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CONTROL CIRCUIT WITH ANSWER BACK AND SUPERVISORY SIGNALS

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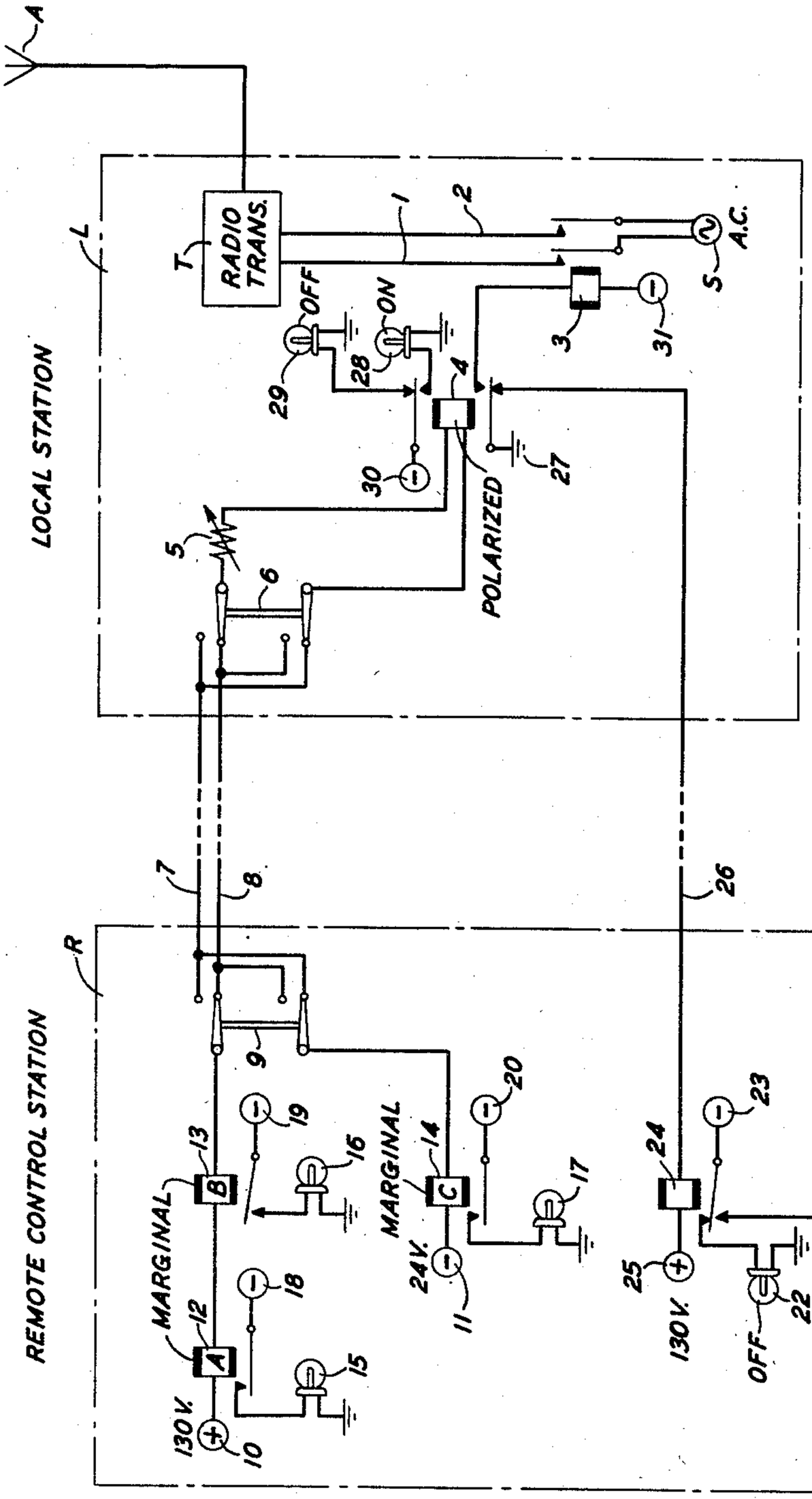

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CONTROL CIRCUIT WITH ANSWER BACK AND SUPERVISORY SIGNALS

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This invention relates to a control system for controlling the operation of a radio transmitter either locally or over a control line from a remote point and, more particularly, to a control system having safety features for preventing various trouble conditions on the control loop from accidentally starting the radio transmitter and thereby causing it to radiate its carrier unnecessarily. Such unintentional carrier radiation is undesirable not only because of the cost of the power consumed but chiefly because it is liable to produce unnecessary interference or crosstalk on neighboring carrier channels.

Accordingly, it is an object of this invention to provide improved means for starting a radio transmitter either locally or from a remote point.

Another object of the invention is to provide improved means for minimizing false operation of a remote control system.

Still another object of the invention is to provide improved means for furnishing warning indications both as to the occurrence of line facility impairments in a remote control system and also as to their specific nature.

These and other objects of the invention are accomplished by controlling the starting and stopping of a radio transmitter at a local station in accordance with reversals of the direction in which current, supplied over a two-wire control line extending from the local station to a remote control station, flows through the windings of a control relay. Each station is equipped with control means for effecting reversals of the flow of control line current through the control relay. Since the control means are independently operable, each station has means for indicating the actual condition of the transmitter. As a safety precaution, the indicating means are designed to be operated continuously. Additional indicating means are installed at the remote control station for furnishing separate warning indications of different kinds of line facility impairments. The invention also provides for preventing false operation of the control means by various types of line facility troubles, such as crosses between the lines, open line conditions, and accidental grounds on the control line.

These and other features of the invention are more fully discussed in connection with the following detailed description of the drawing which is a schematic circuit diagram of a control system in accordance with the invention.

In the control system shown in the drawing, a local signaling station L is shown to be provided with a radio transmitter T having its output connected to an antenna A. The radio transmitter T may be of any suitable type, known to those skilled in the art, which is designed to be operated by electric power supplied from an alternating current source S over a power supply circuit which includes the conductors **1** and **2** and the armatures of a power relay **3**. When the power relay **3** is unenergized, as is represented in the drawing, its armatures are in their released position so that the power supply circuit **1—2** is

open with the result that the transmitter T is not in an operating condition.

The energization of the power relay **3** is controlled by the bottom armature of a control relay **4** which is a polar type responsive to changes in the direction of the flow of current through its windings; that is, when current flows through its windings in one direction, its armatures are moved to their outer contacts and, when current flows through the windings in the opposite direction, the armatures move to engage their inner contacts. The control relay **4** has the further design construction that, if the flow of current in its windings is interrupted or stopped, its armatures will remain in the position to which they had been moved at the time of the cessation of current.

At the local station L, the windings of the control relay **4** are connected through an adjustable resistor **5** and a two-position reversing switch **6** to a two-wire control line **7—8** extending from the local station L to a remote control signaling station R. A similar two-position switch **9** is located at the remote control station R for connecting one wire of the line **7—8** to a source **10** of positive 130 volt potential and for connecting the other wire of the line **7—8** to a source **11** of negative 24 volt potential. Thus, current flows continuously over the line **7—8** with the direction of its flow subject to reversal by the manually operable switch **9**.

Two marginal relays **12** and **13** have their windings connected in series between the positive source **10** and the upper arm of the switch **9** while a third marginal relay **14** has its winding connected in series between the negative source **11** and the lower arm of the switch **9**. Each of the relays **12, 13,** and **14** has an armature for controlling the illumination of a respectively different one of a plurality of indicating lamps **15, 16,** and **17** by their respectively associated power supply source **18, 19,** and **20**. The lamps **15, 16,** and **17** are provided for indicating the occurrence of various types of line facility disturbances or irregularities as is discussed in detail hereinafter.

The remote control station R is further provided with two "on" and "off" lamps **21** and **22** which are alternatively illuminated by a power supply source **23** under the control of the armature of a relay **24**. One side of the energizing windings of the relay **24** is connected to a source **25** of positive 130 volt potential and the other side is connected to a line **26** extending to the local station L. At the local station L, the line **26** is terminated at the lower contact associated with the bottom armature of the polarized control relay **4**, this armature being connected to a ground **27**. A similar set of "on" and "off" lamps **28** and **29** is located at the local station L. The lamps **28** and **29** are alternatively illuminated by a power supply source **30** under the control of the top armature of the control relay **4**.

The operation of the control system will now be described firstly with reference to its condition as shown in the drawing wherein currrent from the positive 130 volt source **10** is represented as being applied to the upper end of the windings of the polarized control relay **4**, the lower end of these windings being connected to the negative 24 volt source **11**. With current flowing through the windings of relay **4** in this direction, its armatures are moved into engagement with their outer contacts so that the bottom armature disconnects ground **27** from the windings of the power relay **3** thus opening its energizing circuit extending from a power supply source **31**. As a result, the armatures of the power relay **3** will be in their released position thereby opening the power supply circuit **1—2** of the radio transmitter T and causing it to be in an unoperated condition.

This unoperated condition of the radio transmitter T will be indicated to an operator at the remote control

station R because the ground 27 will now be connected to the line 26 thereby enabling current from the source 25 to cause relay 24 to move its armature into engagement with its upper contact for effecting the illumination of the "off" lamp 22 by current from the source 23. At the same time, the unoperated condition of the radio transmitter T will be indicated to an attendant at the local station L due to the fact that the top armature of the control relay 4 now causes current from the source 30 to illuminate the "off" lamp 29.

When an operator at the remote control station R wishes to start the radio transmitter T, this is accomplished by reversing the position of the switch 9 which, with it originally in the position shown in the drawing, will now cause both its arms to engage their upper contacts. Accordingly, current from the positive source 10 will now flow over the upper line conductor 7, through the lower arm of the switch 6, windings of the control relay 4, resistor 5, upper arm of switch 6, back along the lower line conductor 8, and then over the lower arm of switch 9 to the negative source 11. Since current from the positive source 10 is now applied to the lower end of the windings of the polarized control relay 4, the direction of the flow of current through its windings is thus reversed thereby causing it to move its armatures into engagement with their inner contacts. This transfers the ground 27 from the line 26 to the winding of the power relay 3 which now becomes energized by current from the source 31 and operates its armatures to close the power supply circuit 1—2 thereby starting the radio transmitter T.

At this time, the removal of the ground 27 from the line 26 effects the deenergization of the relay 24 at the remote station R. Relay 24 consequently releases its armature thus transferring the power source 23 from the "off" lamp 22 to the "on" lamp 21. The resulting extinguishment of the "off" lamp 22 and the illumination of the "on" lamp 21 serves to inform the operator at the remote station R that the radio transmitter T has been started. Also at this same time, the movement of the upper armature of the control relay 24 transfers the power source 30 from the "off" lamp 29 to the "on" lamp 28 to inform the attendant at the local station L that the radio transmitter T has been started.

After having been started, the radio transmitter T can be stopped by an operator at the remote station R again reversing the position of the switch 9 which, in accordance with the example just described, will restore the system to the condition shown in the drawing. Thus, the starting and stopping of the radio transmitter T can be controlled by an operator at the remote station R by manually operating the switch 9 to reverse the direction in which current flows over the control line 7—8 and then through the windings of the polarized control relay 4.

If, when the system is in the condition shown in the drawing, the attendant at the local station L wishes to start the radio transmitter T, the attendant reverses the position of the switch 6 which, with it originally in the position shown in the drawing, will now apply positive current from the line conductor 8 over the lower arm of switch 6, through the windings of the control relay 4, resistor 5, and then over the upper arm of the switch 6 to the line conductor 7. Since positive current is now applied to the lower end of the windings of the polarized relay 4, it will move its armatures into engagement with their inner contacts to perform the same functions that were described above.

The attendant at the local station L can stop the operation of the radio transmitter T by changing the position of his switch 6 which, in the case of the example described above, will restore the control system to the condition shown in the drawing. In this manner, the attendant at the local station L can control the starting and stopping of the radio transmitter T by manually operating the switch 6 for reversing the connections of

the line conductors 7 and 8 to the windings of the polarized control relay 4 and thereby reversing the direction of the flow of current through the windings of relay 4.

It is to be understood that the control switches 6 and 9 can be operated independently of each other. For example, with the system in the condition shown in the drawing, the attendant at the local station L can start the transmitter T by moving his switch 6 into engagement with its upper contacts. Later, if an operator at the remote station R wishes to stop the transmitter T, this can be accomplished by moving the switch 9 into engagement with its upper contacts. The transmitter T can then be started again by the attendant at the local station L moving his switch 6 into engagement with its lower contacts. Thus, any reversal of the position of either one of the control switches 6 and 9 will effect a reversal of the condition of the transmitter T and will also cause the illumination of the appropriate one of the "on-off" lamps at each station.

It should be noted that, by always having one or the other of these lamps illuminated at each station, a continuous positive indication of the condition of the transmitter T is obtained. Although it might be cheaper to use just one lamp at each station which would be illuminated for only one condition of the transmitter T, this would provide a lesser degree of safety because there would be no sure way of being informed of a failure of the filament in the lamp whereas a filament failure would be readily apparent when two lamps are used at each station as described above.

Having thus described the independently operable control means at each station for effecting the starting and stopping of the transmitter T, the manner in which the invention provides for preventing false operation of the control means by various types of line facility impairments, such as crosses between the lines, open line conditions, and accidental grounds on the control line, will now be described. Let it be assumed firstly that a cross occurs between the wires of the control line 7—8. This will cause the current in the winding of the control relay 4 to be reduced to zero. As was stated above, the design construction of the control relay 4 is such that, if the flow of current in its windings is interrupted or stopped, its armatures will remain in the position to which they had been moved at the time of the cessation of current. In other words, the armatures of relay 4 will move only in response to an actual reversal of the flow of current in its windings. Therefore, since the occurrence of a cross on the line 7—8 effects a cessation of the flow of current in the windings of relay 4 instead of a reversal, the armatures of relay 4 will not be actuated thereby but will remain in the position to which they were last operated so that there will be no false operation of the starting means at this time.

Similarly, the occurrence of an open on the control line 7—8 will likewise reduce the current in the winding of relay 4 to zero and, for the same reasons as discussed above, will not effect a change in the position of the armatures of the control relay 4.

An accidental ground on that one of the control line wires 7—8 which is at that time connected to the upper arm of the control switch 9 will be positive with respect to the negative 24 volt source 11 with the result that, although the magnitude of the current in the winding of the control relay 4 will be reduced, its direction of flow will remain unchanged so that the armatures of the relay 4 will remain in the position to which they were last operated. If a ground occurs on the control line wire 7—8 which happens at that time to be connected to the lower arm of the control switch 9, it might either increase or decrease the magnitude of the current in the winding of the control relay 4 depending on whether the location of the ground is near the local station L or near the control station R but, in either case, the current will not change

its direction of flow and therefore the position of the armatures of relay 4 will not be changed.

Thus, it can be understood that the accuracy of the performance of the means for starting the radio transmitter T is enhanced due to the fact that the control system is not susceptible to false operation by the occurrence of various trouble conditions on the control line, such as crosses between the lines, open line conditions, and accidental grounds on the control line.

During the existence of certain of the trouble conditions described above, an operator at the control station R will be unable to effect a reversal of the position of the armatures of the control relay 4. Therefore, when the above-mentioned impairments of the line facilities occur, they should be corrected without undue delay. In order to do this, an operator at the remote control station R should be informed promptly both as to the occurrence of a trouble condition on the line 7—8 and also as to the specific nature of the trouble. This is accomplished in part by connecting the windings of two marginal relays 12 and 13 in series between the positive source 10 and the upper arm of the control switch 9, and by connecting the winding of a third marginal relay 14 in series between the negative source 11 and the lower arm of the switch 9. Relays 12 and 14 require the flow of 20 mils current through their windings in order to operate their armatures, whereas relay 13 will operate its armature in response to the flow of only 6 mils current through its winding.

At this point, it should be noted that the value of the resistor 5 at the local station L is so adjusted as to provide an initial normal line current of 10 mils. Consequently, when the normal line current of 10 mils is flowing over the loop 7—8, the armatures of relays 12 and 14 are in their released positions and the armature of relay 13 is in its operated position. Under these conditions, the indicating lamps 15, 16, and 17 will not be illuminated.

If an open should occur in the control loop 7—8, the line current will be reduced to zero, as was stated above, with the result that the marginal relay 13 will release its armature thereby effecting the lighting of its associated lamp 16. Due to the fact that the lamp 16 becomes lit only in response to the occurrence of an open on the loop 7—8, this provides an operator at the control station R with a positive warning indication of the specific nature of the trouble condition.

The occurrence of a ground on that one of the control line wires 7—8 which is at that time connected to the upper arm of the switch 9 will, unless it happens to be a high resistance ground, increase the current through the winding of relay 12 to more than 20 mils. This will cause the armature of relay 12 to become operated thereby lighting the lamp 15. In the event that a high resistance ground should occur on this line wire, it will decrease somewhat the current then supplied to the winding of the control relay 4. However, as this reduction will not be enough to impair the control of the operation of the armatures of relay 4, no alarm warning is required.

If a ground occurs on the control line wire 7—8 which happens at that time to be connected to the lower arm of the control switch 9, it will sufficiently increase the current flowing through the winding of relay 14 so that its armature will become operated to effect the lighting of the lamp 17.

The occurrence of a cross between the wires of the control loop 7—8 will increase the current flowing through the windings of both relays 12 and 14 to an extent sufficient to cause both of them to operate their armatures. Accordingly, the lamps 15 and 17 will now be illuminated simultaneously to indicate this trouble condition.

Thus, the above described illumination of the lamps 15, 16, and 17 functions to indicate promptly both the occurrence of a trouble condition on the loop 7—8 and also its specific nature.

It is to be understood that this specific embodiment of the invention has been shown and described above for the purpose of explaining the principles and features of operation of the invention. Various modifications thereof may be made within the scope of the invention which is defined in the claims appended hereto.

What is claimed is:

1. In combination, a first station having electrically operable equipment, a power supply circuit for energizing said equipment, control means for alternatively closing and opening said power supply circuit for correspondingly starting and stopping the energization of said equipment, said control means including at said first station a polar relay having an energizing winding and armature means, a second station having a source of electrical potential, an electrically conductive two-wire loop extending between said stations, a first two-position switch at said second station for reversibly connecting said source to the wires of said loop, and a second two-position switch at said first station for reversibly connecting said energizing winding to the wires of said loop, both of said switches being operable independently of each other, said armature means being operated in one direction for effectuating one type of control over said power supply circuit in response to the placing of any one of said switches in one of its positions and being operated to effectuate the other type of control over said power supply circuit in response to the subsequent movement of any one of said switches to its other position.

2. A control system comprising in combination a first station, a second station, an electrically conductive two-wire loop extending between said stations, electrical potential means at said second station connected to one end of said loop, a polar relay at said first station having an energizing winding connected to the other end of said loop whereby a closed circuit is formed for the continuous flow of line current from said potential means through the winding of said relay, said relay having armature means operable alternatively to first and second positions, said armature means being operated to said first position in response to the flow of line current through the winding of said relay in a first direction and being operated to said second position in response to the flow of line current through the winding of said relay in a second direction, said second direction being the reverse of said first direction, independently operable reversing means for reversing the direction of the flow of line current through the winding of said relay, said reversing means including means at said first station for reversing the connection of the winding of said relay to the two wires of said loop, said reversing means further including means at said second station for reversing the connection of said potential means to the two wires of said loop, electrically operable equipment at said first station, and a power supply circuit for energizing said equipment, said power supply circuit having alternative closed and opened conditions for correspondingly starting and stopping the energization of said equipment, said power supply circuit being placed in its closed condition for starting the energization of said equipment in response to the operation of said armature means to one of said positions, said power supply circuit being placed in its opened condition for stopping the energization of said equipment in response to the operation of said armature means to the other of its positions.

3. A control system in accordance with claim 2 and having a plurality of indicating means at each of said stations for continuously indicating the particular instantaneous condition in which said power supply circuit has been placed, a plurality of energizing circuit means at each of said stations, each of said energizing circuit means being connected to only a respectively different one of said indicating means, and control means for effecting the closing of one of said circuit means at each of said stations alternatively with the opening of another

of said circuit means at each of said stations whereby at any time there is always one of said circuit means in a closed condition at each station, said control means being operated for controlling the opening and closing of said energizing circuit means at each station in accordance with reversals in the direction of the flow of line current through the winding of said relay, said control means including said armature means.

4. A control system in accordance with claim 2 and having indicating means at each of said stations for instantaneously indicating the particular condition in which said power supply circuit has been placed, energizing circuit means for energizing said indicating means, and control means for controlling the opening and closing of said energizing circuit means in accordance with reversals in the direction of the flow of line current through the winding of said relay, said control means including said armature means.

5. A control system in accordance with claim 4 wherein said energizing circuit means include a one-wire electrically conductive line extending between said stations, a relay at said second station having an energizing winding connected to one end of said one-wire line, the other end of said one-wire line being terminated at said armature means, and local circuit means at said second station for energizing the indicating means thereat, said relay at said second station having armature means for controlling the opening and closing of said local circuit means.

6. A control system in accordance with claim 2 and having adjustable means for adjusting the initial value of said line current to an assigned value, a plurality of indicating means at said second station for indicating departures of the instantaneous value of said line current from said assigned value, each of said indicating means having a separate and independent energizing circuit, a plurality of marginal relays each having an energizing winding connected in series between said potential means and said reversing means at said second station, a first one and a second one of said marginal relays being connected by said reversing means to one wire of said two-wire loop, and a third one of said marginal relays being connected by said reversing means to the other wire of said two-wire loop, each of said marginal relays having an armature for controlling the opening and closing of a respectively different one of said energizing circuits in accordance with the release and operation of the respective armature, said first and third marginal relays being designed to operate independently their respective armatures only in response to the flow through their respective windings of current having an instantaneous value larger than said assigned value, said second marginal relay being designed to operate its armature in response to the flow through its winding of current having an instantaneous value smaller than said assigned value.

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