April 5, 1932. O. S. FIELD 1,852,406

RELAY

Filed Feb. 13, 1930

FIG. 1.

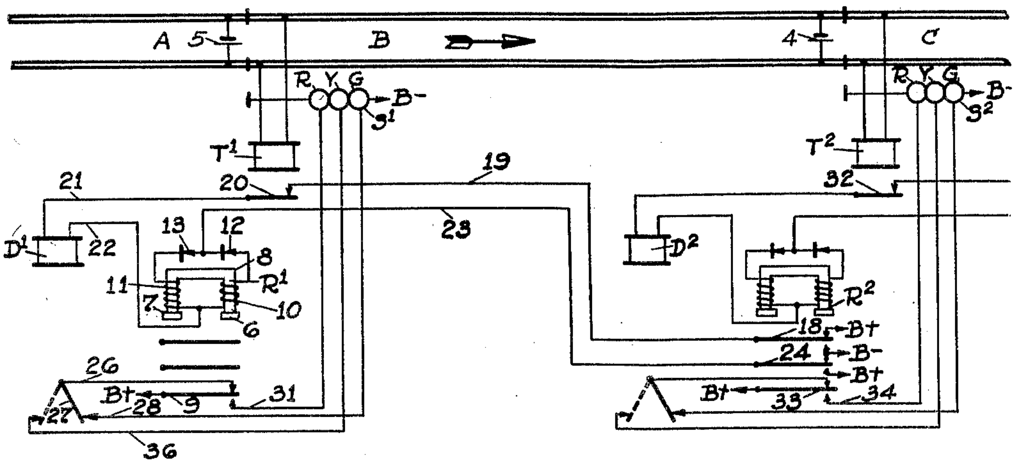
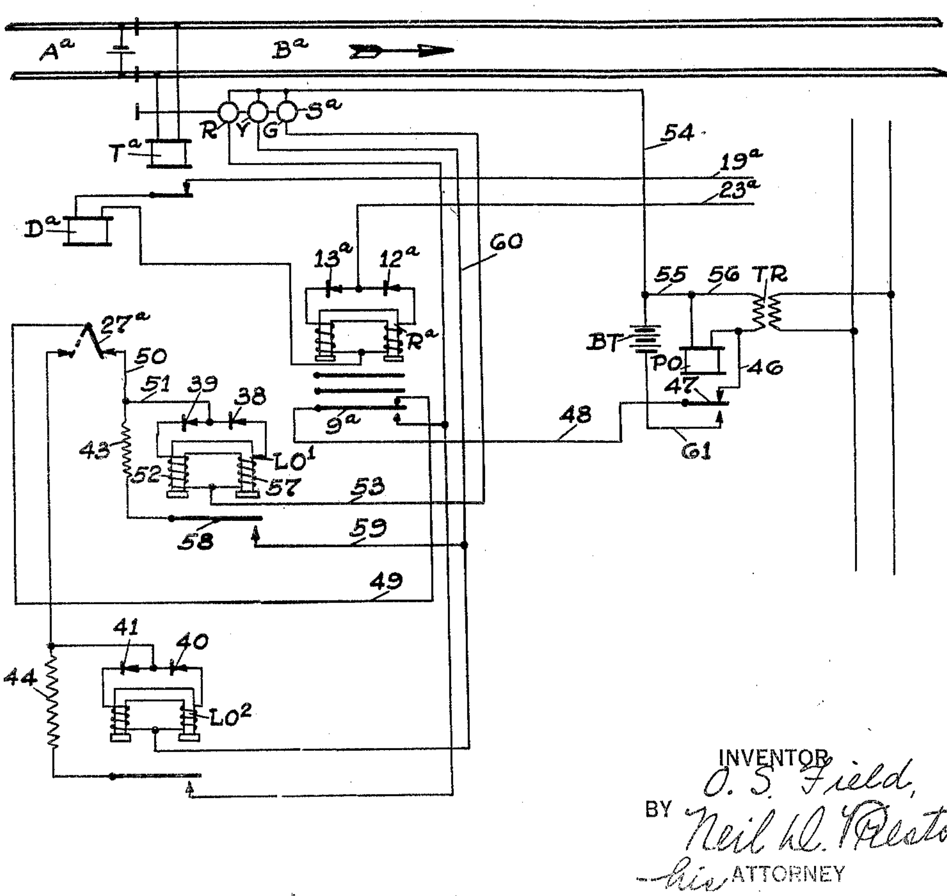


FIG. 2.



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UNITED STATES PATENT OFFICE

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RELAY

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This invention relates to electrically operated relays, and more particularly pertains to tractive type relays which are operable on either direct current or alternating current, and which are unresponsive to a reversal in polarity of the current supplied to their energizing circuits.

In some cases, it is desirable to operate relays over polarized circuits to thereby gain the advantages of the inherent cross protection features and the added number of controls provided thereby. The control of a three indication railroad traffic controlling signal is one such case. However, the use of the usual polar-neutral direct current relay, or the usual three position alternating current relay has a disadvantage in that the contacts of such relays must be operated to their deenergized positions in order to be operated to the opposite extreme positions selected by the application of energy of opposite polarity. As the deenergized position of such relays is used to cause the associated signals to display red or danger indications, a flashing of red or danger indications is occasioned by the change from one less restrictive indication to the other less restrictive indication.

Also, it is sometimes desirable to operate a relay at one time by alternating current, and to operate it at another time by direct current. This is illustrated by the usual light-out relay employed with railway signals to cause a more restrictive indication to be given should a particular incandescent bulb burn out. But, it is generally understood that a relay operated on direct current gives more satisfactory results than the same relay operated on alternating current.

With the above and other considerations in mind, it is proposed to provide in accordance with the present invention, a relay device or arrangement which is operable on either alternating current or direct current and is unresponsive to a reversal of polarity of its energizing source in either case.

More specifically, it is proposed to provide a neutral relay having two windings each being connected in series with a half-wave rectifier, with the two series combinations connected in multiple in such a way that, when direct current is applied to the multiple-series combination, one winding of the relay will be energized, while if the applied polarity is reversed, the other winding will be energized. Also, with either one or the other of the two windings energized as determined by the series rectifiers, the polarity of the magnetic flux produced in the relay core by the windings will be the same in either case. It is obvious that such a combination will provide for the energization of the two windings alternately when alternating current is supplied to the terminals of the combination.

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

Fig. 1 is a diagrammatic representation of one embodiment of the present invention as applied to a stretch of railway track provided with block signals;

Fig. 2 shows in a diagrammatic manner an application of the embodiment of the present invention as used for light-out relays.

With reference to Fig. 1 of the accompanying drawings, a stretch of railway track is shown comprising the exit end of a track section A, the whole of a track section B, and the entrance end of a track section C. These blocks or track sections A, B and C are separated from each other by the usual insulated joints; with each block or track section supplied with the usual track relay at its entrance end and the usual track battery at the exit end. In the specific example shown in Fig. 1, a track relay T^1 is shown at the entrance to track section B having an associated track battery 4 located at the exit end of the said track section; a track relay T^2 located at the entrance end of the track section C, also having associated therewith a suitable track battery (not shown); and a track battery 5 located at the exit end of track section A. At the entrance of the track sections B and C are located signals S^1 and S^2 respectively, which are represented as three indication color light signals giving red, yellow and green indications. These indications have the usual significance with each indication being produced by the energization of an electric incandescent bulb or lamp located so that its light rays pass through a suitable color screen and such other optical means as may be required.

At the signal locations, polar relays D^1 and D^2 are located respectively. These polar relays are controlled over polarized circuits in accordance with the traffic conditions along the railway track in advance of the respective signal locations at which they are located.

Two neutral relays R^1 and R^2, constructed according to the present invention, are located respectively at the signal locations S^1 and S^2. The relay R^1, for example, includes a magnetic circuit made up of two core members 6 and 7 interconnected by a back strap 8, said magnetic circuit having associated therewith an armature 9 for operating the usual contacts.

Coils 10 and 11 are wound oppositely on the cores 6 and 7 respectively. The lower terminals of these coils are connected, while the upper terminals of these coils are connected in series through two rectifier units 12 and 13, which allow current to pass only in the directions indicated by the arrow heads in the drawings. With such connections, the coils 10 and 11 are alternately energized when the polarity of the applied current is reversed. Also, the windings are so placed on the cores that such alternate energization always produces magnetic flux in the magnetic circuit in the same direction.

Let us consider that traffic conditions in advance of signal S^2 are such that the polar relay D^2 and neutral relay R^2 are in energized conditions. Thus, an energizing circuit is completed for the polar relay D^1 and the neutral relay R^1 so long as the track relay T^1 remains energized. This energizing circuit may be traced as follows:—from the positive terminal of a suitable source of electrical potential indicated as B+, through front contact 18 of relay R^2, wire 19, front contact 20 of track relay T^1, wire 21, windings of relay D^1, wire 22, winding 10 of relay R^1, rectifier unit 12, wire 23, front contact 24 of relay R^2, to the negative terminal of the suitable source indicated as B−. With this energizing circuit completed, the contacts of relays D^1 and R^1 are caused to be in energized positions. It is here noted that the relays D^2 and R^2 are energized over similar control circuits.

The armature 9 of the relay R^1 is supplied with suitable contacts as diagrammatically represented. These contacts control the electrical energy supplied to the signal S^1 and to the polarized control circuits for the D and R relays located at the next signal location in the rear of signal S^1. With the armature 9 of relay R^1 in an energized position, energy is supplied from the positive terminal of a suitable source of electrical potential indicated as B+, through front contact 9 of relay R^1, wire 26, polar contact 27 of relay D^1 in a right-hand position, wire 28, through the incandescent bulb of the green indicating means G of signal S^1, to the negative terminal of the suitable source indicated as B−. The signal S^1 is thus caused to give its least restrictive indication.

If a train approaches the track section B, the signal S^1 is displaying the green or unrestrictive indication as above explained to allow the train to pass. As soon as the train actually passes onto the track section B, the track relay T^1 is shunted thereby opening the energizing circuit of the relays D^1 and R^1 at its front contact 20. As soon as the relay R^1 is deenergized the incandescent bulb in the green indication means G of signal S^1 is deenergized and the incandescent bulb in the red indication means R is energized from the positive terminal of a suitable source of electrical potential indicated as B+, through back contact 9 of relay R^1, wire 31, through the incandescent bulb of the red indicating means R of signal S^1, to the negative terminal of the suitable source indicated as B−.

The train proceeds to the signal S^2 which is displaying a green indication allowing the train to pass onto track section C. As soon as the track relay T^2 is deenergized its front contact 32 opens the energizing circuit of the relays D^2 and R^2, thereby causing the incandescent bulb of the green indicating means G of the signal S^2 to be deenergized and the incandescent bulb of the red indicating means R to be energized from the positive terminal of a suitable source of electrical potential indicated as B+, through back contact 33 of relay R^2, wire 34, incandescent bulb of the red indicating means R of signal S^2, to the negative terminal of the suitable source indicated as B−.

The deenergization of the relay R^2 causes the polarity normally applied to the relays D^1 and R^1 to be reversed. This application of energy of reverse polarity is accomplished as soon as the train entirely leaves the track section B allowing front contact 20 of relay T^1 to assume an energized position. This energizing circuit is traced as follows:—from the positive terminal of a suitable source of electrical potential indicated as B+, through back contact 24 of relay R^2, wire 23, rectifier 13, winding 11 of relay R^1, wire 22, windings of relay D^1, wire 21, front contact 20 of relay T^1, wire 19, back contact 18 of relay R^2, to the negative terminal of the suitable source indicated as B−. The application of reverse polarity to the relay D^1, causes its polar contact 27 to assume a left-hand dotted line position as well as causing the contacts of relay R^1 to also assume energized positions. The energization of these relays D^1 and R^1 cause the energization of the incandescent bulb of the yellow indicating means Y of the signal S^1. This energizing circuit is traced as follows:—from the positive terminal of a suitable source of electrical potential indicated as B+, through front contact 9 of relay R^1, wire 26, polar contact 27 in a dotted line position, wire 36, through the incandescent bulb of the yellow indicating means Y of the signal S^1, to the negative terminal of the suitable source indicated as B−.

When the train leaves the track section C and passes onto the next track section in advance (not shown), the track relay T^2 is energized allowing the relays D^2 and R^2 to be energized with a reverse polarity causing the incandescent bulb of the yellow indicating means Y of signal S^2 to be energized in a similar manner as already explained for signal S^1. The energization of relay R^2 again places normal polarity upon the energizing circuit of the relays D^1 and R^1. The application of normal polarity on the relay D^1 causes the polar contact 27 to return to a normal full line position.

If the incandescent bulb of the red indication means of the signal S^1 were controlled from a neutral contact on the relay D^1 instead of by the neutral contact 9 of the relay R^1, it would be momentarily energized upon 27 moving from one extreme position to the other causing a false indication to be momentarily displayed. This would be true no matter how quickly the polarity of the applied potential to the relay D^1 was reversed, as the magnetic flux in the core of a polar-neutral relay must pass through a zero value before it can build up with a new polarity. At the time that the magnetic flux in a relay core passes through a zero value, the neutral armature is caused to be operated to a deenergized position. The addition of various means and devices for causing the slow operation of such a polar-neutral relay still does not eliminate the operation of the neutral armature to a deenergized position as the magnetic flux value passes through zero.

However, in accordance with the present invention, the incandescent bulb of the red indicating means of the signals S^1 and S^2 are governed by contacts on their respective neutral relays R^1 and R^2. These relays R^1 and R^2 do not drop their neutral armatures upon the reversal of polarity, as the application of reverse polarity only causes the energization of the normally energized coil on each relay and at the same time causes the deenergization of the other coil on each relay. These two energizing coils on the R relays are so connected that the magnetic flux produced by each coil, with current flowing as determined by the respective rectifier units, always flows in the same direction in the magnetic circuit. In other words, the magnetic flux in a particular relay core does have to pass through a zero value when opposite polarity is applied, but is allowed to decrease at a normal time rate according to the inductance of the circuit during such change in polarity, until the opposite winding has been energized. As the magnetic flux produced by each of these coils is in the same direction or of the same polarity, there is a certain amount of residual magnetism in the core after any particular deenergization which serves to eliminate the actual occurrence of a zero value of flux in the relay core. It is noted that the rate of decrease of the flux in the relay core may be varied in the usual way to provide that it may not assume such a small value as to allow the armature of the relay to drop before the opposite coil is sufficiently energized to hold the armature in an energized position.

With the normal polarity now applied to the relays D^1 and R^1, the signal S^1 is caused to give a green indication. When the train passes onto the second track section in advance of the signal S^2, signal S^2 is caused to give a clear or green indication, in a similar manner as explained for signal S^1.

With reference to Fig. 2 of the accompanying drawings, the relay embodying the present invention is shown as used for a light-out relay operable on either alternating current or direct current. This application of the embodiment of the present invention is shown as employed with a signal location similarly controlled as the signal location S^1 in Fig. 1 of the accompanying drawings. Thus, it is deemed unnecessary to explain the various controls that are governed in accordance with traffic conditions. Also, the various devices and the various circuits in Fig. 2 which are similar to those of Fig. 1 are designated with the same reference characters having distinctive exponents *a*. More specifically, Fig. 2 shows track sections A and B of Fig. 1 replaced by track sections A^a and B^a; signal S^1 replaced by signal S^a; track relay T^1 replaced by track relay T^a; polar relay D^1 replaced by polar relay D^a; relay R^1 replaced by relay R^a; rectifier units 12 and 13 replaced by rectifier units 12^a and 13^a; and control wires 19 and 23 replaced by control wires 19^a and 23^a respectively.

The signal S^a is supplied with electrical energy either from an alternating current transmission line through a local transformer TR or from a local battery source BT. A power-off relay PO is associated with the local transformer TR being connected directly across the secondary winding of the transformer. It is obvious that the power-off relay PO will be energized at all times that the alternating current transmission line is supplied with power. This energization of the relay PO causes alternating current to be applied to the control circuits of the signal S^a through a front contact on the power-off relay, while if the relay is deenergized due to an alternating current power failure, direct current is supplied from the battery source BT through a back contact on the relay PO.

Two light-out relays LO^1 and LO^2 are associated with the control circuits of the indicating means of signal S^a. These light-out relays have associated therewith rectifier units 38 and 39, also 40 and 41 respectively, and are constructed in a similar manner as explained for the R relay with the additional feature that, the resistance and impedance of the windings must be so proportioned, that the currents, which flow when either direct current or alternating current is applied, will produce the same effective pull on the armatures. The impedance value will of course vary slightly according to the frequency of the alternating current supply, which must of course be taken into consideration during the design of the relays for a particular application in practice. It is noted, however, that the direct current resistance and the alternating current impedance will not have the usual relationship due to the absence of a reversal of magnetic flux in the relay core.

Two resistances 43 and 44 are provided to compensate for the difference in resistance between the control circuits as determined by whether the light-out relays LO are energized or deenergized.

The control circuits of the signal S^a will now be explained considering only those circuits which are different from Fig. 1 and more specifically as determined by the governing control of the contacts 9^a and 27^a of the relays R^a and D^a respectively.

Considering that the alternating current transmission lines supplied with suitable alternating current potential which the local transformer TR in turn supplied to the power-off relay PO, and that the traffic controlling part of the system is such that the incandescent bulb of the green indicating means G of the signal S^a should be energized, the energizing circuit for the incandescent bulb of the green indicating means G is traced as follows:—from the lower terminal of the secondary of transformer TR, through wire 46, front contact 47 of the power-off relay PO, wire 48, front contact 9^a of relay R^a, wire 49, polar contact 27^a of relay D^a in a light-out normal position, wires 50 and 51, rectifier unit 39, left-hand winding 52 of relay LO^1 wire 53, incandescent bulb of the green indicating means G of signal S^a, wires 54, 55 and 56, to the upper terminal of the secondary winding of the local transformer TR. This is the energizing circuit for the incandescent bulb of the green indicating means G of the signal S^a as normally supplied with alternating current. It is of course understood, that on one half of the alternating current cycle that current flows through the circuit in the direction traced, but on the other half of the cycle the current flows in a reverse direction, thus including the right-hand coil 57 of relay LO^1 and rectifier unit 38 in place of the left-hand coil 52 and rectifier unit 39. From this explanation, it is obvious that the coils 52 and 57 are alternately energized with the application of alternating current. Also, as the coils are so wound and the rectifier units so connected that the currents which flow in the coils each produce magnetic flux in the relay core in the same direction or of the same polarity. Since this is true, a continuous uni-directional flux is produced in the magnetic circuit of the relay LO^1 which has no zero value due to the combination of the arrangement of coils and rectifiers, and also due to the fact that the reversal of polarity does not cause the residual magnetism to be reduced to zero before the opposite polarity is built up.

As the signal S^a is supplied with an incandescent bulb for each indicating means, the circuit for the relay LO^1 is opened causing its armature 58 to assume a deenergized position if the bulb in the green indicating means G burns out. With the armature 58 of relay LO^1 deenergized, the incandescent bulb of the yellow indicating means Y of signal S^a is energized through a circuit from the polar contact 27^a in a right-hand dotted line position, through wire 50, resistance 43, back contact 58 of relay LO^1, wires 59 and 60, incandescent bulb of the yellow indicating means Y of signal S^a, to the wire 54 and through the circuit as heretofore traced.

As the green indication of signal S^a represents a clear signal for allowing traffic to pass normal speed, the display of the yellow indication, which is a more restrictive or caution indication, insures that the engineer on the train does not miss the signal location in passing and also that such indication, which is received, is on the side of safety.

Should the polar contact 27^a be in a left-hand dotted line position for controlling the energizing circuit of the incandescent bulb in the yellow indicating means Y of signal S^a for a given traffic condition as explained for Fig. 1, the light-out relay LO^2 is included in this circuit. This light-out relay LO^2 shunts itself out and applied energy to the incandescent bulb of the red indicating means R, if the signal from the incandescent bulb for the yellow indicating means Y which burns out, all of which is accomplished in a similar manner as explained for the relay LO^1.

The negative terminal of the battery BT is connected to the control circuits at the same point as the upper terminal of the secondary of local transformer TR, while the opposite terminal of the battery BT is connected through wire 61 to the back contact 47 of power-off relay PO. Thus, it is obvious that should the power-off relay PO which is connected directly across the secondary of local transformer TR become energized, its back contact 41 would allow direct current to be applied from the battery BT through the same energizing circuits heretofore explained. In the case of each of the LO relays embodying the present invention, only one of their windings would be energized when controlled by direct current depending upon the polarity at the relay terminals. This will not be pointed out in detail as the specific operation of the relay on direct current has been pointed out for Fig. 1 of the accompanying drawings.

Thus, a relay embodying the present invention has been shown as being useful in polarized direct current control circuits, and in circuits where both alternating and direct currents are used for controlling purposes.

In brief, the present invention provides means for supplying a continuous uni-directional magnetic flux from an alternating current by use of two half-wave rectifiers and two windings having their magnetic circuits interconnected, said rectifiers and said windings being bridge connected to produce a magnetic effect of a full-wave rectifier current.

Having described a relay combination as one specific embodiment of the present invention and two applications in which such a relay combination may be used, it is desired to be understood that the combination selected and the applications shown are to facilitate in the disclosure of the invention rather than to limit the number of forms which the invention may assume; and, it is to be further understood that various modifications, adaptations and alterations may be applied to the specific embodiment shown to meet the requirements of practice without in any manner departing from the spirit or scope of the invention except as limited by the appended claims.

Having described my invention, I now claim:

1. In a traffic controlling system for railroads, a stretch of railway track, a plurality of signals governing traffic over said stretch of railway track, a polar relay located at each of said signals and operated over a polarized circuit governed by traffic conditions in advance of the corresponding one of signals, a neutral relay having two windings connected in a multiple combination, said multiple combination connected in series with said polar relay in said polarized circuit, one rectifier in series with one of said two windings, another rectifier in series with the other one of said two windings, means governing the relative restrictiveness of said signals, said means including said polar relay and said neutral relay, whereby the restrictiveness of said signals may be altered over said polarized circuit without affecting the position of said neutral relay.

2. In a traffic controlling system for railroads, a light signal giving indications of varying restrictiveness, each indication having a control circuit, a light-out relay in each of said control circuits for causing the indication next in order of restrictiveness to be given if the control circuit of a particular indication is opened, said light-out relay being operable on either direct current or alternating current, an electro-magnetic operating mechanism for said relay, and means providing said mechanism with the same effective magnetic flux values whether said control circuits are supplied with direct or alternating currents.

3. In a traffic controlling system for railroads, a color light signal giving a plurality of indications of varying restrictiveness, an incandescent bulb for each indication, each of said incandescent bulbs having a control circuit, means for supplying said control circuits with either alternating current or direct current, and a plurality of light-out relays each for causing one of said bulbs next in order of restrictiveness burns out, said light-out relays including a magnetic circuit, two coils associated with said magnetic circuit, and two rectifier units, one connected in series combination with one of said coils, the other connected in a series combination with the other one of said coils, said two series combinations connected in a multiple combination, said multiple combination connected in series with its respective one of said control circuits of said incandescent bulbs.

In testimony whereof I affix my signature.

OSCAR S. FIELD.