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ELECTRICAL CONTROL APPARATUS

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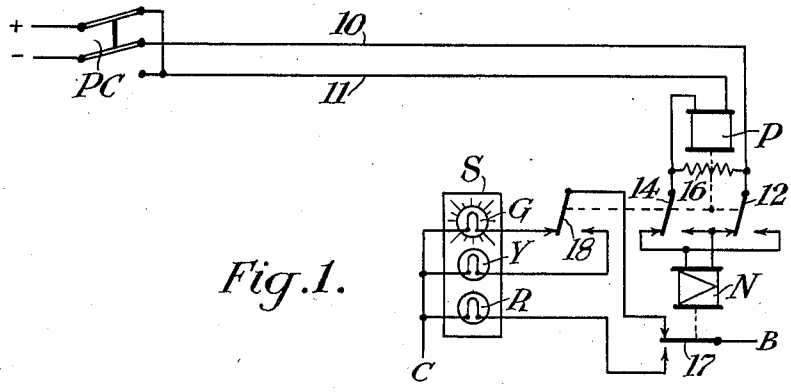


Fig. 1.

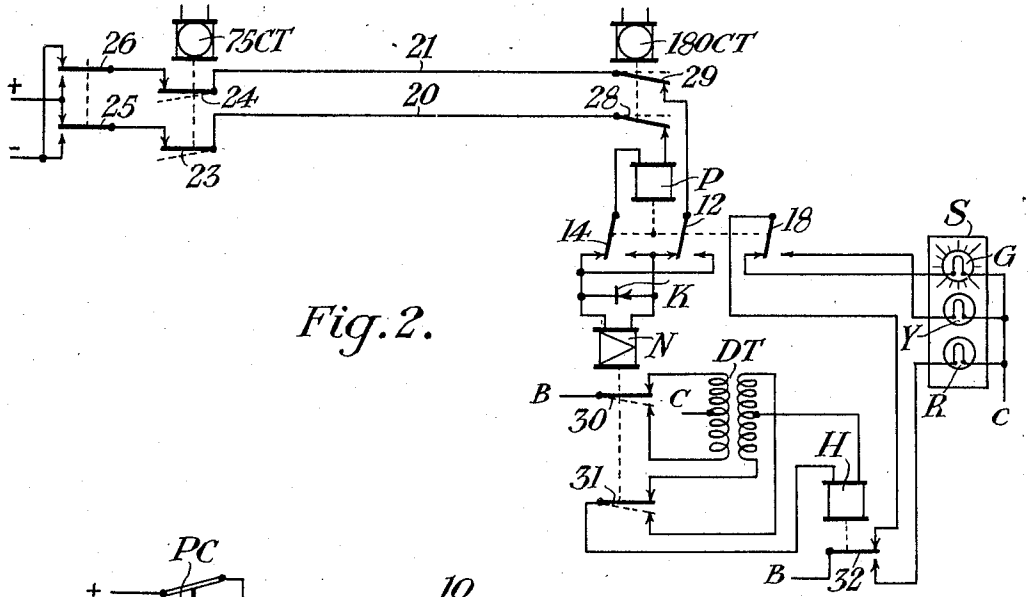


Fig. 2.

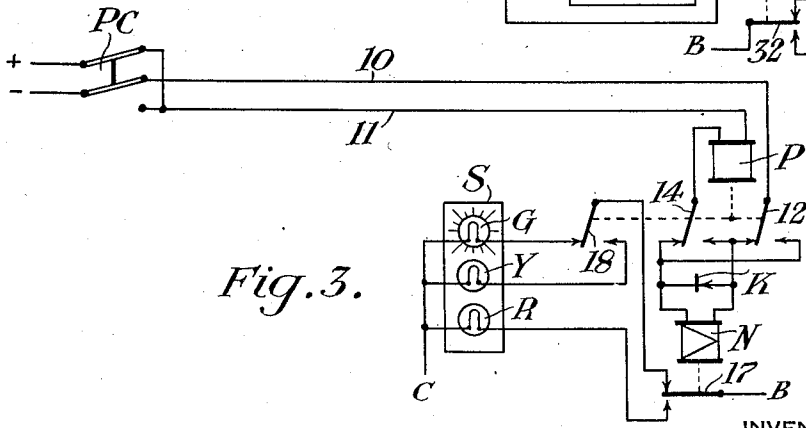


Fig. 3.

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ELECTRICAL CONTROL APPARATUS

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9 Claims. (Cl. 177—353)

My invention relates to electrical control apparatus, and particularly to apparatus for effecting one function when a control circuit is energized by current of one relative polarity and another function when the control circuit is energized by current of the other relative polarity.

The apparatus of this invention is an improvement on that shown and claimed in Letters Patent of the United States No. 2,250,214, granted July 22, 1941, to Harry E. Ashworth.

In the Ashworth application there is shown control apparatus employing a polar relay and a biased polar relay energized from a polarized control circuit, and arranged so that the biased polar relay checks the polar relay to insure that it responds to a change in the polarity of the energy supplied over the control circuit.

The polar relays employed in this apparatus require much less operating current than the biased polar relays and hence may have windings of relatively low resistance when connected in a series circuit. If the windings of these relays are connected in multiple across the control circuit in the manner shown in the Ashworth application, most of the energy supplied over the control circuit flows through the winding of the polar relay and relatively little of the energy flows through the winding of the biased polar relay. It has been found that if the control circuit is very long, too little energy is supplied to the winding of the biased polar relay to pick up the contacts of this relay.

It is an object of this invention to provide improved control apparatus of the type described and in which the windings of the polar and biased polar relays are connected in series so that the winding of the polar relay does not divert energy from the biased polar relay, thereby making operation of the biased polar relay more positive and also making possible operation of this relay over much longer control circuits than has heretofore been practicable.

Another object of the invention is to provide improved control apparatus of the type described which is arranged so that the winding of the polar relay is maintained energized during movement of the contacts of the relay from one position to the other to thereby insure that on a change in the polarity of the energy supplied to the relay the contacts of the relay will complete their movement from one position to the other.

A further object of the invention is to provide improved control apparatus of the type described which is arranged to include a snubbing circuit for the winding of the biased polar relay to thereby delay release of the contacts of this relay so that when coded energy in which the energy impulses are relatively short is supplied over the line circuit, release of the contacts of the biased polar relay will be delayed so that the picked-up and released periods of the relay contacts are rendered substantially equal in length.

Another object of the invention is to provide improved control apparatus having a polar relay energized over a control circuit, an auxiliary relay associated with the polar relay and energized from the control circuit over connections governed by contacts of the polar relay and having means effective on a change in the polarity of the energy supplied to the control circuit to maintain the contacts of the auxiliary relay picked up during movement of the contacts of the polar relay from one position to the other.

Other objects of the invention and features of novelty will be apparent from the following description taken in connection with the accompanying drawing.

I shall describe three forms of control apparatus embodying my invention, and shall then point out the novel features thereof in claims.

In the drawing Fig. 1 is a diagram illustrating one embodiment of my invention energized over a control circuit employing steady energy.

Fig. 2 is a diagram illustrating a modification of my invention energized over a control circuit employing coded energy, and

Fig. 3 is a diagram illustrating the modification of Fig. 2 energized over a control circuit employing steady energy to provide the equivalent of a retained neutral polar relay.

Similar reference characters refer to similar parts in each of the three views.

Referring to Fig. 1 of the drawing, the reference character P designates a polar relay, while the reference character N designates an auxiliary relay. The windings of the relays P and N are energized over a polarized control circuit here shown as comprising conductors 10 and 11 which are connected by contacts of a pole changer PC with a suitable source of direct current, such as a battery the terminals of which are designated + and —. The conductors 10 and 11 may be line wires, or they may be the track rails of a section of railway track, while the pole changer PC may be a manually operated device, it may be the contacts of a relay, or it may be any other suitable mechanism.

The conductor 10 is connected to polar contact 12 of relay P, while conductor 11 is connected to one terminal of the winding of relay P. The other

terminal of the winding of relay P is connected to contact 14 of the relay. The contacts 12 and 14 control connections for connecting the winding of the relay N in series with the winding of the relay P.

The relay N is of the polar biased type and its contacts become picked up when and only when energy flows in one direction through the relay winding. One relay which I may employ is shown in application, Serial No. 194,160, of Harry E. Ashworth, while another relay which I may employ is shown in United States Patent No. 2,057,605 issued October 13, 1936, to Herman G. Blosser. The various parts of the apparatus are arranged so that the relay N picks up only when the positive terminal of the source is connected to the left-hand terminal of the relay winding.

A resistance 16 having a resistance substantially greater than that of the winding of relay N may be connected across the conductors 10 and 11 to provide means to maintain energization of the winding of relay P during movement of the relay contacts from one position to the other.

The contact 17 of relay N and contact 18 of relay P may cooperate to perform any desired control function, as, for example, to control the lamps of a signal S.

When the equipment is in the condition shown in the drawing, energy from the positive terminal of the source flows through conductor 11, winding of relay P, and contact 14 of relay P to the left-hand terminal of the winding of relay N, through this winding, contact 12 of relay P, and conductor 10 to the negative terminal of the source. Under these conditions, the windings of relays P and N are energized in series, while the polarity of the energy supplied to the relay P is such that the relay contacts occupy their left-hand positions as shown, and the direction of flow of energy through the winding of relay N is that which is effective to pick up the contacts of the relay. Accordingly, contact 17 of relay N and contact 18 of relay P cooperate to establish the circuit of the lamp G of signal S.

On a reversal of the pole changer PC the positive terminal of the source is connected to conductor 10 and the negative terminal of the source is connected to conductor 11. At the instant of reversal of the pole changer PC contacts 12 and 14 of relay P are in their left-hand positions, as shown, so that energy flows from the positive terminal of the source over conductor 10, and contact 12 of relay P to the right-hand terminal of the winding of relay N, through the relay winding, contact 14 of relay P, winding of relay P, and conductor 11 to the negative terminal of the source.

The energy flowing in this direction through the winding of relay N tends to cause release of the contact of this relay, while this energy flowing through the winding of relay P causes the contacts of this relay to move out of engagement with their left-hand contacts and into engagement with their right-hand contacts.

As soon as the contacts 12 and 14 of relay P move out of engagement with their left-hand contacts, the circuit traced above for energizing the windings of the relays P and N in series is interrupted. The operating characteristics of the relay P may be such that the relay contacts will continue to move subsequent to interruption of the supply of energy to the relay winding so that the relay contacts will complete their movement to their right-hand position.

When the contacts of relay P complete their movement to their right-hand positions, a circuit is complete to energize the windings of relays P and N in series, while this circuit is arranged so that the positive terminal of the source is connected to the left-hand terminal of the winding of relay N so that the energy supplied to the winding of this relay is effective to pick up the relay contacts. In addition, the energy supplied to the winding of relay P is effective to maintain the contacts of this relay in their right-hand positions.

As a result of movement of the contacts of relay P from their left-hand to their right-hand positions, contact 18 interrupts the circuit of the lamp G of signal S and establishes the circuit of the lamp Y. This circuit includes front contact 17 of relay N so that it is established only if relay N is picked up.

The operation of the equipment on a subsequent change in the polarity of the energy supplied over the conductors 10 and 11 is similar to that described in detail above and will not be repeated.

On interruption of the supply of energy over the conductors 10 and 11 contact 17 of relay N releases and interrupts the circuit of lamp Y or G and establishes the circuit of the lamp R.

If, on a change in the polarity of the energy supplied over the conductors 10 and 11, the contacts of relay P fail to move from one position to the other, the conductors 10 and 11 will be connected to the winding of relay N in such manner that the positive terminal of the source is connected to the right-hand terminal of the relay winding. Accordingly, the direction of flow of energy through the winding of relay N will be such that the energy is ineffective to pick up the relay contacts and contact 17 will remain released and maintain the circuit of the lamp R of signal S. The relay N, therefore, checks response of the realy P to changes in the polarity of the energy supplied over the conductors 10 and 11.

If desired, a resistor 16 may be connected between the contacts 12 and 14 of relay P to provide means to energize the relay P during movement of the relay contacts between their two positions to thereby insure that on a change in the polarity of the energy supplied to the conductors 10 and 11 the contacts of relay P will complete their movement from one position to the other. The resistor 16 is preferably of substantially higher resistance than the winding of relay N so that when the contacts of relay P establish the circuit of the winding of relay N, most of the energy supplied over the conductors 10 and 11 is supplied through the winding of relay N. Because of the high resistance of resistor 16 relatively little energy is supplied to the winding of relay P while the relay contacts are in transit. However, after the contacts of relay P have started their movement, little force is required to cause the contacts to continue their movement and the energy supplied through the resistance 16 is sufficient for this purpose.

It will be seen that the arrangement of the control apparatus is such that the relay P is connected in series with the winding of the relay N. Accordingly, even if the relay P has a relatively low resistance winding, it will not divert energy from the relay N, nor will it materially reduce the current in the winding of relay N, and sufficient energy will be supplied to the relay N to operate this relay even though the conductors 10 and 11 are relatively long.

Although the modification shown in Fig. 1 of

the drawing has been illustrated and described in connection with a control circuit in which steady energy is employed, it should be understood that this modification is adapted for use also with a control circuit in which coded or periodically interrupted energy is employed.

In Fig. 2 of the drawing there is shown a modified form of my invention which is particularly adapted for use in signaling systems employing coded energy in which the energy impulses are relatively short. Signaling systems of the type in which this modification is adapted to be employed are shown in application Serial No. 393,363 of George W. Baughman, filed May 14, 1941, and in application Serial No. 405,821 of Thomas W. Tizzard, Jr., filed August 7, 1941.

In the systems shown in these applications there is a line circuit having at opposite ends thereof continuously operating coding devices. The contacts of these devices are operated at different rates and the contacts of each of the devices control connection from the line wires to a source of current or to line relays. As the contacts of the coding devices operate at substantially different rates, there are frequently recurring periods in which the contacts of the coding devices are in such relationship that energy is supplied from the source at one end of the line circuit to the line relays at the other end of the line circuit. Since the duration of the energy impulses supplied to the line relays at either end of the line circuit is determined by the relationship of the contacts of coding devices operating at different speeds, these impulses vary in length and some of them may be extremely short.

It has been found that some types of decoding apparatus operate most satisfactorily if the picked-up and released periods of the code following relays are approximately equal in length. The modification shown in Fig. 2 provides means to employ the control apparatus of this invention in signaling systems of the type described, and to render the code following relay slow in releasing so that the picked-up periods of the relay will be nearly equal in length to the released periods.

The diagram forming Fig. 2 of the drawing shows the line relays and associated apparatus at one end of the line circuit together with the means for energizing these relays over the line circuit. As therein shown, a code transmitter 75CT is located at one end of the line wires 20 and 21 and has contacts 23 and 24 which are continuously operated between picked-up and released positions at a predetermined rate, such as 75 times a minute. The contacts 23 and 24, when picked up, connect the wires 20 and 21 through contacts 25 and 26 of a pole changing device to a source of current.

A code transmitter 180CT is located at the other end of the line wires 20 and 21 and has contacts 28 and 29 which are continuously operated between their picked-up and released positions at a predetermined rate, such as 180 times a minute. The contacts 28 and 29 when released connect the line wires 20 and 21 to the windings of line relays P and N in series.

The relay P is a stick polar relay the contacts of which when moved to either position remain in that position until energy effective to move the contacts to their other position is supplied to the relay winding, while the relay N is a biased polar relay similar to the corresponding relay of the system shown in Fig. 1. The relay P has contacts 12 and 14 which control the circuit of relay N in the manner explained in connection with the modification shown in Fig. 1. The modification shown in Fig. 2 differs from that shown in Fig. 1 in that a rectifier K is connected across the terminals of the winding of relay N and is poled to permit flow of energy in the direction opposite to that which is effective to pick up the contacts of the relay N.

The relay N has a contact 30 which controls the supply of energy to the primary winding of a decoding transformer DT, and a contact 31 which rectifies the energy supplied from the secondary winding of the transformer DT to the relay H.

In operation, when the contacts of the coding device 75CT are picked up and the contacts of the coding device 180CT are released, a circuit is established to supply energy over the line wires 20 and 21 to the line relays P and N. When the contacts 25 and 26 of the pole changing device are picked up, the energy supplied over the line wires is of normal polarity and the contacts 12 and 14 of the relay P occupy their left-hand positions as shown, while the positive terminal of the source is connected to the left-hand terminal of the winding of relay N so that the energy flows through the winding of relay N in the direction effective to pick up the relay contacts. Accordingly, the contacts of relay N are picked up.

As soon as the contacts of code transmitter 75CT become released, or those of code transmitter 180CT become picked up, the circuit for supplying energy to the relays P and N is interrupted. On interruption of the flow of current in the winding of the relay P the contacts of this relay remain in their left-hand positions because of the stick polar characteristic of the relay.

On interruption of the circuit of the relay N a current is induced in the relay winding which tends to flow in the same direction as the current previously present in the relay winding. The rectifier K provides a low resistance path for this current so that this current flows through the winding of relay N and maintains the flux in the relay core for a time and thereby maintains the contacts of relay N picked up for a period subsequent to interruption of the supply of energy to the relay. After the expiration of this interval, the contacts of relay N release.

On subsequent reestablishment by the contacts of the code transmitters 75CT and 180CT of the circuit for supplying energy over the line wires 20 and 21 to the line relays P and N the contacts of the relay N become picked up, while they again become released on interruption of the supply of energy over the line wires.

As a result of the release and picking up of the contact 30 of relay N, the two portions of the primary winding of transformer DT are alternately energized and impulses of energy are induced in the secondary winding of the transformer, while the energy supplied from this winding to the winding of relay H is rectified by the contacts 31 of relay N as explained in United States Patent No. 2,237,788, issued April 8, 1941, to Frank H. Nicholson and Leslie R. Allison.

Because of the snubbing effect on the relay N of the circuit including the rectifier K the picked-up periods of the contacts of the relay N are somewhat longer than the impulses of energy supplied to the relay. The various parts are selected and proportioned so that the snubbing effect of the rectifier delays the release of the contacts of relay N long enough to make the picked-

up periods of the contacts of relay N approximately equal in length, on the average, to the released periods of the relay. Accordingly, the impulses of energy supplied from the transformer DT to the relay H when the contacts of relay N are in their picked-up position are of substantial magnitude and duration and insure that the energy supplied to the relay H is adequate to keep the relay picked up.

The relay H has a contact 32 which cooperates with contact 18 of relay P to control the circuits of the lamps of signal S. When contact 32 is picked up and contact 18 is in its normal or left-hand position as shown, the circuit of the lamp G is established.

On release of the contacts 25 and 26 of the pole changing device the polarity of the energy supplied to the line wires 20 and 21 is reversed and may be considered to be of reverse polarity. At this time energy from the positive terminal of the source flows over back contact 26, front contact 24 of code transmitter 75CT, line wire 21, back contact 29 of code transmitter 180CT, contact 12 of relay P, rectifier K, contact 14 of relay P, winding of relay P, back contact 28 of code transmitter 180CT, line wire 20, front contact 23 of code transmitter 75CT, and back contact 25 to the negative terminal of the source. The energy supplied over this circuit to the winding of relay P causes the contacts of this relay to shift from their left-hand to their right-hand positions. The rectifier K provides a low resistance path through which energy may be supplied to the relay P so that the winding of relay P is supplied with energy of relatively high value. As soon as contacts 12 and 14 become disengaged from their left-hand contacts, the circuit for supplying energy to the winding of relay P is interrupted, but the relay contacts continue to move and complete their movement to their right-hand or reverse positions.

When the contacts of relay P are in their reverse positions and energy of reverse polarity is supplied over the line wires, energy is no longer supplied through the rectifier K. Instead the energy flows through right-hand contact 12 of the relay P to the left-hand terminal of the winding of relay N, through this winding, right-hand contact 14 of relay P, and thence through the winding of relay P. As soon as the contacts of relay P complete their movement to their reverse positions, therefore, the windings of relays P and N are again energized in series, while the direction of flow of energy through the winding of relay N is the same as it was before reversal of the polarity of the energy supplied to the line wires and is effective to pick up the relay contacts. In addition, when the contacts of relay P are in their reverse positions, energy no longer flows through the rectifier K to energize the relay P, while this rectifier permits energy to flow in the snubbing circuit for relay N as explained above.

On the supply of coded or periodically interrupted energy over the line wires the contacts of relay N pick up and release so that energy is supplied through the transformer DT to the relay H and contact 32 of this relay is picked up. At this time, as contact 18 of relay P is in its right-hand position, the circuit of the lamp G is interrupted and the circuit of the lamp Y is established.

On subsequent picking up of the contacts 25 and 26 of the pole changing device so that energy of normal polarity is again supplied over the line wires, energy is again supplied through the rectifier K to energize the relay P as long as the contacts of relay P remain in their reverse positions. When the contacts of relay P move to their normal positions, the windings of relays P and N are again energized in series.

If the supply of energy over the line wires is interrupted, relay N will cease to follow code and energy will no longer be supplied through the transformer DT to the relay H so that contact 32 of relay N will release and establish the circuit of the lamp R of signal S.

If on a change in the polarity of the energy supplied over the line wires the contacts of relay P fail to change their position, the positive terminal of the source will be connected to the right-hand terminal of the winding of relay N instead of to the left-hand terminal of this winding. Accordingly, the energy which flows through the winding of relay N will flow in the wrong direction to pick up the relay contacts and the contacts of the relay will remain released. Furthermore, under these conditions energy may flow freely through the rectifier K and little or no energy will flow through the winding of relay N so that even if this relay were not of a type responsive to energy of one polarity only, its contacts would not become picked up. The relay N, therefore, checks operation of the relay P, while the rectifier K assists in checking the relay P by preventing energization of the relay N unless the relay P properly responds to a change in the polarity of the energy supplied thereto.

The arrangement of relays shown in Fig. 2 of the drawing is not limited to use where coded energy is employed, but is adapted for use where steady energy is employed and when these relays are used in this manner, they operate to provide the equivalent of a retained neutral polarized relay. That is, the relays operate so that on a change in the polarity of the energy supplied to them, the contacts of the relay N will remain picked up while the contacts of relay P change from one position to the other. This is advantageous as it prevents a flash of the lamp R of a signal, which would otherwise be present. Fig. 3 is a diagram showing this application of the invention.

The apparatus shown in Fig. 3 is substantially the same as that shown in Fig. 1 except for the addition of the rectifier K which is connected between the terminals of the winding of the relay N. When the pole changer PC is in the position shown, energy of normal polarity is supplied over the conductors 10 and 11 and the windings of the relays P and N are energized in series. At this time the contacts of the relay P occupy their left-hand or normal positions, while the positive terminal of the source is connected to the left-hand terminal of the winding of the relay N. Accordingly, the contact 17 of relay N is picked up and cooperates with the contact 18 of relay P to establish the circuit of the lamp G of signal 1S.

On a change in the position of the contacts of the pole changing device PC the supply of energy of normal polarity to the conductors 10 and 11 is interrupted and energy of reverse polarity is supplied thereto. On interruption of the supply of energy of normal polarity to the conductors 10 and 11 and consequent interruption of the flow of energy through the winding of relay N, a current is induced in this winding and flows freely through the rectifier K so that the contacts of the relay are maintained picked up, as

explained in connection with the modification shown in Fig. 2.

On the supply of energy of reverse polarity to the conductors 10 and 11 energy flows from the positive terminal of the source over conductor 10, left-hand contact 12 of relay P, rectifier K, left-hand contact 14 of relay P, winding of relay P, and conductor 11 to the negative terminal of the source. At this time the positive terminal of the source is connected to the right-hand terminal of the winding of relay N, but since the resistance of the relay winding is much greater than that of the rectifier K little current tends to flow through the relay winding. Furthermore, at this time the induced current is still present in the relay winding and opposes flow of current in the relay winding in the direction from the right-hand to the left-hand terminal of the relay winding. Accordingly, little or no current flows through the winding of relay N in this direction at this time. This is desirable as current flowing in this direction would tend to reverse the flux in the relay core with the result that the relay contacts would become released.

The energy of reverse polarity supplied through the rectifier K to the winding of relay P causes the contacts of this relay to shift to their right-hand or reverse positions. As soon as contacts 12 and 14 become disengaged from their left-hand contacts, the circuit traced above for supplying energy to the winding of relay P is interrupted, but because of the operating characteristics of the relay its contacts continue to move and complete their movement to their right-hand or reverse positions. When the relay contacts are in this position, the positive terminal of the source is again connected to the left-hand terminal of the winding of relay N and the relays P and N are energized in series, while the direction of flow of energy through the winding of the relay N is that which is effective to maintain the contacts of the relay picked up.

On movement of contact 18 of relay P from its normal to its reverse position it interrupts the circuit of the lamp G and establishes the circuit of the lamp Y. As the contact 17 of relay N is maintained picked up during movement of the contacts of relay P between their two positions, the circuit of the lamp R of signal S is maintained interrupted and this lamp is not momentarily lighted.

On subsequent change in the position of the contacts of the pole changing device PC so that energy of normal polarity is supplied to the conductors 10 and 11 the equipment operates substantially as described and its operation will not be traced in detail.

On interruption of the supply of energy over the conductors 10 and 11 the contact 17 of relay N becomes released and interrupts the circuits of the lamps G or Y and establishes the circuit of the lamp R.

From the foregoing it will be seen that the rectifier K provides a snubbing circuit for the relay N so that the contacts of this relay remain picked up for a period subsequent to interruption of the supply of energy to the relay winding. In addition, the rectifier K provides a low resistance path through which energy may be supplied to the winding of relay P on a change in the polarity of the energy supplied over the conductors 10 and 11 and prior to a change in the position of the contacts of the relay P. Since the energy for the relay P may flow through the rectifier K, it is not required to flow through the relay winding where it would reverse the flux in the relay core and cause release of the relay contacts.

In addition, it will be seen that as the supply of energy to the relay N is controlled by contacts of the relay P, the energy always flows in the same direction through this relay winding regardless of the polarity of the energy supplied to the conductors 10 and 11. Accordingly, on a change in the polarity of the energy supplied to the conductors 10 and 11 there is no change in the flux in the core of the relay N and the contacts of this relay will remain picked up.

If it is desired to have the relay N check the relay P, the relay N should be of the polar biased type so that its contacts will pick up only when energy flows in the proper direction through the relay winding. However, if it is not necessary to check the relay P, or if the relay P is of a safety type which does not require checking, the relay N may be a neutral relay, and it may be provided with a copper ferrule or other means in addition to the snubbing circuit including the rectifier K to render it slow in releasing.

Although the modifications shown in Figs. 2 and 3 have been illustrated and described as employing a relay P the contacts of which will continue to move subsequent to interruption of the supply of energy to the relay winding so as to complete their movement from one position to the other on a change in the polarity of the energy supplied to the relay, it should be understood that these modifications may be provided with a resistor connected between the contacts of the relay P as shown in Fig. 1 to maintain the relay winding energized during movement of the relay contacts between their two positions.

Although I have herein illustrated and described only three forms of control apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a control circuit comprising a first and a second conductor, means for at times supplying energy of one polarity and at other times supplying energy of the other polarity to said conductors, a polar relay having one terminal of its winding connected to said first conductor, an auxiliary relay which picks up when and only when current flows through the winding thereof in a given direction, said polar relay having a first contact effective when in one position to connect said second conductor to one terminal of the auxiliary relay winding and effective when in its other position to connect said second conductor to the other terminal of the auxiliary relay winding, said polar relay having a second contact effective to connect the other terminal of the winding of the polar relay to the terminal of the auxiliary relay winding other than that to which said second conductor is connected, whereby the windings of the polar and auxiliary relays are energized in series over said conductors, and whereby on a change in the polarity of the energy supplied to said conductors there is a change in the direction of flow of energy through the winding of the polar relay but not through the winding of the auxiliary relay if the contacts of the polar relay respond to the change in the direction of flow of energy through the relay winding, a rectifier connected across the terminals of the wind-

ing of the auxiliary relay and poled to provide a low resistance circuit for the flow of energy induced in the relay winding on interruption of the supply of energy to the relay winding to thereby render the relay slow in releasing, and a circuit controlled by a contact of said auxiliary relay and a contact of said polar relay.

2. In combination, a control circuit comprising a first and a second conductor, means for at times supplying energy of one polarity and at other times supplying energy of the other polarity to said conductors, a polar relay having one terminal of its winding connected to said first conductor, an auxiliary relay which picks up when and only when current flows through the winding thereof in a given direction, means effective when the polar relay contacts are in their normal position to connect the other terminal of the polar relay winding to the first terminal of the auxiliary relay winding and to connect the second terminal of the auxiliary relay winding to the second conductor, said means being effective when the polar relay contacts are in their reverse positions to connect said other terminal of the polar relay winding to the second terminal of the auxiliary relay winding and to connect the first terminal of the auxiliary relay winding to said second conductor, whereby the windings of the polar and auxiliary relays are energized in series and whereby on a change in the polarity of the energy supplied to said conductors there is a change in the direction of flow of energy through the winding of the polar relay but not through the winding of the auxiliary relay if the contacts of the polar relay respond to the change in the direction of flow of energy through the relay winding, a rectifier connected across the terminals of the winding of the auxiliary relay and poled to provide a low resistance circuit for the flow of energy induced in the relay winding on interruption of the supply of energy to the relay winding to thereby render the relay slow in releasing, and a circuit controlled by a contact of said auxiliary relay and by a contact of said polar relay.

3. In combination, a control circuit comprising a first and a second conductor, means for supplying over said control circuit coded energy comprising relatively short energy impulses which are separated by relatively long intervals during which no energy is supplied, the energy supplied to said control circuit being of normal polarity at times and being of reverse polarity at other times, a polar relay having one terminal of its winding connected to said first conductor, a code following auxiliary relay which picks up when and only when current flows through the winding thereof in a given direction, said polar relay having a first contact effective when in its normal position to connect the other terminal of the polar relay winding to the first terminal of the auxiliary relay winding and having a second contact effective when in its normal position to connect the second terminal of the auxiliary relay winding to the second conductor, said polar relay first contact being effective when in its reverse position to connect the other terminal of the polar relay winding to the second terminal of the auxiliary relay winding and the polar relay second contact being effective when in its reverse position to connect the second conductor to the first terminal of the auxiliary relay winding, whereby the windings of the polar and auxiliary relays are energized in series and whereby on a change in the polarity of the energy supplied to said conductors there is a change in the direction of flow of energy through the winding of the polar relay but not through the winding of the auxiliary relay if the contacts of the polar relay respond to the change in the direction of flow of energy through the relay winding, a rectifier connected across the terminals of the winding of the auxiliary relay and poled to provide a low resistance circuit for flow of energy induced in the relay winding on interruption of the supply of energy to the relay winding to thereby render the relay slow in releasing so that the relay contacts are in their picked-up periods approximately as long as they are in their released periods, and apparatus governed by code following operation of said auxiliary relay and by a contact of said polar relay.

4. In combination, a control circuit comprising a first and a second conductor, means for at times supplying energy of one polarity and at other times supplying energy of the other polarity to said conductors, a polar relay having one terminal of its winding connected to said first conductor, an auxiliary relay having contacts which are moved from their released to their picked-up positions when the relay winding is energized, means effective when the polar relay contacts are in their normal position to connect the other terminal of the polar relay winding to the first terminal of the auxiliary relay winding and to connect the second terminal of the auxiliary relay winding to the second conductor, said means being effective when the polar relay contacts are in their reverse positions to connect said other terminal of the polar relay winding to the second terminal of the auxiliary relay winding and to connect the first terminal of the auxiliary relay winding to said second conductor, whereby the windings of the polar and auxiliary relays are energized in series and whereby on a change in the polarity of the energy supplied to the conductors there is a change in the direction of flow of energy through the winding of the polar relay but not through the winding of the auxiliary relay if the contacts of the polar relay respond to the change in the direction of flow of energy through the relay winding, a rectifier connected across the terminals of the winding of the auxiliary relay winding and poled to provide a low resistance circuit for flow of energy induced in the relay winding on interruption of the supply of energy to the relay winding to thereby render the relay slow in releasing, said rectifier also providing a low resistance circuit through which on a change in the polarity of the energy supplied to said conductors and prior to a change in the position of the polar relay contacts energy may be supplied to the winding of the polar relay without flowing through the auxiliary relay winding, whereby on a change in the polarity of the energy supplied to said conductors the contacts of said auxiliary relay remain picked up, and a circuit governed by a contact of said auxiliary relay and by a contact of said polar relay.

5. In combination, a control circuit comprising a first and a second conductor, means for at times supplying energy of one polarity and at other times supplying energy of the other polarity to said conductors, a polar relay having one terminal of its winding connected to said first conductor, an auxiliary relay having contacts which are moved from their released to their picked-up positions when the relay winding is energized, means governed by the contacts of the polar relay

for reversibly connecting the terminals of the winding of the auxiliary relay to the other terminal of the winding of the polar relay and to said second conductor, a rectifier connected across the terminals of the auxiliary relay winding and poled to provide a low resistance circuit for flow of current induced in the relay winding on interruption of the supply of energy to the relay winding to thereby render the relay slow in releasing, said rectifier also providing a low resistance circuit through which on a change in the polarity of the energy supplied to said conductors and prior to a change in the position of the polar relay contacts energy may be supplied to the winding of the polar relay without flowing through the auxiliary relay winding, whereby the auxiliary relay contacts remain picked up on a change in the polarity of the energy supplied to said conductors, and a circuit governed by a contact of said auxiliary relay and by a contact of said polar relay.

6. In combination, a pair of control conductors to which energy of one polarity is supplied at times and to which energy of the other polarity is supplied at other times, a polarized relay having one terminal of its winding connected to one of said control conductors, an auxiliary relay, an asymmetric unit connected between the terminals of the winding of said auxiliary relay, and means governed by polar contacts of said polarized relay for reversibly connecting the auxiliary winding and said asymmetric unit in multiple between the other terminal of the polarized relay winding and the other one of said control conductors.

7. In combination, a pair of control conductors to which energy of one polarity is supplied at times and to which energy of the other polarity is supplied at other times, a polarized relay having one terminal of its winding connected to one of said control conductors, an auxiliary relay having normally released contacts which become picked up when and only when energy flows through the relay winding from its first to its second terminal, an asymmetric unit connected between the terminals of the auxiliary relay winding and poled to permit energy to flow from the second to the first terminal of said winding, and means governed by polar contacts of said polarized relay for reversibly connecting the auxiliary relay winding and said asymmetric unit in multiple between the other terminal of the polarized relay winding and the other one of said control conductors.

8. In combination, a pair of control conductors to which energy of one polarity is supplied at times and to which energy of the other polarity is supplied at other times, a polarized relay having one terminal of its winding connected to one of said control conductors, an auxiliary relay, and means including a polar contact of said polarized relay for reversibly connecting the winding of the auxiliary relay between the other terminal of the winding of the polarized relay and the other control conductor, said means being effective in each position of the contact of said polarized relay to connect in multiple with the winding of the auxiliary relay and in series with the winding of the polarized relay an asymmetric unit poled to permit flow of energy therethrough when the position of the polarized relay contact and the polarity of the energy supplied to said control conductors are out of correspondence.

9. In combination, a first and a second conductor, means for reversibly connecting said conductors with a source of direct current, a first relay having a contact movable between a first and a second position, said first relay being of a type the contacts of which when in their first position are moved to their second position when and only when energy flows through the relay winding from its first to its second terminal, the first terminal of the winding of said first relay being connected to said first conductor, an auxiliary relay, and means including a contact of said first relay for reversibly connecting the winding of the auxiliary relay between the second terminal of said first relay and said second conductor, said means being effective in each position of the contact of said first relay to connect in multiple with the winding of said auxiliary relay and in series with the winding of said first relay an asymmetric unit poled to permit flow of energy therethrough when the position of said first relay contact and the polarity of the energy supplied to said control conductors are out of correspondence.

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