

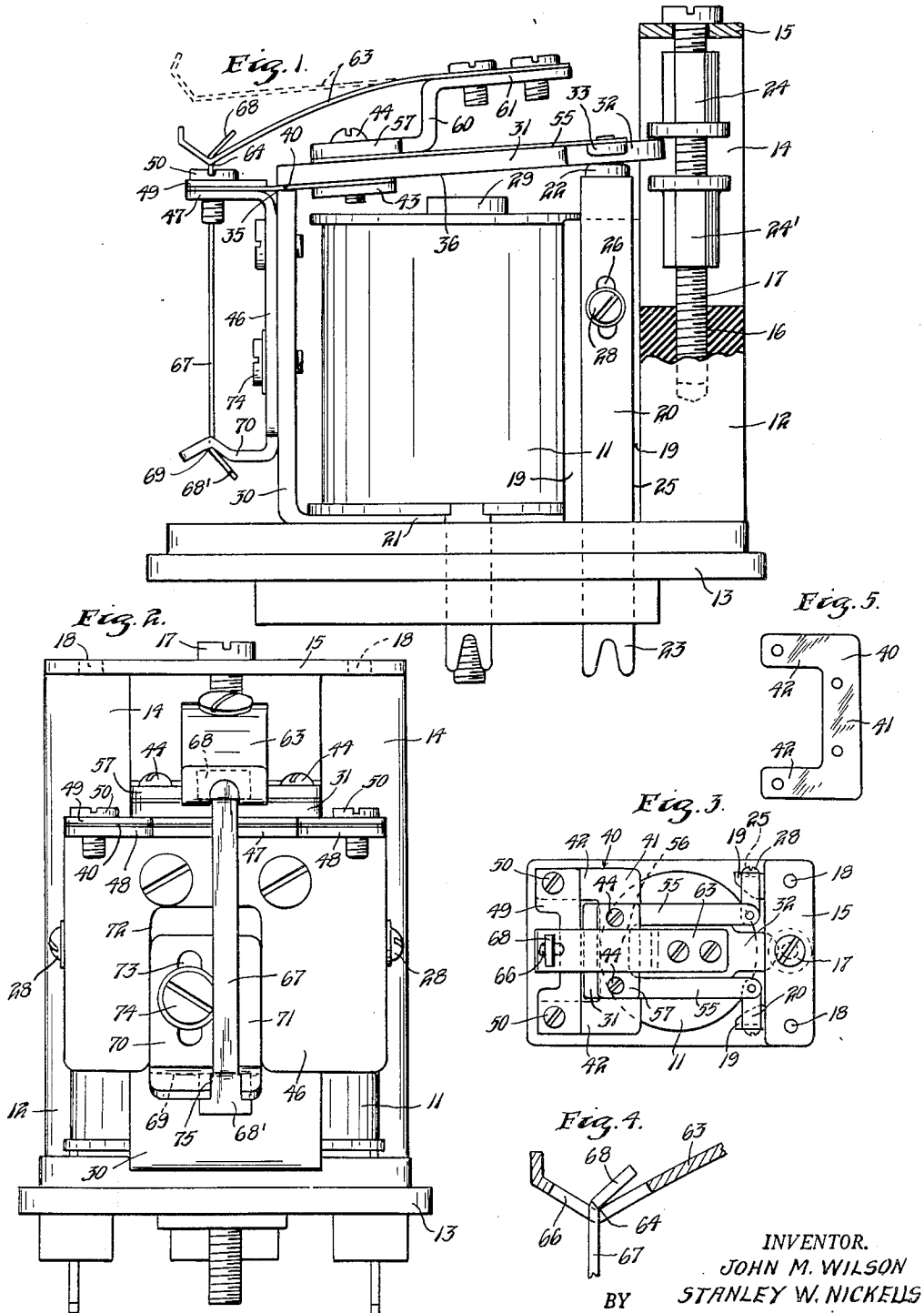
March 20, 1951

J. M. WILSON ET AL

2,545,835

RELAY

Filed Sept. 29, 1947



INVENTOR.
JOHN M. WILSON
BY
STANLEY W. NICKELS
George H. Fisher
ATTORNEY

UNITED STATES PATENT OFFICE

2,545,835

RELAY

John M. Wilson, Minneapolis, and Stanley W. Nickells, St. Louis Park, Minn., assignors to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

Application September 29, 1947, Serial No. 776,644

2 Claims. (Cl. 175—336)

1

The present invention relates to an improved relay structure and more particularly to sensitive control relays which are utilized to perform accurate control functions.

Sensitive relays of an electromagnetic type are often called upon to respond in conjunction with a control circuit to a specific value of an electrical condition applied thereto. It is of prime importance that a relay of the type used in control systems and required to perform accurate circuit opening and closing be readily adaptable for close calibration and that it have an inherent stability which will enable it to maintain its calibration accurately over a longer period of time, possibly under adverse conditions.

Relays of ordinary structure are not adaptable to perform accurately calibrated control functions inasmuch as the various elements thereof employed are of such nature as to permit changes in operating characteristics. These changes can usually be attributed to relatively crude hinge structures allowing slight displacements of the armature in directions other than rotational about its intended axis of rotation or to biasing means which permit the retractive force on the armature to vary by virtue of crude linkage or by vagaries in the usual bias effecting means used.

There have been relays devised in the past to perform highly calibrated control functions but these devices are ordinarily delicate in structure and employ design features requiring high tolerance manufacture. Among the difficulties encountered with relays of this type are the low power handling capacity and the inherent delicacy which causes them to lose their calibration after a relatively short time, especially if employed where ruggedness is desirable. Furthermore, the initial cost of high tolerance construction is relatively high and inasmuch as the feature of low power handling capacity would entail the use of secondary or power relays the cost would be prohibitive for certain control applications.

The features of a rugged, low cost relay structure having simple calibration means and the ability to maintain its calibrated characteristics accurately over a long life period are all present in the relay comprising the instant invention.

It is consequently an object of the present invention to provide a sensitive relay with a high degree of mechanical stability which will enable it to accurately maintain its calibrated operating characteristics over a long period under adverse conditions.

It is a further object of the present invention to provide a relay which may be readily and ac-

2

curately calibrated by simple adjustment means.

It is a further object of the present invention to provide an improved hinge structure which in conjunction with improved biasing means provide stable operating characteristics of the relay armature.

It is a still further object to provide a relay structure in accordance with the beforementioned objects in which the elements thereof are simple to manufacture and assemble and thereby provide relatively low cost production and yet meet the requirements of a device of high quality.

Other objects of the present invention will become apparent from the accompanying specification and drawing, of which

Figure 1 is a side-elevational view of the improved relay;

Figure 2 is a rear-elevational view;

Figure 3 is a plan view of the improved relay;

Figure 4 is a fragmentary view showing the knife edge engagement between the relay bias spring and its floating linkage; and

Figure 5 is a detail of the flexure support comprising a part of the relay hinge structure.

In the embodiment of our invention shown, the improved relay is fixed, by means not shown, to a bracket of non-magnetic material, preferably molded plastic, comprising an upstanding portion 12 and a base portion 13, the up-standing portion 12 is formed to provide a bifurcated portion defined by extending arms 14. The arms 14 are bridged by an iron plate 15 which may be properly registered by means of extrusions 18 cooperating with corresponding registering holes pierced through plate 15. Plate 15 is further secured by means of a stud 17 extending there-through and properly threaded into tapped hole 16 of the upstanding portion 12 of the bracket. Flanged nuts 24 and 24' are positioned on stud 17 intermediate the plate 15 and upstanding portion 12 for limiting the motion of the relay armature 31 as will be hereinafter explained.

The upstanding portion 12 also includes flange portions 19 for the mounting of stationary contact arms 20, which flange portions 19 are integral with the upstanding portion 12 along the extent of the same and abut against the bifurcated arms 14. A slot 26 is provided in each of the contact arms 20 in order that it may be vertically adjusted and secured by means of screw 28 which is threadedly associated with the portion 19. The flange portions 19 are provided with outward facing grooves 25 of the same cross-sectional configuration as contact arms 20 to properly register contact arms 20 and restrict

3

them from motion in any direction other than the vertical intended for adjustment purposes. The upper ends of contact arms 20 are bent into a horizontal plane and are provided with electrical contacts 22. The opposed ends of contacts 20 project through base portion 13 by provision of slots therefor to form terminals 23 suitable for the connecting and soldering of electrical conductors.

The electromagnetic operator comprises an L-shaped frame member of magnetic material having a horizontal leg 21 and a vertical leg 30, horizontal leg 21 being secured to the base 13 in any suitable manner. Secured to the horizontal leg 21 is a core member 29 which is surrounded by an electromagnetic coil 11. An armature 31 is disposed over and extends between the upper end of the vertical leg 30 and core member 29 and is pivotally associated with leg 30 and adapted for movement toward and away from core member 29 in a manner well known in the relay art. An extension of armature 31 in the form of a tongue 32 terminating intermediate flanged nuts 24 and 24' is provided to limit its motion to the extent provided by the disposition of said flanged nuts on stud 17.

It is preferred that the movement of armature 31 toward or away from core member 29 be rotational about an axis defined by the engagement of the lower surface 36 of armature 31 with the rearward edge 35 of the upper end of the vertical leg 30. The edge 35 serves as a knife edge for cooperation with the plane undersurface 36 of armature 31. A flexure member 40 is associated with the armature 31 and the vertical leg 30 in such a manner as to restrict the armature from translational motion in the plane of the before-mentioned axis and yet permit rotational movement of the armature about this axis.

Referring to Figures 3 and 5, flexure member 40 is formed of very thin flexible material and is bifurcated to form a pair of arms 42 and a transverse portion 41. Transverse portion 41 extends across the armature 31 on the inner side of the line of engagement between armature 31 and leg 30 of the frame and is secured to the armature by means of a plate 43 and screws 44. Since the flexure 40 is of a very thin material, it is preferred that the plate 43 extend to the lateral extremities thereof in order to protect flexure 40 from damage during handling, etc. The arms 42 extend rearward of vertical frame member 30 with the space between the arms having sufficient width so that arms 42 do not interfere with either vertical leg 30 or armature 31 which are in direct engagement with each other.

Secured to the vertical portion 30 of the frame is a bracket 46 (as best shown in Figure 1) having an outwardly extending horizontal portion 47, the plane of the upper surface of which substantially corresponds to the plane of the upper end of vertical leg 30. The outstanding portion 47 of bracket 46 is bifurcated to form arms 48 generally corresponding in position to arms 42 of flexure member 40. The arms 42 of flexure 40 are secured to arms 48 by means of a clamping plate 49 generally conforming in shape to outstanding member 47 and secured thereto by means of screws 50. Flexure member 40 thus provides a linkage between the armature 31 and vertical leg 30 which functions to maintain the armature substantially rigid to transverse or longitudinal motion, but permits rotation of the armature about the beforementioned axis defined

4

by the engagement between the lower surface 36 of armature 31 and the knife edge 35. The armature biasing means, which will be described hereinafter insures engagement between the surface 36 and knife edge 35 further to define positively the axis of rotation of armature 31.

The movable contact blade shown is of a single-pole single-throw type which comprises a pair of blades 55 which are integrally connected at the extremity opposite the contacts 33 by a transverse section 56. Blades 55 overlie armature 31 and are secured in place by means of a plate 57 overlying the transverse section 56, plate 57 being secured to armature 31 by means of the screws 44 which also clamp flexure member 40 against the armature.

Plate 57 has an extended portion forming a vertical member 60 and a forwardly extending member 61 disposed above and substantially parallel to armature 31. Member 61 is disposed substantially forward of the hinge structure formed by flexure member 40 and the axis of engagement between armature 31 and core member 30 for the purpose of attaching thereto one end of a cantilever bias spring 63.

Spring 63 is formed of flat material, as may best be seen from Figure 1 in which it is shown in its untensioned position in dotted lines. As shown in Figures 3 and 4, the free end of spring 63 is provided with a slot 66 of substantially greater longitudinal than transverse dimension, the purpose of which will be hereinafter described. The free end is bent upwardly along a transverse line which lies intermediate the longitudinal extremities of the slot 66 to provide a V-shaped recess 64 in the free end.

Spring 63 is stressed downwardly by an I-shaped floating linkage 67 which is associated at one end with the recess 64 of spring 63 and at the other end with a recess 69 disposed in bracket 70 which is adjustably secured to the upstanding leg 30.

The vertical member 71 of bracket 70 is rectangular in shape (as best shown in Figure 2) and is adapted to be received by a slot 72 formed in bracket 46 and to be vertically slidable therein. A vertical slot 73 and screw 74 permits a limited range of vertical adjustment of bracket 70 to effect a desirable amount of tensioning of spring 63, whereupon bracket 70 may be secured in place by means of the screw 74 which is threadedly associated with the upstanding core leg 30. The lower portion of bracket 70 is bent outwardly at substantially 90 degrees and is provided with a longitudinal slot 75 of slightly wider dimension than the narrow portion of the I-shaped linkage 67. The end of member 70 is formed in substantially an inverted V-shaped recess 69 in order to provide a suitable receiving means for the knife edge associated with the lower extremity of floating linkage 67. Floating linkage 67 is associated with bracket 70 at one end and with the free end of cantilever spring 63 at the other and functions to flex spring 63 to a degree providing a desirable bias effect on armature 31. Linkage 67 has transverse projections 68 and 68' provided at its upper and lower extremities respectively which are bent inwardly at approximately 45 degrees so as to dispose the edges thereof in knife edge engagement with recesses 69 and 64 respectively. The knife edge engagement between member 60 and recess 64 is best shown in Figure 4 which is an enlarged partial view in section showing the functional relationship of

these members. Member 68' and recess 69 cooperate in a similar fashion. The surfaces forming the knife edge recesses 64 and 69 are disposed substantially symmetrically about the vertical and include an angle greater than 90 degrees, preferably about 120 degrees, so as to insure free knife edge engagement of linkage projection 68 and 68' with recesses 64 and 69 respectively over the limited angular displacement between these members encountered in operation of the relay.

In the practice of our invention, the upper surface of vertical member 30 is machined to insure an accurate knife edge 35 being formed at the rear edge thereof. Similarly the under surface of the armature 31 in the region of engagement thereof with upstanding member 30 is machined to insure an accurate plane configuration. The relative positions of the upper surface of the vertical frame member 30, the upper surface of pole member 29, and the stop member 24' are such that when the armature 31 is pulled fully in, the lower surface of armature 31 bears only against the rear edge 35 of vertical member 30 and is spaced from the upper surface of pole 29. In this way an accurate definition of the axis of rotation of armature 31 is obtained, as being the rear edge 35 of the upper surface of vertical member 30. Although a more positive knife edge may be formed at the end of member 30, this method of fabrication is entirely satisfactory and preferred from the standpoint of economy of manufacture.

The arms of flexure member 40 are formed preferably of a very thin, low spring rate material and function primarily as suspension members for armature 31 with reference to core member 30. In fact, flexure arms 42 in no way define the axes of rotation of armature 31, rather, the manner of flexing of arms 42 is determined by the rotation of the armature and consequently any translation of the armature due to the presence of flexure 40 is non-existent or negligible. It will be further noted that the forces exerted on flexure 63 by floating linkage 67 consist substantially of forces substantially having only a vertical component. In other words, linkage 67 is associated with spring 63 in such a manner as to remove the horizontal component of rotation from flexing of the cantilever spring 63. The advantages flowing from this arrangement are two-fold. One advantage lies in the fact that the component forces acting on flexure suspension 40 of a compressional nature are removed to insure that this flexure is at all times under tension, in which direction it has its greatest strength and consequently its highest degree of stability. Further the removal of the horizontal component of rotation from flexing the cantilever spring allows the use of spring material of greater rate which offers the advantages of increasing the stability of spring 63 over the relay life, increases the life of this flexure generally, and allows the use of a cantilever flexure of minimum length thus reducing the size of the overall assembly.

As an illustration of a practical application of the embodiment of the relay shown and described, the condition may be imposed that the coil 11 have a resistance of 3000 ohms and comprise the plate load of an electron tube which may be an element of a control device adapted to operate the instant relay at a control point reflecting itself as a specific value of conduction of the said electron tube. It is therefore necessary to accurately calibrate the relay to respond as de-

sired by means of the various adjustment means provided therefor.

The movable contact blade 55 may be preformed according to practice well known in the art in order to effect a desirable initial tension even before engagement with stationary contacts 22.

The maximum in position is then established by adjusting the in-stop 24' to provide a given gap between the armature 31 and the end of pole piece 29 according to the desirable drop-out characteristics of the armature which is determined by the conditions surrounding the specific relay application and which may be given a tentative value according to experience.

The contact blades 20 are then adjusted so as to provide the desired contact pressure when armature 31 is in its lowermost position in which it is in engagement with the in-stop 24'. In making this adjustment, care is taken to insure that contact is made simultaneously between each of the two movable contacts and the fixed contact.

The out-stop 24 is then adjusted to provide for a desirable differential between the pull-in and drop-out points.

The beforementioned adjustments are of a preliminary structure and the values noted are according to specifications which may be previously established experimentally for the specific application of the relay. Final adjustment of the relay involves applying an operating voltage to the terminals of coil 11 and adjusting the bias force of spring 63 by vertically positioning the member 71 so that the relay armature pulls in at a desired value.

Final adjustment of the armature pull-in may be then effected by slightly varying the position of out-stop 24 and, although the preliminary adjustment of in-stop 24' will fairly well determine the dropouts of the relay, a fine adjustment of this characteristic may be effected by slightly changing the position of in-stop member 24'. It will be found convenient in practice to accurately calibrate the relay as a factory adjustment and utilize adjustable out-stop 24 and in-stop 24' as fine adjustments to accommodate for different conditions surrounding installation which entail slight changes in the relay characteristics.

While we have illustrated a particular embodiment of our present invention, it will be understood that we do not wish to be limited to the precise details thereof inasmuch as changes may be made without departing from the true spirit and scope thereof as set forth in the appended claims.

We claim as our invention:

1. In an electromagnetic device; a stationary magnetic structure having a first portion carrying a coil and a second portion spaced from said coil carrying portion and terminating in a sharp elongated uninterrupted edge; an armature having a flat surface in pivotal engagement with said edge of said portion of said magnetic structure and movable toward and away from the end of said coil carrying portion; flexure means in the form of a member of resilient metal having its extremities rigidly fastened to said armature and said magnetic structure, said extremities each being so fastened at a plurality of spaced points for preventing translational movement of said armature relative to said stationary magnetic structure, said flexure means having an intermediate portion thereof cut away from the

7

entire width of the area over which said armature overlies said sharp edge so as to permit engagement of said armature and said sharp edge over such entire overlying area and having a locus of flexure when attached to said armature and said magnetic structure substantially in line with said edge of said magnetic structure; and biasing means urging said armature into pivotal engagement with said edge and out of contact with said coil carrying portion without imparting any appreciable translational force to said armature.

2. In an electromagnetic device; a stationary magnetic structure having a first portion carrying a coil and a second portion spaced from said coil carrying portion and terminating in a sharp elongated uninterrupted edge; an armature having a flat surface in pivotal engagement with said edge of said portion of said magnetic structure and movable toward and away from the end of said coil carrying portion; flexure means in the form of a member of resilient metal having its extremities rigidly fastened to said armature and said magnetic structure, said extremities each being so fastened at a plurality of spaced points for preventing translational movement of said armature relative to said stationary magnetic structure, said flexure means having an intermediate portion thereof cut away from the entire width of the area over which said armature overlies said sharp edge so as to permit engagement of said armature and said sharp edge over such entire overlying area and having a locus of flexure when attached to said armature and said magnetic structure substantially in line with said edge of said magnetic structure; and biasing means urging said armature into pivotal

8

engagement with said edge and out of contact with said coil carrying portion without imparting any appreciable translational force to said armature, said biasing structure including a cantilever spring member attached at one extremity to said armature and a tension link having one end mounted in a notched bracket attached to said magnetic structure, the other ends of said spring member and said link being pivotally connected together.

JOHN M. WILSON.

STANLEY W. NICKELLS.

REFERENCES CITED

15 The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
20 1,085,721	Berdon	Feb. 3, 1914
1,210,617	Dunham	Jan. 2, 1917
1,481,104	Lenaghan	Jan. 15, 1924
1,867,099	Roe	July 12, 1932
1,946,261	Zupa	Feb. 6, 1934
25 2,089,157	Aufiero	Aug. 3, 1937
2,098,926	Schneider	Nov. 9, 1937
2,115,836	Zupa	May 3, 1938
2,174,592	Peek	Oct. 3, 1939
2,282,933	Cahill	May 12, 1942
30 2,333,735	Ort	Nov. 9, 1943
2,316,312	Bone	Apr. 13, 1943
2,390,796	Kovalsky	Dec. 11, 1945

FOREIGN PATENTS

Number	Country	Date
35 288,001	Great Britain	Apr. 5, 1928