

March 29, 1949.

G. DEAKIN

2,465,359

TIE LINE FOR AUTOMATIC TELEPHONE EXCHANGES

Original Filed May 14, 1945

4 Sheets-Sheet 1

Fig. 1.

JUNCTION DIAGRAM
TIE LINE

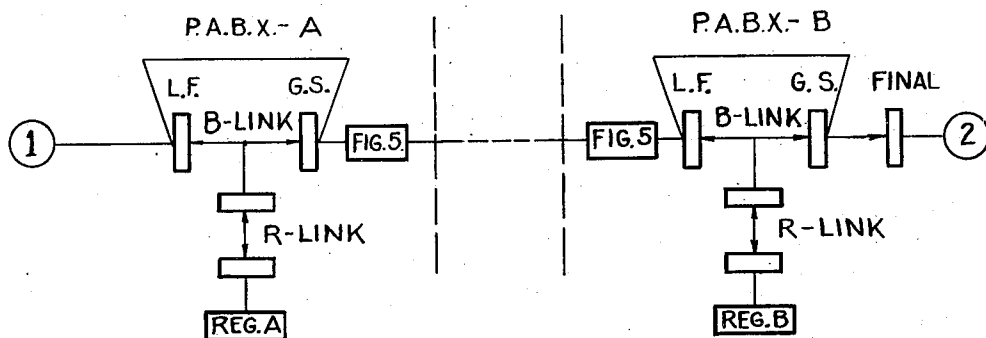
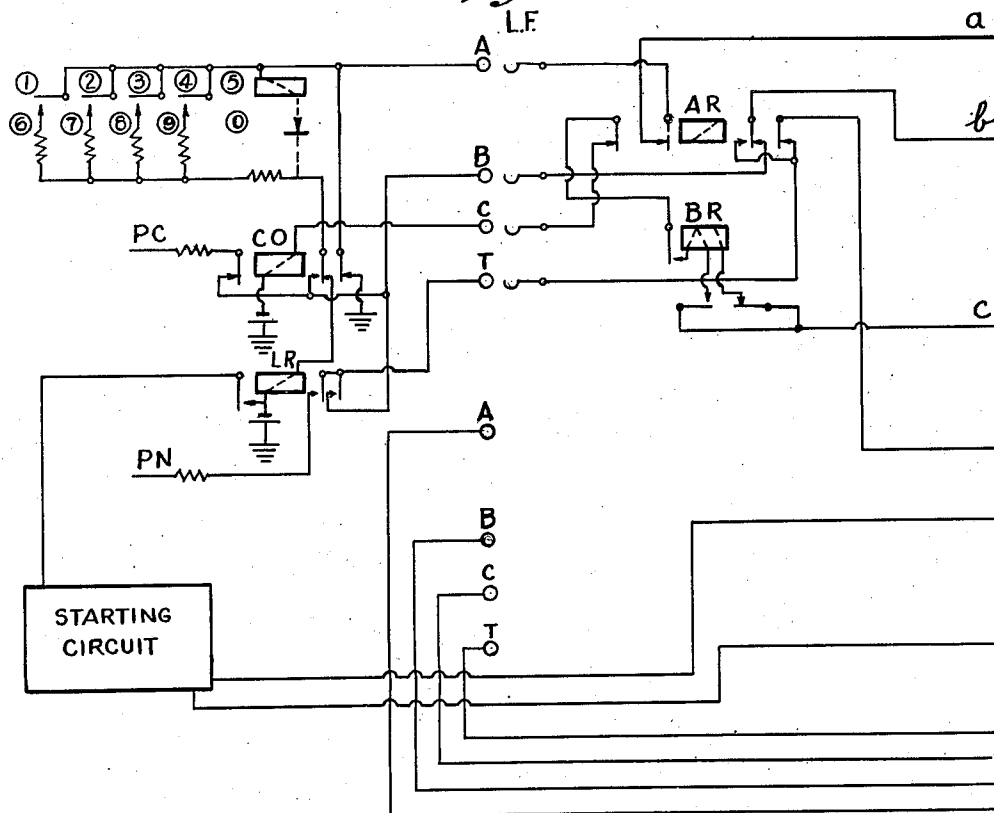


Fig. 2.



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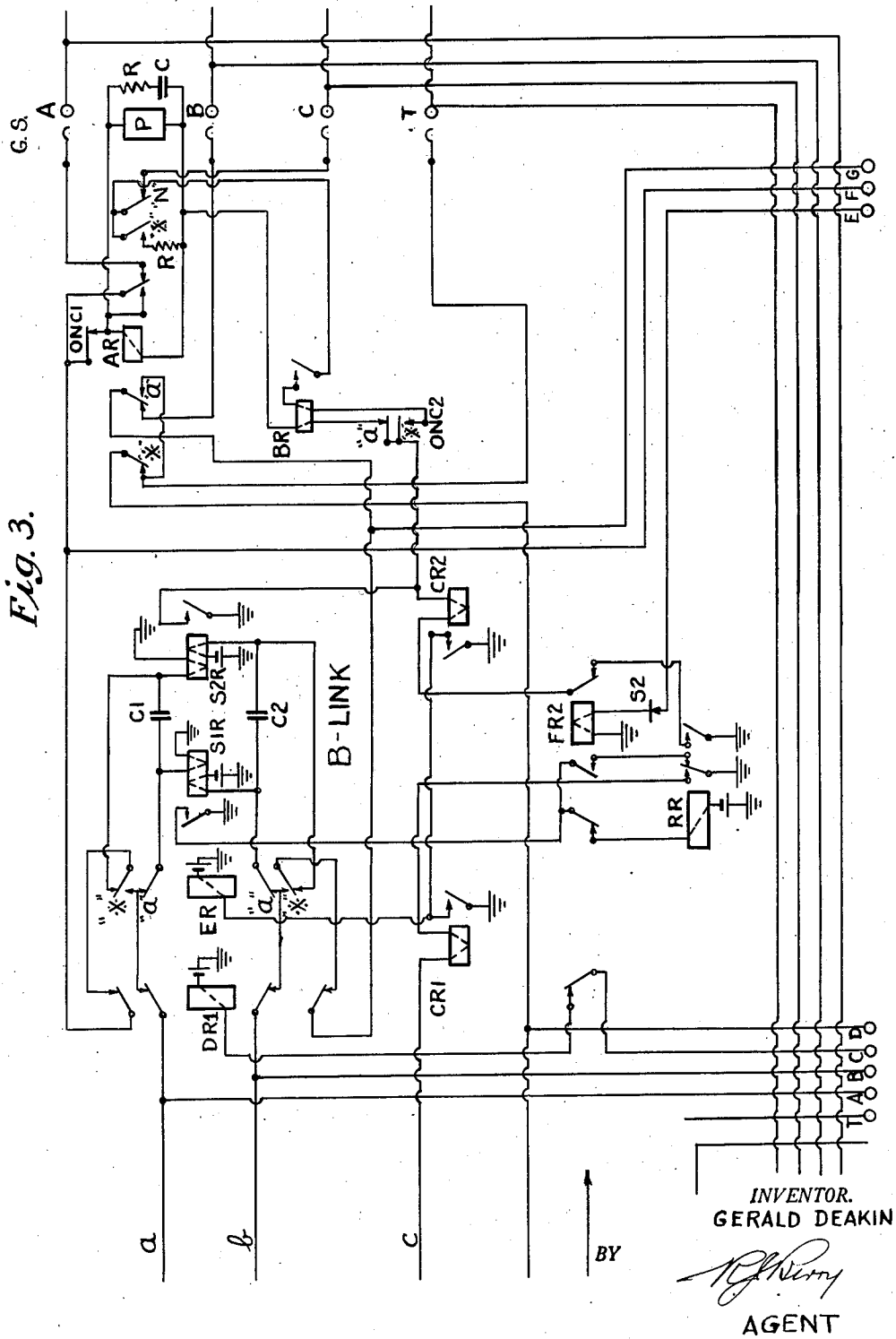
2,465,359

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4 Sheets-Sheet 2

Fig. 3.



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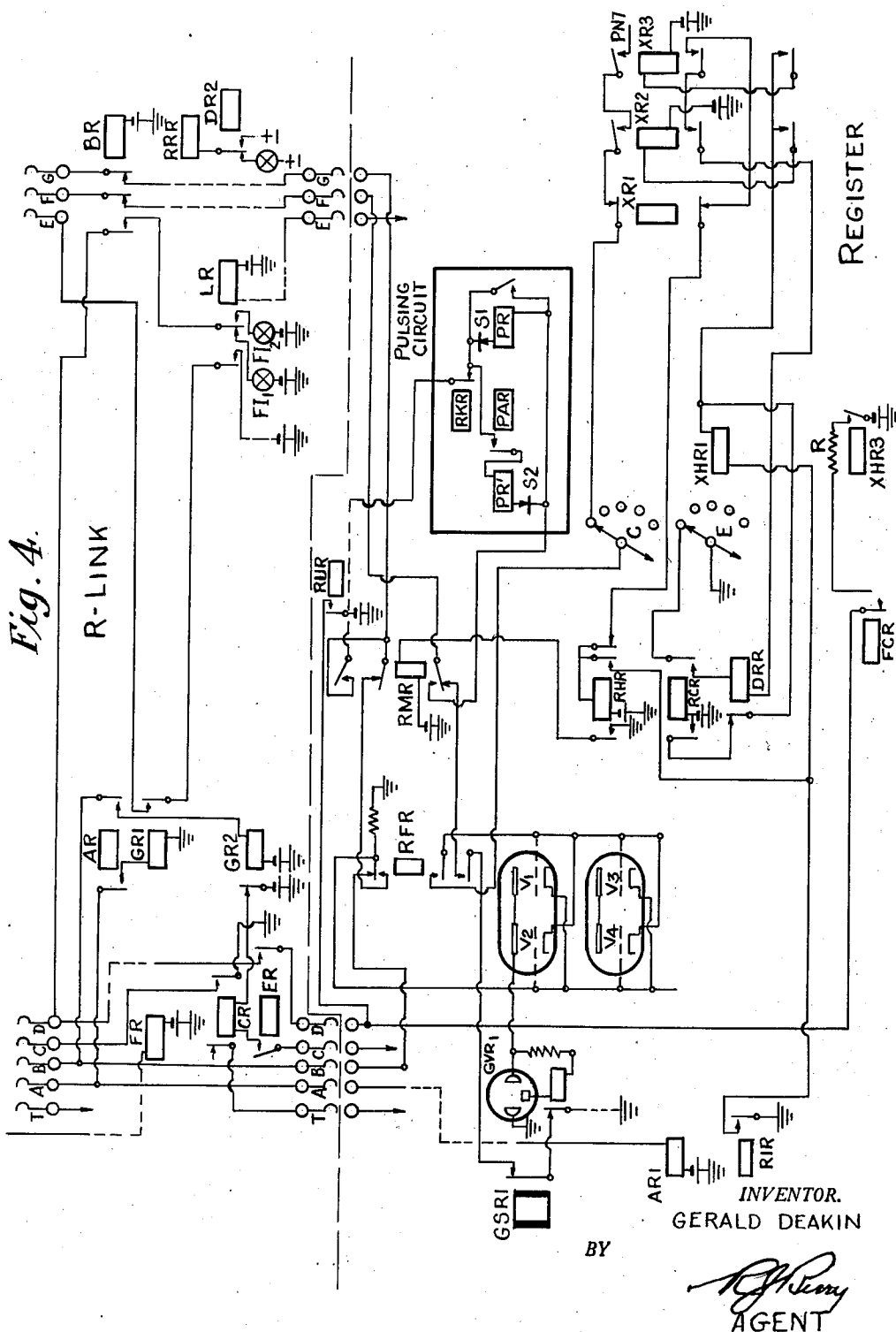
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TIE LINE FOR AUTOMATIC TELEPHONE EXCHANGES

Original Filed May. 14, 1945

4 Sheets-Sheet 3



March 29, 1949.

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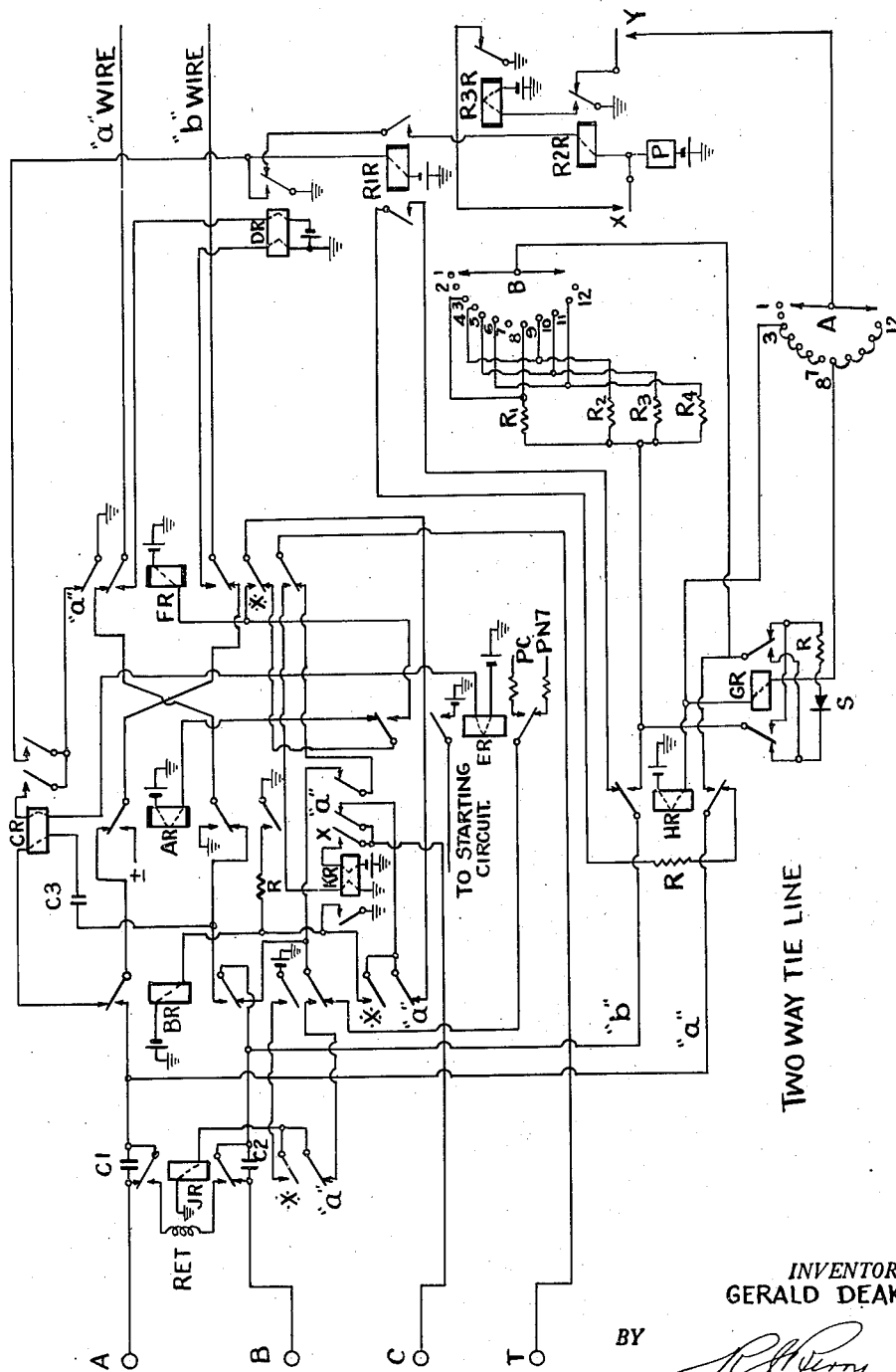
2,465,359

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Fig. 5.



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TIE LINE FOR AUTOMATIC TELEPHONE EXCHANGES

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Original application May 14, 1945, Serial No. 593,602. Divided and this application May 21, 1945, Serial No. 594,873

9 Claims. (Cl. 179-18)

1

This invention relates to new and useful improvements in multi-exchange telephone switching systems.

The present is a division of my application, Serial No. 593,602, filed May 14, 1945.

The object of the present invention is to provide for switching over a two-wire, two-way tie line between two automatic telephone exchanges, such as two private automatic branch exchanges.

Throughout the specification the term "B link" is used to denote a trunk comprising a set of relays by means of which a line finder is connected with a first group selector and may also be connected with a register.

Also throughout the specification the term "R link" has been used to denote a circuit comprising a set of relays which may be connected by means of finder switches with the B link and also with the register.

The various features of the invention will more clearly appear from the following description of an embodiment with reference to the drawings, in which:

Fig. 1 is a junction diagram of two P. A. B. X's inter-connected by a tie line forming the object of the present invention;

Fig. 2 shows the important portions of a substation at a P. A. B. X and a line finder through which the substation may be extended;

Fig. 3 is a local link at the P. A. B. X connected with the line finder of Fig. 2 and having at its other end a group selector;

Fig. 4 illustrates an R-link which may connect a register also diagrammatically shown in this figure with a local link of Fig. 3; and

Fig. 5 illustrates the terminal equipment of the tie line.

Only the circuits of the tie line terminal equipment are shown in detail; all the others have been simplified.

Fig. 1 indicates the general arrangement of a two-way tie line and two P. A. B. X's, "A" and "B" which are served by the line. The method of operation is the same no matter at which end of the tie line the call originates. Each end is connected to the banks of the line finders and group selectors of local B-links at the two P. A. B. X's. At P. A. B. X "A," the group selector of a B-link picks up one end of the tie line at a P. A. B. X "B," the line finder of a local B-link picks up the other end of the tie line. A register is connected with the local B-link at each P. A. B. X through an R-link in the usual way.

It is assumed that the tie line number is 7. Whenever this digit is keyed by a station 1, regis-

2

ter A is converted to dial pulsing as on an out-trunk call. These pulses are received by the tie line at P. A. B. X "B" and converted by the tie line to normal key pulses so as to operate register B in the normal way. The tie line at the receiving end acts as a repeater-translator.

Station keys tie line digit 7

When station (Fig. 2) removes the handset, a B-link (Fig. 3), an R-link (Fig. 4), and a register are connected to the calling line in the usual way.

When the digit 7 is keyed, the register stores the digit in the usual way and locks up relay XR2 (Fig. 4) and XR3 of the first group of digit storing relays.

B-link at P. A. B. X "A" chooses idle tie line

The group selector (Fig. 3) of the selected B-link hunts for a free tie line (Fig. 5) the T-terminal of which has potential PN1 applied over ER, BR, KR, FR back. When a free tie line is found, the register (Fig. 4) stops the group selector and makes the customary second test.

Register A converted to out-trunking

When RCR (Fig. 4) makes its front contact, it closes a circuit from ground, brush E of the out-control switch terminal I, front RCR, winding low resistance DRR, front XR2, front XR3, back XR1, back RHR, winding RHR to battery. RHR operates and locks up over a front contact of RIR. As soon as RHR breaks its back contact, DRR releases and RCR short-circuits XR2 and XR3. These relays release and in turn release XHR1. RHR energizes RMR (Fig. 4) which disconnects brushes F and G from the normal selection circuit and in place thereof connects them to the out-trunk dial pulsing circuit.

When RCR releases, PO goes from position 1 to position 2.

P. A. B. X "A" end of tie line operates

When the group selector reaches the tie line, the first test over the "t" wire may be traced from terminal T (Fig. 5), back FR, back KR, back BR, back ER, resistor to potential PN1. The second test over the "b" wire may be traced from the B-terminal, back JR, back BR, second back BR, back ER, resistor to potential PN1.

After the second test, AR (Fig. 5) operates, circuit from ground (Fig. 3), front RR, back FR2, winding low resistance CR2, lower contact ONC2, low resistance winding of BR, front BR, back AR, brush C, back KR, (Fig. 5), back BR, back FR,

back ER, winding of AR to battery. AR applies a momentary impulse of ringing current over the tie line to P. A. B. X "B" and closes a circuit from ground, front AR, resistor R, winding of BR to battery. BR opens the circuit of AR and locks up over a front contact and a back contact of KR to the C-terminal. BR disconnects the B-terminal from the T-terminal, disconnects the bridge, including relay CR, from the tie line. When AR releases and removes ringing current from the tie line, the "a" and "b" wires are extended through from the A and B terminals of the group selectors to the distant P. A. B. X "B."

"B" end of tie line operates

In tracing the following circuits, one must bear in mind that the B exchange end of the tie line is a mirror image of the A end shown in Fig. 5.

When relay AR (Fig. 5) applies ringing current to the called end, relay CR of the tie line in P. A. B. X "B" operates in series with condenser C3 and locks up over a circuit from ground, back FR, front CR, winding CR, winding ER to battery. CR also energizes slow release relay RIR which places a holding shunt across the A and B bank terminals. This circuit may be traced from terminal A, back JR, back HR, resistor R, front RIA, back HR, back JR to the B-terminal. This will hold the register when one is connected to the tie line, as explained hereinafter.

RIR (Fig. 5) also energizes R2R and magnet P of a marker switch having brushes A and B. The brushes do not advance from position 1 to position 2 until the circuit of P is opened by DR when the latter operates. Contacts "X" and "Y" of the marker switch close as soon as P moves out of its home position 1.

R-link, B-link and register connected to tie line at P. A. B. X "B"

When ER in P. A. B. X "B" operates, it energizes the starting circuit (Fig. 2) and places potential PC on the "t" wire, circuit from PC (Fig. 5), resistor, front ER, back BR, back KR, back FR to the T-terminal. An R-link at the P. A. B. X "B" picks up a B-link and then a register, after which the register causes the line finder of the B-link to pick up the tie line exactly as though a station in P. A. B. X "B" were calling. The tie line is double-tested in the usual way. When the line finder at the B-exchange seizes the tie line, FR operates. The circuit from the C-terminal at the B end of the tie line may be traced over back KR, back BR, back FR, front ER, winding FR to battery. FR locks up to the "c" wire and bridges pulsing relay DR across the "a" and "b" wires. DR operates in series with PR (Fig. 4) of the register and the marker switch goes from position 1 to position 2 when P de-energizes.

The opening circuit of DR (Fig. 5) at P. A. B. X "B" may be traced from ground, one winding of DR, front FR, "b" wire to P. A. B. X "A" back FR, front BR, back JR, terminal A, brush A of group selector (Fig. 3), thence through the B-link and R-link (Fig. 4) to terminal F of register at exchange A, front RMR, winding PR, and in parallel rectifier S1, back RKR, back RUR, front RMR, terminal F, the R and B links (Fig. 3) to brush B of the group selector, thence terminal B of the tie line (Fig. 5) back JR, front BR, back AR, back FR, "a" wire to P. A. B. X "B," front FR and the other winding of DR to battery. The direction of current flow is such as to operate PR (Fig. 4) of the register.

Station 1 keys number of station 2

The subscriber at station 1 (Fig. 2) keys number 635 which we will assume is the number of station 2, and the digits 6, 3 and 5 are recorded and stored by the second, third and first groups of digit-storing relays, respectively, of the register at P. A. B. X "A" in the same manner as the first three digits of a city number on an out-trunk call.

Register A transmits dial pulses to tie line at P. A. B. X "B"

When PR (Fig. 4) of the register operates, it energizes PAR which locks up over a front contact of RIR, PAR connects PR1 in series with rectifier S2 in multiple with PR and S1 but as S2 has the opposite polarity of S1, no current flows through PR1 until pulsing is completed, as explained later. PR (Fig. 4) closes the circuit of RKR and six dial pulses corresponding to the first digit 6 are sent out by RKR exactly as on a city call. The marker switch P (Fig. 5) of the tie line at P. A. B. X "B" advances six steps; that is from position 2 to position 8.

Conversion of dial-type pulses to key-type pulses

Brushes A and B of the step-by-step switch P at P. A. B. X "B," as previously stated, are in position 2 when pulsing starts. They may be advanced one to ten steps depending upon the number of pulses sent by the register A. R2R does not fall off during pulsing but at the end of a series of pulses DR remains on its front contact long enough to allow R2R to make its back contact and to release R3R.

When one pulse is sent by register A, DR at the B exchange advances P to position 3. When R2R makes its back contact, it energizes HR over contact Y, brush A and terminal 3. HR is a long changeover relay and when it breaks its back contacts it releases AR1 (Fig. 4) of the register at B. When it makes its front contacts, it bridges resistor R1 (Fig. 5) across the "a" and "b" wires leading to register B, and also rectifier S in series with resistor R. The rectifier is so polarized that the circuit simulates the condition when key 1 (Fig. 1) is depressed.

When brush B of the marker switch is advanced two steps to terminal 4, it simulates the condition that exists when key 2 is depressed, and so on. When brushes A and B are advanced six steps, corresponding to the digit 6, resistor R1 is bridged across the register circuit and at the same time the connections of rectifier S are reversed by GR, thus simulating the depression of key 6 at a calling station.

Register B receives key-type pulses from tie line

DR, upon receiving the first series of pulses, sends P to position 6. When R2R releases, it closes a circuit from ground, back R2R, contact "Y" of P, brush A, terminal 6, winding GR, winding HR, to battery. As previously explained, the keying condition of digit 6 is simulated and register B receives and stores digit 6, after which it causes the group selector of the B-link in P. A. B. X "B" to select a final identified by potential PN6. R3R releases shortly after R2R and returns P to its home position.

The remaining two digits 3 and 5 are received by the register at P. A. B. X "B" in the usual way and the chosen final is caused to select station 2.

Register B releases

When the third digit is stored, XHR3 (Fig. 4) of register at exchange B operates and establishes a circuit from battery, front XHR3, resistor R, back FCR, terminal D, brush D of R-link, front ER, brush D of B-link finder, terminal D of B-link (Fig. 3), "t" wire, back AR of line finder (Fig. 3), brush T, (the "t" wire circuit via the group selector is open at the final), terminal T of tie line (Fig. 5), front FR, one winding of KR to ground. KR does not at this moment operate because of the presence of resistor R. However, when the selection of the called line is completed, register B releases and sends the R-link to the ringing or busy position, as the case may be. Full battery is now placed on the "d" wire of the R-link (Fig. 3) or the "t" wire of the tie line (Fig. 5) over either interrupter F11 or F12. This full battery operates KR (Fig. 5) which locks up to the "c" wire over a second winding, at the same time releasing FR and energizing BR. JR does not operate as it does at the originating P. A. B. X "A" since KR has opened its operating circuit.

A momentary holding circuit is now established from the bridge in register A to the bridges relays GR1 (Fig. 4) and GR2 in the R-link at P. A. B. X "B."

Register A and R-link at P. A. B. X "A" release

During pulsing the direction of current flow in the "a" and "b" wires from DR (Fig. 5) at P. A. B. X "B" to P. A. B. X "A" is such as to operate relay PR (Fig. 4) of register A. However, when FR (Fig. 5) is released, the direction of current flow in the "a" and "b" wires is reversed and current now flows from the G-terminal (Fig. 4) of register A to the F-terminal and consequently over front PAR, winding PR1 and rectifier S2. PR1 operates RUR which releases the register as on an out-trunk call.

Holding shunt placed on tie line at P. A. B. X "A"

RUR places full battery on the "d" wire of the R-link which is transmitted through the R and B links and group selector to the "t" wire of the tie line (Fig. 5) and energizes JR, which relay did not operate when XHR3 (Fig. 4) placed battery on the "d" wire through resistor R. The circuit from the T-terminal may be traced back via back FR (Fig. 5), back KR, front BR, back AR, winding JR to ground. JR locks up over a front contact and a front contact of BR, at the same time disconnecting itself from the "t" wire. JR removes the short-circuit from transmission condensers C1 and C2 and places the holding retardation coil shunt across the originating end of the tie line, thus holding the R-link and subsequently the B-link busy at P. A. B. X "B." Condensers C1 and C2 prevent a flow of current from the transmission relays SIR and S2R in the B-link (Fig. 3) at P. A. B. X "A." The tie line circuit is operated and maintained on a full metallic basis.

Called station 2 answers

When the called station 2 answers, the R-link at P. A. B. X "B" releases in the usual manner and the tie line connection is established through the B-links at P. A. B. X's "A" and "B."

Release

The release of the connection is always under the control of the originating station; that is, station 1 of P. A. B. X "A." When this station hangs up, the B-link releases in the usual manner

and frees the tie line; whereupon BR and JR (Fig. 5) release and remove shunt from the tie line. Supervisory relay SIR of the B-link at P. A. B. X "B" falls away and releases the connection at the distant P. A. B. X.

What I claim is:

1. In a telephone system, two exchanges, a line having two like ends at the exchanges interconnected by two wires, a plurality of stations, local links and switching means at each exchange, means for operating said switching means to establish connections between a calling and a called station at an exchange, or a calling or called station and the end of the line, a control relay at each exchange normally disconnected from the line, means controlled by the calling exchange for connecting the relay at the called exchange with the two wires of the line, means controlled by the calling exchange for connecting the end of the line at the called exchange with the switching means thereat, and means controlled by the connected relay for operating the last-mentioned switching means.

2. The system according to claim 1, a plurality of line finders at each exchange, each local link having the wipers of a finder at one and the wipers of a selector at the other end, terminal banks with which said wipers cooperate, and multiple connections from the two-wire portion of the line to the banks of the finders and selectors at both exchanges.

3. In a telephone system, two exchanges, a line having four-wire ends at the exchanges interconnected by two wires, a plurality of stations at each exchange, local links and selectors at each exchange, means for operating said selectors to establish connections between a calling and called station at an office or a calling station and the four-wire end of the line, a relay at each exchange normally disconnected from the line, means responsive to the selection of the line at a calling exchange for connecting with the two wires thereof the relay at the called exchange, means also responsive to said selection for connecting with the four-wire end of the line at the called exchange a local link, and means controlled by said relay at the called exchange for controlling the operation of the selectors thereat to select a called line.

4. In a telephone system a plurality of private automatic branch exchanges, tie lines interconnecting them, each having a two-wire portion and two four-wire ends, the latter at two different exchanges, a plurality of stations at each exchange, line finder and selector switches at each exchange, local links connecting the wipers of said switches in pairs, terminal banks with which said wipers cooperate and with which the two-wire portion of a tie line is connected in multiple at each exchange, means including a register at each exchange for operating said switches to establish connections between a calling and called station at an exchange or a calling station and the four-wire end of an idle tie line leading to the called exchange, a stepping relay at each exchange normally disconnected from the line, means responsive to the selection of a tie line at a calling exchange for connecting with the two wires thereof the stepping relay at the called exchange, means also responsive to said selection for connecting with the four-wire end of the selected tie line at the called exchange a local link and a register therewith, and means controlled by said stepping relay at the called exchange for operating the last-mentioned register.

7

5. In a telephone system, two exchanges, a two-way trunk interconnecting them, a plurality of stations at each exchange, a controller at each station operable in accordance with the digits of the called number, automatic switching means at each exchange for connecting a calling or called station with the trunk, numerical control equipment associated with the switching means at each exchange for controlling its operation as determined by the controller of the calling station, second numerical control equipment associated with the trunk at each exchange but normally disconnected therefrom, means for operating the second control equipment at the called office as determined by the controller of the calling station, and means controlled by said second equipment for operating the control equipment of the switching means at the called office.

6. The system according to claim 5, and in which the first-mentioned control equipment is a register.

7. The system according to claim 5, and in which the second control equipment is a step-by-step switch.

8

8. The system according to claim 5, and in which the first-mentioned control equipments are operated by one system of control, and the second equipments by a different system of control.

9. The system according to claim 5, and in which the first-mentioned control equipments are multi-potential registers, means for converting the register at the calling exchange for sending series of impulses, means in the second equipment at each exchange responsive to the series of impulses sent by the register at the same exchange for controlling the register at the called exchange.

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