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TRANSMISSION CONTROL CIRCUIT

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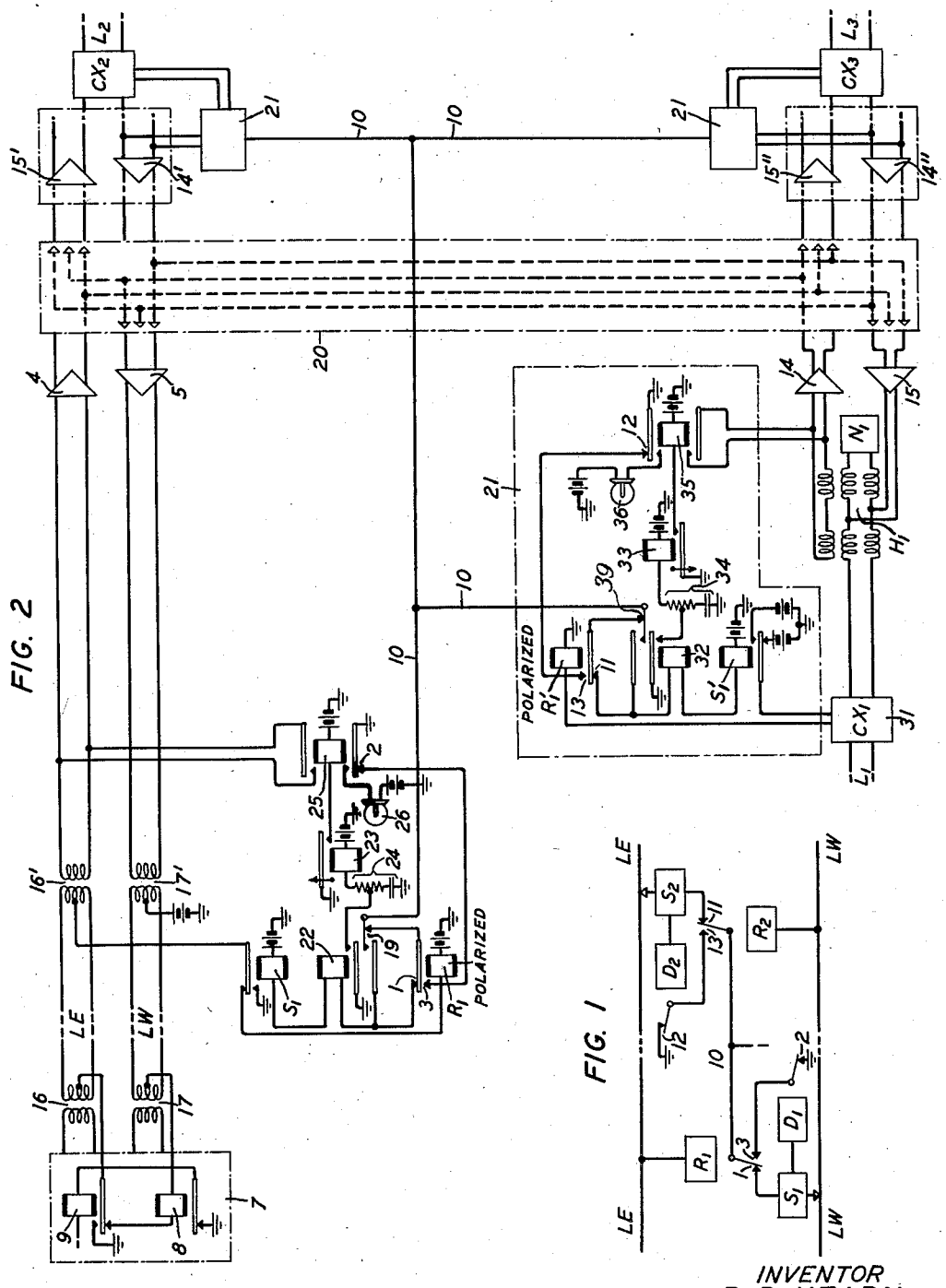

FIG. 2

FIG. 1

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TRANSMISSION CONTROL CIRCUIT

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4 Claims. (Cl. 179—170)

The present invention relates to the transmission of currents from one line to another and more particularly to transmission control and repeating arrangements.

Where currents for signal or control purposes are sent over lines that are divided into sections or that are branched, some form of repeater may be used to route the currents over the proper paths. When the control currents are used at the junction points or elsewhere to set up a particular circuit condition for the transmission of other message waves, a difficulty may arise from the liability of false operation of the circuit control apparatus by disturbing currents.

The present invention provides for repeating and utilizing the signal or control currents and makes provision against false operation of the circuit conditioning apparatus by interfering currents.

In a specific form, the invention may be embodied in a system for transmitting speech or visual-image currents over interconnected lines containing repeaters. The control currents in the specific form to be described are direct currents which are transmitted in part over the same circuits as carry the speech or image currents and they are used to condition these circuits for one-way transmission at a time, of the speech or message currents. Additional circuit control functions may also be performed as required. These control currents are repeated from one line to another as conditions may require.

On lines exposed to interference, especially open wire lines, lightning or other currents of high intensity and short duration are liable to interfere with proper control of the transmission circuits by the control currents and it is a general object of the invention to minimize such interfering effects.

Referring to the attached drawing, there is shown in Fig. 2 in schematic form so much of a complete picture transmitting and talking circuit, with direct current control equipment, as is necessary to a complete understanding of the invention, while Fig. 1 is a simplified diagram to show the essential operation of the control circuits.

A general understanding of the invention in its essentials will be facilitated by first considering the simplified circuit diagram of Fig. 1 showing an east line LE and a west line LW associated as the two sides of a four-wire circuit, with direct current control apparatus as shown. Assuming that the control currents are to be transmitted in the eastward direction over the line LE, the receiving relay R_1 shifts its armature from contact 1 to contact 3, closing circuit from ground at 2 over the control lead 10 and normal contact 11 to energize the sending relay S_2 of the next line section. The sending relay in the manner to be described later on projects control current over the next line section. A delay device D_2 energizes with S_2 and opens normal contact 12. If the energizing circuit of S_2 and D_2 is momentarily broken, device D_2 will not close contact 12 because of its delay action feature.

With the circuit closed through as above traced, if a lightning flash or other disturbance occurs on the lines, such as to cause both polarized relays R_1 and R_2 to shift their armatures to their opposite contacts for a brief instant of time, the direction of the control current over the lines will not be reversed. For, even though the armature of relay R_2 closes contact 13, it finds the contact 12 open and therefore cannot supply ground to the control lead 10 such as might cause energization of S_1. The lead 10 is shown as branching to the repeater equipment of other lines so that if a ground is placed on the lead by any receiving relay, the sending relays of all the lines through which the conductor 10 is extended are energized.

The control repeater equipment includes circuit control apparatus (not shown in the simplified Fig. 1) for conditioning repeaters in the lines LE and LW for one-way transmission. The circuit provisions that have been described for preventing a reversal of the control currents also prevents, in a manner that will be described, the conditioning of this repeater equipment for the wrong direction of transmission.

In Fig. 2 four different lines are shown radiating from the central switching or branch point indicated by the rectangle 20. These four lines comprise first the four-wire subscriber's loop including the east line LE and the west line LW and the three two-wire inter-office lines L_1, L_2 and L_3. The circuits enclosed in the rectangle 20 are preferably an interconnecting network of the type described and claimed in an application for Letters Patent of C. W. Green, Serial No. 730,493, filed June 13, 1934. That is, each of the lines radiating from this branching point is interconnected with each of the other lines so that transmission received over one line is sent out over each of the other lines. For this purpose, as disclosed more fully in the Green application, each of the lines as it enters the network 20 is in the form of a four-wire circuit comprising a transmitting branch and a receiving branch. The lines LE and LW are already a four-wire cir-

cuit and contain the four-wire repeater comprising elements 4 and 5. The line L_1 is provided with a hybrid coil arrangement H_1 and balancing network N_1 to provide in a manner common in the repeater art two one-way branches, one leading through the amplifier 14 toward the network 20 and the other leading through the amplifier 15 from the network 20 toward the line L_1. In similar manner line L_2 terminates in a pair of one-way branches containing repeaters 14' and 15' and line L_3 is similarly provided with one-way branches including amplifiers 14'' and 15'', the hybrid coil arrangements for these latter lines not being shown. All of the lines could be four-wire lines like LE, LW or two-wire lines like L_1, etc.

The dotted lines and arrows inside the rectangle 20 show the paths taken by the message waves transmitted and received over the various one-way circuits radiating from the network 20. For example, waves received over the line LE through the amplifier 4 divide between the three outgoing branches leading to the lines L_1, L_2, and L_3 respectively as shown by the arrows. Similarly the waves received over any line entering the network 20 are sent out over each of the other lines, but are prevented from reentering the same line or the opposite side of the same four-wire line by the nature of the interconnecting network as shown more fully in the Green application.

The four-wire line LE—LW leads out to a station 7 which may contain any suitable transmitting and receiving apparatus, but will be assumed for purposes of disclosure to include picture transmitting and talking apparatus which may be of the type shown for example in application for Letters Patent by A. Weaver Serial No. 734,152, filed July 7, 1934. Of this apparatus only the sending relay 9 and the receiving relay 8 are shown in the drawing. Speech currents or currents representing a picture are sent out from the station 7 over the line LE and currents of similar character are received at the station over the line LW. The receiving relay 8 may be arranged as in the Weaver application or otherwise to actuate a signal notifying an attendant that a picture is about to be received. The sending relay 9 may be operated manually or otherwise associated with the picture transmitting machine so that this relay is actuated when pictures are to be sent out over the line LE. The circuit details of this terminal apparatus are more fully disclosed in the Weaver application referred to.

It will be understood that a similar station is present on each subscriber's loop entering offices to which the lines L_1, L_2, and L_3 extend so that when a picture is sent out or speech is transmitted from any one station it is received at the corresponding station on each of the other subscriber lines.

Associated with each of the four lines coming into the switching point shown is a direct current repeater system of the type generally indicated in Fig. 1 above described. The repeater associated with the line LE—LW comprises polarized receiving relay R_1 and sending relay S_1, an auxiliary sending relay 22, a slow release relay 23, made slow because of the connection of the combination resistance and capacity 24 in the energizing circuit of this relay, and a local or switching relay 25.

The control current repeater associated with the line L_1 is generally indicated at 21 and differs from that associated with the line LE—LW only in the difference in type of control current sent out on the line. The repeaters for the lines L_2 and L_3 may be identical with that for line L_1 and are similarly numbered as 21, 21. Each of these repeaters is associated with its corresponding line through suitable composite arrangements CX—1, CX—2 or CX—3 which may be of any suitable type known in the art for enabling direct current to be sent over the corresponding line without interfering with the transmission of speech or picture currents.

The operation of Fig. 2 will now be described. Let it be assumed that a picture is to be sent from the station 7 on the line LE—LW to corresponding stations on other subscriber lines. The attendant at the station 7 prepares the transmitting machine to transmit the picture and connects it to the terminals of the outgoing line LE, at the same time closing a suitable energizing circuit for the sending relay 9 causing this relay to attract its armature, breaking at its back contact the energizing circuit for the receiving relay 8 and closing at its front contact a circuit from ground over the simplex circuit comprising the two sides of the line circuit LE between the repeating coils 16 and 16', normal contacts of the sending relay S_1 of the repeater circuit, and winding of receiving relay R_1 to battery, causing the latter relay to become energized. The circuit just traced remains closed for the duration of the transmission of the picture.

The receiving relay R_1 when energized closes a circuit from ground at the armature of relay 25, normal contact 2, front contact 3, normal contact 19, to the control lead 10 which leads to all of the other repeaters. The effect at the various other repeaters can be seen from considering the effect of this ground on the lead 10 at the repeater 21 associated with the line L_1. This ground on conductor 10 causes the energization of the sending relay S_1' and auxiliary relay 32, the circuit extending from conductor 10 through normal contact 30, normal contact 11 and the windings of relays 32 and S_1' to battery. Relay S_1' in shifting its armature reverses the current on the line L_1, the effect of which is described later on. Relay 32 when energizing closes a circuit through the winding of relay 33 which energizes. When the relay 33 attracts its armature its closes a circuit for relay 35 which energizes, lighting lamp 36 and at its lower armature and front contact, closing a shunt across the input side of the repeater 14 thus disabling this side of the four-wire circuit terminating the line L_1. At the upper armature and back contact of relay 35, the normal ground extending to the contact 13 of the relay R_1' is broken. The lighting of the lamp 36 indicates to an attendant that transmission is taking place through this station in a direction from the network 20 toward the line L_1.

A similar action takes place in each of the other repeaters 21 associated with the line L_2 and L_3 since the lead 10 is connected in a similar manner to those repeaters. The corresponding amplifier elements 14' and 14'' are disabled by the closure of a short circuit by relays similar to 35. Transmission can now take place from the station 7 over the line LE to the branching network 20 and thence over each of the lines L_1, L_2, and L_3.

The effect of reversing the current in this manner on line L_1 can be seen from considering the repeater 21 to be receiving from the similar re-

peater at the distant office to which line L_1 leads. Suppose that the sending relay at such distant station had operated in response to control current received from a subscriber's line or another inter-office trunk. Such current reversal would energize relay R_1' and ground would have been placed on the conductor 10 through the front contact 13 of relay R_1' and the contact 12 of the relay 35. This ground would have had the effect of energizing all of the auxiliary and sending relays associated with each of the other lines including auxiliary relay 22 and sending relay S_1 in the repeater associated with the line LE—LW. This would cause the relays 22, S_1, 23 and 25 of that repeater to energize, sending current out over the loop comprising lines LE and LW and the winding of relay 8 and, at the central station, lighting lamp 26, closing a short circuit across the input of repeater 4 and breaking the connection at point 2. Thus the picture apparatus at the substation on line LE—LW would have been conditioned for receiving.

As was explained with the aid of the simplified diagram of Fig. 1, if a sudden disturbance occurs on the lines after the direct current repeaters have been operated to condition the circuit for transmission in one direction, the momentary operation of the receiving relays causing their armatures to shift to their opposite contacts or to vibrate, will not have the effect of changing the conditioning of the line for the message transmission.

For example assuming as at first that transmission is taking place from the station 7 on the line LE—LW to the other lines, relays 32 and S_1' (as well as the corresponding relays in the repeaters associated with lines L_2 and L_3) will be operated and the relays 33 and 35 will likewise be operated. If now a disturbance on the lines momentarily causes relays R_1 and R_1' to shift their armatures to their opposite contacts, this will not have the effect of releasing relay 35 nor energizing relays S_1 and 22 because of the slow release characteristics of relay 33. Thus, the shunt across the input of repeater 14 from the armature and front contact of relay 35 remains unbroken and the lamp 36 remains illuminated.

A prolonged opening of the circuit of lead 10 will restore the apparatus to normal. For example, after the picture has been transmitted from the station 7 on line LE—LW, and the relay 9 has been released for a sufficient length of time, receiving relays R_1, 31 and S_1' will fall back and after a sufficient time the slow relay 33 will fall back. The time required for the latter relay to be deenergized is determined by the constants of the circuit particularly the resistance and condenser combination 34. For example, when the relay 32 releases and removes ground from its front contact, current continues to flow from the battery associated with relay 33 through the winding of that relay, through resistance and into the condenser to ground. The condenser slowly charges up and reduces the current flow to the point where relay 33 releases after which relay 35 falls back and restores the circuit to the condition shown in the drawing. This same action occurs at each of the other repeaters 21 associated with the other line such as L_2 and L_3.

The receiving relay corresponding to the relay 8 of the substation 7 is restored when the relay S_1 releases since positive battery of say 135 volts potential is now applied to each side of the line LE—LW, one battery being connected through the back contact of the relay S_1 and the winding of relay R_1 and the other battery being connected to repeating coil 17'.

It is to be understood that the invention is not limited to the particular circuit details disclosed herein, but is capable of wide modification and variation within the scope of the appended claims.

What is claimed is:

1. In combination, lines each having a sending circuit and a receiving circuit, a receive relay for each line each having its winding operatively connected to the receiving circuit, a send relay for each line having an energizing circuit, and a time delay device for each line controlled from the energizing circuit for the send relay of the respective line, the receive relay and the time delay device of the same line conjointly controlling the send relay energizing circuit of another line.

2. In combination, in a control current circuit for transmission lines, a first repeater, a second repeater associated with respective lines, each repeater comprising a send relay and a receive relay, the receive relay of the first repeater controlling the send relay energizing circuit of the second repeater, and means for preventing transient impulses from causing energization of the send relay of the first repeater during the intended period of operation of the send relay of the second repeater comprising a sluggish device operated under control of the send relay energizing circuit of the second repeater, said device controlling the send relay energizing circuit of the first repeater.

3. In a signalling system, a line divided into sections, a repeater for each line section, each repeater comprising a receiving relay and a sending relay, the energizing circuit of the sending relay being controlled by a contact on the receiving relay of the same repeater, a slow release relay in each repeater controlled by the energizing circuit of the sending relay, the sending relay energizing circuit of one repeater being controlled jointly by contacts on the receiving relay and slow release relay of another repeater.

4. In a system for the transmission of pictures over line wires, a direct current control circuit extending over the line for conditioning the line for transmission in only one direction at a time comprising relays controlled by the direct currents on the line, and means preventing false operation of said conditioning circuit by short disturbing impulses on the line comprising a delay device interposed in the control circuits of the conditioning relays to prevent their release in response to short impulses.

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