

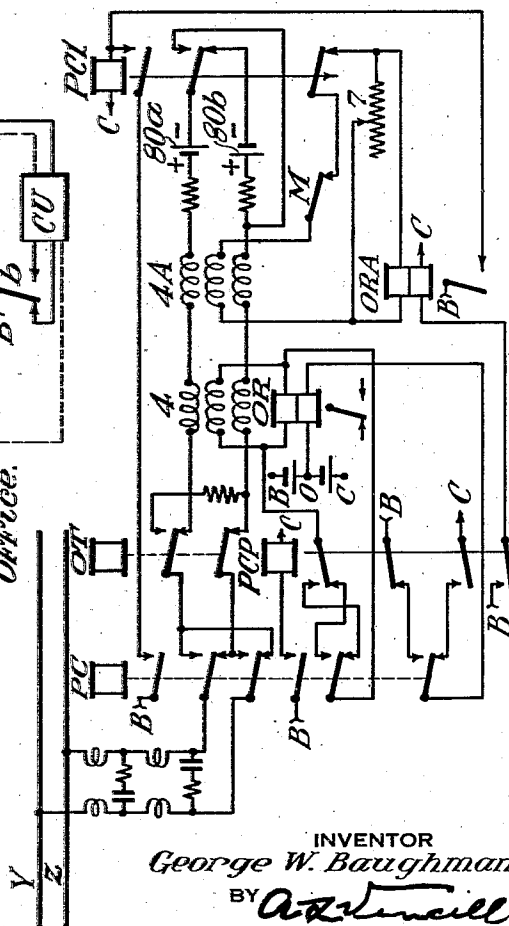
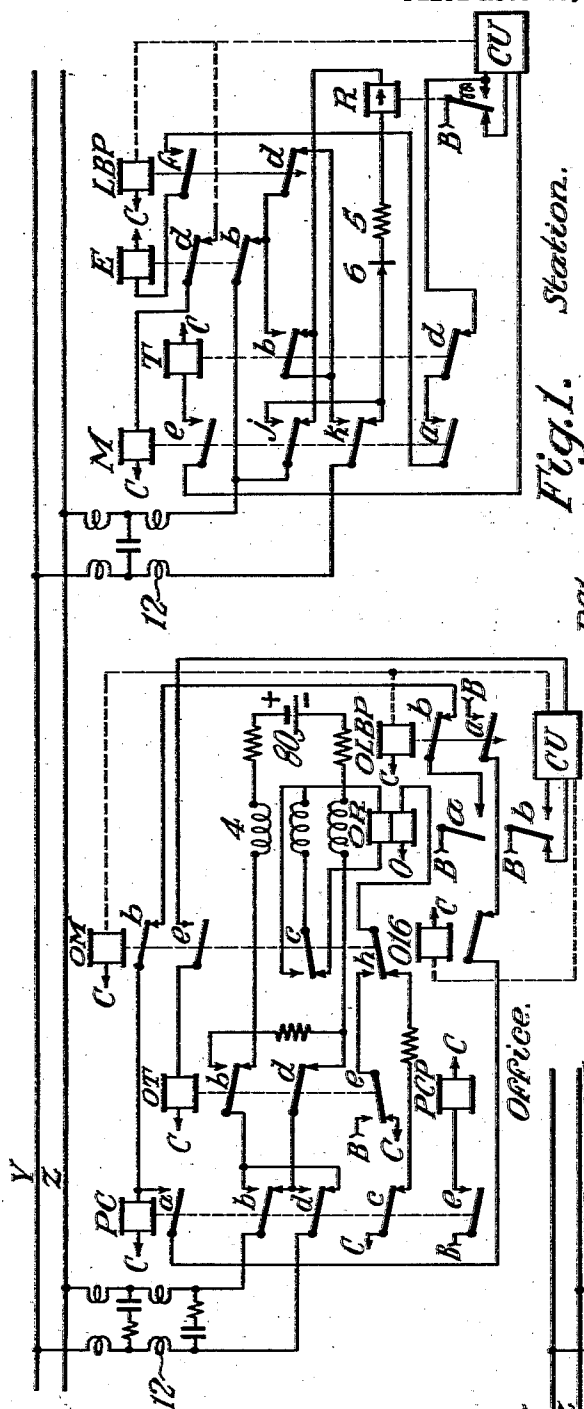
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REMOTE CONTROL SYSTEM

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REMOTE-CONTROL SYSTEM

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My invention relates to remote control systems and more particularly to the line circuits for such systems of the normally closed bridged type such as shown, for example in the United States Patent No. 2,303,875, issued December 1, 1942, and No. 2,350,668, issued June 6, 1944, to G. W. Baughman and N. F. Agnew for remote control systems.

In systems of this character a line circuit is employed which extends from the control office through a plurality of field stations at spaced locations within the controlled territory, by means of which a line relay at each station connected across the line is normally energized by line current from a central battery located at the office. Control codes are transmitted from the office at times to which coding units controlled by the station line relays are selectively responsive by periodically interrupting at the office the supply of line current from the office line battery. The station coding units are also adapted to transmit indication codes to the office at times over the same line wires by periodically connecting the line wires together at the transmitting station through a low impedance to vary the current delivered to the line circuit by the office battery, the indication codes being received by a line relay at the office of the stick polar type which is connected to the line through a transformer.

Since the station coding units are capable of initiating codes at any time the line is free, one requirement for systems of this character is the provision of means for preventing interference so as to give only one station access to the line at a time. This is accomplished by the use of line relays at the stations which are responsive to current of one polarity, and by the provision of means controlled by the office line relay in response to the first impulse of a received code for reversing the line polarity and at the same time reversing the connections of the line relay at the transmitting station, so that during the transmission of the code only the line relays at the office and at the transmitting station respond to the code, the others remaining released until the line polarity is restored to normal at the end of the code. To prevent interference between the transmitters at two or more stations which initiate codes at the same time, a current limiting resistance is interposed between the line battery and the line to render the connection between line wires due to the operation of the transmitter at a station near the office, effective to shunt the line to control the line relay at any more remote station so as to cause the latter to respond to a code which differs from the one

which the associated coding unit is capable of transmitting; a lock out circuit in the station coding unit serving to discontinue the operation of the transmitter at the more remote stations under this condition.

The object of the present invention is to improve the efficiency of transmission in systems of the type described so as to adapt them to operation over line circuits which are relatively long, electrically, or which have line wires of relatively high resistance.

I shall describe one form of apparatus embodying my invention and shall then describe the novel features thereof in claims.

Referring to the accompanying drawing Fig. 1 shows a typical line circuit for a remote control system of the type described, modified in accordance with my invention comprising a pair of line wires Y and Z extending from the control office, shown at the left, through a plurality of similarly arranged field stations of which one is shown in the right hand portion of the drawing over which the line relays R at each station are normally energized in multiple by current from a line battery 80 located at the office. Fig. 2 shows a modification of that portion of the apparatus of Fig. 1 which is located at the control office for regulating the voltage supplied by the line battery in accordance with a feature of my invention.

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

Referring to Fig. 1, the line circuit may be traced from battery 80 through the primary windings of an impulse transformer 4, the secondary of which is connected to the office line relay OR to render relay OR responsive to variations in line current, thence over back contacts b and d of an office transmitter relay OT and of a pole changer relay PC through the coils of a low pass filter 12 to the line wires Y and Z the filter 12 being included in the circuit to enable the line wires to be used jointly for telephone communication or other purposes. At each station a connection across the line wires Y and Z is normally closed through a similar filter 12, back contacts j and k of a master relay M and the winding of the station line relay R. The winding of relay R is of relatively high resistance and has a resistor 5 in series therewith so as to properly proportion the circuit for efficient operation when the installation includes the usual number of stations which is about thirty, the relays R being connected across the line wires in parallel. In addition the circuit includes a rectifier 6 in series

with the relay arranged to pass current of only one polarity. Ordinarily, line relays of the biased polar type which are inherently responsive to current of one polarity only are used in preference to ordinary neutral relays because of their high sensitivity and the purpose of the rectifier is not to polarize the relay, but rather to block the flow of current through the relay when its polarity is such that the relay is incapable of responding thereto.

The office line relay OR is of the magnetic stick type arranged to be held in its last operated position when deenergized and is controlled locally as described in the above mentioned patents so that it is automatically restored to its normal position after a time interval if it is accidentally reversed and in that manner is maintained in its normal position as shown, when the system is at rest.

Except for the added rectifier 6, the station apparatus is generally similar to that of Patent No. 2,303,875. The office apparatus is also generally similar to that of this patent, except for the addition of a biasing circuit for relay OR controlled by contact *c* of relay PC as shown. These modifications do not change the normal mode of operation of the system which will now be briefly described.

Each line relay OR or R controls a coding unit CU which is normally conditioned to receive codes and which may be caused to transmit codes at times the transmitting condition being manifested by the energization of a master relay OM or M. When the office master relay OM is energized to initiate the transmission of a control code to the stations, it completes a circuit at its contact *e* governed by the office coding unit for periodically energizing the transmitter relay OT, contacts *b* and *d* which periodically interrupt the line current of normal polarity to operate the line relays R at the several stations to control the station coding units in accordance with the code, while contact *e* of relay OT completes circuits over front contact *h* of relay OM for supplying current of reversible polarity locally to the lower winding of relay OR to cause the office coding unit to respond to the code, the upper or line winding of relay OR being temporarily disconnected from transformer 4 by the operation of contact *c* of relay OM.

When the master relay M at a field station is energized to initiate the transmission of an indication code to the office, the operation of its pole changer contacts *j* and *k* reverses the connections of the associated line relay R, and at the same time completes a connection from line Y over its front contact *k* and the back contacts *d* and *b* of the relays LBP and E of the station coding unit to line Z causing relay R at the transmitting station to release while increasing the current delivered by the line battery 80 through transformer 4 to induce an impulse therein to reverse relay OR. Relay PC now picks up over the circuit from terminal B of the local office battery over contacts *b* of relays OLBP and OM through relay PC to terminal C and relay OLBP is energized by the office coding unit to complete a stick circuit at its contact *a* to hold relay PC energized until the code is fully received as manifested by the operation of a relay O16 controlled by the office coding unit. The operation of contacts *b* and *d* of relay PC reverses the polarity of the current supplied to the line thereby releasing relay R at each station other than the trans-

mitting station, that is, at each station at which relay M occupies its released position.

When the master relay at the transmitting station is energized it also completes a circuit at its contact *e* governed by the associated coding unit for periodically energizing the transmitter relay T. Relay LBP is energized by the coding unit in response to the first operation of relay R, and then contact *b* of relay T operates periodically to connect the line wires together and to open the circuit for relay R. Since line wire Z is now positive, relay R picks up each time relay T releases during the transmission of the code over the connection from line wire Z over front contact *j* of relay M through relay R and over back contact *b* of relay T and front contact *k* of relay M to line wire Y and when relay T picks up the line wires are connected together through the coils 12 over front contacts *k* and *b* of relays M and T, and back contact *b* of relay E, consequently relay OR at the office responds to the line current variations to control the office coding unit in accordance with the code and relay R at the transmitting station operates in unison therewith to control the coding unit by which relay T is governed, while relays R at the other stations remain released until the line polarity is restored to normal by relay PC at the end of the code.

In the event two stations initiate codes at the same time, the two relays T will operate in unison as long as the corresponding code steps are alike but the codes transmitted from the different stations differ in the length of one or more steps and a point is reached where relay T at one station either releases to generate a short even numbered step while relay T at another station remains picked up to generate a corresponding long step or the relay T at one station remains released to generate a long odd numbered step after relay T at another station picks up to terminate the step. The codes are assigned in such an order that the station nearer the office will prevail under this condition. This is desirable because the connection between wires Y and Z produced by relay T includes only the relatively low resistance of the coils 12 and is fully effective to release the line relays at more remote stations, but it is not necessarily effective to release those at stations nearer the office because of the effect of the resistance of the intervening line wire. It will be seen therefore that the line relays at the more remote stations which are in the transmitting condition will be operated in accordance with the code transmitted by relay T at the station nearer the office, and at such stations on one step or another relays R and T will both be released for a time sufficient to complete a lock out circuit which extends from terminal B at the right hand contact of relay R over back contact *d* of relay T, front contacts *a* and *f* of relays M and LBP through relay E to terminal C, whereupon relay E will become energized and open its back contact *d* to release relay M to stop further transmission from the more remote station, the interrupted code being stored for transmission in its entirety when the line is again free in a well known manner.

Considering now the modifications of the line circuit comprising my invention, it will be seen that if the system is applied to line circuits which are unusually long or of higher resistance not only will a higher line voltage be required for the proper operation of the more remote line relays but the percentage change in line current

due to the operation of their transmitter relays will be smaller due to the increased resistance of the intervening line wires and to the increased current flow through the line relays nearer the office. When the rectifier 6 is interposed in the circuit for each line relay R, as shown, the transmitting relays T at the more remote stations are rendered capable of causing much larger variations in line current so that the operation of the office line relay OR is more positive for the reason that the flow of current through the line relays R at the other stations which are not in the transmitting condition is blocked by the rectifiers 6, decreasing the line current and increasing the voltage across line wires Y and Z at the remote transmitting station, and the system is thereby adapted for use over line circuits which are electrically longer or of unusually high resistance.

It will be seen that this expedient is ineffective under two conditions: (1) When a number of stations initiate codes at the same time; but in this case the operation of the transmitters at the more remote stations is not required, as already explained. (2) When the system is in its normal at rest condition with current of normal polarity supplied to the line. In the latter case, in order to initiate the transmission of a code by the operation of the transmitter relay at the most distant station, it is necessary to have the office line relay OR normally in condition to respond to an increase in line current of a materially smaller value than that by which it is operated in response to the successive steps of the code. This is accomplished by biasing relay OR so as to overcome in part the magnetic force by which it is held in its normal position by the provision of a local circuit for relay OR which includes back contact c of relay PC and back contact h of relay OM, as shown, which circuit is closed only when the system is in its normal at rest condition.

It will be seen therefore that while relay OR is normally in condition to respond to an impulse tending to operate it to reverse which is so weak that the relay would not respond properly to a succession of such impulses constituting a code, the operation of relay PC by the initial operation of relay OR reverses the line polarity and renders the rectifiers 6 effective to suppress the flow of current through the line relays at other stations so that the code impulses supplied to relay OR are relatively strong and its reliable operation is thereby insured.

In a long line circuit arranged as described it will be evident that a relatively high voltage line battery may be required and that since the drop through the current limiting resistances and the office filter coils is decreased, due to the decrease in the line current, when a station is transmitting, the changes in the line current due to the operation of a transmitter at a station near the office may be unduly large overloading the filter coils so as to produce noise in a telephone circuit superimposed upon the line wires Y and Z.

This difficulty is overcome by the provision of the arrangement illustrated in Fig. 2, comprising an additional line relay ORA connected to the line through an impulse transformer 4A in series with the transformer 4 by which the relay OR controlling the office coding unit is controlled. Relay ORA is controlled like relay OR but responds only to a relatively large change in line current as produced by the initial operation

of a transmitter at a nearby station, due to the provision of an adjustable resistance 7 for shunting its line winding to render the relay less sensitive. The high voltage line battery is divided into two sections 80a and 80b and when relay ORA reverses it completes a pick-up circuit for a stick relay PC1, which relay becomes energized in response to the reversal of relay ORA and by removing section 80b of the line battery from the circuit reduces the line voltage to the desired value. Relay OR which reverses at the same time, energizes relay PC as already described in connection with Fig. 1 and relay PC completes a stick circuit for holding relay PC1 energized until the end of the code.

It is to be understood that the system includes means for preventing the response of relay OR to the current variations caused by the reversal of polarity of the line current by relay PC. Relay PC controls a slow acting repeater relay PCP as shown in Fig. 2 and circuits jointly controlled by relays PC and PCP serve to open the connection between relay OR and transformer 4 when relay PC picks up or releases and to complete local circuits to hold relay OR reversed for a brief period when relay PC picks up and to hold relay OR normal for a corresponding period when relay PC releases. These circuits are also effective to prevent the response of relay OR to the changes in line current due to the pick up or release of relay PC1, as will be readily apparent.

Due to the marginal adjustment of relay ORA provided by resistance 7 if this relay were connected permanently in circuit it might fail to operate on the initial impulse of a code from an intermediate station and might operate in response to one of the succeeding impulses of that code and thereby interfere with its proper reception. For this reason relay ORA is disconnected from transformer 4A during the transmission of control codes by including a back contact of the master relay M in its circuit, as shown, and is also disconnected from transformer 4A when relay PC1 picks up. Relay PCP is picked up by relay PC during the reception of the initial impulse of an indication code and completes a local circuit as shown, for restoring relay ORA to normal. This local circuit is effective to hold relay ORA normal and non responsive to the increase in line current due to the release of relay PC1 at the end of the code, and also to hold relay ORA normal during the reception of a code, even though relay PC1 is not operated. It will be seen therefore that relay ORA provides means effective when the line current variations transmitted from the more remote stations are increased for limiting the line current variations transmitted from nearby stations.

Although I have herein shown and described only one form of apparatus embodying my invention, it is to be 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 remote control system, an office and a plurality of stations connected by two line wires, a line relay of the biased polar type responsive to current of one polarity only having an electronic rectifier in series therewith passing current of only the one polarity to which such relay is responsive connected across the line wires at each station, a source of current at the office normally

supplying current of said one polarity to the line wires to maintain all said line relays energized a line relay at the office responsive to variations in the current supplied to said line circuit, a master relay at each station effective when energized to reverse the connections of the associated line relay and rectifier to render such relay responsive only to line current of reverse polarity and to momentarily connect the line wires together to effect an initial operation of the office line relay, a pole changer relay at the office for reversing the polarity of the line current in response to said initial operation of the office line relay, a transmitter relay at the station at which the line relay is responsive to current of reverse polarity for repeatedly connecting the line wires together to operate the office line relay in accordance with a code, means comprising the electronic rectifiers at the other stations for blocking the flow of current through the line relays at such stations to increase the effect of the operation of said transmitter relay, and means at the office for biasing the office line relay to render it responsive to a smaller variation in line current when the polarity is normal than when it is reversed.

2. In a remote control system, an office and a plurality of stations connected by two line wires, a line relay having an electronic rectifier in series therewith passing current of one polarity only connected across the line wires at each station, a source of current at the office normally supplying current of said one polarity only to the line wires to maintain all said line relays energized, a master relay at each station adapted to become energized only when the associated line relay is energized to establish momentarily a low resistance connection between the line wires and at the same time to reverse the connections of the associated line relay to effect its release, a line relay at the office responsive to current variations in said line current, a pole changer relay controlled by the office line relay for reversing the polarity of the current supplied to the line circuit when the master relay at any station becomes energized to thereby interrupt the supply of current to the line relays at other stations at which the master relays are not energized, a transmitter relay at each station rendered effective when the associated line relay is energized to periodically vary the current supplied to the associated line relay to control the office line relay in accordance with a code and means effective when said line current is of said one polarity and the line relays at all stations are energized for biasing the office line relay when all said line relays are supplied with current to render said relay responsive to a smaller variation in line current than is available for the operation of the relay when only one line relay is supplied with current.

3. In a remote control system, an office and a plurality of stations connected by two line wires, a line relay having an electronic rectifier in series therewith passing current of one polarity only connected across the line wires at each station, a source of current at the office normally supplying current of said one polarity only to the line wires to maintain all said line relays energized, a line relay at the office inductively coupled to the line circuit and responsive to predetermined varia-

tions in the line current, a pole changer at the office for at times reversing the polarity of the line current to discontinue the supply of current to said line relays, means at each station for at times connecting the line wires together to vary the line current, and means at the office for biasing said office line relay to render it responsive to a smaller variation in the line current when the polarity is normal than when it is reversed.

4. In a remote control system, an office and a plurality of stations connected by two line wires, a source of current of reversible polarity at the office normally supplying current of one polarity to the line wires, a line relay at each station connected across the line wires having an electronic rectifier in series therewith passing current of said one polarity only, a pole changer relay at the office for at times reversing the polarity of the current supplied to the line circuit, a line relay at the office responsive to variations in the current supplied to the line circuit for controlling said pole changer, code transmitting means at each station for at times connecting the line wires together through a relatively low resistance to periodically increase the line current in accordance with a code to which the office line relay is responsive and at the same time reversing the connections of the associated station line relay to render such relay responsive thereto, a second line relay at the office responsive only to the larger increases in the line current due to the operation of the transmitters at nearby stations, and means controlled by said second line relay for supplying current of a reduced voltage to the line circuit from said source during the operation of such transmitters at nearby stations.

5. In a remote control system, an office and a plurality of stations connected by two line wires, a source of current of reversible polarity at the office normally supplying current of one polarity to the line wires, a line relay at each station connected across the line wires having an electronic rectifier in series therewith passing current of said one polarity only, a pole changer relay at the office for at times reversing the polarity of the current supplied to the line circuit a line relay at the office responsive to variations in the current supplied to the line circuit for controlling said pole changer, code transmitting means at each station for at times connecting the line wires together through a relatively low resistance to periodically increase the line current in accordance with a code to which the office line relay is responsive and at the same time reversing the connections of the associated station line relay to render such relay responsive thereto, a second line relay at the office responsive only to the larger increases in the line current due to the operation of the transmitters at nearby stations, means effective when said second line relay fails to respond to the increase of line current by which a code is initiated for preventing its response to succeeding increases in line current during the transmission of such code, and means controlled by said line relay when it responds to the initiation of a code for supplying current of a reduced voltage to the line circuit from said source until such code is completed.

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