

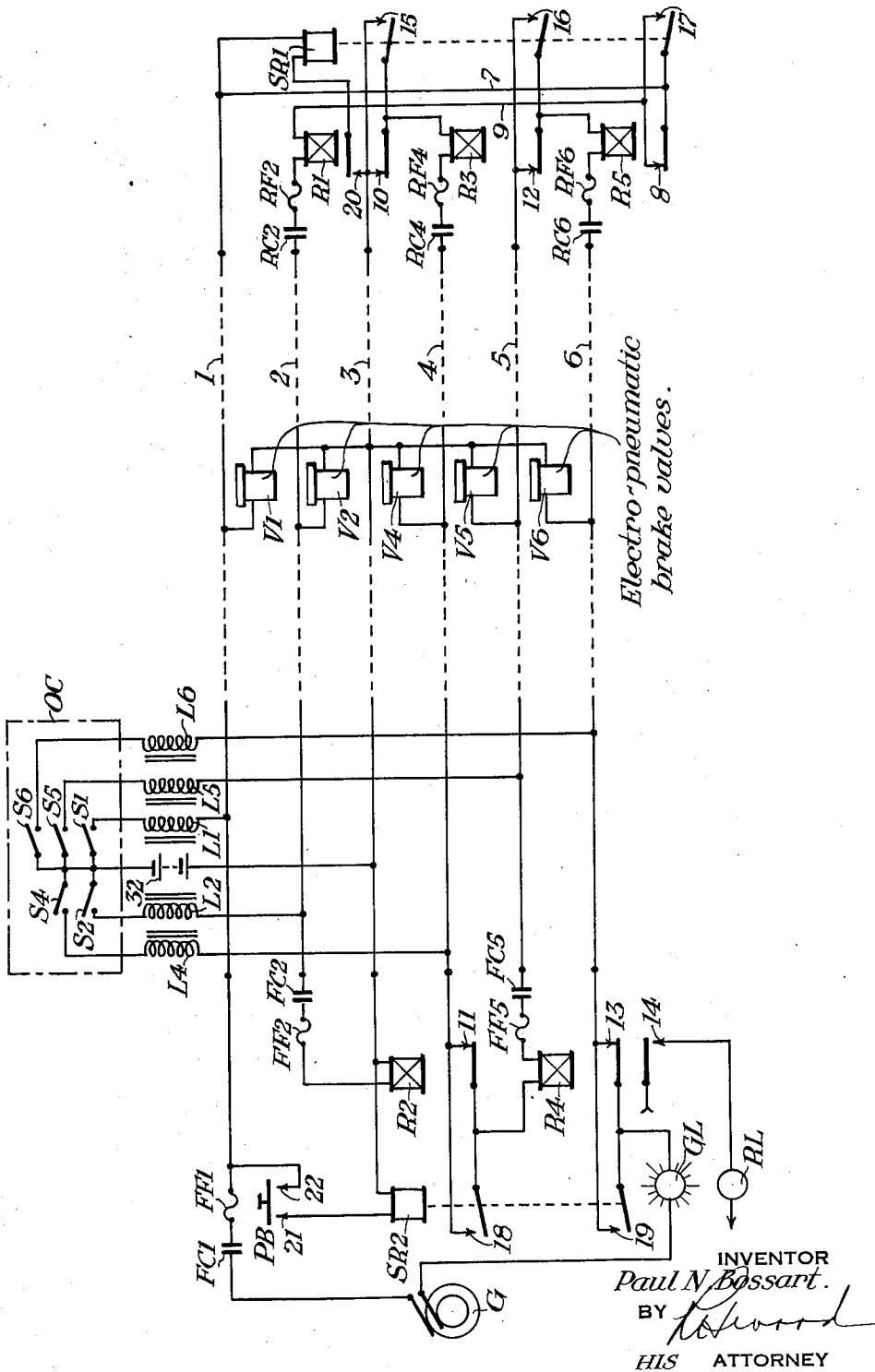
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ELECTRIC SIGNALING SYSTEM

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ELECTRIC SIGNALING SYSTEM

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My invention relates to electric signaling systems, and particularly to signaling systems for checking the integrity of electrical control circuits.

A feature of my invention is the provision of novel and improved apparatus to both check the continuity of the control wires of control circuits, and to detect short circuit conditions between the control wires without interference to the operation of the apparatus governed by these control circuits. Other features and advantages of my invention will appear as the specification progresses.

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

The accompanying drawing is a diagrammatic view of a preferred form of apparatus embodying my invention when employed with an electro-pneumatic brake control system for railway trains. Although the invention is peculiarly fitted for employment with electro-pneumatic brake control systems for railway trains, its utility is by no means to be limited to this one application as it is susceptible to use in other fields. It is to be understood that this one form of apparatus embodying the invention is by way of illustrating the many places where it is useful.

Referring to the drawing, the control wires 1, 2, 3, 4, 5, and 6 are the brake control wires of an electro-pneumatic brake control system and which wires each run the full length of the train. In the drawing the left-hand full line portions of the control wires are at the forward end of the train, from which point the train brakes are controlled, the right-hand full line portions of the control wires are at the rear of the train, the intermediate full line portions of the control wires are at an intermediate car of the train, and the dotted line portions of the control wires represent the portions through the other cars of the train. The control wire 3 is a common return wire which forms one side of each of five different control circuits, the other side of each of which is formed by a particular one of the other wires 1, 2, 4, 5, and 6.

V1, V2, V4, V5 and V6 represent the electro-pneumatic brake valves located on the above-mentioned intermediate car of the train and the windings of which valves are connected between the common return wire 3 and the other wires 1, 2, 4, 5, and 6, respectively. It is to be understood that a similar series of electro-pneumatic valves is located on each of the other cars of the train. Each of these valves, preferably, in-

cludes a direct current magnet and governs a specific operation of the train brakes. Thus, in one system of train brake control the operation of valve V1 opens the brake cylinder to the atmosphere to release the brakes, the operation of valve V2 admits air pressure to the brake cylinder to apply the brakes, while the valves V4, V5 and V6 are used in connection with a speed governor to increase the brake cylinder pressure as the speed of the train is increased at certain definite speeds. These electro-pneumatic valves are controlled through the medium of a controller designated as a whole by the reference character OC, and which controller is ordinarily located at the head end of the train. This controller OC includes five circuit controlling contacts S1, S2, S4, S5 and S6, which govern the control circuits for the valves V1, V2, V4, V5 and V6, respectively. Thus, with contact S1 closed, a control circuit may be traced from one terminal of a source of direct current such as battery 32 over contact S1, choke coil L1, control wire 1, winding of electro-pneumatic valve V1, common return wire 3, and thence to the other terminal of the current source, and the magnet of valve V1 is energized. It is to be understood, of course, that the corresponding electro-pneumatic valve of each of the other cars of the train is energized in parallel with valve V1. In a similar way, the closing of each of the other contacts S2, S4, S5 and S6 is effective to complete a control circuit for energizing the corresponding valves V2, V4, V5 and V6, as will be readily understood by an inspection of the drawing. The choke coils L1, L2, L4, L5 and L6 are interposed one in each of the associated control circuits. The function of these choke coils will be referred to later. It is to be seen, therefore, that manipulation of the controller OC to operate the several circuit controlling contacts thereof is effective to energize and deenergize the several electro-pneumatic brake valves of the cars of the train.

The apparatus thus far described, except for the choke coils, is that required for an electro-pneumatic train brake system in present day use. With such construction, it is desirable to check and indicate the unbrokenness of the control wires and to also detect any short circuit between any group of the control wires, so that the operator may be assured at all times that the train brake apparatus will function if operated. Accordingly, I provide signaling apparatus which is effective to check the unbrokenness of the control wires and to detect any short circuit between any two of the wires, and to that end a source of

alternating current G, alternating current relays R2 and R4, condensers FC1, FC2 and FC5, fuses FF1, FF2 and FF5, indicator lamps GL and RL, direct current relay SR2 and a push button PB are located at the forward end of the train. At the rear end of the train there are located alternating current relays R1, R3 and R5, condensers RC2, RC4 and RC6, fuses RF2, RF4 and RF6, and a direct current relay SR1.

This signaling apparatus is arranged to connect the several control wires 1, 2, 3, 4, 5, and 6 in a series signaling circuit which extends back and forth from the front to the rear end of the train. Starting with the top terminal of generator G this series signaling circuit may be traced over condenser FC1, fuse FF1, control wire 1 to the rear end of the train, wire 7, front contact 8 of relay R5, wire 9, winding of relay R1, fuse RF2, condenser RC2, control wire 2 to the front end of the train, condenser FC2, fuse FF2, winding of relay R2, control wire 3 to the rear end of the train, front contact 10 of relay R1, winding of relay R3, fuse RF4, condenser RC4, control wire 4 to the front end of the train, front contact 11 of relay R2, winding of relay R4, fuse FF5, condenser FC5, control wire 5 to the rear end of the train, front contact 12 of relay R3, winding of relay R5, fuse RF6, condenser RC6, control wire 6 to the front end of the train, front contact 13 of relay R4, indicator lamp GL, and thence to the opposite terminal of the generator G. It follows that alternating current flows through this series circuit from generator G to illuminate lamp GL providing the relays R1, R2, R3, R4 and R5 are all picked up and the control wires 1, 2, 3, 4, 5, and 6 are unbroken, but if any one of the control wires breaks or a relay is deenergized the circuit is opened, the relays are all released and the lamp GL is extinguished. With relay R4 released and its back contact 14 closed, a simple circuit is completed for supplying current from any convenient source of current, not shown, to the indicator lamp RL and that lamp is illuminated to warn the operator of trouble in the series signaling circuit.

Any short circuit between two or more of the control wires will deenergize one or more of the relays R1, R2, R3, R4 and R5, which in turn will release and open the series circuit at some point not included in the short circuit. This characteristic of the series circuit is assured by the fact that the winding of an alternating current relay is interposed in each connection where two control wires are connected together and a front contact of each relay is interposed in the adjacent connection of the control wires, while the source of current is connected between the first and the last of the control wires. Thus, the operating winding of relay R1 is interposed in the connection between the control wires 1 and 2 and the front contact 10 of relay R1 is interposed in the next adjacent connection between control wires 3 and 4, the operating winding of relay R2 is interposed in the connection between control wires 2 and 3 and front contact 11 of relay R2 is interposed in the adjacent connection between control wires 4 and 5, the operating winding of relay R3 is interposed in the connection between control wires 3 and 4 and its front contact 12 is interposed in the adjacent connection between wires 5 and 6, the operating winding of relay R4 is interposed in the connection between control wires 5 and 6 and its front contact 13 is interposed in the adjacent circuit

connection leading from control wire 6 to the generator G, and the operating winding of relay R5 is interposed in the connection between control wires 5 and 6 and its front contact 8 is interposed in the adjacent connection between control wires 1 and 2. A short circuit between control wires 1 and 2 shunts relay R1 and that relay releases to open the series circuit at front contact 10 which is external to the short circuit between wires 1 and 2. A short circuit between wires 1 and 3 shunts both relays R1 and R2 and the series circuit is opened at front contacts 10 and 11. A study of this series circuit will disclose that a short circuit between any two or more of the control wires will shunt at least one of the relays and open the series circuit at a contact external to the short circuit and thus deenergize all of the relays and warn the operator of the trouble.

The condensers FC1, FC2 and FC5 at the forward end of the train and the condensers RC2, RC4 and RC6 at the rear end of the train are provided to block the flow of direct current in the series circuit but allow the alternating current to flow. In case trouble should occur, such as a short circuit in condensers FC2, there would be a low resistance path for direct current from control wire 2 through condenser FC2 short circuited, fuse FF2, and winding of relay R2 to control wire 3, since the ohmic resistance of the winding of relay R2 would be low. The fuse FF2 associated with condenser FC2 is so chosen as to melt when a current slightly larger than the maximum current required for the series circuit is passed therethrough. Hence, in the case condenser is short circuited and contact S2 is closed and the battery 32 is connected across control wires 2 and 3, the fuse FF2 would melt in response to the direct current passing through the low resistance path and would open the series circuit, with the result that the lamp GL would be extinguished and the lamp RL would be illuminated to inform the operator of the trouble. The other fuses of the system are each chosen for loads similar to the fuse FF2 and thus a short circuit condition of any one of the condensers results in the series circuit being opened and the display of the indicator lamp RL. The condenser FC1 and fuse FF1 are used to prevent the flow of direct current through the source of alternating current G, the fuse FF1 protecting against a short circuit condition of condenser FC1 the same way as fuse FF2 protects against a short circuit condition of condenser FC2. The choke coils L1, L2, L4, L5 and L6 are used to offer a high impedance to the alternating current through the source of direct current 32.

When power is first applied to the series circuit it is necessary to bridge around the front contacts of the several alternating current relays in order to initially energize the operating windings of these relays and pick up the relays to close the series circuit. This is accomplished by means of the direct current relays SR1 and SR2. Relay SR1 is provided with three front contacts 15, 16 and 17. Front contact 15, when closed, completes a shunt path around front contact 10 of relay R1, front contact 16 completes a shunt path around front contact 12 of relay R3, and front contact 17 completes a shunt path around front contact 8 of relay R5. Relay SR2 is provided with two front contacts 18 and 19. Front contact 18, when closed, completes a shunt path around front contact 11 of relay R2, and front contact 19 completes a shunt path around front contact 13 of relay R4.

Relay SR1 is energized with direct current when contact S1 is initially closed to connect the battery 32 across the control wires 1 and 3. This circuit for relay SR1 may be traced from battery 32, over contact S1, choke coil L1, control wire 1, winding of relay SR1, back contact 20 of relay R1 and common return wire 3 back to battery 32. When contact S1 is closed the relay SR2 is energized by depressing the push button PB to close its contact 21—22, as will be readily understood by an inspection of the drawing. It will be seen, therefore, that when contact S1 and push button PB are operated the two relays SR1 and SR2 are picked up and the series circuit is completed, with the result that all of the relays R1, R2, R3, R4 and R5 are energized and picked up to close their respective front contacts. When relay R1 picks up and opens its back contact 20, the relay SR1 is deenergized and releases to open the shunt paths around the front contacts of relays R1, R3 and R5. With push button PB released, the relay SR2 is deenergized and releases to open the shunt paths around the front contacts of relays R2 and R4. In order to make sure that the alternating current relays are picked up the contact S1 may be opened momentarily to remove energy from the relays SR1 and SR2 and deenergize these relays. In case some trouble prevents the alternating current relays from picking up, the lamp GL will be extinguished when relays SR1 and SR2 are released and the lamp RL will remain illuminated to indicate the trouble. The train brake control system referred to hereinbefore has provision for operating pneumatically alone and the operator would be expected to switch over to this mode of operation when any trouble is indicated by the lamps GL and RL, either during normal operation or in the case of failure to initially energize the series circuit.

Although the electro-pneumatic valves are operated on direct current and their magnets are each wound with a relatively large number of turns, they still may have a relatively low impedance for 60 cycle alternating current, which is the frequency of the alternating current usually available, since the magnets of the several valves form shunt paths for the series circuit and since each car of the train is provided with a series of the valves. This condition means that the impedance of the condensers and relays for the series circuit should be relatively low and considerably less than the shunting impedance of the magnets of the brake valves in order to obtain a reliable operation of the series circuit. If this condition is not fulfilled, it is quite possible that certain relays of the series circuit might be energized with current of a magnitude much larger than the magnitude of the current energizing other relays of the series circuit. The choke coils L1, L2, etc., also exert a shunt effect on the series circuit when the corresponding controller contacts are closed. It can be shown that the impedance of the relay condenser combination which bridges two control wires should be not more than one-third as great as that of the lowest shunt which might be placed across these two control wires by the apparatus of the brake control system. The alternating current relays are preferably selected so that the impedance of the associated condenser is largely balanced out by the inductive reactance of the relay. Furthermore, the relays R1, R2, etc., are preferably designed to have about the same impedance in the open position as in the closed position. In considering

the commercial adaptation of the invention to a brake control system of the type referred to hereinbefore, commercial condensers of about 500 microfarads and alternating current relays of a standard Z armature type will provide a series circuit which will function efficiently and the cost of which will be reasonable.

Although the series signaling circuit is here employed with six control wires it may be used with a less or a greater number of control wires. For example, if only four control wires are to be checked, the relays R4 and R5 would be omitted. In this case, relay R3 would control the connection between wires 1 and 2 and which connection includes the winding of relay R1, and relay R2 would control the connection between wire 4 and the source of alternating current. If eight control wires are to be checked then an additional alternating current relay would be located both at the front and rear ends of the train and these additional relays would be inserted in the circuit in a manner similar to relays R1 to R5. It should be pointed out that the signaling circuit embodying my invention may be used with any even number of control wires greater than two, and may be readily applied to any odd number of control wires greater than one if a return wire is provided, either one used already for another purpose, or one added to complete the signaling circuit.

Although I have herein shown and described only one form 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 a control system involving at least four control wires each extending between two remote stations the combination therewith including, a source of current at one station and having its terminals connected between a first and a last one of the control wires, a plurality of relays part located at said one station and part located at the other station, means to connect the control wires in a series circuit back and forth from one station to the other with a winding of a different one of the relays interposed in each connection where two control wires are connected together and with a front contact of each relay interposed in the next adjacent connection of the control wires, and signaling means responsive to current flowing in said series circuit.

2. In a control system involving at least four control wires each extending between two remote stations the combination therewith including, a source of current at one station and having its terminals connected between a first and a last one of the control wires, a plurality of relays part located at said one station and part located at the other station, means to connect the control wires in a series circuit back and forth from one station to the other with a winding of a different one of the relays interposed in each connection where two control wires are connected together and with a front contact of each relay interposed in the next adjacent connection of the control wires, means partly at each of said stations to at times shunt around the front contact of each of the relays to initially energize said series circuit, and signaling means controlled by said series circuit.

3. In a control system involving at least four control wires each extending between two remote

stations the combination therewith including, a source of current at one station and having its terminals connected between a first and a last one of the control wires, a plurality of relays part
 5 located at said one station and part located at the other station, means to connect the control wires in a series circuit back and forth from one station to the other with a winding of a different
 10 one of the relays interposed in each connection and with a front contact of each relay interposed in the next adjacent connection of the control wires, whereby a short circuit between any group
 15 of the control wires deenergizes a relay to open a contact external to the short circuit which will cause all the relays to be deenergized, and signaling means controlled by at least one of the relays.

4. In a control system involving at least four
 20 control wires each extending between two remote stations the combination therewith including, a source of current at one station and having its terminals connected between a first and a last one of the control wires, a plurality of relays
 25 part located at said one station and part located at the other station, means to connect the control wires in a series circuit back and forth from one station to the other with a winding of a different one of the relays interposed in each connection
 30 where two control wires are connected together and with a front contact of each relay interposed in the next adjacent connection of the control wires, whereby a break in a control wire or a short circuit between any two of the control wires will
 35 cause the series circuit to be opened and all the relays deenergized, a first signaling means responsive to current flowing in said circuit, and a second signaling means controlled over a back contact of at least one of said relays.

5. In a control system involving at least three
 40 control wires each extending between two remote stations the combination therewith including, a source of signaling current, a plurality of relays responsive to such signaling current, means to connect the control wires in a series circuit start-
 45 ing from one terminal of the source of current and passing back and forth from one station to the other over the control wires with the winding of a different one of the relays interposed in each connection where two control wires are
 50 connected together and with the remote end of the last control wire connected with the other terminal of the current source and with a front contact of each relay interposed in the next adjacent
 55 connection, and signaling means responsive to the current flowing in said series circuit.

6. In a direct current control system involving
 at least four control wires each extending between two remote stations the combination there-
 60 with including, a source of alternating current at one station and having its terminals connected between a first and a last one of the control wires, a plurality of alternating current relays, means to connect the control wires in a
 65 series circuit back and forth from one station to the other with a winding of a different one of said relays interposed in each connection where two control wires are connected together and with a front contact of each relay interposed in
 70 the next adjacent connection of the control wires, a direct current relay at each station and having front contacts which shunt around the front contacts of the alternating current relays at the same station, manually controlled means
 75 for at times energizing said direct current relays

to close the series circuit to initially energize the alternating current relays whereby said series circuit is then effective to check the unbroken-
 ness of the control wires and to detect a short circuit between any group of the control wires,
 5 and signaling means governed by said series circuit.

7. In a direct current control system involving
 at least four control wires each extending between
 10 two remote stations the combination therewith including, a source of alternating current at one station and having its terminals connected between a first and a last one of the control wires, a plurality of alternating current relays, a plu-
 15 rality of condensers, a plurality of fuses, means to connect the control wires in a series circuit back and forth from one station to the other with a winding of a relay together with a condenser and a fuse interposed in the connection
 20 where two control wires are connected together and with a front contact of each relay interposed in the next adjacent connection of the control wires, a direct current relay at each station having front contacts which shunt around the front
 25 contacts of the alternating current relays at the same station, manually controlled means for at times energizing said direct current relays to initially energize the alternating current relays whereby said series circuit is closed and is effective
 30 to check the unbrokenness of the control wires and to detect a short circuit between any group of the control wires without interference from said control system and to detect a short circuit condition of a condenser.

8. In a signal system involving six control wires
 35 extending from a control station to a remote station, a first relay at the remote station and having an operating winding connected between a first and a second of the control wires, a second relay at the control station and having an
 40 operating winding connected between the second and a third of the control wires, a third relay at the remote station and having an operating winding connected between the third and a fourth
 45 of the control wires, a fourth relay at the control station and having an operating winding connected between the fourth and a fifth of the control wires, a fifth relay at the remote station and having an operating winding connected between
 50 the fifth and a sixth of the control wires, a source of current at the control station connected between the first and sixth control wires, a front contact of the first relay interposed in the winding connection of the third relay, a front
 55 contact of the second relay interposed in the winding connection of the fourth relay, a front contact of the third relay interposed in the winding connection of the fifth relay, a front contact of the fourth relay interposed in the connection
 60 to the current source, a front contact of the fifth relay interposed in the winding connection of the first relay, means for at times shunting around each of said front contacts for initially energizing said relays, and an indicator inter-
 65 posed in the connection to the current source.

9. In a signal system involving six control wires
 extending between a control station and a remote
 70 station, five relays the first, third and fifth of which are located at the remote station and the second and fourth of which are located at the control station, means including a front contact
 75 of the fifth relay to connect a winding of the first relay between a first and a second of the control wires, means including a front contact of the first relay to connect a winding of the third

relay between a third and a fourth of the control wires, means including a front contact of the third relay to connect a winding of the fifth relay between a fifth and a sixth of the control wires, means to connect a winding of the second relay between the second and third control wires, means including a front contact of the second relay to connect a winding of the fourth relay between the fourth and fifth control wires, a current source, means including a front contact of the fourth relay to connect said source between the first and sixth control wires, means for at times shunting around the front contact of each of said relays to initially energize said relays whereby said control wires are serially supplied with current from said source, and signaling means governed by the current flowing in said control wires.

10. In a signal system involving at least four control wires extending between a control station and a remote station, three relays a first and a third of which are located at the remote station and a second of which is located at the control station, means including a front contact of the third relay to connect a winding of the first relay between a first and a second of the control wires, means including a front contact of the first relay to connect a winding of the third relay between a third and a fourth of the control wires, means to connect a winding of the second relay between said second and third control wires, a current source, means including a front contact of the second relay to connect said source between the first and fourth control wires, means for at times shunting around the front contact of each of said relays to initially energize the relays whereby said control wires are serially supplied with current from said source, and signaling means governed by the current flowing in said control wires.

11. In a signal system involving at least three control wires extending between a control station and a remote station, three relays a first and a third of which are located at the remote station and a second of which is located at the control station, means including a front contact of the third relay to connect a winding of the

first relay between a first and a second one of the control wires, means to connect a winding of the second relay between the second and a third one of the control wires, a current source located at the control station, means to connect one terminal of the source with said first control wire, means including a front contact of said first relay and a front contact of said second relay to connect a winding of the third relay between said third control wire and the other terminal of the current source, means for at times shunting around the front contact of each of said relays to initially energize said relays whereby said control wires are serially supplied with current from said source, and signaling means responsive to the current flowing in said control wires.

12. In a signal system involving at least four control wires extending between a control station and a remote station, three relays a first and a third of which are located at the remote station and a second of which is located at the control station, means including a front contact of the third relay to connect a winding of the first relay between a first and a second of the control wires, means including a front contact of the first relay to connect a winding of the third relay between a third and a fourth of the control wires, means to connect a winding of the second relay between said second and third control wires, a current source, means including a front contact of the second relay to connect said source between the first and fourth control wires, a fourth relay located at the remote station and having front contacts which shunt around the front contacts of said first and third relays, a fifth relay located at the control station and having a front contact which shunts around the front contact of said second relay, means including a back contact of the first relay and a push button at the control station to energize said fourth and fifth relays for initially energizing said first and third relays as well as the second relay whereby said control wires are serially supplied with current from said source, and signaling means responsive to the current flowing in said control wires.

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