Nov. 1, 1938. W. K. HOWE 2,134,945

RELAY

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FIG. 1.

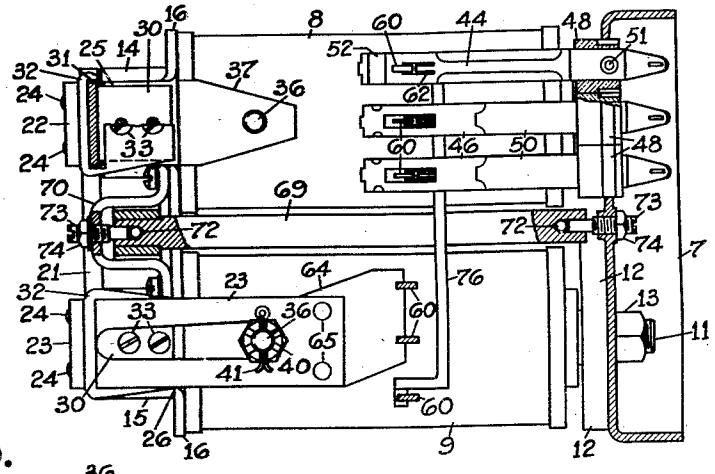

FIG. 3.

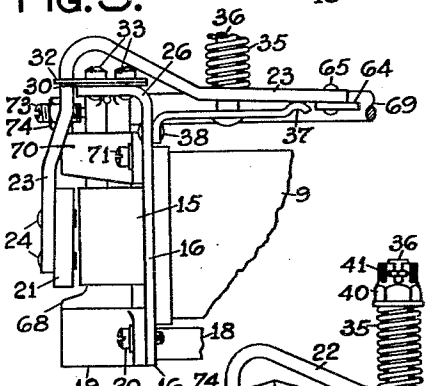

FIG. 2.

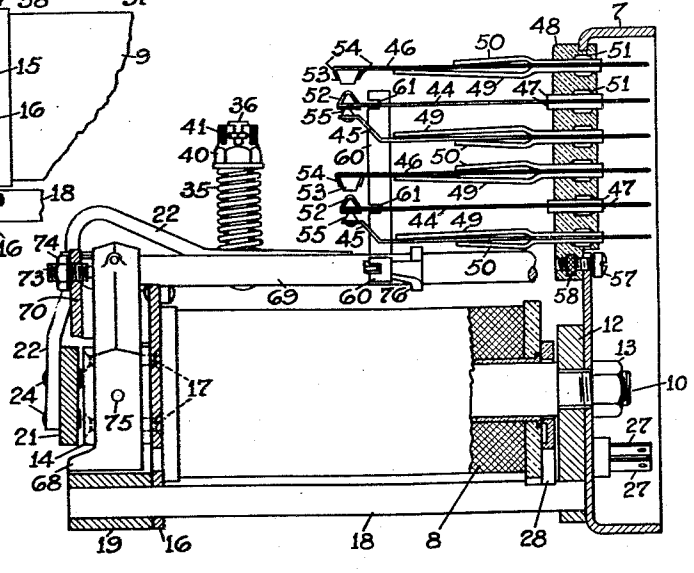

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FIG. 5.

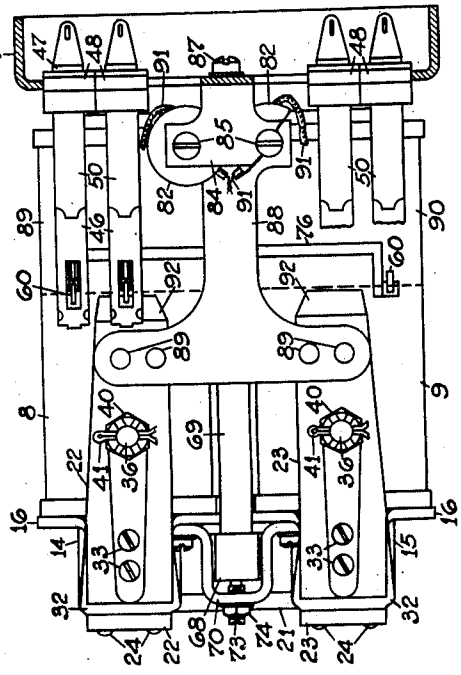


FIG. 6.

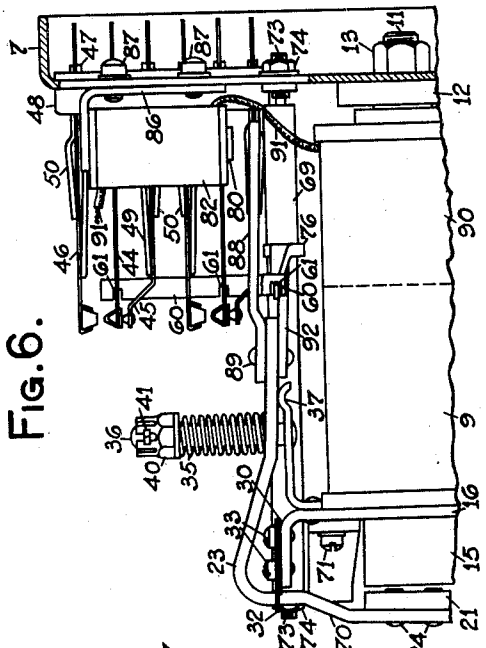


FIG. 7.

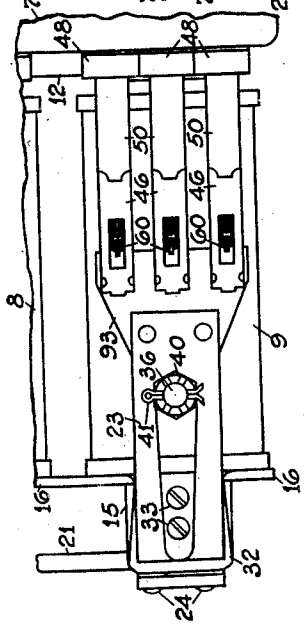
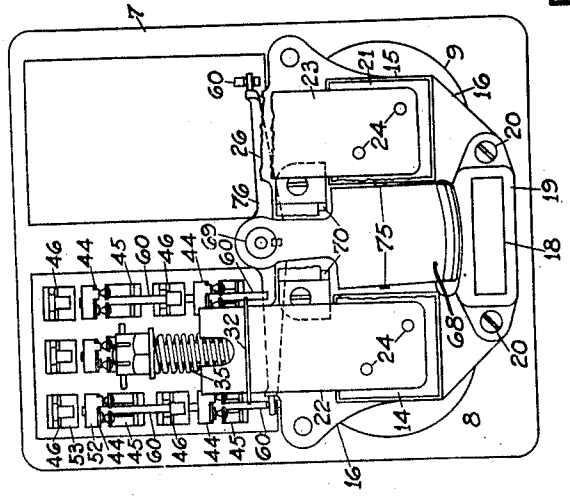


FIG. 4.



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Patented Nov. 1, 1938

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UNITED STATES PATENT OFFICE

2,134,945

RELAY

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Application July 20, 1934, Serial No. 736,260

11 Claims. (Cl. 200—93)

This invention relates in general to relays, and more particularly to a compact type of relay conforming with the requirements prescribed for use in railway signalling systems and the like.

In providing safe operation of trains over certain conflicted railway track switch and signal layouts, the control and/or operation of certain conflicting traffic controlling devices must be interlocked to prevent an operation of any of such devices which might interfere with a safe train movement over a route then aligned. One means for accomplishing such interlocking is by the well-known mechanical arrangement for at times preventing the movement of the manual controlling means for the traffic controlling devices, but such mechanical means are rapidly being superseded by systems in which the manual controlling means are at all times free to be operated and the operation of the associated traffic controlling device is safeguarded by interlocking the electrical controlling and/or operating circuits through the medium of various relays controlled both by train movements and the position of the traffic controlling devices.

In such systems, a rather large number of relays are required to provide the necessary interlocking of circuits, and as the safety of train operation is dependent upon the reliability of the operation of these relays, such specifications in the construction thereof have been prescribed which hitherto has resulted in a relay constructed of comparatively large dimensions, expensive construction and a great deal of housing space which is not always available in the railway system. Relays of different contact capacity and relays of different operating characteristics have also been of different dimensions and shape which require the stocking of spare relays of such type as well as preventing interchangeability of mounting spaces.

In view of the above and other considerations it is proposed in accordance with the present invention to provide a relay having operating characteristics and reliability which conforms with the prescribed specifications for use in railway signalling, and yet which has such reduced dimensions as will provide considerable saving in cost of manufacture as well as in the cost of housing space required. It is also proposed to provide a relay of a standard dimension regardless of contact capacity or characteristic of operation, and in which the majority of parts are interchangeable in the assembly of any of the various sizes or types.

Other objects, purposes and characteristic features of the present invention will appear as the description thereof progresses, during which references will be made to the accompanying drawings, in which—

Fig. 1 is a plan view of a relay constructed in accordance with the present invention with some parts removed and others sectioned to more clearly show the construction.

Fig. 2 is a sectional side elevational view of Fig. 1.

Fig. 3 is a side elevational view of a portion of Fig. 1.

Fig. 4 is an elevational view of the armature end of the relay shown in Fig. 1 also with certain parts removed and others broken away.

Fig. 5 is a plan view of substantially the same relay as shown in Fig. 1 with additional features providing different operated characteristics.

Fig. 6 is a partial side sectional view of the relay shown in Fig. 5; and

Fig. 7 illustrates still another change which may be made in the present relay to provide still a different type of operation.

One of the forms in which the present relay may be arranged is the polar neutral type, that is, the type in which one armature is operated to a definite position in response to either of two polarities of energization, while a second armature responds only to the presence of energy. Such type of relay has been shown in Figs. 1, 2, 3 and 4 of the accompanying drawings and is assembled about a rigid back plate 7 formed of sheet metal with the outside edges pressed at right angles thereto to add to its rigidity.

The electro-magnetic structure of this relay comprises two coils 8 and 9 wound around magnetic cores 10 and 11 respectively, which cores have threaded rear ends of reduced diameter which pass through holes in a magnetic back strap 12 as well as through holes registering therewith in the plate 7, with nuts 13 clamping the back strap 12 between the shoulders formed by the reduced diameter core ends and the plate 7 to support the electro-magnetic structure thus formed. The front ends of the cores 10 and 11 have enlarged rectangular pole pieces 14 and 15 respectively which are joined by a non-magnetic armature supporting member 16 suitably fixed thereto such as by rivets 17 passing through the pole pieces 14 and 15, as shown in Fig. 2. Suitable coil terminals 27 are provided for external wire connections thereto, and these terminals 27 may be secured to an insulating member 28 having a hollow boss extending through the back plate 7.

The polarized field structure comprises a permanent bar magnet 18 carried below and midway between the cores 10 and 11, the rear end thereof being placed through a closely fitting hole in the magnetic back strap 12 as shown in Fig. 2 so as to abut the back plate 7 and is thereby magnetically joined to the cores 10 and 11. The front end of the permanent magnet 18 extends through a rectangular hole in the armature supporting member 16 and terminates in a magnetic pole piece 19 attached by screws 20 to the armature supporting member 16.

A neutral armature 21 arranged to operate to a position magnetically connecting the front ends of the pole pieces 14 and 15, which armature 21 is carried by two arms 22 and 23 fixed thereto by rivets 24 so as to extend upwardly and over the top of the coils 8 and 9 respectively, the horizontal portion of arm 22 being broken away in Fig. 1 and Fig. 4. The non-magnetic armature supporting member 16 is provided with two spaced outwardly extending lugs 25 and 26 (see lug 26 in Fig. 3) serving to support the armature 21 through pivoting means acting upon the vertical portion of the armature arms 22 and 23.

The pivoting means for the neutral armature has herein been shown in Fig. 3 as flat pivot strips 30 entering shallow horizontal slots 31 in the inside of each of the armature arms 22 and 23, with retaining strips 32 arranged to encircle the arms 22 and 23 to thereby retain the strips 30 within the slots 31 of the operating arms 22 and 23. Screws 33 are threaded into the lugs 25 and 26 and serve to clamp both the pivot strips 30 and the retaining strips 32 upon the upper surface of the lugs 25 and 26. Inasmuch as the travel of the neutral armature 21 is very slight the horizontal slots 31 allow the armature arms 22 and 23 to rock slightly about the ends of the strips 30 to thereby provide an armature hinging means which offers a minimum of friction and permits substantially no lost motion.

The neutral armature 21 thus pivotally supported is biased away from the pole pieces 14 and 15 by compression springs 35 operating on respective vertical rods 36, which rods 36 are suitably attached at their lower ends to respective rearwardly extending horizontal arms 37 which are in turn attached to the armature supporting member 16 by rivets 38. The vertical rods 36 extend through cut-away portions in the horizontal part of the armature arms 22 and 23, with the lower ends of the compression springs 35 resting on the top surface of these armature arms, while the upper ends engage the lower surface of respective castle nuts 40 threaded upon the upper ends of the rods 36. The downward biasing force exerted by the springs 35 upon the armature arms 22 and 23 can obviously be adjusted by the nuts 40, and the desired position thereof may be retained by cotter keys 41 extending through the respective rods 36.

In the present relay, the springs 35 may be replaced by weights, or specifically, a rather heavy bar may be provided to join the two armature arms 22 and 23 which will then act to bias the arms 22 and 23 downwardly and operate the neutral armature 21 away from the pole pieces 14 and 15 when the energization of the windings 8 and 9 falls below a predetermined value. While these armature biasing weights would not be as easily adjustable as the springs 35, the weight or gravity biasing means does have the advantage of being entirely reliable and obviates the danger of a broken or improperly adjusted spring causing a failure of the armature 21 to release when the relay coils are de-energized.

The biased or de-energized position of the neutral armature is limited by upturned ends of the arms 37 which engage the lower surfaces of the respective armature arms 22 and 23, while the attracted or energized position thereof is limited by enlarged protruding heads of the rivets 24 which engage the surface of the pole pieces 14 and 15 when the armature is attracted thereto.

The contracts operated by the neutral armature 21 have been shown as flexible movable fingers 44 which cooperate with flexible back contact fingers 45 and with similar flexible front contact fingers 46, all of which fingers are moulded into insulating members 48 to thus form several vertical contact groups. The center four vertical groups (two of which have been omitted in Fig. 1) are operated by the neutral armature, while the two extreme outer vertical groups (one being omitted in Fig. 1) are operated by the polar responsive armature as will be described later.

The front contact fingers 46 and the back contact fingers 45 are provided with long rigid stop strips 49 placed on the side thereof adjacent the associated movable fingers 44, with short stop strips 50 arranged on the opposite sides thereof, these long and short stop strips being fixed to the opposite sides of the associated fingers by through rivets 51 within the moulded insulating member 48. The movable contact fingers 44 are reinforced within the moulded member 48 by stub strips 47 held each side thereof by similar rivets 51.

It is, of course, understood that the above-described contact fingers are first assembled with their stops, as shown, and then held by a suitable jig while being moulded within a suitable insulating holding material, such as bakelite, to form the vertical contact group as shown in Fig. 2. In the sectioned view of one of the contact holding members 48 shown in Fig. 1, it may be seen that the rear of the members 48 has a reduced width thereby presenting a greater electrical "creeping" distance, that is, the linear surface distance separating the contact fingers of adjacent vertical groups. These contact groups can, of course, be arranged in various other combinations to suit the particular requirements.

The tops of the vertical contact holding members 48 have traversed slots therein which receive an edge of the back plate 7 when the contact holding members 48 are placed within an opening of the vertical back plate 7 as shown in Fig. 2, and the lower ends are held by screws 57 threaded into inserts 58 embedded within the contact holding material 48, which screws 57 then serve to clamp the lower end of the members 48 against the back plate 7.

The movable fingers 44 of each vertical contact group are connected by an insulating strip 60 which passes through elongated clearance holes in both the front fingers 46 and the back fingers 45 as well as through elongated slots in the longer stop strips 49, but is operably connected to the movable fingers 44 by notches 61 therein. The upper front contact finger of the outer vertical group in Fig. 1 has been broken away to illustrate the manner of installing the insulating strips 60. The movable contact fingers 44 are each provided with a rectangular hole having an inwardly extending projection 62 integral with the finger 44, which projection is bent in assembling either upwardly or downwardly at right angles thereto

to allow the insulating strip 60 to be inserted endwise through the movable fingers of the vertical groups, and when in place, the insulating strip 60 is moved toward the front of the contact fingers so that the notches 61 receive a portion of the contact fingers 44 and the projection 62 is then bent back into place, thereby retaining the insulating strip 60 in such position.

Contact points are attached to the extreme front ends of the contact fingers as may be seen in Fig. 2, thus permitting the contact points to be easily inspected and cleaned when the relay is in service. The particular arrangement of contact points shown comprises a substantially mound-shaped strip 52 of contact material such as silver attached to the upper surface of the movable fingers 44, the ends of this mound-shaped strip 52 being of a reduced width and laterally staggered to hold the strip 52 in place when placed through openings in the fingers 44 and bent inwardly against the lower surface thereof. The upper surface of the mound-shaped strip 52 registers with the lower surface of a wedge-shaped silver plated carbon block 53 which is held against the lower surface of the front contact finger 46 between lugs 54 formed integral therewith. The edges of the fingers 46 are provided with notches as shown in Fig. 1 which are filled with solder which knits to both the silver plated carbon block 53 and the finger 46 to insure a good electrical and mechanical connection therebetween. The previously mentioned ends of the strip 52 which are bent against the lower surface of the strips 44 are arranged to overlap and the lower surface of these ends register with laterally spaced silver contact buttons 55 attached to bifurcated upturned ends of the back contact fingers 45.

The four center vertical contact groups are operated by two bridges 64 attached to the respective armature arms 22 and 23 by rivets 65, the armature arm 22 and its associated bridge 64 being removed in Fig. 1, but it is to be understood that it is to be assembled in the same manner as the similar armature arm 23. The lower ends of the strips 60 are provided with notches 61 similar to the notches receiving the movable contact fingers 44 and these lower notches 61 receive the rearwardly extending ends of the bridges 64. This provides a means for both pushing the strips 60 upwardly as well as for pulling them downwardly by the operation of the armature 21. In this manner, the compression springs 35 furnish the means for biasing the armature 21 to its deenergized position and to provide the necessary force to insure proper contact pressure between the movable fingers 44 and the back fingers 45, thereby providing a more reliable operation and an easier adjustment thereof than is obtainable in former relays of this type in which such biasing force is provided by a downward deformation of the movable fingers formed during fabrication. It will be noted in the extreme outer contact group in Fig. 1 that the movable contact finger 44 is cut away in the portion between the strip 60 and the holding member 48 to provide greater flexibility.

The polar responsive portion of the present relay comprises a pendulous armature 68 co-acting with the inner vertical edges of the electro-magnet pole pieces 14 and 15 and magnetically coupled by an enlarged convex lower end to a concave upper surface of the permanent magnet pole piece 19 through a small separating air gap. The polar responsive armature 68 is suitably fixed to a reduced end of a horizontal shaft 69 extending longitudinally between the back plate 7 and an outwardly extending front supporting bracket 70 held to the non-magnetic armature supporting member 16 by screws 71. A concentric hole is drilled in each end of the shaft 69, each hole receiving a closely fitting end of a trunnion bearing 73, one trunnion bearing 73 being threaded into the back plate 7 and another being threaded into the front supporting bracket 70. These trunnion bearings 73 are adjusted to a position wherein their ends abut a ball-bearing 72 placed at the ends of each hole in the shaft 69, and are locked in such a position by nuts 74 to thus support the shaft 69 in a manner which permits a minimum friction in rotation and substantially no end play.

A horizontal beam 76 is suitably attached to the mid-section of the shaft 69 with the ends thereof operably connected to the insulating strips 60 of the two extreme outer vertical contact groups in the same manner as the neutral armature contact bridges 64. The polar responsive armature 68 is shown in Fig. 4 as retained against the pole face 15 by flux produced by the permanent magnet 18, thereby holding the horizontal beam 76 in its counter-clockwise operated position which pushes the movable fingers 44 upwardly in the right-hand group and pulls the movable fingers downwardly in the left-hand group. Residual pins 75 are provided in each side of the polar responsive armature 68 to insure the proper residual air gap when operated either against the pole piece 14 or pole piece 15.

The position of the polar armature 68 in Fig. 4 is of course in response to a definite polarity of energization of the electro-magnet coils 8 and 9, and obviously if the reverse polarity is next applied, the armature 68 will swing to a position adjacent the pole piece 14 and reverse the position of the movable contacts in the two outer groups. When the energization of coils 8 and 9 of the present relay is shifted from one polarity to the other, it will be obvious that the neutral armature 21 will be released from the pole pieces 14 and 15 when the flux in the magnetic structure passes through a zero value and will be again attracted when the new direction of flux reaches a normal value. This operation is permissible in some applications, but, however, other applications require that the neutral armature remain in its attracted position during a change in the position of the polar armature in response to a quick change in the polarity of energization of the relay, and a means for obtaining such operation has been disclosed in Fig. 5 and Fig. 6.

The relay construction in this embodiment is substantially the same as previously described in connection with Fig. 1, but with a neutral armature retaining means added, which comprises two vertical magnetic cores 80 having windings 82, with a top magnetic yoke 84 attached by screws 85 to magnetically join the upper ends of the two cores 80. The top yoke 84 is provided with a downwardly extending integral arm 86 attached to the back plate 7 by screws 87 to thereby support the retaining electro-magnetic structure thus formed.

The relay in Fig. 5 and Fig. 6 is also provided with an additional T-shaped member 88 attached by rivets 89 to both of the armature arms 22 and 23 with a rearwardly extending leg having a widened end co-acting with the lower ends of the two cores 80 and positioned to be adjacent these core ends when operated upwardly by the attraction of the neutral armature 21.

In addition to the operating windings 8 and 9,

two secondary windings 89 and 90 are placed on the cores 10 and 11 which are connected in series and in multiple with the windings 82 which are also connected in series, these connections being indicated by wires 91 in Fig. 5 and Fig. 6. In changing the polarity of the operating windings 8 and 9 it will be obvious that current will be induced in the coils 89 and 90 due to the changing flux values and direction in the main electro-magnetic structure, and this current being conducted through the windings 82 will produce a flux in the retaining electro-magnetic structure effective to hold the member 88 and consequently the armature 21 in its attracted position during the period in which the flux of the main magnetic structure is passing through its zero value, and, of course, when the flux in the main magnetic structure reaches its normal value in the new direction the armature 21 will be subsequently retained thereby.

In Fig. 5 and Fig. 6 the two center vertical contact groups have been omitted to provide space for the retaining magnetic structure, and the contact operating bridges 92 have been accordingly modified, but otherwise the component parts of this relay may be of identical construction as described in connection with the relay of Fig. 1 and the same reference characters have been assigned thereto.

There are, of course, certain other relay applications wherein it is desirable to provide a response to the presence or absence of energization without detecting the polarity of such energization, and certain modifications may be made in the present relay to provide such characteristics as has been illustrated in the partial view of Fig. 7. In this embodiment all the parts of the relay of Fig. 1 which contribute to the detection of the polarity of energization have been omitted, such as, the permanent magnet structure, armature 68 and apparatus operated thereby, thus permitting the contact operating capacity of the neutral armature 21 to be increased, or by a modified bridge 93 each of the neutral armature arms 22 and 23 can operate three vertical groups of contacts, that is, the neutral armature in Fig. 7 may be arranged to operate any number of vertical contact groups up to six. The other parts of the relay in Fig. 7 are intended to be the same design and dimensions as the parts of the relay of Fig. 1 which respond only to the presence or absence of energy in the operating coils.

In all the various embodiments of the present relay, the contact fingers have been shown as extending rearwardly from the holding members 48 to which the various external wire connections may be soldered, but it is desired to be understood that various other connecting means may be employed which will permit convenient removal of the relay from service without disturbing the arrangement of the external wire connections. A quick detachable connecting means which may be employed in the present relay is shown, for example, in the application of J. F. Merkel, Ser. No. 608,037 filed April 28, 1932 which became Patent No. 2,069,171 on January 26, 1937.

A relay having operating characteristics and reliability which compares with that formerly obtainable only in relays of considerable larger dimensions has thus been provided thereby permitting a substantial saving in manufacturing costs and in housing space required in practical applications. A particular feature of the present device is the provision of a universal structure wherein a standard over-all dimension is maintained regardless of contact capacity or particular operating characteristics. In other words, the present device by different selections of only a few parts may be assembled as a polar neutral relay, a retained-neutral polar relay, or simply a neutral relay, but regardless of the type, the same mounting space is required, and the majority of the parts being interchangeable, the fabrication and repair of the various type is greatly facilitated.

The above rather specific description of the selected forms of the present invention is given solely by the way of example and is not intended in any manner whatsoever in a limiting sense. It is also to be understood that various modifications, adaptations and alterations may be applied to meet the requirements of practice without in any manner departing from the spirit or scope of the present invention except as limited by the appended claims.

What I claim is:

1. In a direct current relay, two spaced horizontal operating electro-magnets magnetically joined at their rear ends, a neutral armature operable to a position magnetically bridging the front ends of the electro-magnets, adjustable compressing spring means biasing the neutral armature away from said bridging position, contact means positively operated in either of two directions by the neutral armature, a permanent magnet extending parallel to the operating electro-magnets, a pendulous vertical armature co-acting with the electro-magnets and the permanent magnet in a manner to distinctly respond to the polarity of energization of the operating electro-magnets, two vertical electro-magnets magnetically joined at their upper ends, a secondary winding on the horizontal operating electro-magnets connected to the vertical electro-magnets whereby the vertical electro-magnets are energized upon current changes in the operating electro-magnets, and a magnetic member attached to the neutral armature and co-acting with the vertical electro-magnets in a manner to retain the neutral armature in said magnetically bridging position during energization of the vertical electro-magnets.

2. In a relay, a neutral armature, an operating electro-magnet for attracting or releasing the neutral armature, adjustable springs biasing the neutral armature to its released position, a retaining electro-magnet disposed at right angles to the operating electro-magnet and arranged to be energized upon current changes in the operating electro-magnet, and a magnetic member attached to the neutral armature and co-acting with the retaining electro-magnet whereby the neutral armature is retained in its attracted position during a reversal of current direction in the operating electro-magnet.

3. In a relay, a neutral armature, an operating electro-magnet for attracting or releasing the neutral armature, adjustable springs biasing the neutral armature to its released position, a retaining electro-magnet disposed at right angles to the operating electro-magnet and connected to be energized upon current changes in the operating electro-magnet, a magnetic member attached to the neutral armature and co-acting with the retaining electro-magnet whereby the neutral armature is retained in its attracted position during a reversal of current direction in the operating electro-magnet, and a plurality of vertically spaced flexible contact fingers operably connected at intermediate points thereof to be

positively actuated in two directions by the neutral armature.

4. In a relay, two spaced horizontal operating electro-magnets magnetically joined at their rear ends, a neutral armature operable to a position magnetically shunting the front ends of the electro-magnets, adjustable springs biasing the neutral armature away from its shunting position, a plurality of vertically spaced horizontal contact fingers pushed upwardly and pulled downwardly at intermediate points thereof by the operation of the neutral armature, a permanent magnet joined at its rear end to the rear of the operating electro-magnets, a pendulous polar armature co-acting with the front ends of the operating electro-magnets and with the front end of the permanent magnet, a rotatable horizontal shaft carrying the polar armature, laterally extending arms on the shaft, and a plurality of vertically spaced horizontal contact fingers pushed upwardly and pulled downwardly at intermediate points thereof by the arms.

5. In a polar-neutral relay, two spaced horizontal electro-magnets joined at one end and having enlarged rectangular pole pieces at the other ends, a horizontal permanent magnet joined at one end to the joined end of the electro-magnets and having an enlarged curved upper pole face at the other end, a neutral armature co-acting with the front of the electro-magnet pole pieces but spaced from the permanent magnet, and a pendulus polar armature co-acting with the upper pole face of the permanent magnet and operable to engage the inner vertical edge of either of the electro-magnet pole pieces.

6. In a relay, two spaced horizontal electro-magnets magnetically joined at their rear ends, an armature co-acting with the front ends of the electro-magnets, armature supporting arms extending horizontally above the electro-magnets, adjustable spring means acting on the armature supporting arms in a manner to bias the armature away from the front ends of the electro-magnets, a plurality of horizontal contact fingers vertically spaced above the electro-magnets, and an insulated member connecting intermediate portions of the contact fingers to the armature supporting arms whereby the contact fingers are positively actuated in each direction.

7. In a polar-neutral relay of the class wherein a neutral armature operates vertical groups of flexible contact fingers in accordance with the energized or de-energized condition of an electro-magnet and a polar armature operates similar contacts according to the polarity of energization of the electro-magnet, the combination of a shaft rotated by the polar armature with a transverse contact operating arm extending beneath the vertical groups of contacts whereby the vertical groups of contacts associated with the polar armature may be positioned and actuated in the same plane as the vertical groups of contacts associated with the neutral armature.

8. A relay having in combination a first armature responsive to the polarity of energization of the relay, a second armature independent of the first armature and responsive to the energization or de-energization of the relay, a plurality of first vertical contact groups operated by the second armature, and means operating a plurality of second vertical contact groups by the first armature, said second groups being positioned in spaced parallel relationship to the first contact groups.

9. In a relay, an electro-magnet, a plurality of vertical groups of contacts mounted in spaced parallel relationship, and mounting and supporting means permitting assembling the relay whereby said vertical groups of contacts may be all operated in unison in accordance with the energized or de-energized condition of the electro-magnet, or some operated in accordance with the energized or de-energized condition of the electro-magnet and others operated in accordance with the polarity of energization of the electro-magnet, or some operated in accordance with the energized or de-energized condition of the electro-magnet and maintained in a definite operated position during a change in position of others which are operated in accordance with the polarity of energization of the electro-magnet.

10. In a relay, in combination, a pivoted armature, electro-magnetic means for actuating the armature, a plurality of movable contact fingers, fixed contact fingers cooperating with the movable fingers, an elongated slot in each of the contact fingers, a notch in the insulating strip for each of the movable contact fingers, the strip passing loosely through each of the slots and receiving a part of each movable contact finger in its respective notch, and means for holding each movable contact finger in its notch to operatively connect only the movable contact fingers to the strip.

11. In a relay, in combination, an electro-magnet, a base supporting the electro-magnet, a panel, a plurality of vertical groups of contacts mounted in spaced parallel relationship on the panel, a polar and a neutral armature cooperating with the electro-magnet, removable means for connecting the polar armature to part of the groups of contacts; means on the panel for replacing part of the groups of contacts by a retaining armature, means for connecting the retaining armature to the neutral armature, operating means for connecting the neutral armature to all the groups of contacts not connected to the polar armature, and means fitting in place of the operating means for connecting the neutral armature to all the groups of contacts.

WINTHROP K. HOWE.