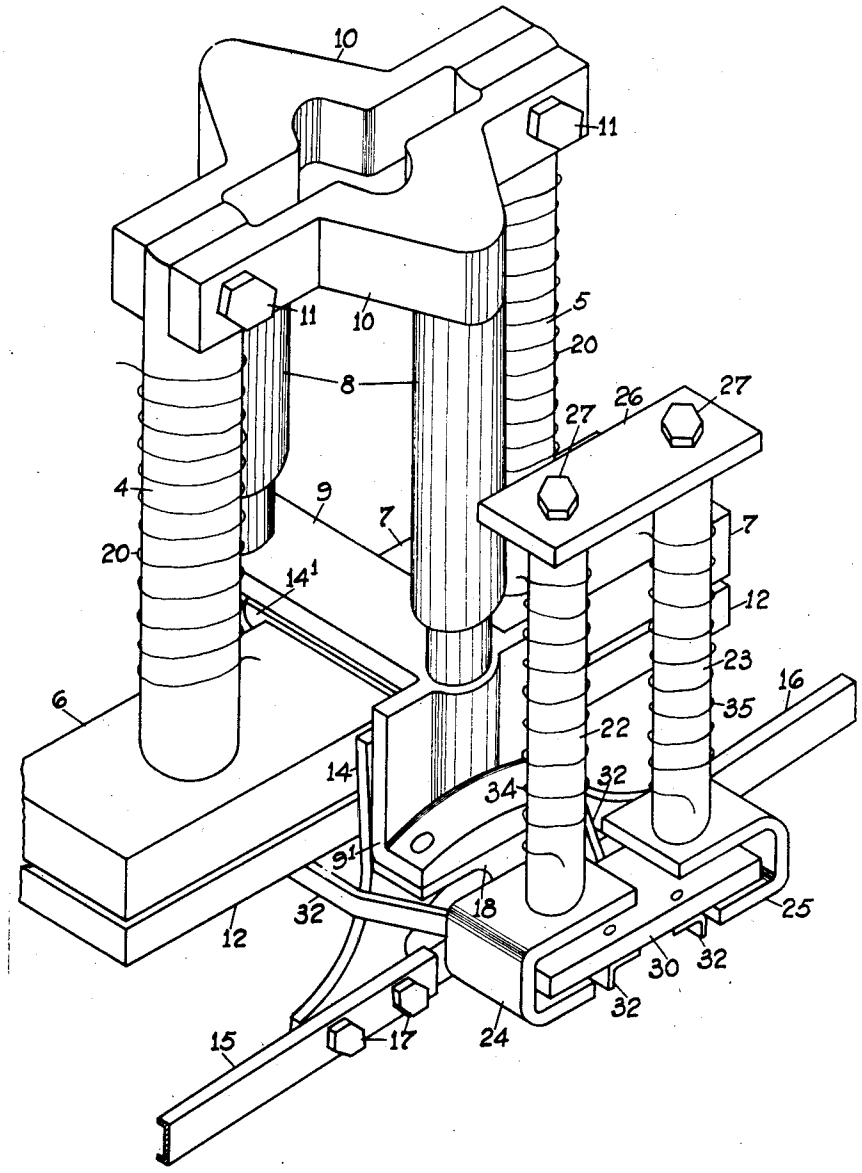
Oct. 26, 1937. J. E. WILLING 2,096,929

RELAY

Filed May 31, 1935 2 Sheets-Sheet 1

FIG. 1.



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RELAY

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FIG. 2.

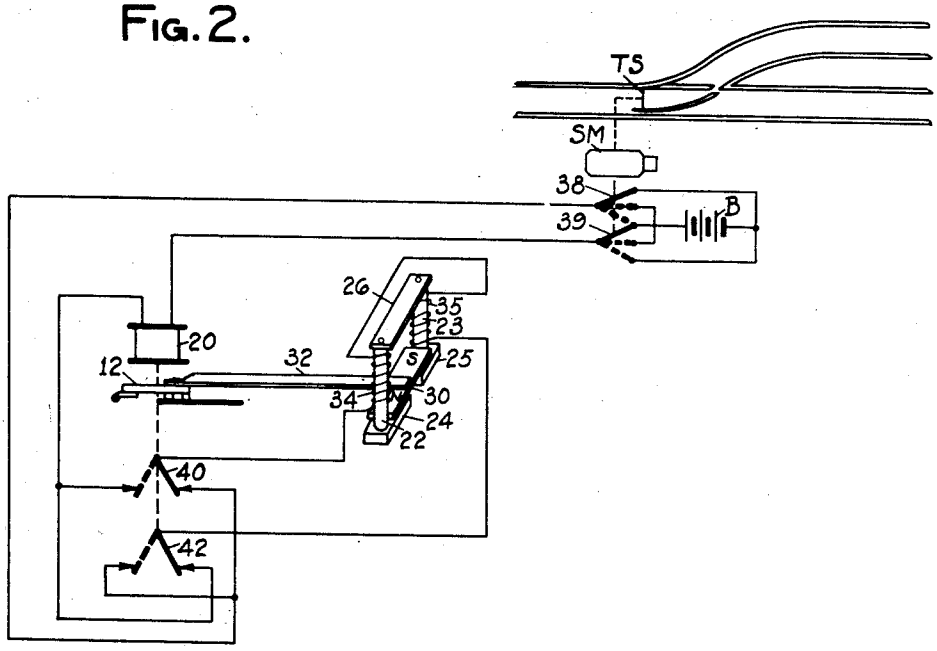
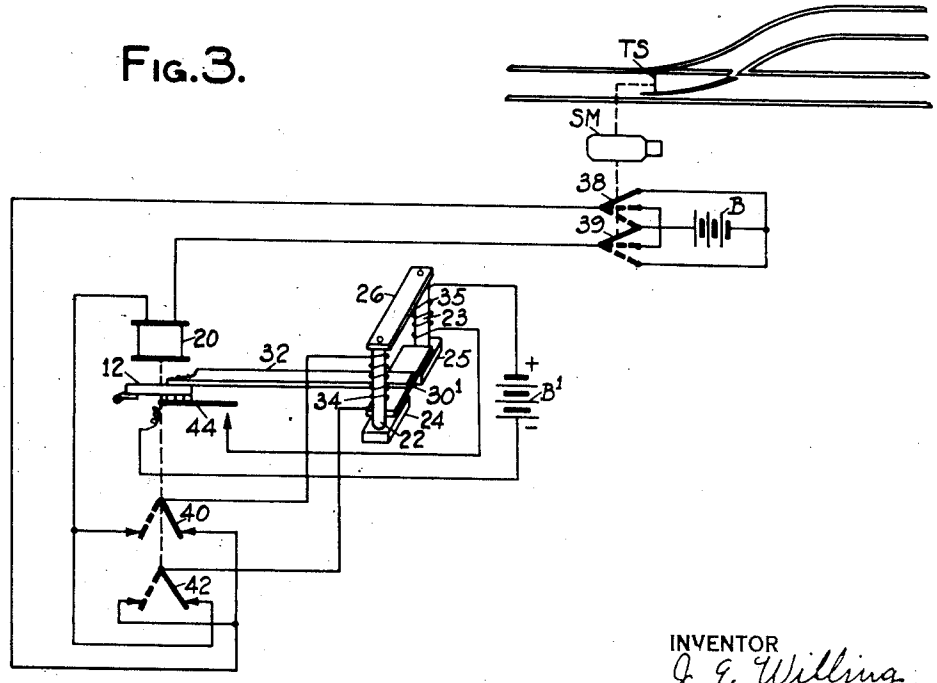


FIG. 3.



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2,096,929

RELAY

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Application May 31, 1935, Serial No. 24,164

10 Claims. (Cl. 175—320)

This invention relates in general to relays and more particularly to a neutral polar type of relay for railway signalling purposes.

It is often necessary in railway signalling systems to provide a neutral polar relay which is arranged to operate its neutral and polar contacts in accordance with the condition of a remote device such as a track switch. For example, such a neutral polar relay may be energized with one polarity or the other of direct current over a suitable control circuit in accordance with the opposite extreme positions of a track switch, and de-energized when the track switch is in an intermediate position, to thereby select circuits for the clearing of signals associated with various routes over the track switch by the positioning of the polar contacts, with this selection of signals being made dependent upon the closing of a neutral front contact. It may happen that the polar armature will fail to change its position in response to a change of polarity due to some accidental friction in the polar structure, or the like, although the neutral armature properly picks up. This would cause a signal to clear for a wrong and possibly an unsafe route.

In view of the above and other considerations, it is proposed in accordance with the present invention to provide a neutral polar relay in which the neutral armature will pick up only when the position of the polar armature corresponds to the polarity of energization of the relay.

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 perspective view of the magnetic structure of a neutral polar relay arranged in accordance with the present invention.

Fig. 2 is a diagrammatic view of one arrangement of the relay partially illustrated in Fig. 1 and shown in connection with a railway track switch.

Fig. 3 is a diagrammatic view of a modified arrangement of the relay partially illustrated in Fig. 1 also shown in connection with a railway track switch.

In Fig. 1 of the accompanying drawings, the magnetic structure of a neutral polar relay constructed in accordance with the present invention is illustrated in perspective, and it is noted that the majority of the mechanical details of this structure are of similar arrangement as shown for example in my earlier Patent No. 1,969,055 granted August 7, 1934, to which reference may be made for details omitted from Fig. 1. This structure comprises two vertical electro-magnet cores 4 and 5 terminating at their lower ends in enlarged pole pieces 6 and 7 respectively and two vertical permanent magnets 8 terminating in a common pole piece 9 at their lower end, the upper ends of the electro-magnet cores 4 and 5 and the permanent magnets 8 all being joined by top yokes 10 of magnetic material held in place by bolts 11.

A neutral armature 12 is pivotably supported beneath the pole pieces 6 and 7, and windings 20 are provided on the cores 4 and 5 to produce a flux attracting armature 12 upwardly by current flowing in either direction therethrough. It may be seen in Fig. 1 that the permanent magnet pole piece 9 extends transversely between and slightly above the inner ends of the pole pieces 6 and 7, and a vertical integral portion 9^1 extends downwardly in front of the neutral armature 12. A hanger member 18 is attached to the lower end of this vertical portion 9^1 of the permanent magnetic pole piece which extends downwardly and is arranged to provide a horizontal pivotal support for a polar armature 14. The pivot means for the polar armature 14 is not entirely shown in Fig. 1, but from the above mentioned Patent No. 1,969,055, it will be seen that polar armature 14 is arranged to operate in a vertical plane about a horizontal pivot extending transversely with respect to the neutral armature 12.

The vertical portion of the polar armature 14 is magnetically coupled through a small air gap to the rear side of the vertical portion 9^1 of the permanent magnet pole piece, and a horizontal integral portion 14^1 of the polar armature extends rearwardly between the inner ends of the pole pieces 6 and 7, and this portion 14^1 is separated by a small air gap from the horizontal permanent magnet pole piece 9. The permanent magnets 8 are arranged with like poles joined to the pole piece 9 so that the polar armature 14 is continuously magnetized with a definite polarity which causes operation of the horizontal portion 14^1 thereof into engagement with either the inner vertical surface of pole piece 6 or the inner vertical surface of pole piece 7 according to the direction of current in windings 20.

Suitable contacts which have not been shown herein are of course operated by the neutral armature 12, and the polar armature 14 is provided with channel members 15 and 16 attached thereto by bolts 17 to extend from opposite sides thereof for the purpose of operating suitable polar contacts, it being understood that these movable

contacts of both the neutral and polar armatures cooperate with suitable fixed contacts in accordance with the usual practice, and may be arranged as shown in detail in Patent No. 1,969,055. In other words, the magnetic structure thus far described provides a means for operating contacts by a neutral armature 12 in accordance with the presence or absence of current in windings 20, and for operating contacts by a separate polar armature 14 in accordance with the direction of current flowing in windings 20.

A neutral armature retaining magnetic structure is also illustrated in Fig. 1 which is located in front of the neutral armature 12 and comprises two vertical electro-magnet cores 22 and 23 which are magnetically joined at their upper ends by a yoke 26 held thereon by studs 27 while the lower ends terminate in C-shaped pole pieces 24 and 25 respectively. These C-shaped pole pieces 24 and 25 extend around opposite ends of a retaining armature 30 so that the lower horizontal ends of the pole pieces coact at times to magnetically hold the retaining armature 30 thereagainst, while the upper horizontal portion of these C-shaped pole pieces 24 and 25 are spaced sufficiently above the armature 30 (even with armature 30 in its raised position) to have substantially no magnetic effect thereon.

The retaining armature 30 is rigidly attached to the neutral armature 12 by connecting arms 32 but is preferably magnetically insulated therefrom by making the arms 32 of non-magnetic material or by any other suitable means. Thus, the retaining armature 30 is moved into engagement with or away from the lower horizontal portions of pole pieces 24 and 25 by the release and pick up respectively of the neutral armature 12, subject to the checking control presently to be described. The retaining cores 22 and 23 are provided with windings 34 and 35 respectively which are arranged, as will be later described, to at times produce a flux attracting armature 30 downwardly with a force which, when multiplied by its greater lever arm, is sufficient to prevent the attraction of the neutral armature 12 when the operating windings 20 are energized. The retaining armature 30 in the form of the present invention shown in Fig. 2, is a permanent magnet, while in the modified form shown in Fig. 3, is a soft iron armature, all as will be later described. It will also be clear that in the magnetic structure illustrated in Fig. 1, the cores 4 and 5, the permanent magnets 8 and the retaining magnetic cores 22 and 23 are all to be supported on an insulating top plate, it being understood that this and various other details which are not shown are to be arranged in accordance with the usual practice or as shown in my prior Patent No. 1,969,055.

The relay of the present invention has been shown in Fig. 2 and Fig. 3 as controlled in accordance with the position of a track switch TS. The track switch TS is shown in a conventional manner as being power-operated by a switch machine SM of a type such as shown for example in the patent to W. K. Howe Patent No. 1,466,903 dated September 4, 1923. Two movable contacts 38 and 39 are shown as associated with the track switch TS and switch machine SM, and this may represent a point detector contact mechanism such as shown in the patent to C. S. Bushnell Patent No. 1,517,236 dated November 25, 1924. It is believed to be sufficient for an understanding of the present invention to know that the contacts 38 and 39 are in their present normal positions when the track switch TS is in a normal position in correspondence with the switch machine SM and is locked; that the contacts 38 and 39 are in their mid-position whenever the track switch TS is unlocked or in operation, and that contacts 38 and 39 are in a reverse or dotted position whenever the track switch TS is in its reverse position in correspondence with the switch machine SM and is locked.

The present relay has been illustrated in Fig. 2 and Fig. 3 in a diagrammatic manner and parts thereof representing parts shown more in detail in Fig. 1 have been given like reference characters. It is also to be understood that, although only such contacts as enter into the relays operating circuits have been shown, various other polar and neutral contacts are of course provided to effect the control of various circuits such as the clearing of signals associated with routes over the track switch TS and for the selecting of various locking and indicating circuits, or the like, in accordance with the usual practice.

Operation

Referring first to Fig. 2, the operating windings 20 of the present relay are energized by current flowing therethrough in a normal direction over a circuit from the (+) terminal of a suitable source of energy such as battery B, through contact 36 in its normal position, through a polar contact 40 in its right hand position, upwardly through winding 34 on the retaining magnetic core 22, downwardly through winding 35 on the retaining magnetic core 23, through a second polar contact 42 in its right hand position, through the operating windings 20 from left to right, and back to the (−) terminal of battery B through contact 39 in its normal position. It will be assumed that current thus flowing from left to right through the operating windings 20 is in a proper direction to operate the polar contacts 40 and 42 to their right hand position, as shown. With these contacts 40 and 42 in their right hand positions, the direction of current flowing in windings 34 and 35 produces a North pole at the retaining pole piece 24 and a South pole at the retaining pole piece 25.

In the form of the present invention shown in Fig. 2, the retaining armature 30 is a permanent magnet with a North pole above the retaining pole piece 24 and a South pole above the retaining pole piece 25 as designated on the drawings. Consequently, the North pole at pole piece 24 and the South pole at pole piece 25 produced by the previously traced energization of windings 34 and 35 is opposed by the permanent magnetization of armature 30 which allows the armature 30 to be substantially free to move upwardly from the pole pieces 24 and 25, thereby allowing the neutral armature 12 to pick up in response to this energization of windings 20.

It will now be considered that the track switch TS is operated by the switch machine SM from its normal position to thereby move contacts 38 and 39 to intermediate positions. This condition obviously de-energizes windings 20 and releases the neutral armature 12, but as soon as the track switch TS has been operated to its reverse position in correspondence with the switch machine SM, the contacts 38 and 39 are moved to their reverse or dotted positions. This completes a reverse energizing circuit for the windings 20 which may be traced from the (+) terminal of battery B, through contact 39 in its reverse or dotted position, from right to left through operating windings 20, through polar

contact 42 in its right hand position, upwardly through holding winding 35 downwardly through holding winding 34, through polar contact 40 in its right hand position, and back to the (—) terminal of battery B through contact 38 in its reverse or dotted position.

This direction of current flowing from right to left in windings 20 causes the polar contacts 40 and 42 to operate to their left hand or dotted positions, but until the polar armature thus responds, it will be clear that the direction of current in the holding windings 34 and 35 has now been reversed, or that is, a South pole is produced in the holding pole piece 24 which is beneath the North pole of the permanent magnet 30 and likewise a North pole is produced in the pole piece 25 which is beneath the South pole of the permanent magnet 30. This condition obviously results in a flux value in the retaining magnetic structure which produces a downward attraction of the retaining armature 30 which is sufficient to prevent the neutral armature 12 from picking up.

It will thus be clear that in the event the polar armature (including contacts 40 and 42) fails to respond to the reversal of current in the operating windings 20, the retaining magnetic structure acts to hold the neutral armature in its released position thereby preventing the completion of a wrong or an unsafe circuit through the polar and neutral contacts of the present relay. However, if the polar contacts 40 and 42 respond in a proper manner to this reverse direction of current in the operating windings 20 and move to their left hand or dotted positions, it will be clear that current again flows upwardly through winding 34 and downwardly through winding 35 which produces a flux which equally opposes the flux of the permanent magnet armature 30 and allows the neutral armature 12 to properly pick up.

The operation of the system in Fig. 2 back to its normal condition is merely an inverse function of the operation already described and therefore will not be pointed out in detail as it will readily be apparent that the operation of the track switch TS and switch machine SM back to its normal position first de-energizes windings 20 to release the neutral armature 12 and when the normal energizing circuit for windings 20 is again completed by the normal locked position of the track switch and switch machine, current flows downwardly through the holding winding 34 and upwardly through the holding winding 35 until the polar contacts 40 and 42 have properly operated to their right hand positions, which produces flux of such a direction in the retaining magnetic structure as to prevent the neutral armature 12 from picking up.

In other words, during the operation of the present system back to its normal condition, the neutral armature 12 cannot pick up properly unless the polar contacts 40 and 42 operate back to their normal or solid line positions in order to apply a direction of current to windings 34 and 35 which releases the retaining armature 30. However, under usual conditions, the polar contacts 40 and 42 properly respond to this normal direction of current in windings 20 to again allow current to flow upwardly through winding 34 and downwardly through winding 35, thereby producing opposing flux values which releases the holding armature 30 and allows the system to assume its illustrated condition.

In the modified arrangement of the present relay shown in Fig. 3, the armature 30^1 is not a permanent magnet, as in Fig. 2, but rather is made of the usual soft iron material. Also, in Fig. 3, only the winding 34 on the retaining magnet core 22 is energized from the battery B in series with the operating winding 20 and the polar contacts 40 and 42, while the other winding 35 on the retaining magnet core 23 is energized from a separate local source of energy such as battery B^1 through a back contact 44 of the neutral armature 12. In as much as the normal energizing circuit in Fig. 3 is the same as that described in Fig. 2 with the omission of winding 35, it will readily be seen that, in its present normal condition, current flows downwardly in the holding winding 34 and from left to right through windings 20, which is in a proper direction to position the polar contacts 40 and 42 to the right and to pick up the neutral armature 12, thereby de-energizing the holding winding 35 at the open back contact 44.

It may be seen in Fig. 3, without tracing the circuits in detail, that a reversal of the track switch TS and switch machine SM will first de-energize the windings 20 to release the neutral armature 12 and subsequently apply a reverse direction of current thereto. When the polar contacts 40 and 42 properly operate to their left hand or dotted positions in response to this reversal of current, current then flows downwardly through winding 34 thereby producing a flux which is equally opposed by the flux produced by the normal downward direction of current in winding 35 with back contact 44 closed, thereby releasing the retaining armature 30^1 and allowing the neutral armature to pick up in response to the energization of operating windings 20.

However, in the event that the polar contacts 40 and 42 do not properly operate to their left hand positions in response to this reversal of current, current will flow upwardly through winding 34, and the closing of neutral back contact 44 will cause current to flow downwardly through winding 35. With these windings 34 and 35 thus energized, a cumulative flux is produced thereby causing a downward attraction of the retaining armature 30^1 which prevents the neutral armature 12 from picking up.

It will thus be seen that the form of the present invention shown in Fig. 3 likewise prevents the wrong or unsafe control of signalling circuits by retaining the neutral armature 12 in its de-energized position in the event that the polar armature fails to properly respond to a reversal of current in the operating windings 20.

In order to conserve the power required to energize winding 35 when it is not required, its energizing circuit includes a back contact 44 of the neutral armature 12 so that under the picked up condition of the present relay, this circuit is open and winding 35 is de-energized.

In operating the system shown in Fig. 3 back to its normal condition, it will be clear that the neutral armature likewise cannot pick up unless the energization of winding 34 is in a direction to produce a flux which opposes the flux produced by the energization of winding 35 and such a direction can be obtained only when the polar contacts 40 and 42 are in their right hand position corresponding to the normal direction of current in the operating windings 20. In this manner, the same check is obtained on the proper polar armature operation in operating back to the normal condition as previously described in

connection with the operation from a normal to a reverse condition.

A neutral polar relay has thus been provided wherein the correspondence of the polar contacts with the polarity of energization of the relay is checked in one form against the permanent magnetization of a retaining armature, and in another form against a constant polarity of electro-magnetization of a portion of the retaining magnetic structure, whereby both forms of the neutral armature is retained in its de-energized position unless the position of the polar contacts properly correspond to the polarity of energization of the relay.

In other words, in the form shown in Fig. 2, the current in the holding windings 34 and 35 is always in the same direction regardless of the polarity of energization of the windings 20 providing the position of the polar contacts 40 and 42 correspond to the polarity of energization of the windings 20, and this direction of current in windings 34 and 35 produces a flux which is neutralized by the permanent magnetization of the armature 30 to thereby allow the neutral armature to pick up. However, in the event the polar contacts 40 and 42 do not correspond to the polarity of energization of windings 20, a reverse direction of current flows in the holding windings 34 and 35 which produces a flux aiding the flux produced by the permanent magnetization of armature 30 and provides a retaining force effective to prevent picking up of the neutral armature 12.

The form of the present invention shown in Fig. 3 accomplishes the same result by maintaining the direction of current in the holding winding 35 constant regardless of the polarity of energization of windings 20, while the current in the holding winding 34 depends upon the position of the polar contacts 40 and 42. When these contacts 40 and 42 properly respond to the energization of windings 20, this direction of current in winding 34 produces a flux which is neutralized by the flux produced by the energization of the other holding winding 35, thereby allowing the neutral armature to pick up. In the event the polar contacts 40 and 42 do not correspond to the polarity of energization of windings 20, the direction of current in the holding winding 34 produces a flux aiding the flux produced by the local energization of winding 35 to thereby provide a retaining force acting on armature 30^1 which prevents the neutral armature 12 from picking up.

An important feature of both the illustrated forms of the present invention is the series arrangement of the operating windings 20, the polar contacts 40 and 42 and the holding windings 34 and 35, whereby it is obvious that a failure or opening of the circuit at any of these points cannot reduce the reliability of the check on the proper polar contact operation, but rather will result in de-energization of the entire relay to provide a restricted but a safe condition. Likewise, the winding 35 in Fig. 3 is energized when required, and must be energized to allow the neutral armature to pick up, so that any failure of this circuit results in a de-energized or safe condition of the relay.

The above rather specific description of one form 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 made 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 relay, an operating magnetic structure, operating windings on the operating magnetic structure, a neutral armature responsive to the energization of the operating windings, a polar armature responsive to the polarity of energization of the operating windings, and means including a retaining magnetic structure magnetically separate and physically spaced from the operating magnetic structure for preventing operation of the neutral armature when the position of the polar armature is out of correspondence with the polarity of energization of the operating windings.

2. In a relay, an operating magnetic structure, operating windings on the operating magnetic structure, a neutral armature responsive to the energization of the operating windings, a polar armature responsive to the polarity of energization of the operating windings, a retaining magnetic structure spaced from the operating magnetic structure, and means including a retaining armature connected to the neutral armature and coacting with the retaining magnetic structure for preventing operation of the neutral armature when the position of the polar armature is out of correspondence with the polarity of energization of the operating windings.

3. In a relay, an operating magnetic structure having operating windings, a neutral and a polar armature coacting with the operating magnetic structure, a retaining armature operatively connected to, and spaced from, the neutral armature, and magnetic means controlled by the polar armature and acting on the retaining armature to prevent operation of the neutral armature when the position of the polar armature is out of correspondence with the polarity of energization of the operating windings.

4. In a relay, an operating magnetic structure having operating windings, a neutral and a polar armature coacting with the operating magnetic structure, a retaining armature connected to the neutral armature, a retaining magnetic structure coacting with the retaining armature, windings on the retaining magnetic structure connected in series with the operating windings, contacts on the polar armature selecting the direction of current in the windings on the retaining magnetic structure, and means permitting the attraction of the retaining armature by one direction of current only in the windings on the retaining magnetic structure.

5. In a relay, an operating magnetic structure having operating windings, a neutral and a polar armature associated with the operating magnetic structure, a retaining magnetic structure having retaining windings connected in series with the operating windings, a retaining armature associated with the retaining magnetic structure and connected to the neutral armature, pole changing contacts operated by the polar armature and arranged to maintain a definite direction of current in the retaining windings only when the position of the polar armature corresponds to the direction of current in the operating windings and polarized magnetic means opposing the flux produced by said definite direction of current in the retaining windings.

6. In a relay, an operating magnetic structure having operating windings, a neutral and a polar

armature associated with the operating magnetic structure, a retaining magnetic structure having retaining windings connected in series with the operating windings, a retaining armature associated with the retaining magnetic structure and connected to the neutral armature, pole changing contacts operated by the polar armature and arranged to maintain a definite direction of current in the retaining windings only when the position of the polar armature corresponds to the direction of current in the operating windings, and a permanent magnet arranged to oppose the magnetism produced by said definite direction of current in the retaining windings.

7. In a relay, an operating magnetic structure having operating windings, a neutral and a polar armature associated with the operating magnetic structure, a retaining magnetic structure having retaining windings connected in series with the operating windings, a retaining armature associated with the retaining magnetic structure and connected to the neutral armature, pole changing contacts operated by the polar armature and arranged to maintain a definite direction of current in the retaining windings only when the position of the polar armature corresponds to the direction of current in the operating windings, and an electro-magnet arranged to oppose the magnetism produced by said definite direction of current in the retaining windings.

8. In a relay, an operating electro-magnetic means, a neutral and a polar armature, a retaining electro-magnetic means, polar contacts selecting the polarity of energization of the retaining electro-magnetic means in accordance with the correspondence between the position of the polar armature and the polarity of energization of the operating electro-magnetic means and a spaced polar retaining armature of magnetic material and operatively, and non-magnetically, connected to the neutral armature and arranged to selectively retain the neutral armature in its de-energized position in accordance with the polarity of energization of the retaining electro-magnetic means.

9. In a relay, an operating electro-magnetic means, a neutral and a polar armature, a retaining electro-magnetic means, polar contacts controlled by the polar armature and selecting the polarity of energization of the retaining electro-magnetic means in accordance with the correspondence between the position of the polar armature and the polarity of energization of the operating electro-magnetic means, a polarizing electro-magnet coacting with the retaining electro-magnetic means, and a retaining armature arranged to selectively retain the neutral armature in its de-energized position in accordance with the correspondence between the polarity of energization of the retaining electro-magnetic means and the polarizing electro-magnet.

10. In combination; a polarized circuit; a relay provided with polar and neutral armatures; a main winding for said relay connected in said circuit and capable when energized to actuate said polar and neutral armatures; an auxiliary electro-magnetic structure having a permanent magnet armature mechanically attached to said neutral armature of said relay, and an auxiliary winding for coacting with said permanent magnet armature; polar and neutral contacts operated by said polar and neutral armatures respectively; and circuit means for reversably connecting said auxiliary winding in series with said main winding depending upon the position of said polar contacts in such a manner that the magnetic flux produced by the energization of said auxiliary winding opposes the flux of said permanent magnet when said polar contacts have properly responded to the energization of said main winding.

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