Oct. 29, 1935. H. A. THOMPSON 2,018,818

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed July 13, 1932 4 Sheets-Sheet 1

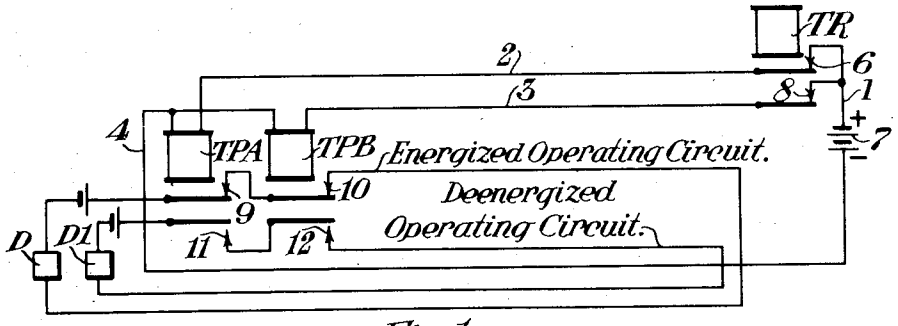


Fig. 1.

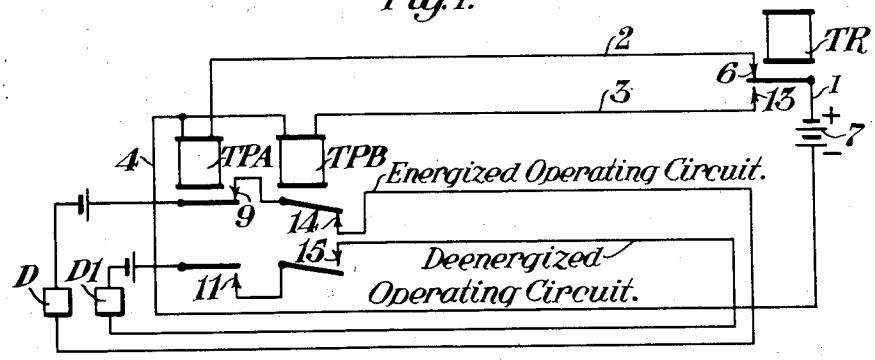


Fig. 2.

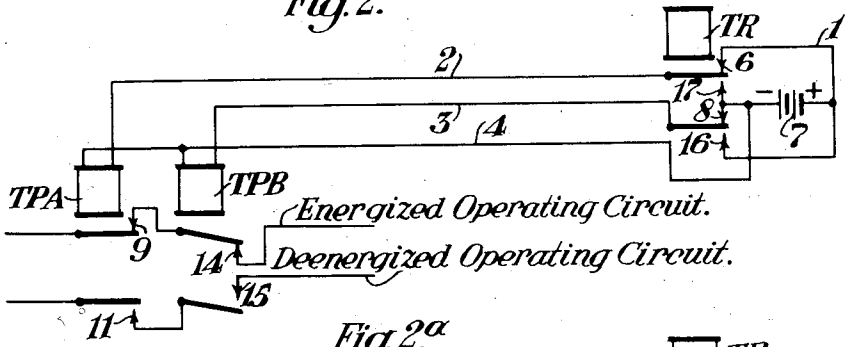


Fig. 2a.

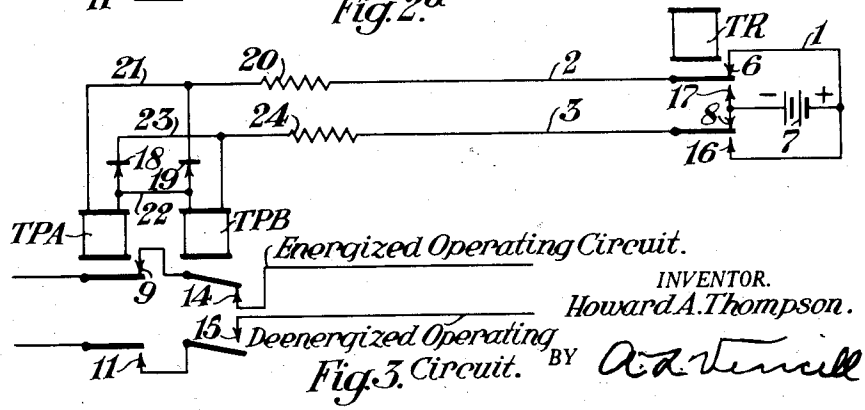


Fig. 3.

INVENTOR.
Howard A. Thompson.
BY
HIS ATTORNEY.

Oct. 29, 1935. H. A. THOMPSON 2,018,818

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed July 13, 1932 4 Sheets-Sheet 2

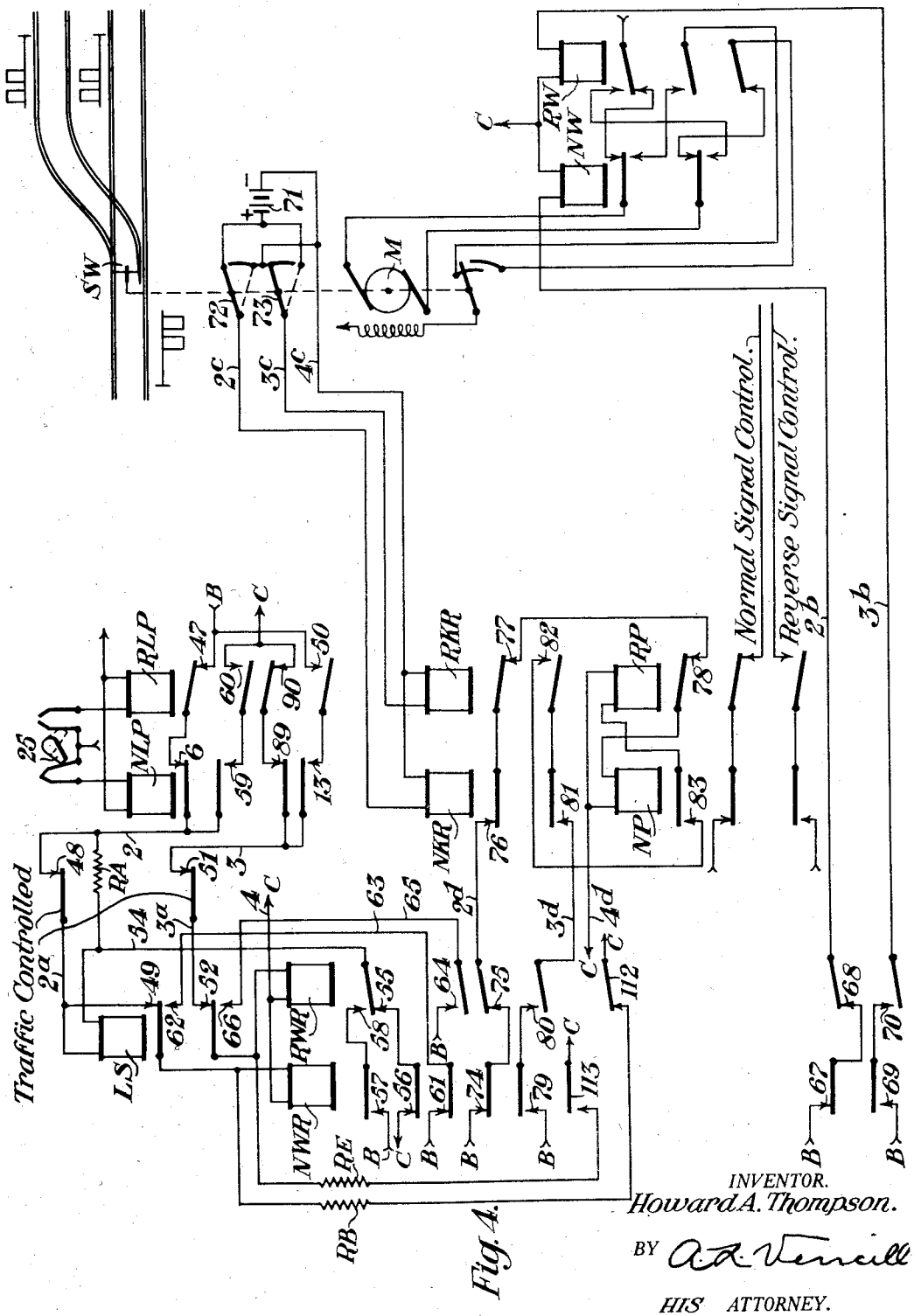


Fig. 4.

INVENTOR.
Howard A. Thompson.
BY A. L. Vennell
HIS ATTORNEY.

Oct. 29, 1935. H. A. THOMPSON 2,018,818

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed July 13, 1932 4 Sheets-Sheet 3

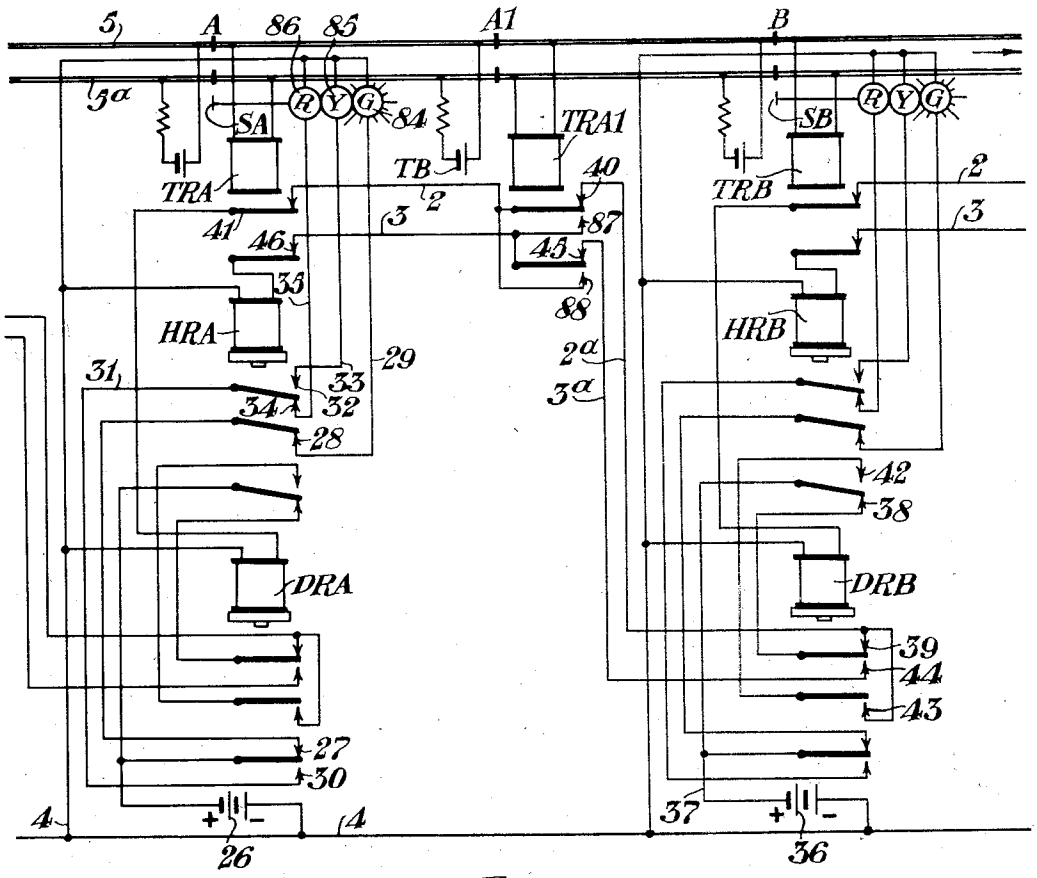


Fig. 5.

INVENTOR.
Howard A. Thompson.
BY A R Vernell
HIS ATTORNEY.

Oct. 29, 1935. H. A. THOMPSON 2,018,818

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed July 13, 1932 4 Sheets-Sheet 4

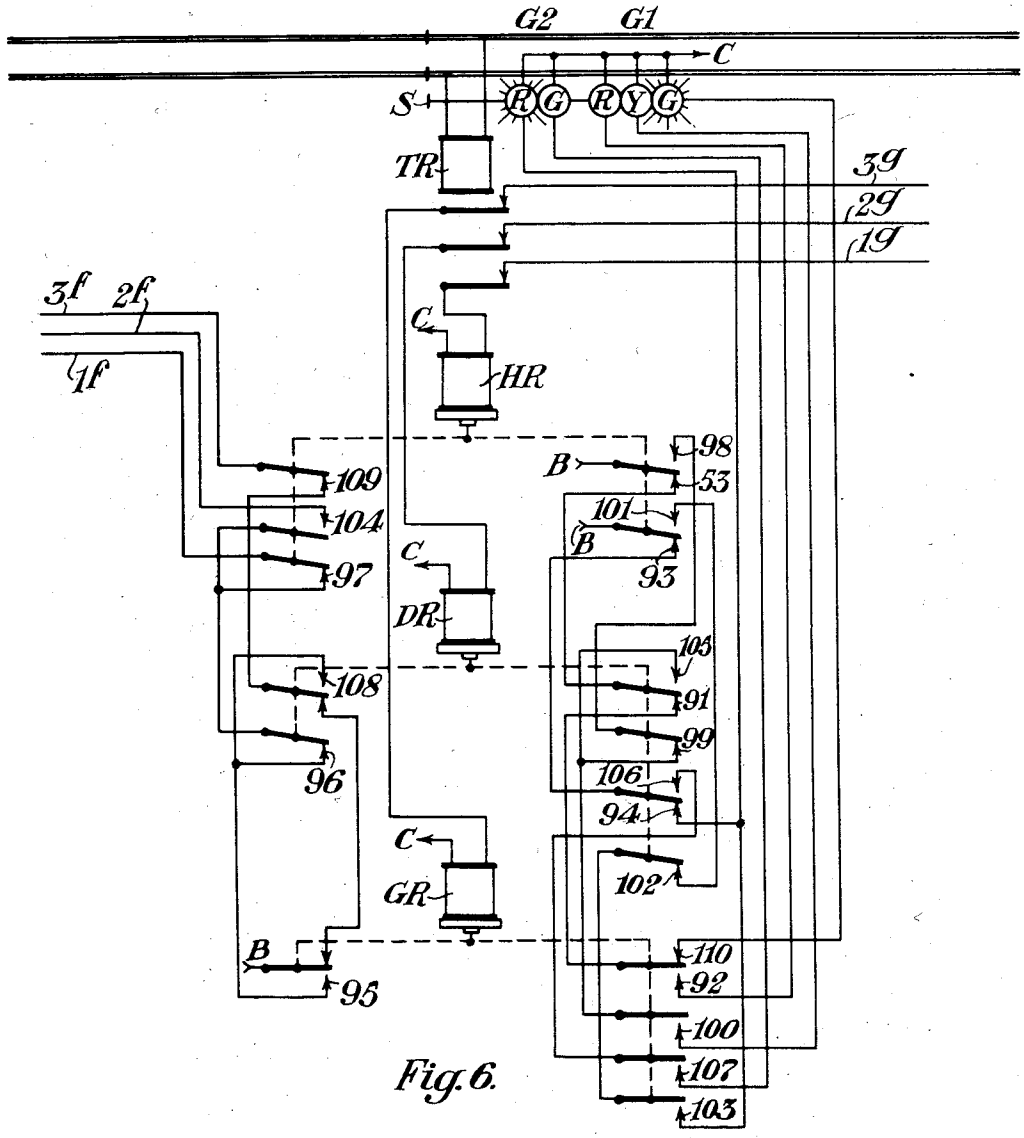


Fig. 6.

INVENTOR.
Howard A. Thompson
BY A R Venicill
HIS ATTORNEY.

Patented Oct. 29, 1935 2,018,818

UNITED STATES PATENT OFFICE

2,018,818

RAILWAY TRAFFIC CONTROLLING APPARATUS

Howard A. Thompson, Edgewood, Pa., assignor to The Union Switch & Signal Company, Swissvale, Pa., a corporation of Pennsylvania

Application July 13, 1932, Serial No. 622,257

17 Claims. (Cl. 175—320)

My invention relates to railway traffic controlling apparatus, and particularly to apparatus for control circuits for railway signal systems.

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

A feature of my invention is the provision of a double wire control circuit using one relay for each wire, and so arranged that an accidental connection of a control wire with the current source will be detected either immediately or at the next operation of the apparatus. A further feature of my invention is the provision of a novel and improved arrangement for control relays associated with a control circuit, whereby a false operation of a relay is less liable to result in a false application of power to a controlled device, than heretofore obtained. Other features of my invention will appear as the specification progresses.

In the accompanying drawings Fig. 1 is a diagrammatic view of one form of apparatus for a double wire control circuit using one relay for each wire and which embodies my invention. Figs. 2, 2*a* and 3 are diagrammatic views of other forms of apparatus for a double wire control circuit and which also embody my invention. Fig. 4 is a diagrammatic view of one form of apparatus embodying my invention applied to the control circuits for a railway switch in an interlocking system, such as disclosed in my copending United States application Serial No. 416,061, filed Dec. 23, 1929, for Multiple control apparatus. Fig. 5 is a diagrammatic view of apparatus showing the application of my invention to the control circuits for a standard three-indication signal system. Fig. 6 is a diagrammatic view of apparatus showing the application of my invention to the control circuits for a standard four-indication signal system.

In the following description reference is made to the accompanying drawings in which like reference characters designate similar parts.

In Fig. 1 a relay TPA is controlled over the front contact 6 of a governing relay TR and a control wire 2 by current from a battery 7, the circuit being from one terminal of battery 7, through wire 1, front contact 6 of relay TR, control wire 2, winding of relay TPA and a common return wire 4 to the opposite terminal of battery 7. A second relay TPB is controlled by current from battery 7 over the front contact 8 of the governing relay TR and a control wire 3 as will be readily understood by an inspection of Fig. 1. Relays TPA and TPB will thus both be energized in response to the picking up of the governing relay TR which may be any controlling relay of a signal system such, for example, as the track relay of the common track circuit. The means for controlling the relay TR forms no part of my invention and is omitted from Figs. 1, 2, 2*a*, and 3 for the sake of simplicity. The two relays TPA and TPB of Fig. 1 are used to jointly control operating circuits arranged to include a front contact of each of the two relays in series, or to include a back contact of each of the two relays in series. In Fig. 1 a normally energized operating circuit for governing the operation of a device indicated by the reference character D includes front contacts 9 and 10 of relays TPA and TPB, respectively, in series. A normally deenergized operating circuit includes the two back contacts 11 and 12 of relays TPA and TPB, respectively, in series, and is arranged to govern the operation of a device indicated by the reference character D1. It will be obvious that these operating circuits can be used to control any desired device such, for example, as a railway signal, or a railway switch mechanism.

It is to be noted that with the circuit arrangement of Fig. 1, an accidental connection of either control wire 2 or 3 to the negative terminal of the source of current, that is, a negative cross on either control wire, will be at once detected by the deenergizing of relay TPA or TPB, depending upon the control wire to which the accidental connection occurs. Deenergizing of either relay TPA or TPB opens the normally energized operating circuit at front contact 9 or 10 with the result that the presence of the negative cross on a control wire is manifested at once by the device D. An accidental connection of either control wire 2 or 3 to the positive terminal of the current source, that is, a positive cross, will be detected at the next operation of the governing relay TR due to relay TPA or TPB, depending upon the control wire to which the accidental connection occurs, being retained energized. In this event the normally energized operating circuit will be opened as it should be, due to the relay on whose control wire no cross has occurred being deenergized. The normally deenergized operating circuit, however, will not now be energized due to the fact that the relay on whose control wire the positive cross has occurred is held energized. It follows that with the apparatus of Fig. 1 a negative cross of either control wire is immediately detected, and a positive cross on either control wire is detected at the next operation of the governing relay. Furthermore, a failure of either relay TPA or TPB to pick up when energized or to release when deenergized,

due to some fault of the relay itself, will be detected in the operating circuits in the same way as an accidental connection of either control wire to the current source.

Fig. 2 differs from Fig. 1 in that relay TPB is controlled over the back contact 13 of the governing relay TR and is thus normally deenergized. That is to say, relay TPA of Fig. 2 is normally energized by current from battery 7 through the front contact 6 of relay TR and over the control wire 2 as in Fig. 1, but relay TPB is normally deenergized as its circuit is normally held open at the back contact 13 of relay TR. Deenergizing the governing relay TR causes relay TPA to become deenergized as in Fig. 1, but relay TPB is now energized by current from battery 7 through the back contact 13 and over the control wire 3. The normally energized operating circuit for the device D now includes the front contact 9 of relay TPA and a back contact 14 of relay TPB in series, and the normally deenergized operating circuit includes the back contact 11 of relay TPA and front contact 15 of relay TPB in series. Hence to energize an operating circuit of Fig. 2 it is necessary that one control relay be energized and the other control relay be deenergized.

It is to be noted that an accidental connection of the control wire 2 to the negative terminal of the current source, that is, a negative cross, will be at once detected by the deenergizing of relay TPA and the subsequent opening of the energized operating circuit. An accidental connection of control wire 3 to the positive terminal of the current source, that is, a positive cross, will be at once detected by relay TPB becoming energized and subsequently opening the normally energized operating circuit. A positive cross on control wire 2 will be detected at the next operation of the governing relay TR due to relay TPA being retained energized with the subsequent failure of the normally deenergized operating circuit to be closed at the back contact 11. Although this positive cross on control wire 2 retains relay TPA energized after relay TR is operated, the energizing of the relay TPB will bring about the proper functioning of the normally energized operating circuit, and hence no false energizing of either operating circuit will result from the positive cross on control wire 2. A negative cross on control wire 3 will cause relay TPB to remain deenergized at the next operation of the relay TR, and the cross will be detected by holding the normally deenergized operating circuit open at the front contact 15. In this event there will be no failure in the operation of the normally energized operating circuit as the relay TPA will then be active to control that circuit. Hence, the arrangement of Fig. 2 provides detection of accidental connections of control wires 2 and 3 with the current source, and insures against false energization of an operating circuit resulting from such accidental connections to the control wires in the same way as with the arrangement of Fig. 1. In addition, the arrangement of Fig. 2 maintains the closed circuit principle for the operating circuits even at such times as when the governing relay TR is deenergized.

Fig. 2*a* is the arrangement of Fig. 2 modified by replacing the single front and back contacts 6 and 13 of relay TR with pole-changing contacts. In this modified arrangement each control relay TPA and TPB when disconnected from battery has its winding shunted. Normally the relay TPA is energized by current from battery 7 over the front contact 6 of the governing relay TR and the control wire 2 the same as in Fig. 2. Normally, relay TPB is not only disconnected from the battery 7, but its winding is also shunted through control wire 3, front contact 8 of relay TR and the common return wire 4. When the governing relay TR is deenergized, the relay TPB is connected to the battery 7 over back contact 16 of relay TR, control wire 3, winding of relay TPB and the common return wire 4. Relay TPA is now not only disconnected from battery 7 but its winding is shunted through control wire 2, back contact 17 of relay TR and the common return wire 4.

By an inspection of Fig. 2*a* it is apparent that a negative cross on control wire 2 will be detected at once by the deenergizing of the relay TPA as in Fig. 2. A positive cross on the control wire 2 will ordinarily result in current flowing directly back to the battery 7 over the path through the back contact 17 when the relay TR is next operated, and the control relay TPA will be deenergized in its usual manner. However, if the positive cross on the control wire should result in the relay TPA being retained energized, the normally deenergized operating circuit will fail to close as relay TR is operated and this positive cross will be thus detected. If relay TPA is retained energized by the positive cross on wire 2, no false energization of an operating circuit will result as the relay TPB is now operated to control these circuits. It is clear that a positive or negative cross on control wire 3 of Fig. 2*a* will cause the apparatus to function in a manner similar to that just described for control wire 2. Hence, the arrangement of Fig. 2*a* also provides a double wire control circuit that detects the presence of a cross on a control wire and insures against any false energization of an operating circuit resulting therefrom.

Fig. 3 is a modification of the pole-changing arrangement of Fig. 2*a* where the common return wire 4 is omitted by adding two asymmetrical units or rectifiers, by providing a connection between the windings of the two control relays, and by inserting a resistor unit in the control wires. With relay TR of Fig. 3 energized, current flows from the positive terminal of battery 7 through wire 1, front contact 6, control wire 2, resistor unit 20, wire 21, winding of relay TPA, rectifier 18 (connected so that current of the present polarity, which I will call normal polarity, flows therethrough in the low resistance direction as indicated by an arrow and the flow of current in the opposite direction is opposed), wire 23, resistor unit 24, control wire 3 and front contact 8 to the negative terminal of battery 7. When the governing relay TR is deenergized, the polarity of the current supplied to the control wires 2 and 3 is reversed and current now flows from the positive terminal of battery 7 through back contact 16 of relay TR, control wire 3, resistor unit 24, wire 23, winding of relay TPB, rectifier 19 (connected so that current of the reverse polarity flows therethrough in the low resistance direction and the flow of current in the opposite direction opposed), wire 21, resistor unit 20, control wire 2 and back contact 17 to the negative terminal of battery 7. Thus, when energy of normal polarity is supplied to the control wires 2 and 3, relay TPA is energized and relay TPB is deenergized, and when energy of reverse polarity is applied to the control wires 2 and 3, relay TPA is deenergized and relay TPB energized. It is to be noted that for current of normal polarity the winding of re-

lay TPB is short-circuited through a connection 22 and rectifier 18 in its lower resistance direction, and the flow of current through this relay is opposed by the rectifier 19. For current of reverse polarity the winding of relay TPA is short-circuited by the connection 22 and rectifier 19 in its low resistance direction, and the flow of current through this relay is opposed by the rectifier 18.

Should rectifier 18 become open-circuited, that is, should it fail in such manner as to open the circuit of relay TPA, this relay will fail to be energized with current of normal polarity, and if rectifier 19 should become open-circuited, relay TPB will fail to be energized with current of reverse polarity. In connection with these two conditions just cited it is to be observed that in each case the windings of the two relays TPA and TPB will receive energy in series, but this energy will not be sufficient to cause either relay to close its front contacts. Should rectifier 18 become short-circuited the winding of relay TPB will be shunted over wire 23, rectifier 18 short-circuited and connection 22, and hence this relay will fail to pick up on current of reverse polarity. Likewise, should rectifier 19 become short-circuited the winding of relay TPA will be shunted over wire 21, rectifier 19 short-circuited and connection 22, and hence relay TPA will now fail to pick up on current of normal polarity. In the event rectifier 18 becomes short-circuited, the short circuit current, in flowing through rectifier 19 will cause a voltage drop across that rectifier which will tend to energize relay TPA falsely. The resistor units 20 and 24 are inserted in the control wires to prevent a large current flow in the event rectifier 18 becomes short-circuited and hence to prevent the possibility of the voltage drop across rectifier 19 at such a time being of sufficient value to cause a false energization of relay TPA. In like manner the resistor units 20 and 24 prevent the short circuit current flowing through rectifier 18, in the event rectifier 19 becomes short-circuited, from setting up a voltage drop across rectifier 18 of sufficient value to cause a false energization of relay TPB.

A negative cross occurring on control wire 2 of Fig. 3 at a time when relay TR is picked up will at once shunt the relay TPA and the presence of the cross will be manifested by the deenergizing of the normally energized operating circuit. A negative cross on control wire 3 will be detected when relay TR is next deenergized by shunting the control relay TPB. It is clear that if a positive cross on either of the control wires 2 and 3 should at any time retain a control relay energized, no false energization of an operating circuit will occur as the result thereof. It follows that the arrangement of Fig. 3 not only provides for the detection of a cross, and protection against false operation being caused by a cross on a control wire, but it also insures against false operation of a control relay due to a possible open circuit or short circuit condition of a rectifier used to obtain polar selectivity of two neutral relays over two line wires.

Referring to Fig. 4, the principle of a two wire control circuit using one neutral relay for each control wire, is applied to the control circuits associated with a railway switch in an interlocking system such, for example, as described in my aforementioned application Serial No. 416,061. A manually operated lever 25 when moved to the left, that is, to the position shown by the solid lines in the drawing, closes a simple circuit to a normal lever repeater relay NLP to energize that relay. Operating the lever 25 to a right-hand position, as shown by dotted lines in the drawings, closes a simple circuit for energizing a reverse lever repeater relay RLP. With lever 25 in its left-hand position and relay NLP picked up, a normal switch controlling relay NWR is energized by virtue of a circuit from positive terminal B of a convenient source of current, through back contact 47 of relay RLP, front contact 6 of relay NLP, control wire 2, traffic controlled contact 48 to be hereinafter referred to, control wire 2^a, front contact 49 of a relay LS also to be hereinafter referred to, winding of relay NWR, and common return wire 4 to the negative terminal C of the current source. When the lever 25 is moved to the right-hand position and relay RLP is picked up, a reverse switch controlling relay RWR is energized by virtue of a circut from positive terminal B through a front contact 50 of relay RLP, back contact 13 of relay NLP, control wire 3, traffic controlled contact 51, control wire 3^a, front contact 52 of relay LS, winding of relay RWR and common return wire 4 to the terminal C.

The traffic controlled contacts 48 and 51 may be governed in accordance with any of the customary circuit networks involving detector locking, approach locking and route locking associated with a railway switch. These circuits form no part of my invention and are hence omitted from the drawings for the sake of clearness.

It is to be noted that with the apparatus in the position shown in Fig. 4, a negative cross on the control wire $2—2^a$ will be at once detected by causing relay NWR to become deenergized, and a positive cross on control wire $3—3^a$ will have a shunt path to the negative terminal C of the current source through the front contact 89 of relay NLP and back contact 90 of relay RLP. If this shunt path is not complete, the relay RWR will be picked up and the presence of this positive cross on control wire $3—3^a$ will thus be at once detected. When lever 25 is reversed and relay RWR is picked up and relay NWR is down, a negative cross on control wire $3—3^a$ will shunt relay RWR, and a positive cross on control wire $2—2^a$ will be shunted to the negative terminal C through back contact 59 of relay NLP and front contact 60 of relay RLP. It follows that the double wire control circuit for the switch controlling relays NWR and RWR provides a detection of the presence of a cross on either of the control wires in the same manner as in Fig. 2*a*.

In accordance with usual practice a switch lock relay LS is associated with the switch controlling relays NWR and RWR. The relay LS is normally energized because one terminal of its winding is connected to the control wire 2^a which is normally connected to the positive terminal of the current source over front contact 6 of relay NLP and back contact 47 of relay RLP, while the other terminal of its winding is connected through wire 54, back contact 55 of relay RWR and front contact 56 of relay NWR to the negative terminal C of the current source. Under the condition of lever 25 being reversed to pick up relay RLP and so to energize the reverse switch controlling relay RWR and deenergize relay NWR, this switch lock relay LS will be kept energized by a circuit from terminal B through back contact 57 of relay NWR, front contact 58 of relay RWR, wire 54, winding of relay LS, wire 2^a, contact 48, wire 2, back contact 59 and front contact 60 to the terminal C of the current

source. A resistor RA is connected across the winding of relay LS when the traffic controlled contact 48 is closed causing this relay to be somewhat slow-releasing when the lever 25 is operated with the traffic controlled contact 48 closed. This will prevent relay LS from releasing during an operation of lever 25, and will permit a change in energization of relays NWR and RWR to take place in response to the operation of lever 25. When the traffic controlled contact 48 is operated, resistor RA will be cut out of the circuit and relay LS will then release quickly to retain relay NWR or RWR, depending upon which of these relays is energized at the time, energized by a stick circuit. The stick circuit for retaining relay NWR energized when the switch lock relay LS is deenergized as the result of the opening of the traffic controlled contact 48, can be traced from terminal B through front contact 61, wire 63, back contact 62 of relay LS and winding of relay NWR to the terminal C. The stick circuit to retain relay RWR energized when the relay LS is deenergized as the result of the opening of the contact 48 when the lever 25 is reversed, extends from terminal B through its own front contact 64, wire 65, back contact 66 of relay LS and winding of relay RWR to the terminal C. A resistor RB is connected across the winding of relay NWR through the back contact 112 of relay RWR causing relay NWR to be slow-releasing in character. A resistor RE is connected across the winding of relay RWR through the back contact 113 of relay NWR causing relay RWR to be slow-releasing in character. This slow-releasing characteristic of relays NWR and RWR will permit relay LS to become deenergized and close the stick circuit of relay NWR or RWR before these relays have released when the traffic controlled contact 48 is opened.

The two relays NWR and RWR jointly control the normal and reverse switch operating relays NW and RW. Normally the relay NW is energized through the front contact 67 of relay NWR, back contact 68 of relay RWR and the control wire 2^b as will be readily understood by an inspection of Fig. 4. When the lever 25 is reversed so that relay RWR is picked up and relay NWR is down, the reverse operating relay RW is energized over back contact 69 of relay NWR, front contact 70 of relay RWR and control wire 3^b. It follows that the principle of requiring one control relay to be energized and a second control relay to be deenergized in order to complete an operating circuit as disclosed in Figs. 2, 2*a*, and 3, is here employed in the control of the switch operating relays NW and RW.

The relays NW and RW in turn control the operating circuits for the switch motor M in the usual manner. These operating circuits for the motor M form no part of my invention, and it is deemed unnecessary to describe them in detail because they will be readily understood by an inspection of Fig. 4. By employing a double wire control circuit, such as heretofore described, for governing the switch controlling relays NWR and RWR, and by applying the principle of requiring one control relay to be energized and the other control relay to be deenergized before an operating circuit can be closed, a false application of power to the switch operating relays NW and RW with a subsequent false operation of the switch motor M, will not result from an accidental cross occurring in the control circuit for the switch controlling relays.

The switch indication relays NKR and RKR of Fig. 4 are likewise controlled by a double wire circuit. The switch, SW when in its full normal position causes the switch circuit controller contacts 72 and 73 to occupy the positions shown by the full lines in Fig. 4, and current is then supplied from the positive terminal of a battery 71 through controller contact 72, control wire 2^c, winding of switch indication relay NKR and the common return wire 4^c to the negative terminal of battery 71. The winding of the reverse switch indication relay RKR is now shunted over control wire 3^c, controller contact 73 and common return wire 4^c. Switch SW, when in its full reverse position, causes the contacts 72 and 73 to assume the positions shown by dotted lines in Fig. 4, and the reverse indication relay RKR is then supplied with current from battery 71 over contact 73 and the control wire 3^c, while the winding of relay NKR is shunted over the control wire 2^c, contact 72 and the return wire 4^c. It follows that the switch indication relays NKR and RKR are included in a double wire control circuit as shown and described in connection with Fig. 2*a* and thus any cross on the control wires 2^c and 3^c will be detected in the same manner as with the apparatus of Fig. 2*a*. Furthermore, these indication relays are employed to control the circuits for other relays on the principle that when one of the indication relays is energized, the other must be deenergized. To be explicit, a normal repeater relay NP is energized from battery terminal B over front contact 74 of the normal switch controlling relay NWR, back contact 75 of the reverse switch controlling relay RWR, control wire 2^d, front contact 76 of normal indication relay NKR, back contact 77 of reverse indication relay RKR, back contact 78 of a repeater relay RP and winding of relay NP to the negative terminal C over the common return wire 4^d. In the event lever 25 is reversed so that the reverse switch controlling relay RWR is energized, switch SW is moved to its reverse position, and the reverse switch indication relay RKR is picked up, the reverse repeater relay RP is supplied with current from the battery terminal B over back contact 79 of relay NWR, front contact 80 of relay RWR, a control wire 3^d, back contact 81 of relay NKR, front contact 82 of relay RKR, back contact 83 of relay NP, and winding of relay RP to the negative terminal C over the return wire 4^d. The repeater relays NP and RP in turn control signaling circuits on the principle that when one relay is energized, the other must be deenergized, as will be clear by an inspection of Fig. 4. It is to be seen, therefore, that the principle of a double wire control circuit using one neutral relay for each control wire is readily adaptable to the controlling circuits associated with a railway switch, and that when so applied, false operation of the switch, or false switch indication, caused by a cross on any of the control wires, is highly improbable. Furthermore, failure of a control relay to release when deenergized will be at once detected and will not result in false operation of the devices.

Fig. 5 shows the application of my invention to a standard three-indication wayside signal system. The traffic rails 5 and 5^a of a stretch of railway are divided into successive track blocks by the usual insulated rail joints. In Fig. 5 only one full block A—B is disclosed, together with the adjoining ends of two adjacent blocks. This track block A—B is divided into two sub-sections A—A1 and A1—B each of which is provided with

a track circuit including the usual track relay, here designated by the reference character TR plus an exponent corresponding to the location, and the usual source of current such as a battery TB. The wayside signals SA and SB govern traffic in the direction indicated by the arrow. These signals may be of the semaphore, or color light, or position light type and are here shown as three-position color light signals capable of displaying clear, approach and stop indications. The operating circuits for each wayside signal are governed by two control relays here designated by the reference characters HR and DR with exponents added to designate the location. These operating circuits are alike for all signals, and it is thought a description of those for one signal will serve for an understanding of all. Referring to signal SA, for example, this signal is provided with a clear operating circuit that passes from the positive terminal of a battery **26**, through front contact **27** of the relay DRA, back contact **28** of relay HRA, wire **29**, signal lamp **84** and the common return wire **4** to the negative terminal of battery **26**. The approach operating circuit is from battery **26**, through back contact **30** of relay DRA, wire **31**, front contact **32** of relay HRA, wire **33**, lamp **85** and common return wire **4** to battery **26**. The stop operating circuit includes battery **26**, back contact **30** of relay DRA, wire **31**, back contact **34** of relay HRA, wire **35**, signal lamp **86**, and common return wire **4**. It follows that with control relay HRA deenergized and control relay DRA energized the clear operating circuit is closed, with relay HRA energized and relay DRA deenergized the approach operating circuit is closed, and with both of these relays deenergized the stop operating circuit is closed. In other words the two control relays HRA and DRA of Fig. 5 control operating circuits in the same manner as the two relays TPA and TPB of Fig. 2.

These two control relays HRA and DRA are controlled by a double wire control circuit which is governed by traffic conditions in advance in the following manner. Normally current is supplied from a battery **36** at the signal location SB in advance, over wire **37**, back contact **38** of relay HRB, front contact **39** of relay DRB, control wire **2a**, front contact **40** of track relay TRA*f*, control wire **2**, front contact **41** of track relay TRA, winding of relay DRA and the common return wire **4** to the opposite terminal of battery **36**. Also, if the relay HRB at signal location SB is energized and relay DRB is deenergized, the control relay DRA is supplied with current from the battery **36**, the circuit including the front contact **42** of relay HRB, the back contact **43** of the relay DRB and thence as before traced. It follows that relay DRA is energized over the control wire **2a—2** when either one of the control relays HRB or DRB at the signal location SB in advance is picked up and the other control relay down. In the event both control relays at the signal location SB are deenergized the relay HRA is supplied with current from battery **36** over wire **37**, back contact **38** of relay HRB, back contact **44** of relay DRB, control wire **3a**, front contact **45** of track relay TRA*f*, control wire **3**, front contact **46** of track relay TRA and winding of relay HRA to the opposite terminal of battery **36** over the common return wire **4**.

As both control wires **2a—2** and **3a—3** are carried through front contacts of track relays TRA*f* and TRA, it is clear that both the control relays HRA and DRA are deenergized when either of the track sections of block A—B is occupied, and the signal SA then indicates stop. At the signal location SB both the control wires **2** and **3** associated with the relays DRB and HRB are carried through front contacts of the track relay TRB, and thus both of these control relays are deenergized when the block to the right of signal location SB is occupied. As described hereinbefore, with both relays HRB and DRB down, the control relay HRA is supplied with current over its control wire **3a—3** and that relay is then energized. It follows, that with the first block in advance of signal SA unoccupied and the second block in advance occupied relay HRA is up and relay DRA down, and the signal SA indicates approach. The control of the relays DRB and HRB being similar to the control of relays DRA and HRA, it is clear that when one block in advance of the signal SB is unoccupied, relay HRB is up and relay DRB down and thus at signal SA the relay DRA is energized and relay HRA deenergized causing the signal SA to display a clear indication. Furthermore, when two blocks in advance of signal SB are unoccupied, and relay DRB is up and relay HRB is down, the relay DRA at signal SA is also supplied with current by the circuit heretofore traced and which includes the back contact **38** of relay HRB as well as the front contact **39** of relay DRB.

A negative cross on control wire **2—2a** will be at once detected by the shunting of the control relay DRA and the setting of the signal SA at stop. A positive cross on control wire **3—3a** will be at once detected by the picking up of relay HRA so that signal SA will be made dark. A positive cross on control wire **2—2a** will be detected the next time the block in advance of signal SB becomes occupied, by the energizing of relay DRA and, as relay HRA is now picked up, the signal SA will be made dark. A negative cross on control wire **3—3a** will be detected the next time the block in advance of signal SB is occupied, by the shunting of relay HRA and the consequent setting of signal SA at stop. Hence, in Fig. 5, a double wire control circuit is provided for governing the signal controlling relays and the principle of requiring one control relay to be energized and the other control relay deenergized before an operating circuit is closed is employed. In Fig. 5 the control relays HR and DR at each signal are slow-releasing in character to prevent the possibility of obtaining a red flash of the stop signal light when the relays change from the approach to the clear position. In the case of track relay TRA*f* the control wires **2** and **3** are shunted by back contacts **87** and **88** when the relay is down. This is to prevent a positive cross on either control wire **2** or **3** causing a false energization of a control relay when relay TRA*f* is deenergized.

When applying the principle of a double wire control circuit with a relay for each wire, one of which must be energized and the other deenergized, to a four-indication wayside signal system, three control relays are provided. Referring to Fig. 6 the control relay GR is added to the control relays HR and DR of Fig. 5, and these relays are so arranged that when any one of them is energized, the other two must be deenergized in order to close an operating circuit. In Fig. 6 only one signal location is illustrated, but it will be understood that the stretch of railway to be protected is provided with successive signal locations similar to that shown in Fig. 6. In accordance with standard practice for four-indication signaling, the color light signal S is provided with two groups

of lamps, the top group G1 consisting of three lamps G, Y, and R adapted to display a green, yellow and red signal light, respectively. The bottom group of lamps G2 consists of two lamps G and R capable of displaying a green and a red signal light, respectively. When the immediate block in advance of signal S is occupied, the R lamp of each group is lighted and the signal indicates stop. When the first block in advance is unoccupied and the second block is occupied, the Y lamp of the top group and the R lamp of the bottom group are lighted, and the signal then gives the approach indication. When two blocks in advance are unoccupied and the third block occupied, the Y lamp of the top group and the G lamp of the bottom group are lighted, and the signal then gives the approach-restrictive indication. When three or more blocks in advance are unoccupied, the G lamp of the top group and the R lamp of the bottom group are lighted, and the signal then gives the clear indication.

When the block in advance of signal S is occupied and track relay TR shunted, all three control relays HR, DR and GR are deenergized as will be evident from an inspection of Fig. 6. A circuit is now closed for the R lamp of the top group G1 from battery terminal B through back contacts 53, 91 and 92 of relays HR, DR and GR, respectively, and thence to the negative terminal C through the lamp R of the top group. A circuit for the R lamp of the bottom group G2 extends from the terminal B through back contacts 93 and 94 of relays HR and DR, respectively, and thence through the R lamp of the bottom group to the negative terminal C. Under this traffic condition the battery terminal B is connected to the control wire 1^f leading to the signal location in the rear of signal S. This circuit includes the back contacts 95, 96 and 97 of relays GR, DR and HR, respectively, and energizes the HR relay at the location in the rear, the wire 1^f being connected with the HR relay in the rear in the same manner as control wire 1^g is connected to the HR relay of signal S. In the event the second block in advance of signal S is occupied and the immediate block in advance unoccupied, the control wire 1^g from the signal location next in advance is supplied with current in the same manner as just described for the control wire 1^f, and thus the relay HR at signal S will be energized. With relay HR picked up, the Y lamp of the top group G1 is energized over the front contact 98 of relay HR and back contacts 99 and 100 of relays DR and GR, respectively. At the same time the R lamp of the bottom group G2 is energized over the front contact 101 of relay HR and back contacts 102 and 103 of relays DR and GR, respectively. Under this traffic condition the control wire 2^f leading to the signal in the rear is supplied with current over the back contacts 95 and 96 of relays GR and DR, respectively, and the front contact 104 of relay HR, to energize the DR relay at that signal, the wire 2^f being connected to the DR relay in the rear in the same manner as wire 2^g is connected to relay DR at signal S. With two blocks in advance of signal S unoccupied and the third block occupied, the control wire 2^g is connected to the positive battery terminal at the signal next in advance in a manner similar to that just described for the control wire 2^f, and thus the control relay DR at signal S is now picked up and relays HR and GR both down. Under this set-up of the control relays the Y lamp of the top group G1 is energized over back contact 53 of relay HR, front contact 105 of relay DR and back contact 100 of relay GR; and the G lamp of the bottom group G2 is energized over back contact 93 of relay HR, front contact 106 of relay DR and back contact 107 of relay GR. The control wire 3^f is now connected to the battery terminal B through back contact 95 of relay GR, front contact 108 of relay DR and back contact 109 of relay HR. With three blocks in advance of signal S unoccupied the control wire 3^g will be supplied with current at the signal location in advance in the same manner as just pointed out for the control wire 3^f; relay GR at signal S will then be picked up and both relays HR and DR will be down. Under this condition the G lamp of the top group G1 is energized over the back contacts 53 and 91 of relays HR and DR, respectively, and the front contact 110 of relay GR; while the R lamp of the bottom group G2 is energized over back contacts 93 and 94 of relays HR and DR, respectively.

It is clear from Fig. 6 that a double wire circuit, and the principle of requiring one control relay to be energized and all the remaining control relays to be deenergized for completing an operating circuit, is adaptable to the control circuits for a signal system providing four or more distinctive indications, and when so applied exactly the same protection as heretofore described, is provided against the possibility of a false clear operation by a positive or negative cross on a control wire.

Although I have herein shown and described only certain forms of 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 pair of control wires, a current source, a governing device capable of assuming two different positions, means controlled in accordance with the position of said governing device for connecting said control wires with and disconnecting said control wires from a given terminal of the current source, a relay associated with each control wire and arranged to assume one position in response to its control wire being connected to said given terminal of the current source and to assume a second position in response to its control wire being disconnected from said given terminal whereby each relay assumes a corresponding position for each of the two positions of said governing device, and an operating circuit controlled jointly by said relays by including a contact of each relay and arranged to be closed when and only when each of said relays occupies its position corresponding to a given position of said governing device.

2. In combination, a pair of control wires, a current source, a governing device having a first and a second position, means controlled in accordance with the position of said governing device for connecting said control wires with and disconnecting said control wires from a given terminal of the current source, a relay associated with each control wire and arranged to assume one position in response to its control wire being connected to said given terminal of the current source and to assume a second position in response to its control wire being disconnected from said given terminal whereby each relay assumes a corresponding position for each of the positions of the governing device, and an operating circuit

jointly controlled by said relays by including a contact of each relay and arranged to be closed when and only when there is agreement between the positions of the relays and the position of the governing device.

3. In combination, a pair of control wires, a governing device having a first and a second position and arranged for connecting the control wires to the positive terminal of a current source in a predetermined manner, a relay associated with each control wire arranged to assume one position in response to its control wire being connected to the positive terminal of the current source and to assume a second position when its control wire is not so connected, and an operating circuit jointly controlled by the two relays and arranged to be energized when and only when each of the two relays occupies its position corresponding to a given one of the positions of said governing device.

4. In combination, a pair of control wires, a governing device having a first and a second position and arranged for connecting each of the control wires to the positive terminal of a current source in either one or the other of its two positions in a predetermined manner, a relay associated with each control wire arranged to be energized in response to its control wire being connected to the positive terminal of the current source and to be deenergized when its control wire is not so connected whereby each relay assumes a condition corresponding to each position of the governing device, and an operating circuit jointly controlled by the two relays by including a contact of each relay and arranged to be energized when and only when each of the two relays assumes its condition corresponding to a given position of said governing device.

5. In combination, a line circuit including two control wires, a relay associated with each of said control wires arranged to assume one position when its control wire is connected to the positive terminal of a current source and to assume a second position when its control wire is not so connected, a governing device having two distinctive positions for controlling said line circuit and arranged to connect each of the two control wires to the positive terminal of the current source in one or the other of its two positions, and an operating circuit jointly controlled by said relays by including a contact of each relay and arranged to be energized when and only when the two relays each occupy its position corresponding to a given one of the positions of the governing device.

6. In combination, a line circuit including two control wires, a relay associated with each control wire and arranged to be energized when its control wire is connected to a given terminal of a current source and to be deenergized when its control wire is not so connected, a governing device having two distinctive positions for controlling said line circuit and arranged to selectively connect the control wires to said given terminal of the current source in one or the other of its two positions, and an operating circuit controlled jointly by said relays by including a contact of each relay and arranged to be energized when and only when each of the two relays occupies its position corresponding to a given one of the positions of the governing device.

7. In combination, a line circuit including two control wires and a common return wire, a governing device having a first and a second position, a current source having one terminal connected to the common return wire and its other terminal connected to one of said control wires with said governing device in its first position and to the other control wire with said governing device in its second position, a relay associated with each control wire and arranged to be energized in response to its control wire being connected to said other terminal of the current source, and an operating circuit controlled jointly by said two relays.

8. In combination, a line circuit including two control wires and a common return wire, a current source having one terminal permanently connected to the common return wire, a governing device having a first and a second position and arranged to connect the other terminal of the current source to one control wire in its first position and to the other control wire in its second position, a relay associated with each control wire having its winding connected between its control wire and said common return wire whereby said relay is energized only when said governing device is moved to a given one of its positions, and an operating circuit controlled jointly by the two relays.

9. In combination, a line circuit including two control wires and a common return wire, a governing device having a first and a second position, a current source having one terminal connected to the common return wire and its other terminal connected to one of said control wires with the governing device in its first position and to the other control wire with the governing device in its second position, a relay associated with each control wire and having its winding connected between its control wire and the common return wire, and an operating circuit including a front contact of one of said relays and a back contact of the other of said relays in series.

10. In combination, a line circuit including two control wires and a common return wire, a governing device having a first and a second position, a current source having one terminal connected to the common return wire and its other terminal connected to one of said control wires with the governing device in its first position and to the other control wire with the governing device in its second position, a relay associated with each control wire and having its winding connected across its control wire and the common return wire to thereby energize each relay when its control wire is connected to said other terminal of the current source, and an operating circuit controlled by the two relays and energized only when a given one of said relays is energized and the other relay deenergized.

11. In combination, a line circuit including two control wires and a common return wire, a governing device having a first and a second position, a current source having one terminal connected to the common return wire and its other terminal connected to one of said control wires with the governing device in its first position and to the other control wire with the governing device in its second position, two relays one each associated with each of said control wires and each having its winding connected between its control wire and the common return wire to thereby energize a given one of the relays and deenergize the other relay in response to the governing device occupying its first position and to reverse the condition of said relays in response to tne governing device occupying its second position, and an operating circuit including a front con-

tact of one of said relays and a back contact of the other of said relays in series.

12. In combination, a line circuit including two control wires and a common return wire, a current source having one terminal permanently connected to the return wire, a governing device having a first and a second position and arranged to connect the two control wires between the other terminal of the current source and the return wire in its first position and to reverse this connection in its second position, a relay associated with each control wire having its winding connected across its control wire and the return wire whereby each relay is energized when its control wire is connected to the said other terminal of the current source and its winding is shunted when its control wire is connected to the return wire, and an operating circuit including a front contact of one of the relays and a back contact of the other of said relays in series.

13. In combination, a line circuit including two control wires and a common return wire, a current source having one terminal permanently connected to the return wire, a governing device having a first and a second position and arranged to connect the current source across the two control wires in its first position and to reverse this connection in its second position, a relay associated with each control wire having its winding connected across its control wire and said common return wire whereby each relay is energized when its control wire is connected to the terminal of the current source opposite that connected to the return wire and is shunted when its control wire is connected to the same terminal as the return wire, and an operating circuit including a front contact of one of the relays and a back contact of the other of said relays in series.

14. In combination, a pair of control wires, a governing device for reversibly supplying current to said control wires, two relays each having its winding connected across said control wires in series with an asymmetric unit, said asymmetric units arranged to permit current of one polarity to energize one relay and current of the other polarity to energize the other relay and so connected that each asymmetric unit shunts the winding of the relay with which it is not connected in series, and a resistor unit serially connected with the control wires for limiting the flow of current in the event of the short-circuiting of an asymmetric unit whereby false energizing of either relay is prevented.

15. In combination with a pair of paralleling control wires, a current source, a governing device including circuit controlling contacts operative to different positions for connecting one end of each of said wires with a given one of the terminals of said source, a pair of relays, means for connecting one terminal of the winding of each relay with the other end of a particular one of said wires, other means for connecting the other terminal of each of said windings with the opposite terminal of the current source for energizing each relay in response to its control wire being connected with said one terminal of the source, and an operating circuit including a contact of each of said relays and closed when and only when the contacts of the governing device are operated to a particular one of its different positions.

16. In combination with a pair of paralleling control wires, a current source, a pair of relays the winding of each of which has one terminal connected with one end of a particular one of said wires, means for connecting the other terminal of each winding with a given terminal of the source, a governing device including a pair of circuit controlling contacts operative to a first and a second position and each of which is interposed between the other end of a particular one of the wires and the opposite terminal of the source for energizing each relay in a particular position of the associated contact, and an operating circuit including a contact of each relay and closed when and only when the position of each relay corresponds to the position of the respective contact of the governing device.

17. In combination with a pair of paralleling control wires, a current source, a pair of relays the winding of each of which has one terminal connected with one end of a particular one of said wires, means for connecting the other terminal of each winding with a given terminal of the source, a governing device including a pair of circuit controlling contacts operative to a first and a second position and each of which is interposed between the other end of a particular one of the wires and the opposite terminal of the source for energizing each relay in a particular position of the associated contact, a first operating circuit including a contact of each relay and closed when and only when the position of each relay corresponds to the first position of contacts of the governing device, and a second operating circuit including a contact of each relay and closed when and only when the position of each relay corresponds to the second position of the contacts of the governing device.

HOWARD A. THOMPSON.