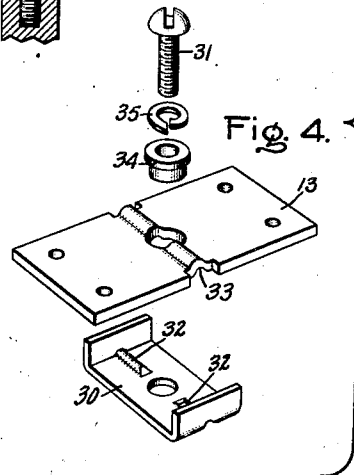
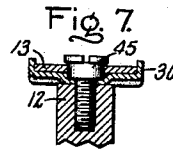
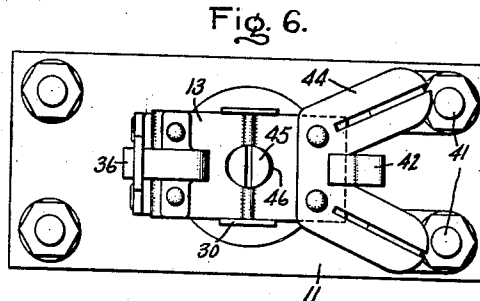
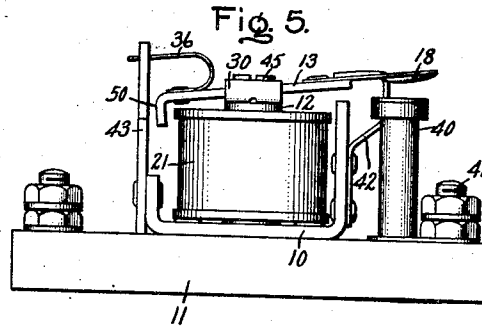
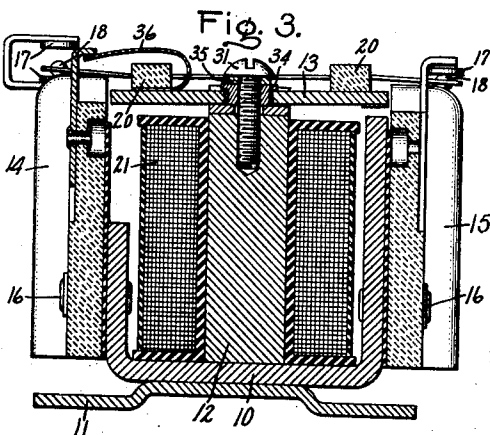
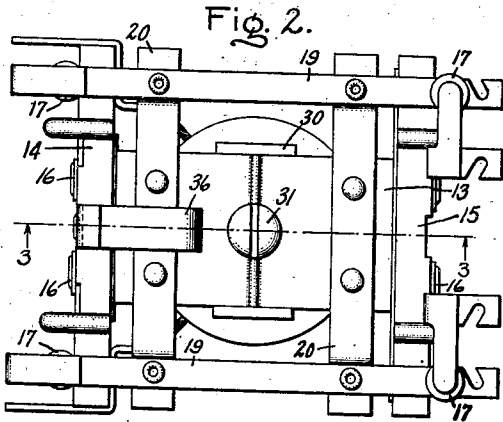
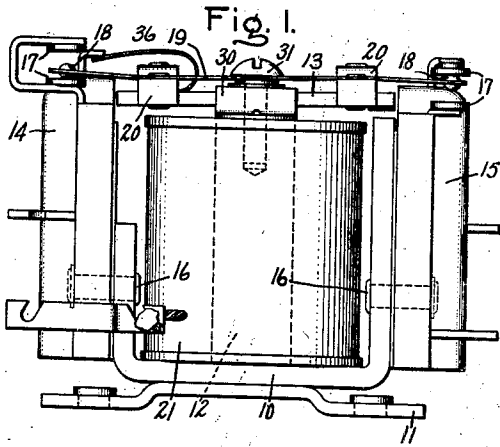


Dec. 25, 1945.

P. H. ESTES
ELECTROMAGNETIC RELAY
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2,391,692



Inventor:
Phillip H. Estes,
by *Harry C. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

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ELECTROMAGNETIC RELAY

Phillip H. Estes, Schenectady, N. Y., assignor to
General Electric Company, a corporation of
New York

Application July 25, 1942, Serial No. 452,295

5 Claims. (Cl. 175-336)

My invention relates in general to electromagnetic relays and more particularly to relays specially designed to evidence a high degree of reliability under adverse operating conditions, such as shock, vibration, bodily acceleration, and extreme conditions of temperature, altitude and humidity.

The invention is particularly useful in connection with vehicles or other mobile equipment provided with electric control or communication facilities, or both. The present-day tendency is toward increased vehicle speeds and rates of acceleration and deceleration, and as vehicle speeds and accelerating rates are increased and more closely regulated, the control equipment has become more complicated. Consequently, a more exacting service is required of each of the component elements. As the process of improvement and refinement continues, certain limiting features of the older equipment and elements are bound to assert themselves from time to time, and as each limitation becomes paramount it must be overcome by a new and improved design in order to open the way for further overall development.

The present invention then relates particularly to electric relays for use in connection with transportation control or communication equipment which may be subjected either simultaneously or consecutively to relatively large impact and vibratory forces and to large and relatively persistent unidirectional accelerating forces in any direction, such as those due to rapidly changing vehicle speeds or rapid changes in the direction of vehicle motion. My relay is also designed to render dependable service under extreme conditions of temperature, altitude and humidity.

Accordingly, it is a general object of my invention to provide a new and improved electric relay which, while dependable in its operation, to an extent heretofore unexpected, shall be compact, of very light weight, and relatively simple and inexpensive to manufacture and assemble, thereby facilitating adaptation and incorporation of the device into large-scale production plans.

It is another object of my invention to provide a new and improved electric relay which shall be capable of operating in a substantially normal manner regardless of the imposition thereon of considerable external force.

It is a further object of my invention to provide a new and improved electric relay designed to permit mounting in any position and to withstand without substantial effect upon its operation rela-

tively large transient or persistent, oscillatory or unidirectional accelerating forces.

It is a still further object of my invention to provide an electric relay which shall substantially maintain its calibration regardless of the position in which it is mounted and independently of its subjection to relatively large vibratory impact or other accelerating forces.

It is a specific object of my invention to provide an electric relay which is inexpensive and simple to manufacture and which will render reliable service under extreme shock, vibration, and temperature, altitude, and humidity limits.

For a more complete understanding of my invention itself and a further appreciation of its objects and advantages, reference should now be had to the following detailed specification taken in conjunction with the accompanying drawing in which Fig. 1 is a side elevation of an electric relay embodying my invention; Fig. 2 is a plan view of the relay of Fig. 1; Fig. 3 is a cross-sectional view taken along the line 3-3 of Fig. 2; Fig. 4 is an exploded perspective view of certain details of the relay of Figs. 1, 2, and 3; Fig. 5 is a side elevation of an electric relay embodying my invention in a modified form; Fig. 6 is a plan view of the relay of Fig. 5; and Fig. 7 is a fragmentary cross sectional view of certain details of the relay illustrated at Figs. 5 and 6.

Referring now to the drawing, and particularly to Figs. 1 to 4, inclusive, my relay comprises a magnetic frame 10 of generally U shape preferably having one long and one short leg. The frame 10 is mounted upon a base 11 and provided centrally of its bight with a magnetic core 12 attached at its base to the frame and extending in parallel spaced relation with the legs of the frame. The upper end of the core 12 serves pivotally to support a rockable magnetic armature 13 in such a position that one end of the armature is located in attractive relation to one leg of the frame 10 for movement toward and away from the frame.

Any desired arrangement of stationary contact structure may be mounted upon one or both of the outside legs of the magnetic frame 10. At Figs. 1, 2, and 3, I have shown a pair of fixed contact supports 14 and 15 made of any suitable insulating material, such as porcelain or a molded insulating compound. The supporting blocks 14 and 15 are attached to the outside surfaces of the frame 10 by any suitable connecting means such as rivets 16 and serve to support a plurality of stationary contact members 17. Suitable moving contact members 18 are mounted upon the

movable armature 13 and insulated therefrom. In the form of the invention shown at Figs. 1, 2, and 3, the movable contacts 18 are mounted at opposite ends of electrically conducting contact spring strips 19 which extend in parallel spaced relation to the armature 13 and are attached to the ends of a pair of transverse insulating members 20 mounted upon the armature 13. It will be noted that the contacts 17 and 18 are arranged with two pairs normally open and two pairs normally closed. Either of these two pairs may to advantage be connected in series circuit relation, since, especially at high altitudes, it has been found that two breaks in series is more efficacious than a single break with the same total gap. In order to establish an actuating magnetic flux through a circuit comprising the long leg of the frame 10, the core 12 and the armature 13, I provide an energizing coil or winding 21 positioned upon the core 12 between the legs of the U-shaped frame 10. For the purpose of withstanding moisture for long periods the winding 21 may be wrapped upon a spool 21a formed of a phenolic condensation product and coated with cellulose acetate. The phenolic product provides mechanical strength even at high temperatures and the acetate is non-corrosive.

For the purpose of minimizing the effect of external forces which might be imposed upon the relay, the armature 13 is rockably mounted at substantially its center of gravity by means of a new and improved knife-edge bearing. Referring now particularly to Figs. 3 and 4, the knife-edge bearing comprises a substantially U-shaped saddle 30 having a substantially flat apertured bight portion and rigidly attached to the upper end of the core 12 by means of a bolt 31. The saddle 30 is provided for at least a portion of its width with a transverse ridge 32 which serves as a knife-edge support for the armature 13. As shown in the drawing, the armature 13 may, if desired, have a shallow transverse groove, as at 33, to provide a knife-edge seat for cooperation with the ridge 32. It will be evident that when the armature 13 is positioned within the saddle 30, the upturned end portions of the U-shaped saddle serve to restrain any lateral or turning movement of the armature.

To secure the armature against longitudinal or upward displacement, a double shouldered annular member or washer 34 is provided in connection with the bolt 31 to serve the dual purpose of firmly connecting the U-shaped saddle 30 to the end of the core 12 and loosely retaining the armature 13 within the saddle. As will be evident, particularly from an examination of Fig. 3, the body portion of the double shouldered washer 34 is of greater diameter than the bolt receiving aperture in the saddle 30 so that when the bolt 31 is screwed down tightly into the core 12, the lower surface of the washer 34 holds the saddle 30 firmly in engagement with the core. The upper overhanging annular shoulder of the washer 34 is spaced from the lower surface of the saddle 30 by a distance greater than the thickness of the armature 13 so that, while the upper shoulder of the washer 34 serves to hold the armature 13 loosely within the saddle 30, it does permit rocking movement of the armature under the influence of a biasing spring and the magnetic attractive force between the armature and the long leg of the relay frame. A lock washer 35 may also be provided to prevent loosening of the bolt 31 as the result of continued vibration.

The armature 13 is biased by means of a flat

leaf spring 36 to a position spaced from the relay core 10. The flat leaf spring 36 is preferably relatively stiff and has a high natural period of vibration, thereby further to protect the relay against external vibratory forces. Furthermore, in order to realize the fullest advantages of my invention, the resonant frequency of all stationary parts should be relatively high and of a different value than that of the armature. Such an arrangement, in combination with my improved armature suspension gives a maximum reliability in severe high frequency vibration, such as is present in aircraft.

At Figs. 5, 6, and 7, I have shown a modified form of my relay the general arrangement of which is somewhat similar to that shown at Figs. 1 to 4, inclusive, and the corresponding component parts of which have been assigned like reference numerals. A few minor variations in the general arrangement have been shown for illustrative purposes. In the first place, the base 11 is made of insulating material so that a stationary contact post 40 and associated terminal connector 41 may be mounted directly upon the base. Also since the relay of Figs. 5 and 6 is not provided with normally closed contacts, it is necessary to provide some stop means, such as a bracket 42, for limiting the circuit opening movement of the armature 13. To provide an abutment for the fixed end of the flat biasing spring 36, a nonmagnetic metallic support 43 is attached to the short leg of the magnetic frame 10. Also, according to this modification a longitudinally split movable bridging contact spring 44 is electrically connected to the armature 13. The purpose of the split contact is to keep the contact resistance at a minimum.

Referring now particularly to Figs. 6 and 7, it will be noted that, as in the previously described modification, the armature 13 is loosely mounted within a U-shaped saddle 30 and both the saddle and armature are retained in position by a bolt 45. The bolt 45 differs from the bolt 31 of Fig. 4 in that its head portion is formed to provide integrally therewith a pair of spaced annular shoulders such as those provided by the washer 34 of Fig. 4. The lower shoulder of the bolt 45 is screwed down firmly against the bight of the saddle 30 in order rigidly to attach the saddle to the end of the core 12, while the upper annular shoulder of the bolt 45 merely overhangs a bolt receiving aperture 46 in the armature 13 and serves to prevent upward displacement of the armature and unseating thereof with respect to the saddle 30. It will be understood that the distance between the annular shoulders on the head of the bolt 45 is greater than the thickness of the armature 13 so that the armature is only loosely held within the saddle. From Fig. 6 it will also be noted that the bolt receiving aperture 45 in the armature 13 may be elongated to a somewhat noncircular form so that the armature is permitted a limited amount of longitudinal displacement. As in the modification of Figs. 1 to 4, inclusive, it will be understood that the armature 13 of Figs. 5 to 7, inclusive, rests at substantially its center of gravity upon the transverse ridge formed internally of the saddle 30.

Attention is directed to the bent end 50 of the armature 13 of Figs. 5, 6, and 7. The end 50 is bent downwardly as viewed in the drawing in order to balance the armature and moving contacts to the fullest extent in all three perpendicular planes in space.

While I have shown only certain preferred embodiments of my invention by way of illustration, many other modifications will occur to those skilled in the art, and I therefore wish to have it understood that I intend in the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In an electromagnetic relay subject to large unidirectional and oscillatory accelerating forces, a stationary magnet frame, a magnetic armature pivotally mounted for movement toward and away from said frame, means for mounting said armature comprising a substantially U-shaped saddle having a flat bight portion provided internally with a transverse ridge, said armature being positioned within said saddle and being rockably seated substantially at its center of gravity upon said ridge thereby to render the movement of said armature substantially independent of said accelerating forces, means for fixedly mounting said saddle upon said frame and loosely securing said armature within said saddle comprising a bolt having a head portion formed to provide a pair of spaced apart annular shoulders, said bolt passing through said armature and said saddle in the region of said ridge and said shoulders being spaced apart a distance greater than the thickness of said armature, and a flat spring connected between said frame and said armature for biasing said armature to a position spaced from said frame.

2. In an electromagnetic relay subject to large unidirectional and oscillatory accelerating forces, a stationary magnetic frame, a magnetic armature pivotally mounted for movement toward and away from said frame, means for mounting said armature comprising a substantially U-shaped saddle having a transverse bight portion provided internally with a transverse ridge, said armature being positioned within said saddle and being rockably seated substantially at its center of gravity upon said ridge thereby to render the movement of said armature substantially independent of said accelerating forces, means for fixedly mounting said saddle upon said frame and loosely securing said armature within said saddle comprising a bolt and a washer formed to provide a pair of spaced apart annular shoulders, said washer passing through said armature to seat upon said saddle and said bolt passing through said washer to hold said washer firmly against said saddle, said annular shoulders being spaced apart a distance greater than the thickness of said armature, and a flat spring connected between said frame and said armature for biasing said armature to a position spaced from said frame.

3. In an electromagnetic relay subject to high unidirectional and oscillatory accelerating forces, a magnetic core member having an energizing winding mounted thereon, an L-shaped magnetic frame portion having one leg in engagement with one end of said core and another leg extending in parallel spaced relation to said core and terminating in substantially the same plane as the other end of said core, a magnetic armature pivotally mounted upon said other end of said core for movement toward and away from said frame member, said armature being dynamically bal-

anced thereby to render the movement of said armature substantially independent of said accelerating forces, means for mounting said armature comprising a substantially U-shaped saddle of appreciable width having a flat bight portion provided internally with a transverse ridge, said armature being positioned within said saddle and being rockably seated substantially at its center of gravity upon said ridge, means including a bolt for rigidly attaching said saddle to said core member and loosely securing said armature within said saddle, said means comprising an annular member formed to provide at least two spaced apart annular shoulders, said bolt passing through said armature and said saddle at a point aligned with said ridge to bring the first of said shoulders into engagement with said saddle for securing said saddle to said core, the second of said shoulders serving as an abutment for preventing displacement of said armature from said saddle while permitting rocking movement of said armature within said saddle, and a flat spring having a high natural period of vibration disposed between said base and the said armature to bias said armature to a position spaced from said frame portion.

4. In an electric relay subject to large unidirectional and oscillatory accelerating forces, a stationary magnetic frame including a coil core, a substantially U-shaped saddle of appreciable width having a centrally apertured flat bight portion provided internally with a transverse ridge, a centrally apertured magnetic armature positioned within said saddle with said apertures in alignment and seated substantially at its center of gravity upon said ridge thereby to render pivotal movement of said armature upon said ridge substantially independent of said accelerating forces, said armature being maintained in alignment by the upright sides of said saddle, and single means for fixedly mounting said saddle upon said core and loosely retaining said armature in said saddle comprising an annular member having at least two spaced apart annular shoulders, one of said shoulders passing through said armature and holding said saddle against said core and the other of said shoulders limiting movement of said armature away from said core.

5. In an electric relay subject to large unidirectional and oscillatory forces, a stationary magnetic frame including a coil core, a knife edge bearing member seated upon said core and having a central aperture therein, a centrally apertured magnetic armature seated transversely upon said bearing member at substantially the center of gravity of said armature and with said apertures in alignment thereby to render pivotal movement of said armature upon said bearing member substantially independent of accelerating forces, guide means for preventing lateral displacement of said armature with respect to said bearing member, and single means for fixedly connecting said bearing member to said core and loosely retaining said armature upon said bearing member comprising an annular member having at least two spaced apart annular shoulders, one of said shoulders passing through said armature and holding said bearing member against said core and the other of said shoulders limiting movement of said armature away from said core.

PHILIP H. ESTES.