July 30, 1963 N. F. LEO 3,099,729

ELECTRICAL RELAYS

Filed July 26, 1960 2 Sheets-Sheet 1

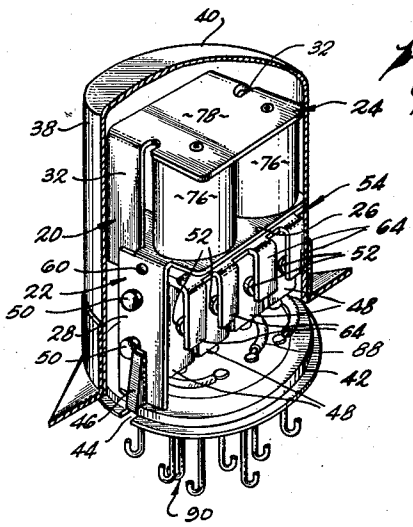


Fig. 1

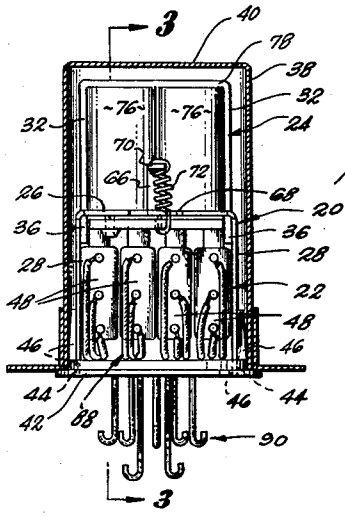


Fig. 2

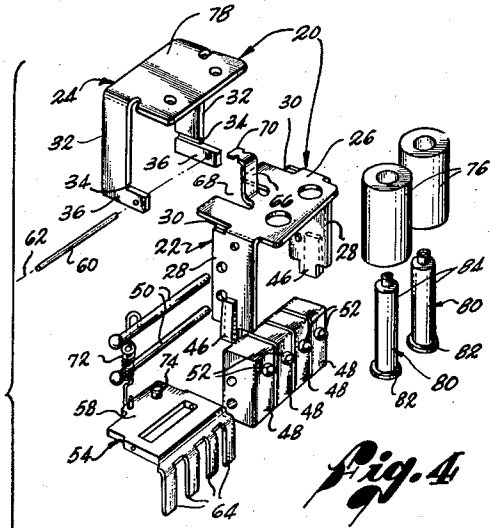


Fig. 4

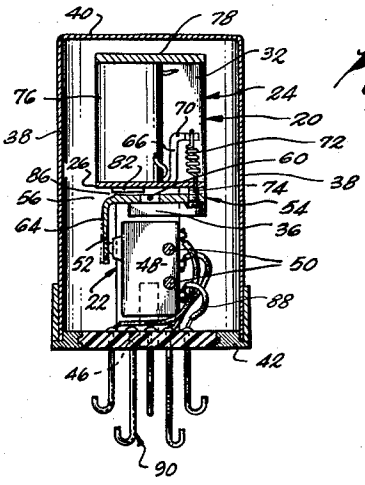
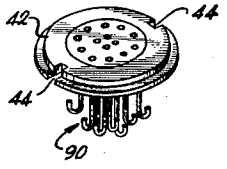


Fig. 3



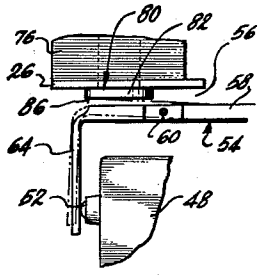


Fig. 5

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ELECTRICAL RELAYS

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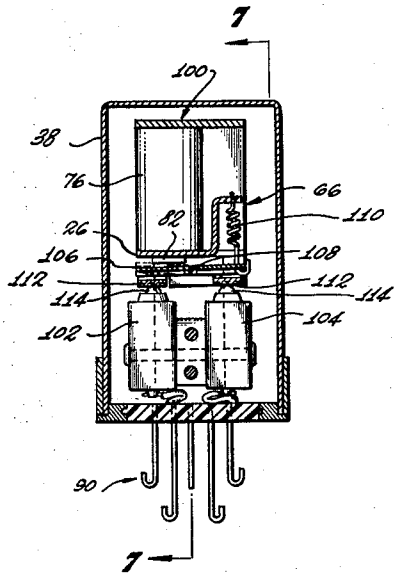


Fig. 6

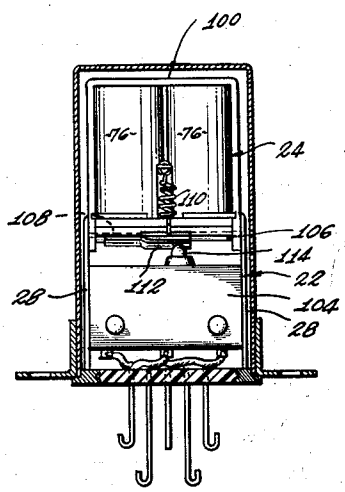


Fig. 7

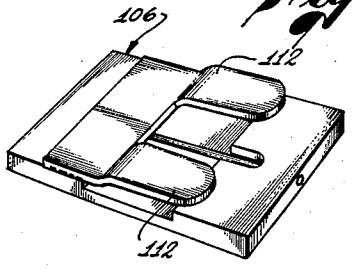


Fig. 9

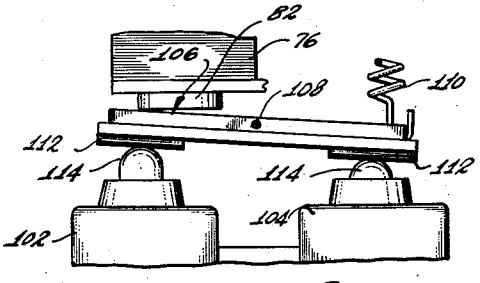


Fig. 8

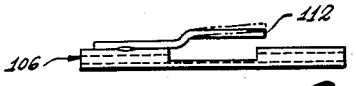


Fig. 10

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3,099,729

ELECTRICAL RELAYS

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5 Claims. (Cl. 200—104)

This invention deals generally with electrical control devices and, more particularly, with improved electrical relays.

My issued U.S. Patent No. 2,904,653 dated September 15, 1959, and entitled Relays discloses an electrical relay equipped with a self-contained electrical switch unit of the well-known "microswitch" type which is operated by an electromagnetically actuated armature of the relay and furnishes the relay contacts. This relay possesses certain highly desirable features of construction and operation which especially adapt the relay to use in modern, miniaturized electrical and electronic equipment, especially that used in airplanes and missiles. These features include miniature size, light weight, improved electrical operating characteristics, such as higher current capacity, extreme sensitivity to electrical control signals, capability of rapid operation, and insensitivity to external forces, such as shock and vibration forces and forces created by velocity changes of direction or magnitude.

A general object of this invention is to provide an electrical relay of the type disclosed in my issued patent which possesses all of the desirable features of the prior relay and certain additional, highly important features.

A more specific object of the invention is to provide an electrical relay of the character described which affords a simple and unique means for adjusting the armature of the relay with respect to the button of the self-contained electrical switch unit operated by the armature.

Another object of the invention is to provide an electrical relay of the character described which is equipped with a plurality of self-contained switch units that render the relay capable of simultaneously controlling several electrical circuits.

Yet another object of the invention is to provide an electrical relay according to the foregoing object in which the several switch units are operated by a common, electromagnetically actuated armature having a plurality of separate, bendable switch-operating fingers that may be individually adjusted with respect to the operating buttons of their respective switch units.

A further object of the invention is to provide an electrical relay of the character described in which the several self-contained switch units are arranged for simultaneous actuation by the armature of the relay.

Yet a further object of the invention is to provide an electrical relay of the character described in which the self-contained switch units are arranged for alternate actuation by the armature of the relay.

A still further object of the invention is to provide electrical relays according to the two foregoing objects which utilize the same simple and economical frame structure.

Other objects of the invention are to provide a relay which is of miniature size, light weight, and possesses the other desirable features of construction and operation preliminarily mentioned that uniquely adapt the relays to their intended purposes.

The invention will now be described in detail by reference to the attached drawings, wherein:

FIG. 1 is a perspective view, partially broken away, of one form of the present relay;

FIG. 2 is an elevational view of the left side of the relay as it is viewed in FIG. 1, the case of the relay being in section;

FIG. 3 is a section taken along line 3—3 of FIG. 2;

FIG. 4 is an exploded perspective view of the relay;

FIG. 5 is an enlarged detail illustrating the movements of the relay armature;

FIG. 6 is a vertical section through a modified relay of the invention;

FIG. 7 is a section taken along line 7—7 of FIG. 6;

FIG. 8 is an enlarged detail illustrating the armature of the modified relay;

FIG. 9 is an enlarged perspective of the armature; and

FIG. 10 is a side elevation illustrating the manner of adjusting the armature of FIG. 9.

The relay illustrated in FIGS. 1–5 of these drawings comprises a frame **20** including a lower, generally channel-shaped member **22** of non-magnetic material and an upper, generally channel-shaped member **24** having low magnetic retentivity. The base **26** of the channel member **22** extends a distance beyond the right-hand edges of the legs **28** of the member, as the latter is viewed in FIG. 4, and a distance beyond the left-hand edges of the legs **28**.

The base **26** of the lower channel member **22** has a pair of slots **30** which open through the left-hand edge of the base and are bounded on one side by the legs **28** of the lower channel member, as shown. The legs **32** of the upper channel member **24** fit within these slots **30**. The slots are slightly narrower than the thickness of the legs of the upper channel member requiring the legs to be grooved, as shown at **34**, to receive the edge portions of the base **26** that define the inner longitudinal sides of the slots **30**. After assembly of the channel members, in this way, the latter are rigidly joined by brazing, for example. The lower ends of the legs **32** of the upper channel member have right-angle portions **36** which extend across the inside of the legs **28** on the lower channel member.

The entire relay structure is enclosed within a hermetic housing consisting of a cylindrical case **38** having an integral end wall **40** and a disc **42** which closes the lower end of the case **38**. This disc has a pair of diametrically opposed notches **44** which receive tongues **46** on the lower ends of the legs **28** of the lower channel member **22**. The disc **42** is brazed or otherwise rigidly secured to these legs.

The contacts (not shown) of the relay are furnished by a plurality of self-contained electrical switch units **48**, preferably of the well-known "microswitch" type. These switch units are mounted side by side between the legs **28** of the lower channel member **22** and are secured to the lower channel member by means of pins **50** which extend through the latter legs and the housings of the switch units. Each switch unit **48** includes a depressible, spring-extended operating button **52**. The extension springs for these buttons, as well as the contacts of the switch units, are enclosed within the housings of the units and, therefore, are not visible in the drawings.

The self-contained switch units **48** are arranged so that their operating buttons **52** are located in a row extending normal to the legs **28** and parallel to the base **26** of the lower channel member **22**. These buttons are operated by magnetic armature **54** which is positioned between the legs of the lower channel member and within the space **56** existing between the switch units and the base **26** of the latter member. This armature includes a flat, generally rectangular body **58** which is pivotally mounted on the frame **20** of the relay by means of a pivot pin **60**. This pin extends through the body **58** of the armature, intermediate and parallel to its right- and left-hand edges, as the relay is viewed in FIG. 3, and is pivotally supported at its ends in the right angular extensions **36** on the legs **32** of the upper channel member **24** for pivoting of the armature on an axis **62**

parallel to the base **26** of the lower channel member and the row of switch buttons **52**.

Extending from the right-hand edge of the armature plate **58**, as the relay is viewed in FIG. 1, are a number of downwardly extending, right angular switch-operating fingers **64**. These switch-operating fingers are aligned with the switch units **48**, respectively, and bear, at their lower ends, against the operating buttons **52** of their respective switch units. The arrangement is such that when the armature **54** pivots in a clockwise direction on its axis **62**, as the relay is viewed in FIG. 1, or in the counterclockwise direction as the relay is viewed in FIGS. 3 and 5, the armature fingers **64** press inwardly against the switch buttons **52** and depress the latter against the action of their respective springs (not shown). The force exerted by the switch springs on the armature fingers, of course, tends to pivot the armature in a counterclockwise direction.

As shown best in FIG. 4, an L shaped finger **66** is struck upwardly from the center of the base **26** of the lower channel member adjacent the left-hand edge of the base, leaving a slot **68** in the base which underlies the right-angled end **70** of the finger. Connected between the end **70** of this finger and the adjacent left-hand edge of the armature plate **58** is a tension spring **72**. This spring tends to pivot the armature against the action of the springs (not shown) of the switch buttons **52**. The tension in spring **72** is set so that it just overcomes the combined force exerted on the armature by all of the springs (not shown) of the switch buttons **52**. Normally, therefore, the armature is retained, by its spring **72**, in its solid line limiting position of FIG. 5 in which the several switch buttons are depressed against the action of their springs by the armature fingers **64**. The armature plate **58** carries an adjustable stop screw **74**, the engagement of which with the underside of the base **26** of the lower channel member **22** limits pivoting of the armature under the action of its spring **72**. This stop screw is initially set to permit just sufficient counterclockwise pivoting of the armature, as the relay is viewed in FIGS. 3 and 5, to assure complete actuation of the switch units **48** and is then fixed in this adjusted position in any suitable way, such as by applying a drop of adhesive to the set screw, as shown.

The armature **54** is rocked, against the action of its spring **72**, to release the switch buttons **52** for extension of the latter by their respective springs, by energizing of a pair of electromagnetic coils **76**. These coils are arranged between the base **26** of the lower channel member **22** and an overlying portion of the base **78** of the upper channel member **24** with the axes of the coils extending normal to these bases and intersecting the armature plate **58** adjacent its left-hand edge, as the relay is viewed in FIGS. 3 and 5. Each coil has a core **80** consisting of a pin having low magnetic retentivity. The lower end of the pin has an enlarged, circular head **82** located below the base **26** of the lower channel member and just above the armature plate **58**. Each pin further includes a slender shank **84** which extends through the coil and has a reduced upper end which fits in a hole in the base **78** of the upper channel member **24**. The upper end of this reduced shank end is peened to rigidly secure the pin in position. In the normal, solid line position of the armature **54** in FIGS. 3 and 5, a narrow gap **86** exists between the heads **82** on the pins **80** and the armature plate **58**.

Energizing of the magnetic coils **76** creates a magnetic field that rocks the armature **54**, against the action of its spring **72**, to the phantom line position of FIG. 5 in which the armature fingers **64** release the switch buttons **52** for extension of the latter by their springs (not shown). When the coils are de-energized, of course, the armature is returned to its normal position by its spring **72** with resultant depression of the switch buttons **52** against the action of their springs. It will be observed that the flux path for the magnetic lines of force is

through the pins or cores **80** of the coils, across the narrow gaps **86** between the lower ends of the pins and the armature plate **58**, through the armature plate to the legs **32** of the upper channel member **24**, and thence through the base **78** of this member to the pins **80**. This path is, therefore, substantially a closed path which, together with the balancing of the armature spring **72** against the springs (not shown) of switch buttons **52**, previously discussed, provides the relay with extreme sensitivity.

The terminals of the switch units **48** and the terminals of the magnetic coils **76** are connected through leads generally denoted by the numeral **88** to a series of mutually insulated terminals **90** depending from the underside of the end closure disc **42** of the relay housing. When connecting the relay in an external circuit, therefore, it is only necessary to connect the leads of the external circuit to the appropriate terminals **90** of the relay. The "microswitch" units **48** may obviously be of the normally closed or normally open type or a mixture of these two types. If a particular switch unit is of the normally open type, of course, it will be retained in its normally closed condition, by the action of the armature spring **72**, when the relay coils **76** are de-energized and will be returned to its normally open state by energizing of these coils. Similarly, if a switch unit is of the normally closed type, it will be retained in its open condition, by the action of the armature spring **72**, when the relay coils **76** are de-energized and will be restored to its normally closed condition by energizing of the coils.

A primary feature of the invention resides in making the armature fingers **64** of a flexible material such that they may be individually bent toward and away from their respective switch buttons **52** to effect individual adjustment of the armature fingers with respect to the switch buttons, as indicated in phantom lines in FIG. 3. This adjustment may be made, for example, for the purpose of obtaining exactly simultaneous actuation of the several switch units by the armature. Thus, owing to slight structural differences in the different switch units **48**, slight differences in the travel of their buttons **52**, and slight inaccuracies in lining up the switch units during installation thereof in the frame **20** of the relay, it is essential that each armature finger be initially adjusted with respect to its particular switch button **52** to assure that the button will be properly depressed when the armature is in its normal position and properly released when the armature is rocked by energizing of the relay coils **76** as well as to assure that the several switch units will be simultaneously operated by the single armature **54** of the relay. As just mentioned, this individual adjustment of the armature fingers with respect to their particular switch buttons is accomplished by bending each finger toward or away from its respective button, as required.

FIGS. 6–10 illustrate an alternative form of the present relay which utilizes the same frame structure **20**, hermetic housing, and magnetic coil arrangement as the relay just described. In this modified relay, a pair of self-contained switch units **102** and **104** of the "microswitch" type are operated in an alternate fashion by a rectangular magnetic armature **106**. This armature is located in the space between the switch units and the base **26** of the lower channel member **22** of the frame **20** and is pivotally supported on the frame **20** by a pin **108** for pivoting of the armature on an axis parallel to the base **26** and intermediate and parallel to the right- and left-hand edges of the armature, as the relay is viewed in FIG. 6. A spring **110** is connected between the finger **66** on the frame **20** and the right-hand edge of the armature to bias the latter to its normal, solid line position of FIG. 6. The left-hand edge of the armature underlies the enlarged, lower ends **82** of the cores of relay coils **76** so that when these coils are energized, the armature is rocked against the action of its spring **110** to its phantom line position of FIG. 6.

Mounted on the underside of the armature **106**, paral-

lel to and at opposite sides of its pivot axis, are a pair of switch-operating fingers **112**. The switch units **102** and **104** are mounted between the legs **28** of the lower channel member **22** of the relay frame **20** and are located directly below these fingers, respectively, as shown best in FIGS. 6 and 8. Fingers **112** are fixed at one end to the armature and bear at their other ends against the spring-extended opearting buttons **114** of the respective switch units **102** and **104**.

In the normal, solid line position of the armature **106** in FIG. 6, button **114** of the left-hand switch unit **102** is depressed, against the action of its srping (not shown), by its armature finger **112** while the button **114** of the right-hand switch unit **104** is released by its respective armature finger **112** and is, therefore, extended by its spring (not shown). When the relay coils **76** are energized, a magnetic field is created which rocks the armature to its phantom line position of FIG. 6, also shown in FIG. 8, against the action of its spring **110**. In this latter position, the button **114** of the left-hand switch unit **102** is released by its armature finger **112** for extension of the switch button by its spring (not shown), while the button **114** of the righthand switch unit **104** is depressed, against the action of its spring (not shown), by its respective armature finger **112**.

Thus, in this modified relay, the two switch units **102** and **104** are operated alternately by the armature, rather than simultaneously as in the earlier relay. The switch-operating fingers **112** of the modified relay are made of a flexible material, as in the earlier relay, so that they may be bent, as indicated in phantom lines in FIG. 10. The fingers are bent in this way to adjust them with respect to their respective switch buttons **114** for the purpose of assuring proper operation of both switch units by the single armature, as in the relay described first.

As in the earlier relay, the terminals of the switch units **102** and **104** are connected to the external terminals **90** of the relay case **38** for connection of the relay in an external electrical circuit.

Clearly, the invention hereinbefore described and illustrated is fully capable of attaining the objects and advantages preliminarily set forth.

While certain presently preferred forms of the invention have been disclosed, these are intended to be purely illustrative in nature since numerous modifications in the design and arrangement of parts of the invention are obviously possible within the spirit and scope of the following claims.

What is claimed is:

1. An electrical relay comprising a frame, a plurality of electrical switch units mounted side by side on said frame in spaced parallel planes of the frame, an L-shaped switch-operating member having two legs positioned in angularly disposed planes substantially normal to said first-mentioned planes and arranged with one leg opposite one side of said switch units and the other leg opposite another side of the switch units whereby said switch units are positioned between said legs, means pivotally mounting said one leg on the frame for pivoting of the operating member on an axis substantially normal to said first mentioned planes, said other leg comprising approximately parallel, separately bendable switch-operating fingers, each switch unit including a spring-extended button at said other side thereof engaged by the adjacent switch-operating finger, said fingers swinging toward the switch units to depress said buttons against the action of their springs upon pivoting of the operating member in one direction and said fingers swinging away from said switch units to release said buttons for extension by their springs upon pivoting of the operating member in the opposite direction, said fingers being separately bendable toward and away from said switch units to individually adjust the fingers relative to their respective switch buttons, and means for selectively pivoting said operating member to operate said switch units.

2. The subject matter of claim 1 wherein said last-mentioned means comprises a spring acting between the frame and said operating member for biasing the latter in said one pivotal direction with just sufficient force to retain said buttons depressed against the action of their springs, a magnetic armature on said one leg of the operating member, and solenoid means on the frame for creating a magnetic field which acts on said armature to pivot said operating member in said opposite direction when the solenoid means are energized.

3. An electrical relay comprising a frame including a first channel member of low magnetic retentivity, a second channel member of non-magnetic material having its base positioned between the legs of the first channel member, an electromagnetic coil mounted between said base of the second channel member and the base of the first channel member and including a central core of low magnetic retentivity having one end extending through the base of the second channel member, an armature plate of low magnetic retentivity positioned between the legs of the second channel member, said plate having one end located opposite said one end of said core, a pivot pin passing through the legs of the second channel member parallel to its base and through said armature plate approximately parallel to and spaced from said end thereof to pivotally support said plate on said second channel member for swinging of said one end of the plate toward and away from said one end of the core, an electrical switch mounted between the legs of the second channel member at the side of said plate opposite said coil, a switch-operating finger extending from said end of and approximately normal to the armature plate and terminating opposite one side of the switch, said switch including a spring-extended operating button at said one side thereof engaged by said finger, said finger swinging toward said switch to depress said button upon pivoting of said armature plate away from said core and said finger swinging away from said switch to release said button for normal spring extension thereof upon pivoting of the armature toward said core, a spring acting between said frame and armature plate for biasing the latter away from said core with sufficient force to depress said button, and said coil being selectively energizable to create a magnetic field which acts on said armature plate to pivot the latter toward said core and thereby release said switch button.

4. The subject matter of claim 3 including a plurality of additional switches, said switches being arranged side by side in parallel planes normal to the pivot axis of the armature plate, a plurality of additional switch-operating fingers extending from said one end of the armature plate substantially parallel to said first-mentioned finger and terminating opposite said additional switches, respectively, each additional switch including a spring-extended operating button engaging its respective switch-operating finger, and said fingers being separately bendable toward and away from their respective switches to individually adjust said fingers relative to their respective switch buttons.

5. An electrical relay comprising a frame including a first channel member of low magnetic retentivity, a second channel member of non-magnetic material having its base positioned between the legs of the first channel member, an electromagnetic coil mounted between said base of the second channel member and the base of the first channel member and including a central core of low magnetic retentivity having one end extending through the base of the second channel member, an armature plate of low magnetic retentivity positioned between the legs of the second channel member, said plate having one end disposed opposite said one end of said core, a pivot pin passing through the legs of the second channel member parallel to its base and through said armature plate intermediate the ends of the plate, a pair of electrical switches mounted side by side between the legs of the second chan-

nel member at one side of said armature plate and located at opposite sides of the pivot axis of the plate, a spring-extended button on each switch opposite the adjacent end of the plate, a bendable finger on each end of the palte engaging the adjacent button so that pivoting of said plate in either direction depresses one button against the action of its spring and releases the other button for extension by its spring, said fingers being individually bendable toward and away from their respective switches to individually adjust the fingers with respect to their respective switch buttons, a spring acting between the frame and armature plate for biasing the latter in a direction to move said one end of the plate away from said one end of the core with sufficient force to depress the corresponding switch button, and said coil being selectively energizable to pivot the plate in the opposite direction.

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