, the direction of the flux lines will be constant. With coil 16 deenergized, the armature will be biased to a position in which the movable contact 40 will not engage either of the stationary contacts 71. When a direct current energization is applied to coil 16 through the terminals 15, the armature or coil 16 will move a limited distance in a particular direction depending upon the polarity of the energization of coil 16. The limited movement of the coil is governed by engagement of contact arm 37, that is the contact 40, with either of the fixed contacts 71. As armature 16 moves, it pivots about an axis defined by a line between the bearing surfaces of pivot arms 45 and bearing arms 49 and 50. Springs 55 bias these bearing surfaces into engagement and also bias the armature of coil 16 toward this neutral or deenergized position since the anchoring or suspension point between spring mounting arm 46 and spring 45 is displaced from its original alignment in which the bearing point, the anchoring point, and the suspension point of the spring fall in a straight line. This displacement creates a component of tension which varies with displacement and is applied against the spring mounting arm 46 to act against the movement of the armature caused by energization of the coil. The component of tension is not, however, sufficient to counteract operation of the relay. Similarly a certain amount of magnetic damping is present in this relay due to the short circuited coil effect of the aluminum bobbin or coil form 34 which tends to dampen out oscillation of the coil 16 when it is energized. With the relay deenergized, however, this type of bias will dampen out tendencies of the armature to move due to external vibration imposed upon the relay. This bias does not appreciably reduce the relay sensitivity.

Figure 3 is a modification of the mounting and pivot structure of armature or coil 16. In this modification, shaft 100 insulated from coil 16 by plate 101 is attached to the form 34 of coil 16. Shaft 100 carries one of the bearing surfaces 106 and the spring suspension point 105 directly. While only a portion of the supporting structure for the armature is shown in Figure 3, it is to be understood that the opposite shaft of coil 16 is similar to the preferred embodiment of the invention in that it carries a wedge shaped bearing surface while shaft 100 carries a conically shaped grooved bearing surface 106. The anchoring hole 105 is similarly offset from the groove or bearing surface 106 but in this modification the offset is not adjustable since both the bearing surface 106 and the spring suspension point 105 are carried on the same member. The support structure 104 for the stationary pivot is somewhat modified from the preferred embodiment in that a bearing bracket 107 which carries pivot arm 45 is secured to support pins 109 and spaced from flange 25 by a spacer 110. The pivot arm 45 in this instance is carried not by the coil but rather is attached on the stationary flange 25. Similarly support bracket 108 is carried on support pins 109 and secured thereto by nuts 111. The spring anchoring arm 54 is adjustably mounted on support bracket 108 and serves as an anchoring post for the one end of spring 55, the other end of which is anchored to the anchoring point 105 in shaft 100. The present mounting arrangement eliminates the adjustment of one bearing surface and in this respect the lateral positioning of pivot arm 45 and hence the coil is fixed. The adjustment of pivot arms 45 with the bearing bracket 107 centers the axis of the coil with the axis of the interpole and determines the axis of rotation. Similarly the adjustment of spring anchoring arm 54 on support bracket 108 adjusts the tension of spring 55 and the point of application of force are the same. The operation of the relay is the same as that described in the preferred embodiment and spring 55 retains the bearing surfaces into engagement and biases the armature against displacement from its neutral or unenergized position.

A study of the present disclosure will suggest many substitutions and equivalents, hence it is emphasized that the present disclosure is to be considered as illustrative only and the scope of the present invention be determined by the appended claims.

I claim as my invention:

1. An electromagnetic device comprising, a magnetic core structure including a cylindrical outer core portion having inwardly projecting pole shoes with arcuate shaped pole tips and a centrally located permanent magnet interpole portion positioned within said outer core portion and between said pole tips to define a pair of arcuate air gaps therebetween, an armature encircling said interpole portion including mounting arms having bearing surfaces therein, one of said bearing surfaces being a conically shaped groove and the other a wedged shaped groove, pivot means including conically shaped pivot pins attached to said core structure, said pins being adapted to engage said bearing surfaces and pivotally mount said armature for limited rotational movement within said air gap, means for adjustably positioning said pivot pins to accurately position said armature in said air gap uniformly between said interpole portion and said pole tips, spring means attached at one extremity to said core structure and at the other extremity to said mounting arms of said armature, said attachment of said mounting arms and said spring means being located between the point of contact of said pivot pins and said bearing surfaces and the attachment point of said spring means and core structure, and means included in said core structure for varying the relative position of said attachment of said spring means to said core structure.

2. An electromagnetic device comprising a magnetic core structure including an outer core portion with pole pieces mounted thereon and a centrally located interpole portion, said outer

core portion and said pole pieces being formed of magnetic material and said interpole being a permanent magnet, means mounting said interpole portion within said core structure to provide a pair of arcuate air gaps between said pole pieces and said interpole, an armature in the form of a rectangular shaped conductor member and including mounting arms having bearing surfaces therein, pivot means attached to said core structure and adapted to engage said bearing surfaces of said armature to pivotally mount said armature for a limited rotational movement within said air gaps in either direction from a predetermined position, means included in said bearing surfaces and said pivot means to provide for point and knife-edge bearing engagements at either end of said armature, said bearing surfaces on said mounting arms and said pivot means being adjustable relative to one another to accurately position said armature in said air gap equidistantly from said interpole and said pole pieces, spring means attached at one extremity to said core structure and at the other extremity to said mounting arms of said armature, the attachment of said mounting arms and said spring means being located between the points of pivotal engagement of said pivot means and said mounting arms and the attachment point of said spring means and said core structure, and means included in said mounting arms for adjusting the relative positions of said point of engagement of said pivot means and the attachment of said spring means to said mounting arms.

3. An electromagnetic device comprising, a magnetic core structure including a cylindrical outer core portion with pole pieces mounted thereon and a centrally located permanent magnet interpole positioned within said outer core portion and between said pole pieces and mounted on said core structure to form a pair of discontinuous arcuate air gaps between said pole pieces and said interpole, an armature having bearing surfaces therein, a pivot structure attached to said core structure and including bearing surfaces for mounting said armature, two of said bearing surfaces being conically shaped pivot pins and the remaining bearing surfaces being a conically shaped groove and a wedge shaped groove, means providing adjustment of said bearing surfaces in said armature and said pivot structure to pivotally mount said armature for limited rotational movement within said air gaps and to position said armature equidistantly between said interpole and said pole pieces, spring means attached at one extremity to said core structure and at the other extremity to said armature, and means included in said core structure for adjustably positioning the attachment of said spring means and said core structure to vary the tension of said spring in the direction of the biasing force applied by said spring to said armature.

ALEX B. CHUDYK.

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