

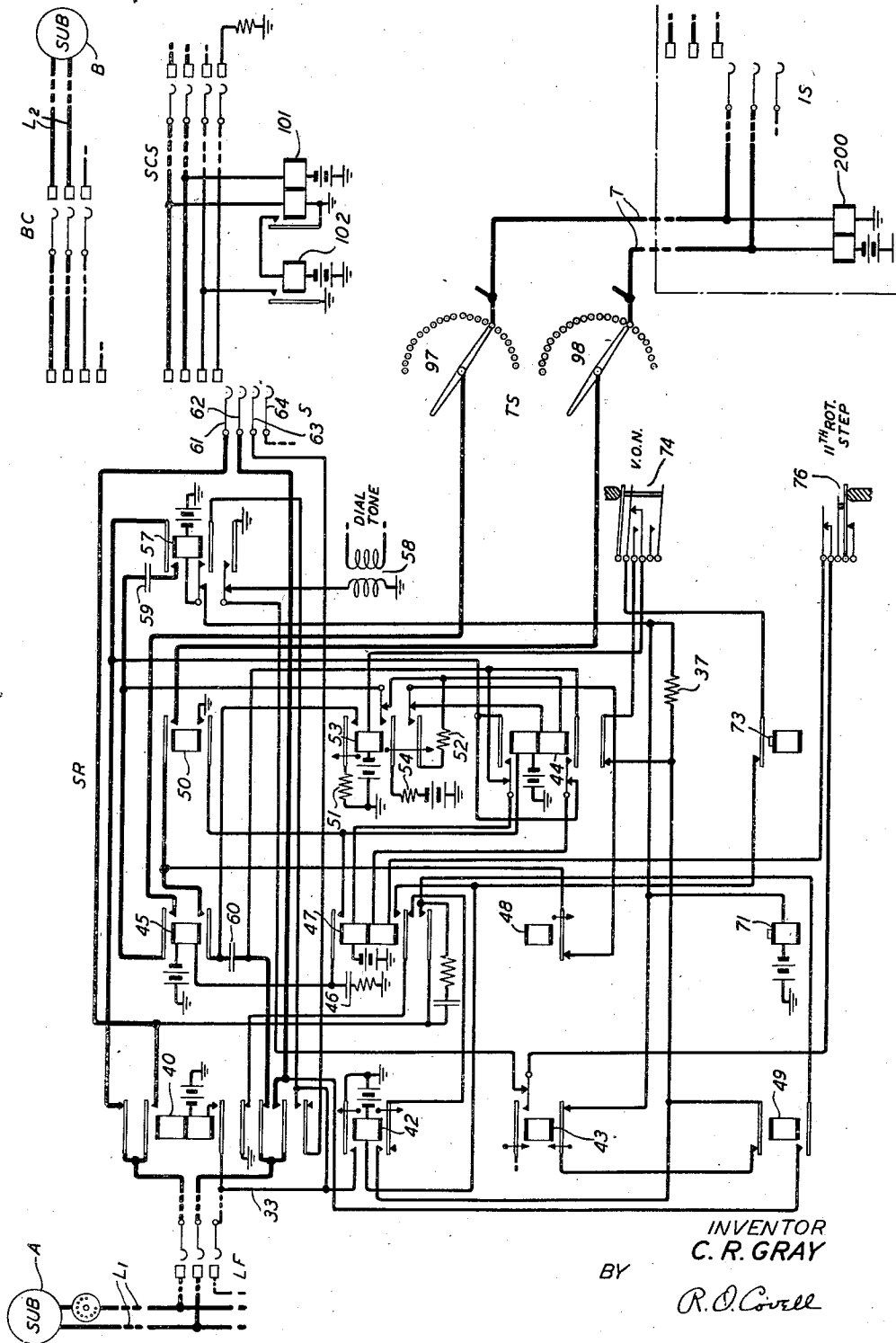
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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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This invention relates to telephone systems and particularly to systems comprising impulse controlled switches for establishing connections between calling and called lines.

It is an object of the invention to provide a more reliable impulse repeating arrangement and to otherwise improve the impulse repeating arrangement in branch office selector-repeaters.

The invention is an improved impulse repeating arrangement in a branch office-selector-repeater. The impulses are received by an impulse receiving relay which directly repeats these impulses to the selector switch of the selector-repeater, or to succeeding selectors in the branch office, and controls a repeating relay which transmits corresponding impulses over a trunk to the main office in two separate grounded circuits, each comprising one of the conductors of the trunk. The impulse receiving relay is adjusted for response to impulses received from calling lines; and the impulse repeating relay is adjusted and has its releasing time controlled to transmit impulses of a character which insures satisfactory operation of impulse receiving means at the distant end of the trunk, the required character being dependent upon the resistance and capacity of the trunk.

A feature of the invention is an impulse repeating arrangement of the aforementioned character in a branch office selector-repeater in which closure of the impulse repeating circuits over the conductors of a trunk to the main office and closure of the supervisory bridge across the conductors of the trunk are controlled by a relay which is initially operated upon seizure of the selector-repeater prior to the receipt of a first train of impulses and thereafter operated in response to the first impulse of each succeeding train of impulses. The operation of this relay immediately upon seizure insures against releasing of the relay during receipt of the first train of dial impulses.

A further feature is the provision of an auxiliary relay in a branch office selector-repeater of the aforementioned character for controlling the connection of dial tone to the calling line. According to this feature one of the conductors of a calling line is connected through a talking condenser to one of the conductors of a trunk to the main office immediately upon seizure of the selector-repeater and selection of a trunk to the main office, the connection between the other conductor of the calling line and other talking condenser being open at a contact of the auxiliary relay so that this condenser will not inter-

fere with the transmission of dial tone to the calling line. When the first dial impulse is received from a calling station, the auxiliary relay operates to terminate the transmission of dial tone and to connect the other conductor of the calling line through the other talking condenser to the other conductor of the trunk, the connection of both of the talking condensers between the conductors of the calling line and the conductors of the trunk to the main office being effective to prevent bell tapping at the calling station during dialing.

The drawing which forms a part of this specification shows, schematically, a system and circuit arrangement in which the invention and its features are embodied. The invention is not, however, limited in its application to the particular system shown in the drawing but is generally applicable to impulse controlled switching and signaling systems.

The drawing, which consists of a single figure, represents a system comprising a branch office and a main office. The branch office is represented by subscribers' stations A and B, lines L1 and L2, a line finder LF, a selector-repeater SR, a service code selector SCS, and a connector BC; and the main office is represented by an incoming selector IS.

The subscribers' stations are of the common battery type and include dials or other impulse senders for controlling the automatic switches through which connections between calling and called lines are established. The line-finder switch LF, selector switch S, service code selector switch SCS, connector switch BC and incoming selector switch IS are of the well-known two-motion step-by-step type. Reference may be had to "Automatic Telephony," second edition, by Smith and Campbell, pages 53 to 65, inclusive, for a description of the structure of such switches and their operation when used as selectors and connectors. Reference may be had to the patent to R. L. Stokely, 1,799,654 of April 7, 1931, for a description of the operation of a two-motion step-by-step finder. The line finder LF is represented by a set of brushes and one set of terminals; the connector BC is represented by its brushes and one set of terminals; the selector SCS is represented by its line and release relays in addition to its brushes 61, 62, 63 and 64 and a single set of terminals; and the selector IS is represented by its brushes, one set of terminals and its line relay.

The selector-repeater is represented in the drawing by the brushes 61, 62, 63 and 64 and

one set of terminals, the vertical stepping magnet 71, release magnet 73, the vertical off-normal springs 74 and the 11th rotary step springs 76 of the selector S; by the brushes 97 and 98 of the trunk hunting switch TS; and by a line relay 47, release relay 42, dial tone control relay 57, impulse repeating relay 45, repeating control relay 53, switching relay 40, supervisory relay 44, and the contacts of other relays which are included in the arrangement for repeating impulses, received by the line relay 47 from a connected calling subscriber's line, over a trunk to the main office and to succeeding selector and connector switches in the branch office. Reference may be had to the copending application of H. Hovland, Ser. No. 361,365, filed on Oct. 16, 1940, for a complete disclosure of this selector-repeater together with various main and branch office trunking arrangements in which the selector-repeater may be used. The same reference characters are used for the various elements of the selector-repeater shown in the drawing of this application as are used for the same elements in the aforementioned copending application of H. Hovland.

Assume now that a call is originated at station A and that the line finder LF is operated to connect the calling line L1 to the selector-repeater SR in usual manner. Upon connection of line L1 to the selector-repeater SR, line relay 47 is operated in a circuit which is traced from battery through the upper winding of relay 47, upper back contact of relay 44, a lower back contact of relay 40, middle brush of line finder LF, through line L1 and the station A, upper brush of line finder LF, upper back contact of relay 40, a lower back contact of relay 44, lower winding of relay 47, back contact of the 11th rotary step springs 76, a back contact of relay 43, a back contact of relay 57, and through a winding of dial tone transformer 58 to ground. At its inner lower front contact, relay 47 closes a circuit for operating relay 42 and a circuit for operating relay 53. Relay 42 connects ground to conductor 33 to hold the line finder LF. As described in the aforementioned copending application of H. Hovland, the trunk hunting switch TS is operated to select an idle trunk to the main office at the same time that the line finder LF starts hunting for the calling line; and, when an idle trunk is selected, relay 50 is operated. When relay 50 operates, it closes a circuit for operating the repeating relay 45 and a circuit for energizing the upper polarizing winding of relay 44. With relays 53, 50 and 45 operated, battery is connected through resistor 54, inner lower front contact of relay 53, upper front contact of relay 45, brush 97, one conductor of the selected trunk T to the main office, and through the right winding of line relay 200 of selector IS to ground; and ground is connected through resistor 51, front contacts of relays 53, 45 and 50, brush 98, other conductor of trunk T, and through the left winding of relay 200 to battery. Relay 200 is thereby operated to prepare the selector IS for response to dial impulses. It is to be noted that the operation of relays 45 and 50 also connects the conductors of the trunk to the main office to one side of the talking condensers 59 and 60, the other side of condenser 60 being connected to one of the conductors of the calling line; but the connection between the other side of condenser 59 and the calling line is open at a contact of relay 57 to prevent interference with the transmission of dial tone to the calling station.

When the calling subscriber dials the first digit of the number of the called subscriber's station with which connection is desired, line relay 47 is alternately released and reoperated as many times as there are units in the digit dialed. The release of relay 47, at the beginning of the first dial impulse, closes circuits, including the lower front contact of relay 42 and back contacts of relays 49 and 43, for operating the vertical stepping magnet 71 and for operating relay 57. Relay 57 closes a locking circuit to conductor 33 before it opens its operating circuit, disconnects the dial tone transformer 58 from the calling line, and closes the connection between the calling line and the talking condenser 59. The connection of condensers 59 and 60 to the calling line during the repeating of dial impulses over trunk T is effective to aid the transmission of these impulses and is also effective to prevent "bell tapping" at the calling station during dialing. When relay 47 reoperates at the end of the first impulse, magnet 71 releases. The release and reoperation of relay 47 in response to each succeeding impulse of the train causes a corresponding operation and release of the vertical stepping magnet 71, the brushes being thereby advanced to the level corresponding to the digit dialed. The vertical off-normal springs 74 are actuated when the shaft moves out of normal position due to the first operation of stepping magnet 71, the winding of relay 53 being thereby connected, through a back contact of relay 44, in parallel with the stepping magnet 71 and under the control of the back contact of relay 47 instead of in parallel with relay 42 and under the control of the front contact of relay 47. Being slow in releasing, relay 53 remains operated until after relay 47 reoperates at the end of the last impulse. Relay 42 is also slow in releasing and remains operated during dialing. The release of relay 47 in response to each dial impulse opens the operating circuit of repeating relay 45, the release of relay 45 being delayed for a desired interval of time by the charging of condenser 46. When relay 47 reoperates at the end of each impulse, relay 45 reoperates. The release and reoperation of relay 45, in response to each impulse, opens and closes the two ground return circuits over the conductors of trunk T to cause a corresponding release and reoperation of the line relay 200, the brushes of selector IS being thereby advanced to a level corresponding to the digit dialed.

The selector-repeater SR is arranged to absorb one or more digits by return of the brushes of selector S to normal after advance to a level corresponding to the digit to be absorbed, to release the trunk to the main office on calls to subscribers in the branch office, and to trunk hunt in a selected level either after the trunk to the main office has been released or prior to the dialing of enough digits to determine whether the called line is in the main office or in the branch office. The operation of the selector-repeater SR on various types of call and in various trunking arrangements is set forth in detail in the aforementioned copending application of H. Hovland.

If the first digit dialed indicates that the call is for a subscriber in the main office or is one which must be completed through the main office, the brushes of selector S are held opposite the selected level without trunk hunting, the impulses created by the dialing of the remaining digits of the called number being repeated by relays 47 and 45 over the trunk to the main of-

office to control the switches through which the desired connection is completed; in this case, relay 43 is operated to open the short circuit around resistor 37 to prevent the further operation of vertical stepping magnet 71 in response to dial impulses.

If the first digit does not determine that the call is to be completed over the selected trunk to the main office, the digit is absorbed by a return of the brushes of selector S to normal. The brushes are then advanced by the impulses created by the dialing of the second digit to a corresponding level; and these impulses are repeated by relay 45, in the manner hereinbefore described, over the trunk to the main office. If the second digit indicates that the call is for a subscriber in the main office, relay 43 is operated, the selector S is not released, and succeeding trains of impulses are repeated to the main office without further operation of the vertical stepping magnet 71.

If the second digit indicates that the called line is in the branch office, relay 48 is operated to release the trunk to the main office. Trunk hunting may occur in the level corresponding to the second digit or in a level selected in response to the impulses for a succeeding digit. When an idle trunk is found relays 49 and 40 are operated, as described in the copending application of H. Hovland. The operation of relay 40 causes the release of relays 47 and 45, and connects the calling line through brushes 61 and 62 to the next switch in the branch office; and the impulses created by the dialing of the remaining digits of the called subscriber's number control the switches in the branch office through which connection with the called line is established.

If the second digit does not finally determine whether the call is a main or a branch office call, the brushes of selector S may or may not be restored to normal to absorb this digit, depending upon the particular trunking arrangement and the value of the digit. If the second digit is absorbed, the third digit may indicate that the call is a main office call; in which case relay 43 is operated and impulses created by further dialing are repeated over the trunk to the main office. But if the second digit is not absorbed, the brushes of selector S are advanced in the corresponding level to hunt for an idle trunk, relay 49 being operated when an idle trunk is found, as described in the copending application of H. Hovland. Since one or more additional digits are required to indicate whether the call is a main or a branch office call, the impulses created by the dialing of the third digit are repeated by relay 45 over the trunk to the main office in the manner hereinbefore described; and these impulses are also repeated by relay 47 over the trunk engaged by the brushes of selector S. This trunk may be connected to a service code selector, other branch office selector, or to a connector. In the drawing, the bank of selector S is represented by two sets of terminals, one set connected to a service code selector SCS and the other connected to a connector BC. Assuming the selection of a trunk leading to a service code selector SCS, the circuit for repeating the third train of impulses includes the windings of line relay 101, brushes 61 and 62, and front contacts of relay 47 and 49. If the third or a succeeding train of impulses finally indicates that the call is to be completed in the branch office, relay 40 is operated in the manner

described in the copending application of H. Hovland to connect the calling line directly to the brushes 61 and 62. If, however, the third or a succeeding train of impulses finally determine that the call is to be completed over the trunk to the main office, relay 43 is operated and relay 49 is released, thereby causing the release of the selector SCS; and, if additional digits are dialed, the impulses are repeated only over the trunk to the main office.

On a call completed by switches in the branch office, the connection is held under control of the calling subscriber by ground potential connected to the terminal engaged by test brush 63. The disconnection of this holding potential when the conversation is ended causes the release of relay 40 and the return of the selector S and line finder LF to normal in the manner described in the copending application of H. Hovland. On a call completed over a trunk to the main office relays 47, 45 and 42 are held under control of the calling subscriber, the talking condensers 59 and 60 being included in the talking connection between the calling line and the trunk to the main office. When the calling subscriber restores the station to normal, relays 47, 45 and 42 release in succession, effecting the return of the selector repeater SR and line finder LF to normal and opening the bridge across the trunk to the main office to effect the return of the switches in the main office to normal.

It is particularly to be noted that the provision of a separate repeating relay 45 for repeating impulses to the main office permits the adjustment of this relay according to the length and character of the outgoing trunks without affecting the response of the impulse receiving relay 47 to dial impulses from the calling line.

What is claimed is:

1. In combination, a line, an impulse receiving relay connected to said line and responsive to current impulses therein, a trunk line, means comprising said impulse receiving relay and an impulse repeating relay for controlling an impulse repeating circuit over the trunk line, the repeating relay being adjusted according to the resistance and capacity of the trunk line, an operating circuit for the repeating relay controlled by the impulse receiving relay, and a condenser connected to the winding of the repeating relay so as to render said relay slow in releasing and thereby increase the length of each closure of the impulse repeating circuit during the repeating of impulses.

2. In combination, a line, an impulse receiving relay connected to said line and responsive to current impulses therein, a trunk line, impulse receiving means connected to said line, means comprising said impulse receiving relay and an impulse repeating relay for repeating impulses in said line to said trunk line, each of the conductors of the trunk line being included in a separate circuit for repeating the impulses to said impulse receiving means, the repeating relay being adjusted according to the resistance and capacity of the trunk line, an operating circuit for the repeating relay controlled by the impulse receiving relay, and a condenser connected to the winding of the repeating relay so as to render said relay slow in releasing and thereby increase the length of each closure of the impulse repeating circuit during the repeating of impulses.

3. In combination, a first line, an impulse receiving relay connected thereto, a circuit in-

cluding said line for operating said relay, a tone source included in said circuit, means for transmitting impulses in said circuit to said relay, a second line, means comprising said relay for repeating impulses from said first line to said second line, an auxiliary relay, a circuit for operating said auxiliary relay closed in response to the first impulse received by said impulse receiving relay, circuit means for maintaining the operation of said auxiliary relay, a condenser, and contacts actuated by the operation of said auxiliary relay for removing said tone source from the operating circuit of the impulse receiving relay and for closing a talking connection including said condenser between said first and second lines.

4. In a branch office selector-repeater comprising an impulse controlled group selector and a non-numerical trunk hunting switch, a line relay, an impulse repeating relay controlled by said line relay to repeat impulses in a separate grounded circuit over each conductor of a trunk selected by said non-numerical switch, a supervisory relay for connection across the conductors of a selected trunk, a slow-to-release relay having normally open contacts in said impulse repeating circuits and normally closed contacts in the connection between said supervisory relay and said conductors, means comprising a front contact of said line relay for operating said slow-to-release relay prior to the receipt of dial impulses to prepare said impulse repeating circuits, means including a contact of said line relay for operating the group selector to select a group of terminals corresponding to a train of impulses incoming to said line relay, means including contacts actuated upon movement of said selector out of normal position to transfer the control of said slow-to-release relay from the front contact to a back contact of said line relay, whereby said slow-to-release relay is held operated

until all of the impulses in the first train incoming to said line relay have been received and is reoperated upon release of said line relay in response to the first impulse of each succeeding train of impulses.

5. In a branch office selector-repeater comprising an impulse controlled group selector and a non-numerical trunk hunting switch, a line relay, an impulse repeating relay controlled by said line relay to repeat impulses in a separate grounded circuit over each conductor of a trunk selected by said non-numerical switch, a supervisory relay for connection across the conductors of a trunk selected by said non-numerical switch, a slow-to-release relay having normally open contacts in said impulse repeating circuits and normally closed contacts in the connection between said supervisory relay and said trunk conductors, means comprising a front contact of said line relay for operating said slow-to-release relay prior to the receipt of dial impulses to prepare said impulse repeating circuits, means including a contact of said line relay for operating said group selector to select a group of terminals corresponding to a train of impulses incoming to said line relay and to select a set of terminals therein connected to an idle trunk, means comprising a contact of said line relay for repeating a train of impulses incoming to said relay after selection of an idle trunk by said group selector to said trunk, means including contacts actuated upon movement of said selector out of normal position to transfer the control of said slow-to-release relay from the front contact to a back contact of said line relay, whereby said slow-to-release relay is held operated until all of the impulses in a first train incoming to said line relay have been received and is reoperated upon release of said line relay in response to the first impulse of each succeeding train of impulses.

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