Sept. 29, 1936. F. B. HITCHCOCK 2,056,147

RELAY

Filed Aug. 11, 1934

FIG. 1.

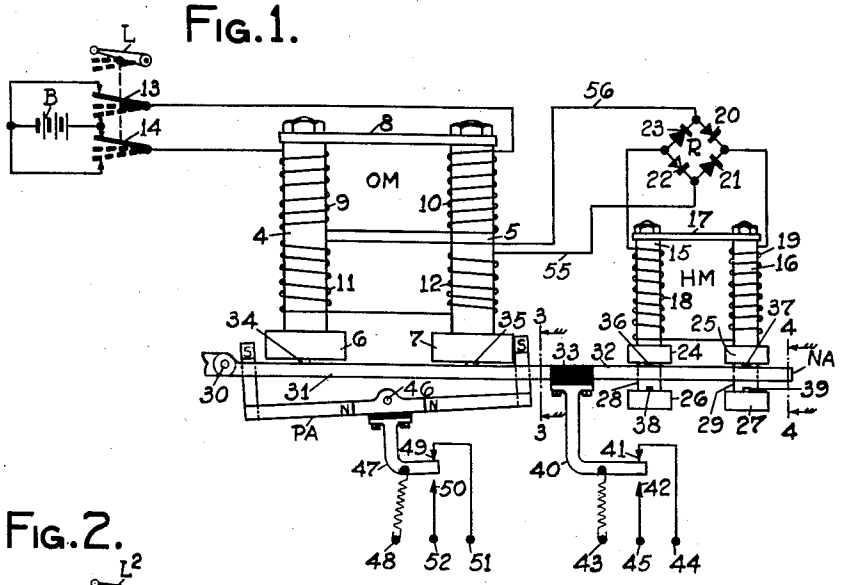


FIG. 2.

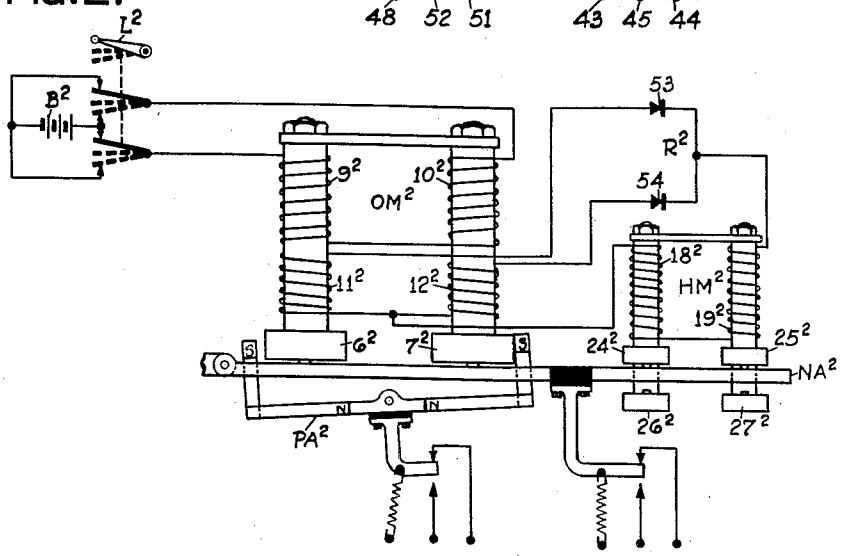


FIG. 3.

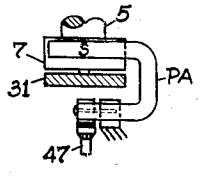
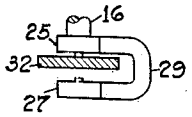


FIG. 4.



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RELAY

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11 Claims. (Cl. 175—320)

This invention relates in general to relays, and has more particular reference to a relay of the retained neutral tractive type with or without a polar armature.

It is often desirable to have a relay slow to release relative to its pick up time; slow to pick up relative to its release time; both slow to pick up and slow to release; and also to have a neutral armature which will remain picked up upon a quick reversal of current in its operating windings.

The present invention proposes to provide the above mentioned characteristics, in an improved manner, by the provision of an auxiliary holding magnet for the neutral armature of a tractive type relay, which holding magnet is inductively coupled with the operating winding in such a manner as to be uniformly effective to accomplish its retaining and retarding functions.

The present invention is to be considered as an improvement over the relays disclosed in the prior patent, Patent No. 1,852,210, dated April 5, 1932, to F. C. Larson.

Other objects, purposes and characteristic features of the present invention will be in part obvious from the accompanying drawing, and in part pointed out as the description of the invention progresses.

In describing the invention in detail, reference will be made to the accompanying drawing, in which like reference characters provided with distinctive exponents designate corresponding parts throughout the several views, and in which:—

Fig. 1 is a diagrammatic illustration of a retained neutral polar relay constructed in accordance with the present invention.

Fig. 2 illustrates in a diagrammatic and conventional manner a second form which the present invention may assume; and

Figs. 3 and 4 are fragmentary sectional views of Fig. 1 taken on lines 3—3 and 4—4 respectively and looking in the direction of the arrows to more clearly bring out the diagrammatic construction illustrated.

Referring to Fig. 1 of the accompanying drawing, a relay is shown as comprising an operating magnet OM, a holding magnet HM, a neutral armature NA, a polar armature PA and a bridge rectifier R. The relay is controlled by a lever L which suitably supplies energy from a battery B. This type of control is shown merely to illustrate the operation.

The operating magnet OM of the relay comprises two core members 4 and 5 having pole pieces 6 and 7 respectively, which core members are connected by a back strap 8. Operating windings 9 and 10 are located on the core members 4 and 5 respectively. Auxiliary windings 11 and 12 are also located on the core members 4 and 5 respectively.

As here shown, the windings 9 and 10 are spaced apart from the windings 11 and 12 on their respective core members, but this arrangement is shown only for the purpose of making the disclosure clear, it being understood that in actual practice the windings 9—11 and windings 10—12 will usually be wound in the same coils, or otherwise closely inductively associated.

The operating windings 9 and 10 are supplied with operating current from the battery B through pole changing contacts 13 and 14 of the lever L to reverse the polarity on the operating windings or to open the circuit, depending upon whether the lever L is operated to extreme positions or to an intermediate position.

The holding magnet comprises core members 15 and 16 connected at the top by back strap 17. Holding coils 18 and 19 are respectively located on the core members 15 and 16 and conductively connected to the auxiliary windings 11 and 12 through a bridge rectifier R comprising asymmetric units 20, 21, 22 and 23. The direction of relatively low conductivity through these asymmetric units or rectifiers is indicated by the arrows. These asymmetric units 20, 21, 22 and 23 may be of any suitable type, such as the copper-oxide dry plate rectifier or the electrolytic type rectifier.

The core members 15 and 16 of the holding magnet HM are provided with upper pole pieces 24 and 25 respectively, and also with lower pole pieces 26 and 27 respectively. The pole pieces 24 and 26 are connected by a U shaped portion 28; and similarly, the pole pieces 25 and 27 are connected by a U shaped portion 29. This will be best understood by noting Fig. 4.

The neutral armature NA is pivoted at the point 30 and has a portion 31 associated with the pole pieces 6 and 7 of the operating magnet OM and a portion 32 associated with the pole pieces 24, 25, 26 and 27 of the holding magnet HM. The portions 31 and 32 of the neutral armature NA are both magnetically and electrically insulated from each other by a portion 33. This neutral armature NA is adapted to be attracted to a picked up position, as illustrated in the drawing, or to assume a dropped away released position when the operating magnet OM is deenergized and the holding magnet has ceased to have a

holding effect on the armature, as hereinafter described. As shown, the releasing tendency or bias of the neutral armature is provided by gravity.

The armature portion 31 is prevented from coming into intimate contact with the pole pieces 6 and 7 by reason of non-magnetic residual pins 34 and 35. Similarly, the armature portion 32 is prevented from coming into intimate contact with the pole pieces 24 and 25 by non-magnetic residual pins 36 and 37, and is also prevented from coming into contact with pole pieces 26 and 27 by non-magnetic residual pins 38 and 39.

Mounted upon the neutral armature NA on the insulating portion 33 is a contact member 40 which cooperates with front contact 41 and back contact 42. The contacts 40, 41 and 42 are conductively connected to binding posts 43, 44 and 45 respectively.

Also, associated with the pole pieces 6 and 7 is a polar armature PA which is formed of a permanent magnet having pole faces N and S which are adapted to be attracted and repelled in accordance with the polarity of the pole pieces 6 and 7. This polar armature PA is pivoted at point 46 and extends in sort of a U shaped fashion about the neutral armature NA as illustrated in Fig. 3.

Mounted on the polar armature PA and electrically insulated therefrom is a movable contact 47 which is electrically connected with binding post 48 and cooperates with front contact 49 and back contact 50 which are respectively connected to binding posts 51 and 52.

It is to be understood that the polar armature PA may be of any suitable type so far as the present invention is concerned, it being sufficient for an understanding of the present invention to know that a polar armature may be associated with the operating magnet OM in any suitable way shown in the prior art such as for example in the Patent No. 1,852,210, to F. C. Larson.

With reference to Fig. 2 of the accompanying drawing, a relay is illustrated which is arranged and controlled in a similar manner as described for Fig. 1. The corresponding parts of Fig. 2 are designated by corresponding reference characters with the distinctive exponent 2. The difference in structure of Fig. 2 over Fig. 1 is that the rectifier R^2 is not of the bridge type but comprises only asymmetric units 53 and 54. These units have the same characters as mentioned for the units of the rectifier R in connection with Fig. 1 but are associated with the auxiliary windings and holding windings in somewhat different manner, as will be described hereinafter.

It is believed that the nature of the invention, its advantages, and characteristic features can be best understood with further description being set forth from the standpoint of operation.

Operation

As illustrated, the relays of Figs. 1 and 2 are shown as being energized. The neutral armatures NA and NA^2 are therefore in picked up positions. The actuation of the levers L and L^2 to mid-positions opens the energizing circuit for the operating coils of the operating magnets and thereby allows the neutral armatures to drop away subject to the effect of the holding magnets HM, as hereinafter pointed out.

With the operating magnets energized, as illustrated, the polar armatures PA and PA^2 are operated to positions as illustrated, but upon the operation of the levers L and L^2 to opposite extreme positions, the polar armatures PA and PA^2 are respectively operated to opposite positions in accordance with the well known laws of magnetism by reason of the reversal of the polarity of the pole pieces of the respective operating magnets with respect to the permanent magnetism of the polar armatures PA and PA^2. In such a case, armatures NA and NA^2 remain picked up, if the reversal of current is accomplished within a relatively short time, by reason of the holding magnets HM and HM^2, as presently to be set forth.

It is to be understood that the levers L and L^2 may be operated to mid-positions or to opposite positions in any sequence whatsoever, and such control is not limited to a manual operation but may be automatic control of any type whatsoever.

With more specific reference to Fig. 1 of the accompanying drawing, consideration will now be given to the effect that the holding magnet HM has upon the neutral armature NA under various conditions of removal of energy and the application of energy of opposite polarities in various sequences.

The operation of the contacts 13 and 14 to mid-positions deenergizing the operating coils 9 and 10, causes the dying out of the flux in the operating magnet OM. Such collapse of the flux in the operating magnet induces a potential in the coils 11 and 12 which causes a current to flow from the upper terminal of coil 12 through wire 55, rectifier unit 21, coil 19, coil 18, rectifier unit 23, wire 56, coil 11, to the lower terminal of the coil 12. This flow of current in the windings 18 and 19 produces a magnet flux in the holding magnet HM which attracts the armature portion 32 toward the pole pieces 24 and 25. This attraction occurs subsequent to the opening of the circuit by contacts 13 and 14 and tends to hold the neutral armature NA picked up until the induced current in the coils 11 and 12 dies to a predetermined low value. Therefore, the drop away of the neutral armature NA is thereby delayed.

After the neutral armature NA is dropped away and the armature portion 32 is in contact with the residual pins 38 and 39, let us assume that the lever L is actuated so as to return contacts 13 and 14 to the position illustrated. This energizes the coils 9 and 10 with current, which causes the building up of the magnetic flux in the operating magnet OM, which in turn induces current in the coils 11 and 12 which flows from the upper terminal of coil 11 to wire 56, rectifier unit 20, winding 19, winding 18, rectifier unit 22, wire 55, coil 12, to the lower terminal of the coil 11. The current thus induced in the windings 11 and 12 energizes the coils 18 and 19 of the holding magnet HM. This causes a flux to flow through pole pieces 26 and 27 resulting in a retaining effect on the armature portion 32 of the neutral armature NA. While such induced current is flowing, the neutral armature NA is prevented from being picked up by the operating magnet OM, thus delaying the response of NA to the operating current.

It is noted that the induced current upon the closure of the circuit for the coils 9 and 10 of the operating magnet flows in an opposite direction in the coils 11 and 12 from that direction in which the induced current flows upon the breaking of the controlling circuit. If it were not for the rectifier unit R (and coils 18 and 19 were connected in series with coils 11 and 12), this reversal of cur-

rent would be effective to energize the coils 18 and 19 of the holding magnet HM in opposite directions. Thus, the magnetic flux produced by the induced current for each successive operation must counter-act the residual magnetism remaining from the preceding operation which would thereby reduce the total holding or retaining effectiveness of the induced current. However, with the rectifying unit R provided in accordance with the present invention, the coils 18 and 19 are always energized in the same direction by the induced currents so that the magnetic flux always flows in the holding magnet HM in the same direction and does not have to pass through zero. This provides for additional efficiency in the retaining effect of the holding magnet HM.

If the operating coils 9 and 10 of the operating magnet OM were always successively deenergized and energized with the same polarity, and the rectifier R was omitted, then the resulting holding effect, even though reduced by reason of the residual which must be bucked down each time, would always be uniform. But, it might happen that the operating coils 9 and 10 of the operating magnet OM would be energized with successively opposite polarities, and in such cases the retaining effect of the holding magnet HM would not be uniform. As provided in accordance with the present invention, the rectifying unit R causes a uniform holding effect even under such circumstances. This is because the current induced in the coils 11 and 12 upon the breaking of the operating current is in a direction which corresponds to the direction of the current induced when the operating coils are energized with the opposite polarity. Thus, it will be evident that if the rectifying unit R were not provided, the coils 18 and 19 of the holding magnet HM would be required to buck the residual when the operating magnet is reenergized with the same polarity, but would not be required to buck the residual when the operating magnet is reenergized with the opposite polarity, thereby making the retaining effect vary in accordance with the particular sequence of polarity applied to the operating magnet OM. However, the arrangement provided in accordance with the present invention causes the holding magnet HM to operate uniformly and efficiently under all circumstances of opening and closing of the operating circuit as well as when the direction of current flow is reversed.

It is apparent that the polar armature PA responds to the reversal of the direction of current flow in the operating coils 9 and 10 of the operating magnet, and it may be desirable under certain circumstances to reverse the polarity of current on the operating coils to cause the operation of the polar armature PA without the dropping away of the neutral armature NA. In an ordinary polar neutral relay, such reversal of energy on the operating coils causes the magnetic flux in the operating magnet to pass through zero and the neutral armature always assumes a dropped away position, at least momentarily, irrespective of how quickly the polarity may be reversed.

In accordance with the present invention, the holding effect of the holding magnet HM acting upon the portion 32 of the neutral armature, which portion 32 is magnetically insulated from the portion 31, is of sufficient duration upon the reversal of current in the operating magnet OM to cause the neutral armature NA to be maintained picked up and allow the polar armature to operate in response to the reversal of polarity. This of course requires that the reversal of polarity be accomplished within a predetermined time dependent upon the total time during which the holding magnet HM will maintain the neutral armature NA picked up. This holding effect or retaining effect may be expressed in other terms by stating that the magnet fluxes in the portions 31 and 32 of the neutral armature NA do not pass through zero at the same time. In fact, the magnetic flux in the portion 31 of the neutral armature is the only flux which passes through zero upon the reversal of polarity, whereas the flux in the portion 32 of the neutral armature only approaches zero. This is due to the rectifying unit R provided in accordance with the present invention.

With reference to Fig. 2 of the accompanying drawing, the resulting effect upon the neutral armature NA^2 is exactly the same as that described for the neutral armature NA of Fig. 1, but the rectifying units 53 and 54 replace the units 20, 21, 22 and 23 of the rectifying unit R. In other words, the coils 11^2 and 12^2 together with the rectifying units 53 and 54 take the place of the bridge rectifier R.

In this Fig. 2, considering the opening and closing of the operating circuit, as occurring successively, the coils 11^2 and 12^2 are effective respectively on such successive operations to provide the inductive current for the coils 18^2 and 19^2. It is believed that this result will be readily apparent to those skilled in the art. The main advantage of the arrangement shown in Fig. 2 is that of the simplification of the apparatus employed.

Although the holding magnets HM and HM^2 are illustrated as having both front and back pole pieces, it is to be understood that the arrangement may be supplied in accordance with the present invention in any combination, that is, without either front or back pole pieces.

For example, the pole pieces 24 and 25 may be so arranged as to not effect the portion 32 of the armature NA to thereby cause the holding magnet to be effective through the pole pieces 26 and 27 to cause a retained or detained pick up of the neutral armature but not effect the release of such armature. It is of course readily apparent that the opposite condition might be set up by the removal of the pole pieces 26 and 27 so as to provide a slow releasing or retained neutral relay with regard to the drop away, but not effect the pick up characteristics.

Thus, the present invention provides a holding magnet in connection with a neutral armature of a relay, so associated inductively with the operating magnet of the relay that it is always effective to the same extent irrespective of whether the same or opposite polarities are applied successively through the operating winding, and also to provide the greatest efficiency in the case of the opening and closing of the operating circuits successively without a reversal of polarity.

Having thus described a relay structure and control therefor as one specific embodiment of the present invention, it is desired to be understood that these forms are selected to facilitate in the disclosure of the invention rather than to limit the number of forms which it may assume; and it is to be further understood that the various adaptations, modifications, and alterations may be applied to the specific form shown to meet with the requirements of practice, without in any manner departing from the spirit or scope of

the invention except as limited by the appended claims.

What I claim is:—

1. In a relay structure, a main armature, a retaining armature, means of non-magnetic material for rigidly connecting said armatures, an operating winding for the main armature, a retaining winding for the retaining armature, and means for furnishing unidirectional current to said retaining winding which current is inductively generated by a change in current in said operating winding.

2. In a relay structure, a main armature, a retaining armature, means of non-magnetic material for rigidly connecting said armatures, an operating winding for the main armature, a retaining winding for the retaining armature, an auxiliary winding inductively coupled to said operating winding, means connecting said auxiliary and said retaining windings in series, and means allowing only unidirectional current to flow in said retaining winding.

3. In a relay structure, a main armature, a retaining armature, means of non-magnetic material for rigidly connecting said armatures, an operating winding for the main armature, a retaining winding for the retaining armature, an auxiliary winding inductively associated with said operating winding, a bridge connected asymmetric unit, and circuit means connecting said retaining and auxiliary windings in series through said asymmetric unit.

4. In a relay structure, a main armature for operating contacts, an operating winding for actuating said main armature, a retaining armature directly and rigidly connected to said main armature but magnetically insulated therefrom, a retaining winding for acting upon said retaining armature, an auxiliary winding inductively associated with said operating winding whereby any change in current value in said operating winding induces a current in said auxiliary winding, circuit means connecting said retaining winding in series with said auxiliary winding, and rectifier means for causing all induced currents in said auxiliary windings to flow in the same direction in said retaining winding.

5. In a relay structure, a main armature for operating contacts, an operating winding for acting upon said main armature, a retaining armature directly and rigidly connected to said main armature but magnetically insulated therefrom, a retaining winding for acting upon said retaining armature in a direction corresponding to the direction that said operating winding acts on said main armature, an auxiliary winding inductively associated with said operating winding whereby any change in current value in said operating winding induces a current in said auxiliary winding, circuit means connecting said retaining winding in series with said auxiliary winding, and rectifier means for causing all induced currents in said auxiliary winding to flow in the same direction in said retaining winding.

6. In a relay structure, a main armature for operating contacts, an operating winding for acting upon said main armature, a retaining armature directly and rigidly connected to said main armature but magnetically insulated therefrom, a retaining winding for acting upon said retaining armature in a direction opposite to the direction that said operating winding acts on said main armature, an auxiliary winding inductively associated with said operating winding whereby any change in current value in said operating winding induces a current in said auxiliary winding, circuit means connecting said retaining winding in series with said auxiliary winding, and rectifier means for causing all induced currents in said auxiliary winding to flow in the same direction in said retaining winding.

7. In a relay structure, a main armature for operating contacts, an operating winding for acting upon said main armature to pick it up or drop it away, a retaining armature directly and rigidly connected to said main armature but magnetically insulated therefrom, a retaining winding for acting upon said retaining armature in one direction or the other depending upon whether said main armature is picked up or dropped away, an auxiliary winding inductively associated with said operating winding whereby any change in current value in said operating winding induces a current in said auxiliary winding, circuit means connecting said retaining winding in series with said auxiliary winding, and rectifier means for causing all induced currents in said auxiliary winding to flow in the same direction in said retaining winding.

8. In a relay structure, a main armature for operating contacts, an operating winding for actuating said main armature, a retaining armature directly and rigidly connected to said main armature but magnetically insulated therefrom, a retaining winding comprising two coils for acting upon said retaining armature, an auxiliary winding inductively associated with said operating winding whereby any change in current value in said operating winding induces a current in said auxiliary winding, circuit means for connecting said two coils in multiple with each other and in series with said auxiliary winding, and rectifier means in series with each of said coils so as to allow current to flow in one direction in one of said coils and in the opposite direction in the other of said coils.

9. In combination, a source of direct current, an inductor having two windings, means for connecting one of said windings with and disconnecting it from said source, an electro-responsive device, a rectifier, and circuit means connecting said electro-responsive device with the other of said windings of said inductor through said rectifier.

10. In combination, a source of direct current, an inductor having two windings, means for at times connecting one of said windings with and disconnecting it from said source with one polarity and for at times connecting said one of said windings with and disconnecting it from said source with the opposite polarity, an electro-responsive device, a full wave rectifier, and circuit means connecting said electro-responsive device with the other of said windings of said inductor through said full wave rectifier.

11. In combination, a source of direct current, a relay having an armature and two windings, means for connecting one of said windings with and disconnecting it from said source, an electro-magnet at times exerting a force on said armature, a rectifier, and circuit means connecting said electro-magnet with the other of said windings of said relay through said rectifier.

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