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O. S. FIELD
POLAR BIASED RELAY

2,491,098

Original Filed Oct. 14, 1940

FIG. 1

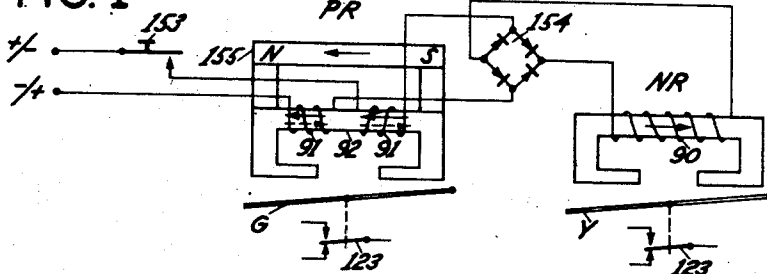


FIG. 2

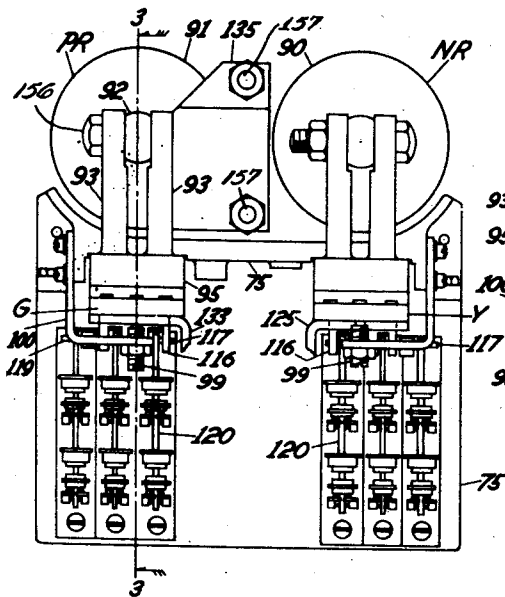


FIG. 3

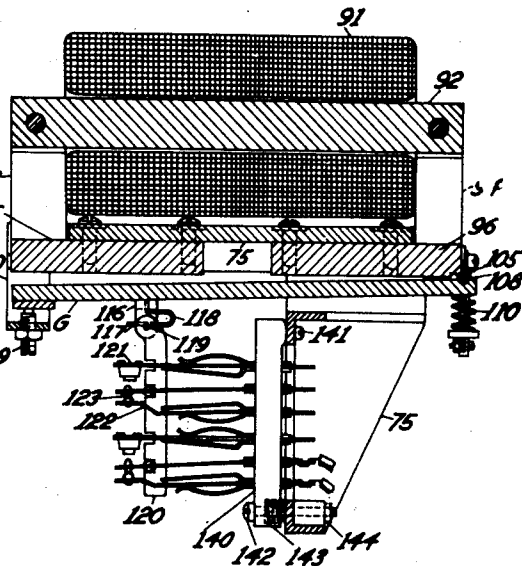
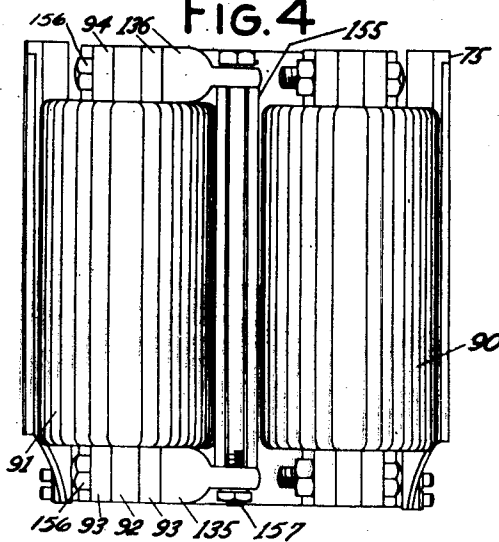


FIG. 4



UNITED STATES PATENT OFFICE

2,491,098

POLAR BIASED RELAY

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Original application October 14, 1940, Serial No. 361,060, now Patent No. 2,376,534, dated May 22, 1945. Divided and this application April 17, 1945, Serial No. 588,748

3 Claims. (Cl. 175—339)

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This invention relates to electromagnetic relays for use on railways, and more particularly pertains to relays of the polar-biased type for distinctive response to polarized control.

This application is a division of my copending application Ser. No. 361,060, filed October 14, 1940, which has resulted in a Patent No. 2,376,534, dated May 22, 1945, in which the relay structure of the present invention besides operating relay contacts also acts to operate the movable spectacle of a searchlight type signal; and no claim is intended to be made in this application to subject matter claimed in such patent.

One of the objects of the present invention is to provide a relay structure comprising two electromagnets each provided with a tractive type armature, with one of the electromagnets being of the neutral type responsive to energization by current of either polarity, while the other electromagnet is of the polarized type responsive to energization by current of only a particular polarity.

A further object of the present invention is to so organize the polarized electromagnet that its armature will respond to the particular polarity with a relatively small operating current; but will not be responsive to energization by the opposite polarity even though the degree of energization may be several times the degree of energization required for operation by said particular polarity.

Another object of the present invention is to provide an electromagnet structure of the polarized type which will not respond to either polarity by the regular degree of operating energization in the event that the polarizing magnet becomes ineffective.

A further object of the invention is to provide the polarized and neutral electromagnets so associated with each other in a unitary structure and circuit organization that the armature of the neutral electromagnet will respond to either polarity and will remain picked up upon a relatively quick reversal of polarity; while the armature of the polarized electromagnet will be actuated only in response to energization by said particular polarity. It should be noted that the structure and circuit organization effecting this feature have been disclosed in my divisional application Ser. No. 782,211, filed October 25, 1947, in which the subject matter involving the circuit organization is being claimed.

Other objects, purposes and characteristic features of the present invention will be in part obvious from the accompanying drawings, and in

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part pointed out as the description of the invention progresses.

In describing the invention in detail, reference will be made to the accompanying drawings, in which like reference characters designate corresponding parts throughout the several views, and in which:

Fig. 1 illustrates in a diagrammatic and conventional manner the circuit organization relating the electromagnetic structure of the present invention to an external control circuit;

Fig. 2 is a front elevation of a relay structure embodying the present invention;

Fig. 3 is a side view of the relay structure with parts shown in section as taken on line 3—3 of Fig. 2;

Fig. 4 is a top view of the relay structure embodying the present invention and shown in Fig. 2; and

Fig. 5 is a sectional view of the polarized electromagnet to show the shape of the molded permanent magnet.

The relay structure of the present invention comprises a frame member 75 which is preferably molded of some suitable non-magnetic material, such as brass, aluminum, Bakelite or the like. This frame structure 75 has a shelf extending across the back portion and protruding outwardly from its back portion (as seen in Figs. 2 and 3) upon which the neutral and polarized electromagnet relays NR and PR are mounted.

Referring to Fig. 2, it will be noted that each relay structure comprises a core and winding structure, an associated tractive type armature, and a contact group. For convenience, the armature of the neutral relay has been designated Y; while the armature of the polarized relay has been designated G. Each armature operates its group of contacts through suitable pusher members 120, as will presently be described in greater detail. The polarized relay PR also includes a permanent magnet 155 as can best be seen in Fig. 4.

As can be most clearly seen in Fig. 4, the shelf portion 75 carries the two electromagnets or relays having coils 90 and 91, and these relays are placed side by side and extending from rear to front of the shelf 75. Since these two relays are similar so far as their coil, armature and contact structure is concerned, only one of them will be described in detail, and this description will be more particularly directed to the polarized relay which includes the permanent magnet 155.

Referring to Fig. 3 which is a sectional view of the polarized relay PR taken on line 3—3 of Fig. 2, it can be seen that a core 92 carries the

winding or coil 91; is positioned above the shelf 75; and is connected in a magnetic circuit including downwardly extending legs 93 and 94, carrying pole pieces 95 and 96, with an airgap between their inner ends.

The armature G, as viewed in Fig. 3, is pivoted at its rear end by a suitable needle bearing such as disclosed in my copending application Ser. No. 548,354, filed August 7, 1944, now Pat. No. 2,435,000, dated January 27, 1948, to which reference may be made for the details of such a bearing. It is sufficient for the purposes of the present disclosure to know that a flattened surface provided by a bearing plate 105 is held in position by two depending legs upon which are mounted springs 110, so that a needle bearing 108, which is received in a V-shaped slot in the top face of the armature, is held in position between the armature and the bearing plate 105. In other words, the armature G is pivoted on a spring biased adjustable needle bearing as disclosed in the above mentioned application.

At the other end, the armature G normally rests against the adjustable back stop 99 mounted upon a suitably extending arm 100. As shown, the armature G is biased by gravity to its deenergized position. But in the parent application above referred to, a biasing spring was also disclosed for each armature to assure the restoration of that armature to its deenergized position by compensating for the weight of the spectacle arm which was jointly operated by the armatures G and Y through the extending arms 133 and 125 respectively. Since the spectacle operation has not been shown, the extending arms 133 and 125 have been omitted. The additional spring biasing means has also been omitted since they are unnecessary for the disclosure of this application. However, it is to be understood that spring biasing means may or may not be employed as may be most desirable for the operating values of the relay armatures.

As above mentioned, each of the armatures G and Y has associated therewith a group or bank of contacts. Each group of contacts comprises a plurality of movable contact arms 123 which may be operated between back contact arms 122 and front contact arms 121 by suitable pusher arms 120. The pusher arms 120 are pivotally connected to their respective armatures by slotted boss members 116 with a suitable pivoting pin 117 which is anchored against endwise movement by a spring latch 118 carried at one end by the lug 116 and at its other end springing into a notch 119 in pin 117. Since the movable contact springs 123 are normally held against their respective back contacts by the weight of the associated armature, there is a certain spring pressure provided by the back contact springs 122 which the weight of the armature normally opposes, but the weight of the armature is assumed to be sufficient to overcome this back spring pressure with plenty of margin. The fixed contact springs 121 and 122 together with the movable contact springs 123 with their respective adjusting arms are mounted or molded into a suitable contact block 140 as viewed in Fig. 3, each contact of course having a suitable extension to the right of the block 140 to provide for the connection of wire leads. These contacts mounted on the blocks 140 can be suitably adjusted before they are inserted into the relay mechanism. When the block 140 is mounted into its recess in the frame structure 75, a suitable mounting screw 141 at the top and a mounting screw 142 at the bottom are inserted so as to pro-

vide an adjustment of the proper location of the contacts with respect to the associated armature to give the desired contact pressure. The screw 141 can be left slightly loose and the proper adjustment of the contacts can be made with respect to the armature by turning the screw 142 to a proper position, the contact block 140 being biased outwardly against the screw 142 from the frame 75 by reason of spring 143. When the proper adjustment has been made, the screw 141 is tightened and a lock nut 144 is set in position. Referring to Fig. 2, it is seen that a plurality of these contact blocks and associated contacts are associated with each of the armatures, and each block is provided with its adjusting screws. With this arrangement of contacts, a variable number of contacts can be associated with each armature without altering the design and proportions of the structure as a whole.

As above mentioned, the general magnetic structure of each relay PR and NR is the same, but the polarized relay core structure includes soft iron extensions 135 and 136, one at each end of the core 92, which extensions are held in position against the respective legs 93 and 94 of the magnetic structure by the bolts 156 which hold the core 92 in position. Parallel with the core 92 and extending between the two soft iron extensions is a permanent magnet 155 held in position by suitable bolts 157, and this permanent magnet is shaped to fit around the coil 91 so as to conserve space and yet have the desired residual magnetic force.

In accordance with the present invention the permanent magnet 155 is provided with such cross sectional area relative to the cross sectional area of the core member 92 that its degree of residual magnetism effectively saturates the core member 92 with flux without producing any substantial degree of flux in the associated armature G. In other words, the close and intimate magnetic connection between the permanent magnet 155 through the extensions 135 and 136 to the core member 92 provides a magnetic path of such low reluctance that there is only a relative small leakage flux passing through the magnetic circuit including the armature G and the air gap between it and the pole pieces 95 and 96.

Fig. 5 shows a cross-sectional view of the core member 92 and the associated permanent magnet 155. From this it will be seen that the permanent magnet 155 is clamped into position by bolts received in the molded recesses of the magnet. In this connection, it may be noted that modern manufacturing of permanent magnets is effected by a molding or sintering process for economical production, and the structure of the present invention takes advantage of this fact.

Referring to the diagrammatic illustration of Fig. 1, it will be seen that the neutral relay NR is associated with the polarized relay PR through a rectifier unit 154 by suitable circuits including a manually operable push button 153 and connected to terminals which may be energized with current of either polarity as indicated by the symbols (+) and (-). Both the armatures Y and G are shown as being connected to their respective movable contacts 123. The polarized relay PR has been illustrated as having its permanent magnet 155 mounted above the core 92 for convenience although it is actually at the side as shown in Fig. 2. This permanent magnet is magnetically connected in multiple with the core 92, and it has sufficient residual magnetism to substantially saturate the associated core 92.

When the switch or push button 153 is actuated to close the control circuit, and assuming that positive potential is placed on the lower terminal while negative potential is placed on the upper terminal, then current flows through the left-hand portion of winding 91 on core 92, through the rectifier structure 154, winding 90 on the neutral relay NR, through the rectifier 154, through the right-hand portion of the winding 91 on core 92, to the other terminal. The current which thus flows in the winding 90 of the neutral relay acts to produce magnetic flux in its core structure which is effective to actuate its armature Y to a picked up position.

The magnetic flux produced in the winding 91 on core 92 with this polarity applied to the circuit organization acts to produce a magnetic flux which is in the same direction as the flux of the permanent magnet 155 passing through the core 92, as indicated by the dotted arrows within the core 92 and the solid arrow in the permanent magnet 155. Since the residual magnetism of the permanent magnet 155 substantially saturates the core member 92, the energization of the winding 91 to the usual degree required for the operation of the neutral relay NR is ineffective to produce any substantial change in the magnetic flux of the core structure. This will be better appreciated by realizing that when a piece of soft iron is substantially saturated, the further energization of an associated winding produces only that additional flux which would be produced if there were no iron core. This additional flux produced by such energization of the winding 91 has two possible magnetic paths, one through the permanent magnet 155, and the other through the armature G and the associated air gap. Regardless of the ratio of division of this additional flux through its two possible paths, it does not actuate the armature G because it is of insufficient value and also because that portion which may pass through the armature is in opposition to that leakage flux which is supplied by the permanent magnet. Thus, it will be apparent that under these conditions the armature G is not actuated; while the armature Y immediately assumes its actuated position. For these reasons, it can be seen that to energize the winding 91 sufficiently with such reverse polarity as to cause the actuation of the armature would require many times the normal degree of energization for the relays PR and NR.

On the other hand, if the opposite polarity is applied to the terminals of the circuit organization of Fig. 1, it will be apparent that the direction of magnetic flux in the core 92 will be reversed as indicated by the associated solid line arrows; while the direction of the magnetic flux produced in the neutral relay structure remains the same by reason of the rectifier unit 154. This opposite polarity will of course cause the actuation of the armature Y of the neutral relay. Also, the magnetic flux produced in the core 92 of the polarized relay PR is now in opposition to the permanent magnet 155; and the core 92 instead of furnishing a shunt path for the residual magnetism of the permanent magnet, opposes the flow of such residual magnetism so that there is a considerable increase of magnetic flux passing through the air gap and the armature. This causes the armature G to be actuated or picked up thus operating its associated contacts to open the back contacts and close the front contacts.

Thus, when the electro-magnetism is in the direction of the full arrow, the core shunt on the

permanent magnet is choked out, and the armature picks up, but when the electro-magnetism is in the reverse direction it has no effect to speak of, since the permanent magnet has saturated the core and the armature remains retracted.

From this it can be seen that the application of energy of one polarity on the circuit organization causes both armatures Y and G to respond; while the application of energy of the opposite polarity results in the response of only the armature Y. If the reversal in polarity on the terminals of this circuit organization is relatively quick, it will be apparent that the armature Y will remain picked up. This is because the rectifier unit 154 causes the winding 90 to always be energized by current flowing in the same direction regardless of the polarity of the potential applied to the terminals of the circuit organization, and also because the rectifier unit 154 shunts the current induced in winding 90 during a change in flux conditions so as to actually delay the decay of flux passing through its core and associated armature. Thus, if the reversal of polarity on the terminals of the circuit organization is relatively quick, the magnetic flux through the armature is maintained above that value necessary to hold the armature picked up during such reversal.

The rectifier unit 154 is connected, as described above, between the windings of the polarized relay PR and the neutral relay NR in a manner to have a portion of winding 91 between the rectifier and the terminals for protection against lightning or other transient surges of potential which may occur across the terminals of the circuit organization.

From the above description, it will be observed that the permanent magnet 155 and the core 92 are magnetically in parallel through a closed magnetic circuit; whereas this parallel magnetic structure has extending pole pieces 95 and 96 with an intervening air gap between them and the armature G. Thus, the magnetic circuit involving the armature is of higher magnetic reluctance than the other two magnetic paths. For this reason, the permanent magnet residual magnetism has practically no effect normally on the armature G because such residual magnetism is shunted by the core 92. Similarly, should the permanent magnet lose its residual magnetism due to a stroke of lightning, severe vibration, or the like, it in turn would provide a shunt path for magnetism produced by the energization of the coil 91 and the armature would not respond under a normal degree of energization of such winding.

In the drawings, Fig. 1 illustrates a circuit organization where it is assumed that ordinarily a particular potential will be applied to the energizing circuit such as will in one case operate both relay armatures and in the other case operate only one. However, it may happen due to transient line voltages, lightning surges and the like, that the potential applied to the energizing circuit will be several times the normal degree of energization required for operation of the relay. In the event that such an abnormal energizing potential is of the wrong polarity for the normal operation of the polarized relay, such potential still will not cause the response of the armature G. This is for the reason above pointed out, namely, that the lines of flux induced by the energization of the winding 91 in such a direction are in the same direction as the saturating magnetic flux from the permanent magnet, and under

such circumstances the winding can merely produce lines of flux the same as if the iron core were not present.

A unitary relay structure has thus been shown and described as comprising a unit which is particularly adaptable for use in polarized circuits, having one group of contacts which are controlled by a neutral relay so as to respond to current of one polarity, and having another group of contacts controlled by a polarized relay so as to respond to current of only a particular polarity. Such a unitary structure is particularly useful in control circuits for use along railroads and the like where reliable relays are required, and where protection against lightning surges and the like is necessary. Especially the provision of the polarized relay of the unitary structure which assures proper polar response even in case of wide variations in the degree of energization, is highly desirable for safety circuits where proper response to polarity is required.

In this connection, it should be understood that the principle of such a polarized relay may be employed in various types of relay structure and electromagnetic devices; and that the polarized relay structure PR may be used as a separate and individual device if desired.

Having thus described a relay structure and organization as one specific embodiment of the present invention, it is desired to be understood that this form is 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 various modifications, adaptations and alterations may be applied to the specific form shown 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 an electromagnetic relay of the type which is operated in response to one polarity of energization but not the other, a core structure having extending pole pieces and a portion adapted to receive windings, a pivoted armature mounted adjacent said pole pieces so as to cooperate therewith and biased to a released position away from said pole pieces, a permanent magnet directly connected to said core structure in a manner that the winding portion thereof forms a magnetic path of low reluctance for the permanent magnet's residual flux, said permanent magnet being proportioned relative to said winding portion of said core structure so as to effectively saturate said winding portion without affording sufficient flux through said pole pieces and said armature to overcome the bias of said armature in either its released or operated position, and windings located on said winding portion of said core structure and energizable with current of either polarity, said windings when energized to an operating value with current of one polarity acting to induce a magnetic flux in said winding portion of said core structure in opposition to the magnetic flux therein provided by said permanent magnet to cause sufficient magnetic flux to pass from said pole pieces into said armature to actuate it to an operated position in opposition to its normal bias, said windings when energized to a comparable current value of the opposite polarity failing to provide enough flux through said armature and said winding portion of said core structure by reason

of its saturated condition to overcome the bias of said armature in either its released or operated position.

2. In an electromagnetic relay of the type which is responsive to one polarity of energization but not the other, a core structure of a general U-shape having at the ends of its legs enlarged pole pieces with flat surfaces in a common plane, an armature spanning said pole pieces and adapted to be actuated from a biased released position to an operated position by magnetic flux passing through working air gaps, a winding on a portion of said core structure, a permanent magnet supported in multiple with said winding portion of the core structure through intimate magnetic contact, said permanent magnet having a cross-sectional area proportioned relative to the cross-sectional area of said winding portion of said core structure so as to effectively saturate said winding portion without providing sufficient flux through said working air gaps to operate said armature from its biased position or hold it in its operated position, said winding when energized by operating current of one polarity acting to oppose the magnetomotive force provided by said permanent magnet in said winding portion of the core structure and to provide sufficient flux through said working air gaps and said armature to actuate it from its biased position to its operated position, said winding when energized with current of the other polarity even though of a greater magnitude failing to provide sufficient flux through said working air gaps and said armature to overcome its bias in either the released or operated position.

3. In an electromagnetic relay of the type which is responsive to one polarity of energization but not the other, a horizontal core and vertical legs attached thereto terminating with inwardly extending enlarged pole pieces, a moveable armature extending across said pole pieces with intervening air gaps and biased to a retracted position away from said pole pieces, a winding on said core, a permanent magnet with soft iron extensions fastened with intimate magnetic contact to the ends of said core, said permanent magnet being proportioned relative to said core to effectively saturate said core without providing sufficient flux through said air gaps to move said armature from its retracted position or hold it in its attracted position, said winding when energized with operating current of one polarity acting to oppose the magnetization of said core by said permanent magnet and provide sufficient flux through said air gaps to operate said armature to its attracted position, said winding when energized with current of the opposite polarity even though of a greater magnitude being ineffective on account of the saturated condition of said core to provide flux through said air gaps sufficient to overcome the bias of said armature in either its retracted or operated positions.

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