June 24, 1941. V. A. LEACH 2,246,739

RELAY

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Fig. 1.

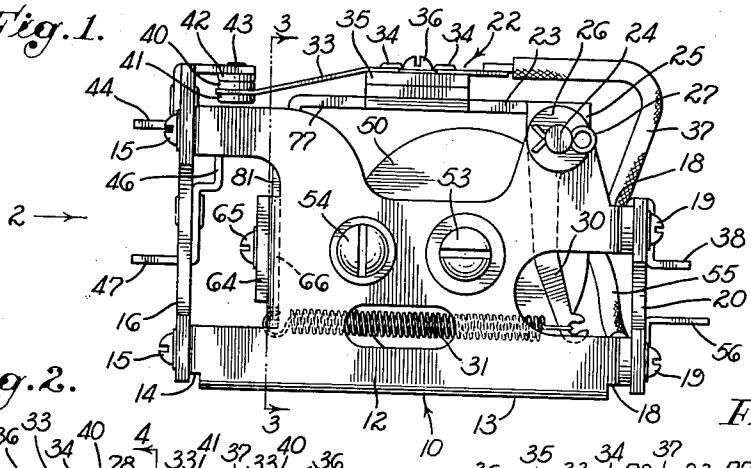


Fig. 2.

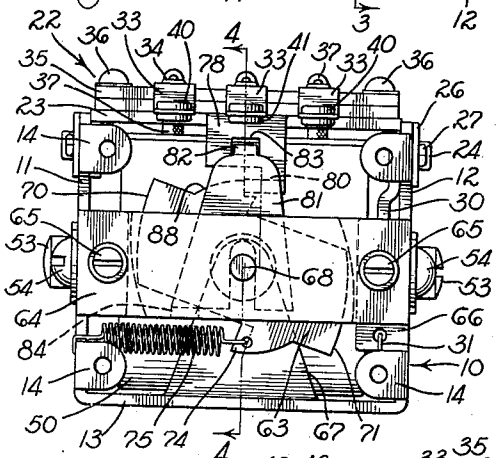


Fig. 3.

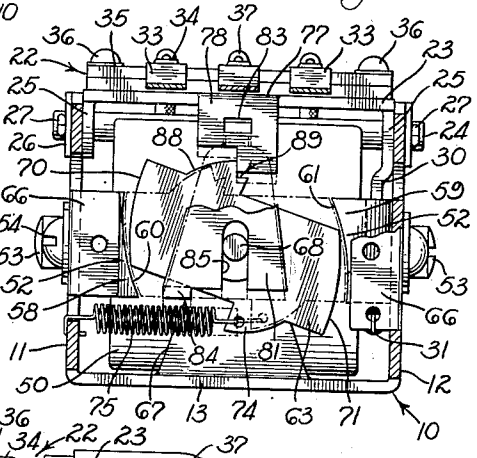


Fig. 4.

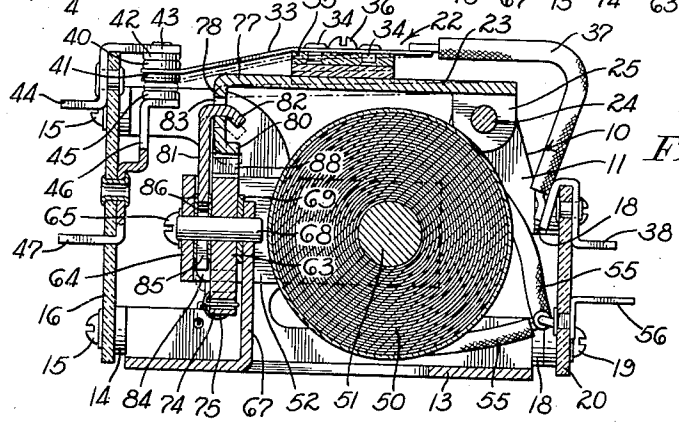
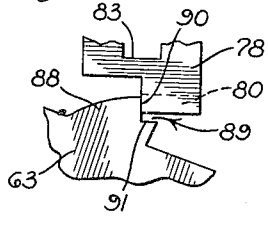


Fig. 5.



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RELAY

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11 Claims. (Cl. 200—87)

My invention relates to electrical control devices in general, and to relays in particular.

The essential elements of a conventional relay include a contactor switch for a main circuit and electromagnetic means to control the contactor switch in response to energization of an auxiliary circuit. The contactor switch is yieldingly urged in one direction toward one of its two stationary positions, usually by spring means, and is moved in the opposite direction toward its other stationary position by electromagnetic means in opposition to the yielding means. In many installations such relays are exposed to incidental forces that either act on the contactor switch directly or act on the movable parts of the electromagnetic means to shift the contact switch from one of its stationary positions to the other in opposition to the yielding means. In other words, mechanical forces originating outside the relay may, at least momentarily, operate the relay in the same manner as would result from closing of the auxiliary circuit through the relay.

In some instances of uncontrolled operation some object accidentally strikes the movable contactor switch, but in most instances of inadvertent operation the actuating force arises from bodily movement of the relay as a whole. Thus, a relay mounted on machinery may be operated by excessive vibration, and a relay carried by a vehicle may be operatively affected by acceleration, deceleration, or sudden change in direction of travel on the part of the vehicle. Such uncontrolled and unpredictable action is usually highly undesirable, especially if the relay has some important role, and in some installations may involve a serious hazard. A relay having an important function in the operation of an airplane, for example, may in the normal course of flying be subject to such vibration, shock, acceleration, or deceleration as to cause it to operate abnormally at critical moments.

It is possible, of course, to reduce this hazard by employing a yielding means of such strength as to resist incidental forces of normal magnitude acting on the contactor switch, but there are disadvantages in relying on such an expedient. In the first place, positive prevention is not achieved because there is the possibility of some force of abnormal magnitude overcoming any spring that may be used, and, in the second place, increasing the strength of the spring increases the demand on the electromagnetic means.

The general object of my invention is to provide a relay of simple but highly efficient construction that will function in a controlled and dependable manner in the face of such external forces. In the preferred form of my invention disclosed herein, it is my purpose in attaining this general object to provide a positive means for immobilizing the contactor switch when the electromagnetic means is de-energized, and further, to make the moving parts of the electromagnetic means immune to the external forces.

With reference to immobilizing the contactor switch, my invention is characterized by the conception of providing a lock that normally blocks movement of the contactor switch but automatically releases the contactor switch whenever the electromagnetic means is energized.

In the preferred form of my invention I propose to operate both the lock and the contactor switch by the electromagnetic means. More specifically, I contemplate operating the relay by electromagnetic means in which a movable armature is adapted to serve both as actuator and lock for the contactor switch.

A further object in mind is to operatively interconnect an electromagnet armature and a contactor switch by means that is irreversible in the sense that it permits the armature to move the contactor switch but locks the contactor switch against transmitting movement to the armature.

With reference to making the movable parts of the electromagnet immune to forces that arise from bodily movements of the relay, my invention is characterized by the concept of pivotally mounting an armature in static balance about its pivot axis so that all forces caused by inertia of the armature mass pass through the pivot axis, no moments about the pivot axis being created. Thus, by blocking the contactor switch with a lock operated by the armature, and then balancing the armature statically, I completely safeguard the relay from operation by vibration, shock or bodily acceleration of the relay.

Those skilled in the art will appreciate from the foregoing that my invention may be embodied in diverse relays for various fields of application. The fact, then, that for the purpose of the present disclosure I elect to describe in specific detail a small relay suitable for aircraft circuits, is not to be taken as limiting the scope of my invention.

The above and other objects and advantages of the invention will be apparent in my detailed

description to follow, taken with the accompanying drawing.

In the drawing:

Fig. 1 is a side elevation of a preferred form of my relay suitable for use in aircraft;

Fig. 2 is a front elevation taken as indicated by the arrow 2 in Fig. 1, the front plate of the relay being removed to reveal the interior mechanism;

Fig. 3 is a transverse section taken as indicated by the line 3—3 of Fig. 1;

Fig. 4 is a longitudinal section taken as indicated by the line 4—4 of Fig. 2; and

Fig. 5 is a view on a greatly enlarged scale of the lock means employed in the relay.

The relay mechanism is mounted in a frame generally designated 10, which may be fabricated from a single sheet of non-magnetic metal bent to form side plates 11 and 12 interconnected by a bottom plate 13. The two side plates 11 and 12 provide inwardly turned ears 14 to receive screws 15 for retaining a front plate or terminal block 16 of insulating material and in like manner at the opposite end of the frame ears 18 are provided to receive screws 19 for retaining a rear plate or terminal block 20 of non-conducting material.

A contactor switch generally designated 22 may include a metal plate 23 that is pivotally mounted on a hinge pin 24 by ears 25, the hinge pin in turn being mounted in suitable bores in the side plates 11 and 12 and being provided at each end with a washer 26 and a cotter pin 27. One of the ears 25 of the plate 23 may be extended as an arm 30, the lower end of which is connected to a forward point of the frame 10 by a helical spring 31. It is apparent that the arm 30, together with the plate 23, forms a bell-crank, and that the force of the spring 31 tends to swing the forward end of the plate 23 upward about the hinge pin 24 as an axis.

One or more switch fingers, preferably of flexible metal, may be mounted on and insulated from the plate 23 to cooperate in opening and closing one or more main circuits when the plate 23 is oscillated. In the particular relay shown in the drawing, I provide three such switch fingers 33 secured by rivets 34 to an insulating block 35 that is in turn attached to the plate 23 by suitable screws 36. Each of the switch fingers 33 is connected by an insulation-covered wire 37 with a corresponding terminal clip 38 on the rear terminal block 20. The forward ends of the switch fingers 33 are adapted to cooperate with stationary contacts of the main circuit or circuits.

In the particular construction shown, each of the switch fingers 33 carries an upper contact 40 and a lower contact 41, which may be referred to as the movable contacts of the relay. Above each of the upper contacts 40 is a stationary contact 42 on a contact arm 43 that is integral with a terminal clip 44 carried by the front terminal block 16. In like manner below each lower contact 41 is a stationary contact 45 on a contact arm 46 that is mounted on the front terminal block 16 and terminates in a terminal clip 47. One of the stationary positions of the contactor switch 22 is an upper position with the movable contacts 40 against the upper stationary contacts 42 and the other stationary position of the contactor switch is a lower position with the movable contacts 41 against the lower stationary contacts 45. In the described arrangement the spring 31 urges the contactor switch to the upper position, but the spring may be disposed in the opposite direction to urge the contactor switch to the other position, if required. One of these sets of stationary contacts 42 and 45 may, of course, be dead or be omitted entirely in installations where the function of the contactor switch is simply to open and close a main circuit.

In various practices within the scope of my invention various electromagnetic arrangements may be employed to move the contactor switch 22 from one of its stationary positions to the other against the resistance of the yielding means that is exemplified by the helical spring 31. In the present illustrative arrangement an electromagnet coil 50 having a core 51 is disposed transversely of the relay frame 10, there being a pole piece 52 in the form of a flat bar attached to each end of the core 51. The coil 50 is connected to each of the side plates of the frame 10 by a suitable screw 53 opposite the core 51 and by a second forwardly spaced screw 54 interconnecting the side plate of the frame and the corresponding pole piece 52. The electromagnet coil 50 is adapted to be connected to an auxiliary or controlling circuit through the medium of a pair of insulation covered wires 55 that connect with corresponding terminal clips 56 on the rear terminal block 20.

The ends of the two pole pieces 52 are bent inward toward each other to form two opposed poles 58 and 59 having opposed arcuate faces 60 and 61 respectively. An armature 63 is adapted to respond to energization of the coil 50 by rotating about an axis approximately midway between the two poles 58 and 59. For mounting the armature to oscillate in the desired manner, I may provide a cross-plate 64 slightly forward of the plane of the poles 58 and 59, the cross-plate being attached by suitable screws 65 to ears 66 on the side plates of the frame 10. Rearward of the plane of the two poles 58 and 59 I may provide an upwardly turned tongue 67 cut from the bottom plate 13 of the frame to serve as a bracket spaced rearward from the cross-plate 64. By virtue of this arrangement I may mount the armature 63 on a pivot pin 68 that passes through suitable bores in the cross-plate 64 and the tongues 67, the drawing showing a spacing washer 69 between the armature and the upwardly turned tongue.

The arcuate face 60 of the pole 58 is eccentric with respect to the pivotal axis of the armature 63, the center of curvature of the face being above that axis, while the face 61 of the pole 59 is also eccentric with respect to the armature axis with the center of curvature below that axis. The two ends of the armature have arcuate faces 70 and 71 corresponding to the pole faces 60 and 61 respectively, the curvature of each armature face being complementary to the curvature of the corresponding pole face, and the armature being dimensioned to place its end faces relatively close to the pole faces when the energization of the coil 50 causes the armature to take a position longitudinally aligned with the two poles, the position shown in dash-dot lines in Fig. 3. It is apparent that, as viewed in Fig. 3, the indicated eccentricity of the complementary faces of the armature and the two poles results in relatively little increase in the gap between the pairs of complementary faces as the armature rotates from its energized position to its de-energized position that is shown in full lines in Fig. 3. It will be noted that in Fig.

3 the lower end of the armature face 70 at the de-energized position is in close proximity to the corresponding pole face 60 and likewise the upper end of the armature face 71 is in close proximity to the complementary pole face 61. The indicated configurations of the poles and the armature favor effective magnetic action to rotate the armature out of its de-energized position, not only because of the relatively narrow air gaps at the de-energized position of the armature, but also because each of the poles, in effect, overhangs an end of the armature in a manner that increases the effectiveness of the magnetic coupling when the coil 50 is energized.

To urge the armature towards its normal de-energized position the armature may be provided with a downwardly extending integral lug 74 that is apertured for engagement by one end of a helical spring 75, the spring 75 being connected to the side plate 11 of the frame.

The contactor switch 22 may be adapted for operative connection to the armature 63 in any suitable manner and any suitable means may be employed for the operative connection. In the particular construction shown a forward extension 77 of the plate 23 is bent downwardly to form a tongue 78 above the armature 63. The lower end of the tongue 78 is of reduced width and terminates in an inwardly turned flange 80. A connector plate 81 for linking the contactor switch 22 to the armature 63 is slidingly mounted between the armature and the cross-plate 64, the connector plate having a finger 82 at its upper end engaging a complementary aperture 83 in the tongue 78 and having a second finger 84 at its lower end engaging the bottom edge of the armature to one side of the armature axis. The connector plate 81 has a guide slot 85 engaging the armature pivot pin 68, and preferably spacers in the form of thin washers 86 are mounted on the pivot pin on opposite sides of the connector plate.

Normally the spring 31 acting on the arm 30 holds the contactor switch in its uppermost position with the upper movable contacts 40 pressed against the upper stationary contacts 42, and the spring 75 normally holds the armature 63 rotated to its normal inclined or de-energized position, the various parts of the mechanism having the positions indicated in full lines in all the figures of the drawing. When energization of the electromagnet coil 50 setting up magnetic flux between the poles 58 and 59 causes the armature 63 to rotate counter-clockwise to its substantially horizontal energized position, the lower edge of the armature moving against the lower finger 84 of the connector plate 81 shifts the connector plate downward, and since the upper finger 82 of the connector plate engages the tongue 78, the contactor switch follows the downward movement of the connector plate. As the armature approaches its horizontal energized position, the lower movable contacts 41 of the contactor switch move against the corresponding lower stationary contacts 45, the various parts of the mechanism then taking the position shown in dot-dash lines in Figs. 3 and 4.

Various locking arrangements may be employed to block movement of the contactor switch when the electromagnet is de-energized. The preferred form of my invention is characterized, however, by an exceedingly simple construction in which the lock consists of an upwardly extending stop lug 88 on the armature 63, the stop lug 88 is so constructed and arranged that when the armature 63 is in its de-energized position the stop lug blocks the path of downward movement of the contactor switch, but immediately moves clear of the path when movement of the armature from its de-energized position to its energized position is initiated. The drawing shows the lug 88 with a notch 89 for engagement with the lower end of the tongue 78. In the normal de-energized position of the armature 63, one face 90 of the notch, as best shown in Fig. 5, rests against the lower edge of the tongue 78 and against the edge ofthe flange 80 of the tongue, thereby limiting the extent to which the armature 63 may be rotated clockwise by the spring 75. At the same time a second face 91 formed by the notch 89 extends into the path through which the lower end of the tongue 78 must move if the contactor switch is to shift downward sufficiently to carry the lower movable contacts 41 against the lower stationary contacts 45. There is normally appreciable clearance between the face 91 and the lower end of the tongue 78 to insure freedom of movement of the stop lug 88 into and out of the normal position of Fig. 5, but the clearance is not sufficient to offer any possibility of the contactor switch reaching its lower operative position while the stop lug is in blocking position.

It is apparent that the lock arrangement described affords positive protection against external forces acting on the contactor switch tending to shift the contactor switch to its lower position. For complete protection it is necessary also to make the armature 63 immune to forces arising from inertia of the armature when the relay is moved bodily as heretofore pointed out. For this purpose the armature 63 is of substantially uniform thickness and is substantially symmetrical about the axis of the armature pivot pin 68. More specifically, it will be noted that the armature body as defined by the straight lines of its longitudinal edges is statically balanced about the axis of the pivot pin and that the lower lug 74 is both diametrically opposite from the upper stop lug 88 and substantially equal in mass to the upper stop lug. The relay may be vibrated or jolted bodily in any direction, then, without operative effect on either the contactor switch or the armature.

The preferred form of my invention described in specific detail herein will suggest to those skilled in the art various changes, modifications, and substitutions that may be made without departing from my underlying concept, and I reserve the right to all such changes, modifications, and substitutions that properly come within the scope of my appended claims.

I claim as my invention:

1. In a relay, the combination, of: a main-circuit contactor switch movable from a first switch position to a second switch position and vice versa; an auxiliary-circuit electromagnet; a pivoted armature operatively connected to said contactor switch and movable from a first armature position to a second armature position to move said contactor switch from said first switch position to said second switch position in response to energization of said electromagnet, said armature being biased to return to said first armature position when said electromagnet is de-energized, said armature being in substantial static balance about its pivot axis to prevent operative turning moments about said axis from inertia of the

armature when the relay is moved bodily by external forces while said electromagnet is de-energized; and locking means effective to hold said contactor switch in said first switch position against external forces when said electromagnet is de-energized and to release said contactor switch automatically when said electromagnet is energized.

2. In a relay a combination as set forth in claim 1 in which both said contactor switch and said locking means are operatively connected to said armature.

3. In a relay, the combination of: a main-circuit contactor switch movable from a first switch position to a second switch position and vice versa; an auxiliary-circuit electromagnet; an armature operatively connected to said contactor switch and movable from a first armature position to a second armature position to move said contactor switch from said first switch position to said second switch position in response to energization of said electromagnet; and a stop means mounted on and unitary with said armature and positioned to be carried thereby into a position blocking movement of said contactor switch from said first switch position of the contactor switch when said electromagnet is de-energized.

4. In a relay, the combination of: a main-circuit contactor switch movable from a first switch position to a second switch position and vice versa; an auxiliary-circuit electromagnet; an armature operatively connected to said contactor switch and movable from a first armature position to a second armature position to move said contactor switch from said first switch position to said second switch position in response to energization of said electromagnet; and stop means unitary with said armature and positioned to be carried thereby into the path of movement of said contactor switch when said electromagnet is de-energized, there being normal clearance between said stop means and said contactor switch sufficient to permit freedom of movement on the part of said armature but not sufficient to permit said contactor switch to reach said second switch position when the electromagnet is de-energized.

5. In a relay a combination as set forth in claim 3 in which said armature is pivoted to rotate about an axis and in which said stop means in its blocking position is so aligned with the axis of the armature pivot that blocking force is directed radially of the pivot axis and therefore creates no turning moment on the armature.

6. In a relay a combination as set forth in claim 3 in which said armature is pivotally mounted to rotate about a pivot axis and is statically balanced with respect to that axis, in which said stop means in its blocking position is so aligned with the axis of the armature pivot that blocking force is directed radially of the pivot axis and therefore creates no turning moment on the armature.

7. In a relay, the combination of: a main-circuit contactor switch movable from a first switch position to a second switch position and vice versa; an auxiliary-circuit electromagnet; a pivoted armature operatively connected to said contactor switch and rotatable from a first armature position to a second armature position to move said contactor switch from said first switch position to said second switch position in response to energization of said electromagnet; a projection on said armature positioned to block movement of said contactor switch from the first switch position to the second switch position when said electromagnet is de-energized; a second projection on said armature; and yielding means connected to said second projection to urge said armature to said first armature position when said electromagnet is de-energized, said armature being statically balanced with said two projections diametrically opposite each other with respect to the pivot axis of the armature.

8. In a relay, the combination as set forth in claim 1 in which said electromagnet has two poles directed toward each other and said pivoted armature is mounted between said poles, the face of one of said poles being arcuate and eccentric in one direction with respect to the axis of the armature, the face of the other pole being arcuate and eccentric in the opposite direction with respect to the axis of said armature; and the corresponding surfaces of said armature being curved complementary to said pole faces.

9. In a relay, the combination of: a contactor switch movable from a first position to a second position and vice versa; an auxiliary-circuit electromagnet; an armature pivotally mounted to rotate about an axis from a first armature position to a second armature position to move said contactor switch from said first switch position to said second switch position in response to energization of said electromagnet; means operatively interconnecting said armature and said contactor switch to transmit force from said armature to said contactor switch, said interconnecting means being operatively movable toward and away from said armature axis; and means on said armature positioned to be carried by the armature to a point radially of said armature axis in said direction of movement of said interconnecting means to block movement of the interconnecting means when said electromagnet is de-energized.

10. In a relay, the combination as set forth in claim 9 in which said armature is statically balanced with respect to its pivot axis to prevent rotation by inertia of the armature when the armature is moved bodily with the relay.

11. In a relay, the combination of: a contactor switch movable from a first position to a second position and vice versa; yielding means urging said contactor switch to said first position; an electromagnet; an armature operatively connected to said contactor switch, said armature being responsive to said electromagnet to move said contactor switch from its first position to its second position in response to energization of the electromagnet; and locking means movable between an ineffective position and an effective position at which the locking means blocks movement of said contactor switch from the first position of the contactor switch to the second position of the contactor switch, said locking means being mechanically responsive to said armature to move automatically to its ineffective position upon initial movement of the armature in response to energization of the electromagnet.

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