

Feb. 25, 1941.

R. B. BUCHANAN ET AL

2,233,282

TELEPHONE SYSTEM

Filed Aug. 16, 1939

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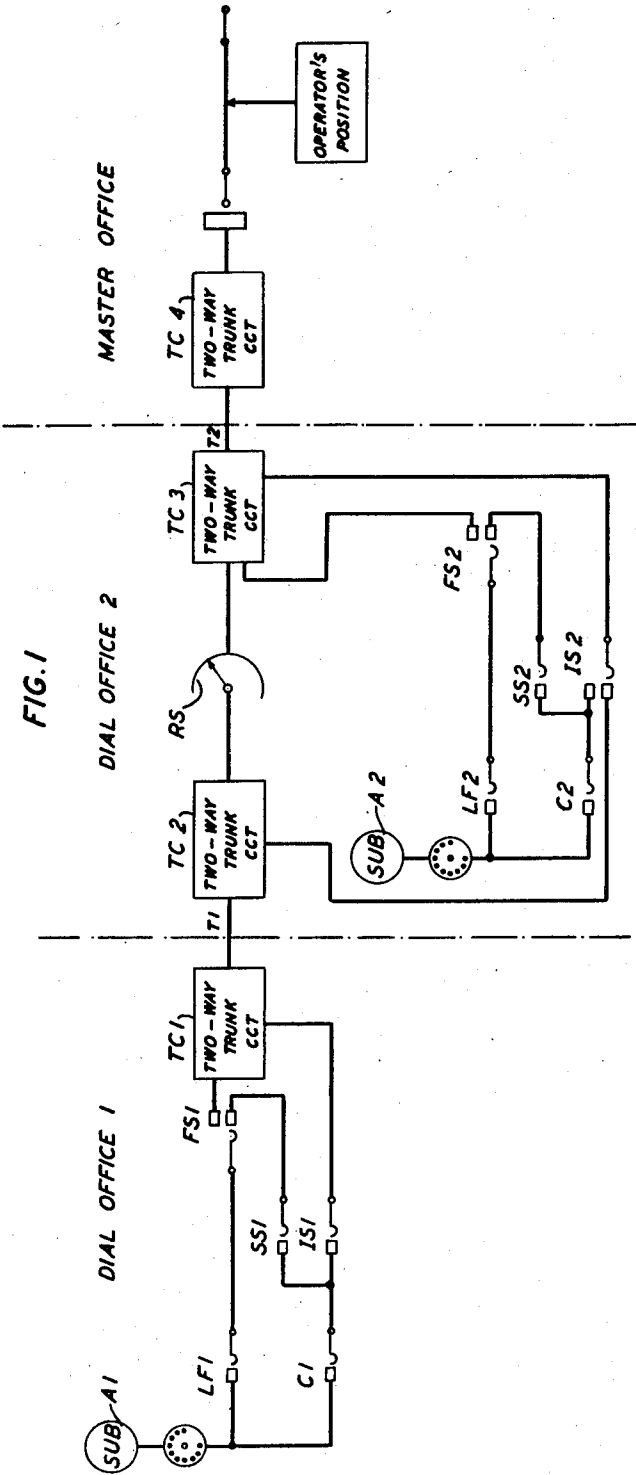


FIG. 7

FIG. 2	FIG. 3	FIG. 4	FIG. 5	FIG. 6
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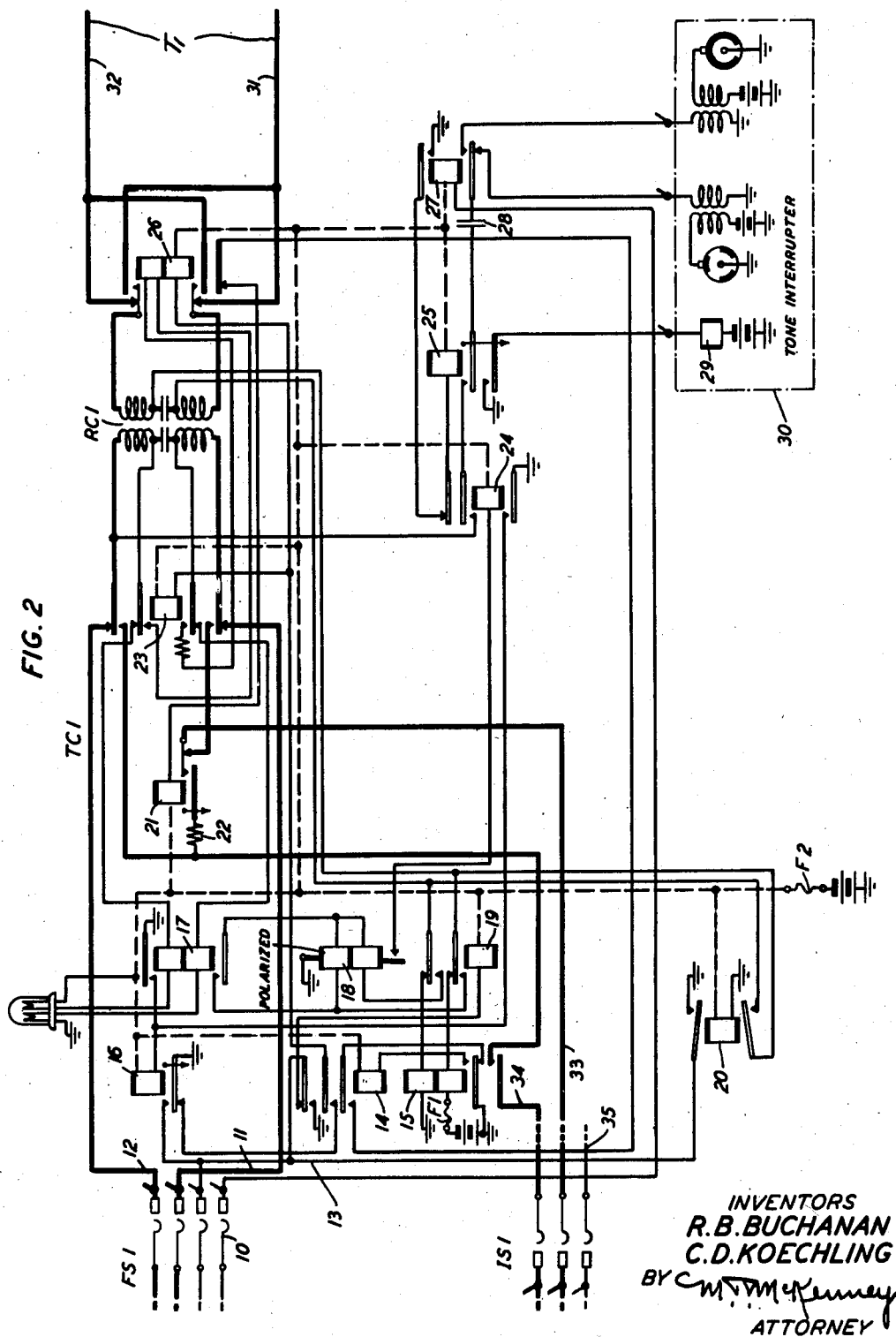
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TELEPHONE SYSTEM

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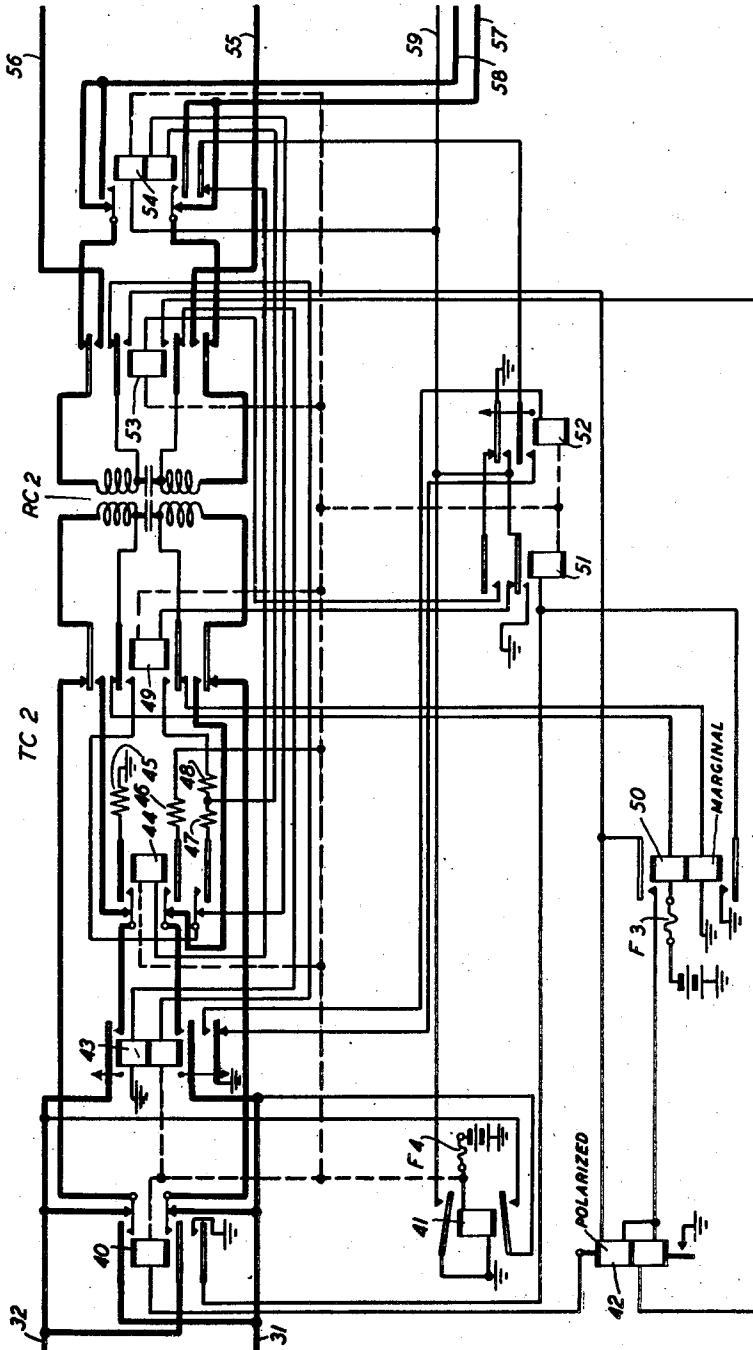
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FIG. 3



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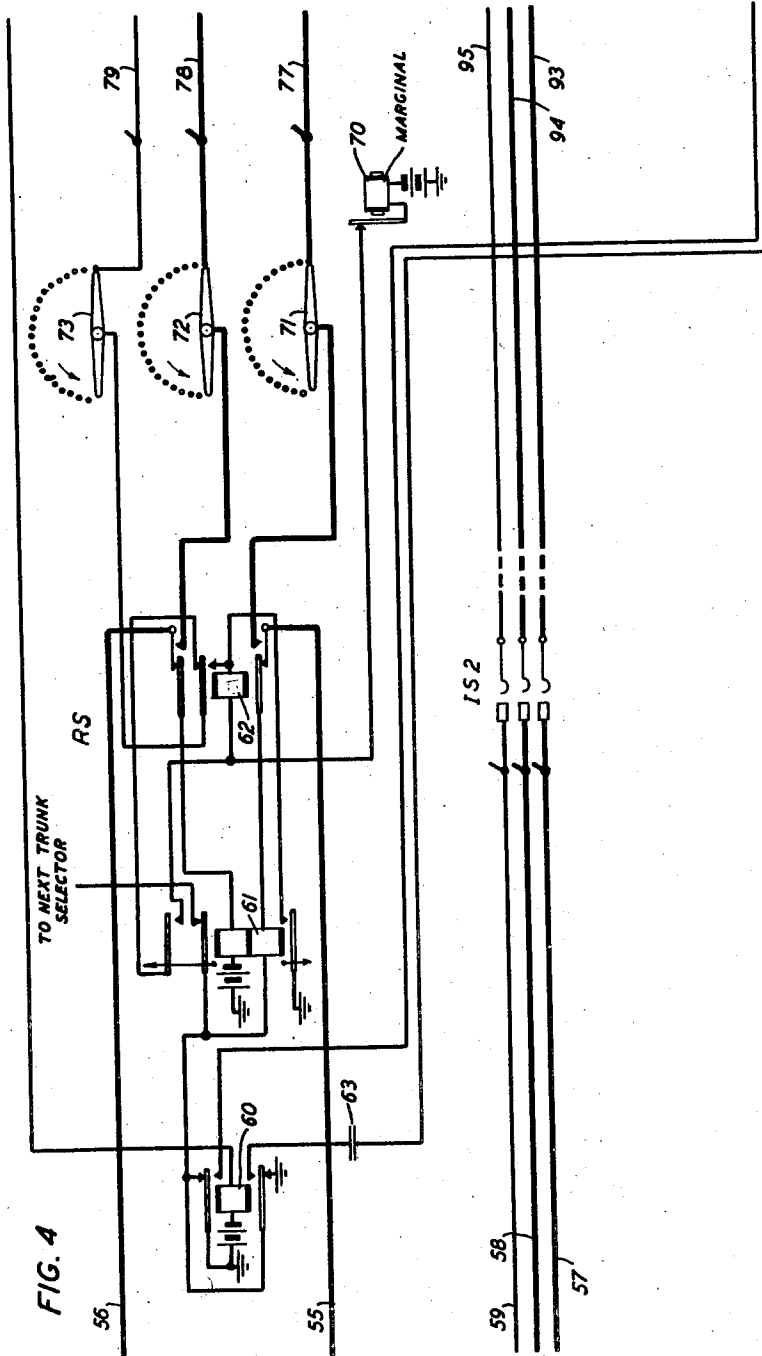
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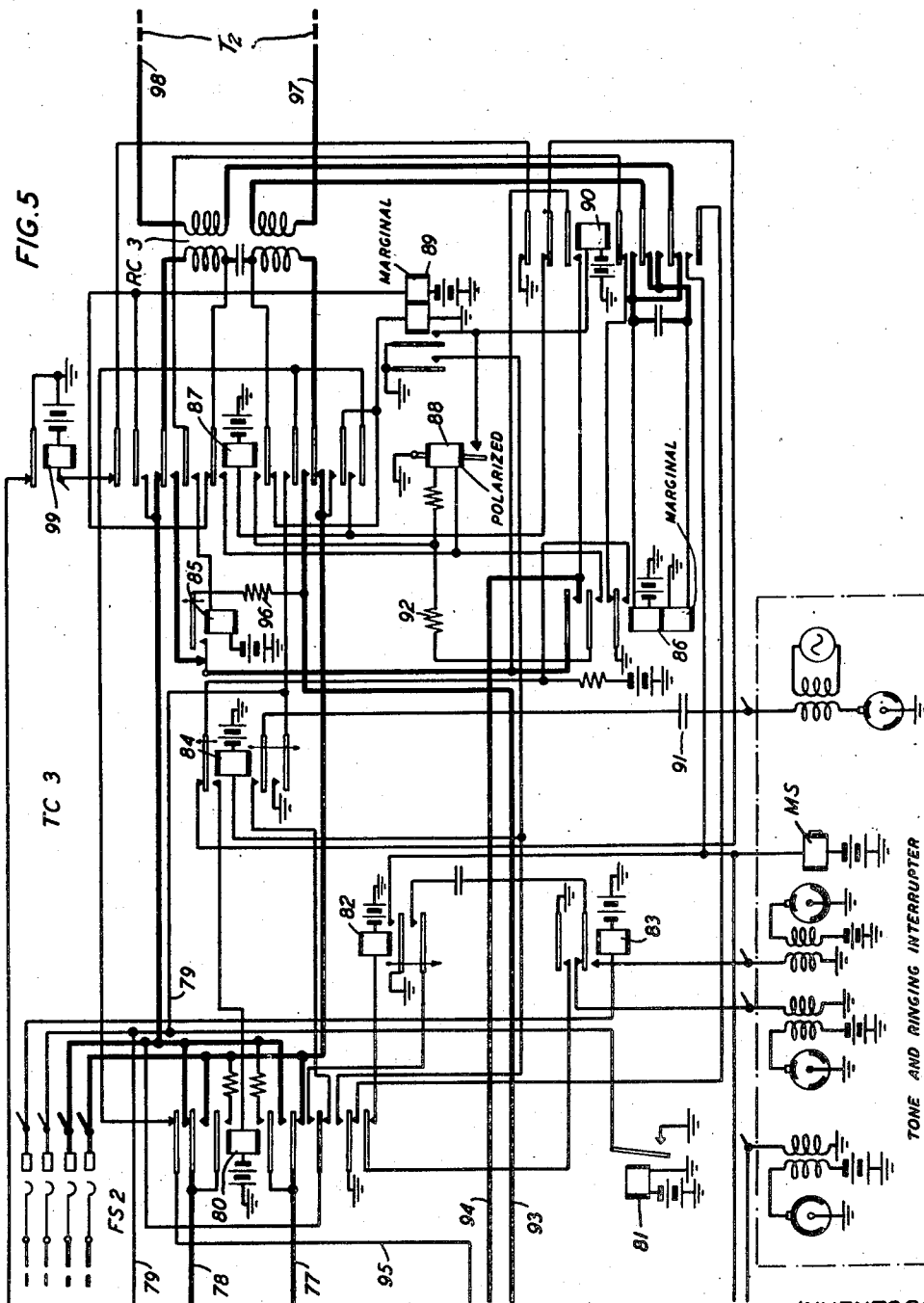
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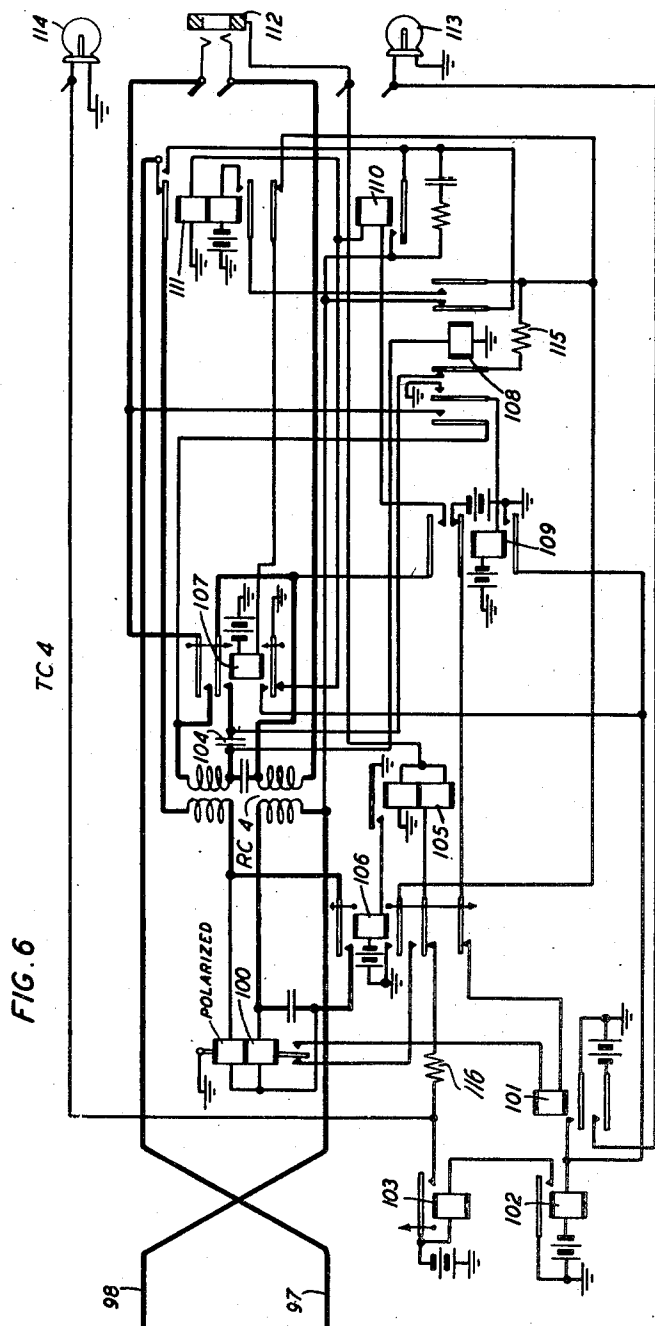
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UNITED STATES PATENT OFFICE

2,233,282

TELEPHONE SYSTEM

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Application August 16, 1939, Serial No. 290,366

12 Claims. (Cl. 179—27)

This invention relates to signaling systems and particularly to systems comprising automatic switches for establishing signaling connections.

It is the object of the invention to decrease the probability of circuit failure and to increase the reliability of the service rendered by automatic signaling systems.

In telephone systems comprising small dial offices interconnected by two-way trunks, it is usual to arrange the two-way trunk circuits at the ends of a two-way trunk so that seizure of the trunk at either end effects the marking of the trunk as busy at both ends. Furthermore, it is usual to provide one fuse for each of these trunk circuits and to provide a relay which operates when the fuse blows for marking the trunk circuit as busy in the banks of the selector switches having access to the trunk to prevent seizure of the trunk circuit on an outgoing call while the trunk circuit is inoperative. If the office is an attended office, an alarm is operated when the trunk circuit fuse blows, to summon a maintenance attendant. If the office is an unattended office, an alarm call is transmitted over an idle and operative trunk to an operator in a master office.

In a system comprising two unattended dial offices and a master office and in which calls to the master office from one of the dial offices are routed through the other dial office, a trunk between the dial offices may be rendered useless by the failure of the fuse in the trunk circuit at either end of the trunk. In such a system the blowing of the fuse in a trunk circuit at the tandem dial office end of a trunk between the dial offices will entirely prevent a call to the master office from subscribers in the other dial office if the disabled trunk is first choice to the selectors in the other dial office unless means are provided for preventing the selection of the disabled trunk. This invention is a two-way trunk circuit in which a relay is provided for simulating seizure by a selector when the circuit is rendered inoperative by the blowing of a fuse which is individual to the circuit.

A feature of the invention is a two-way trunk circuit in which a line relay is responsive to seizure of the trunk at the distant end and a make-busy relay is provided for marking the trunk circuit busy in the banks of selectors having access thereto when the circuit becomes inoperative due to the blowing of a fuse individual to the circuit, there being another fuse individual to the line relay.

A clear and complete understanding of the in-

vention will be facilitated by considering a telephone system in which the invention is embodied, one such system being represented schematically in the drawings which form a part of this specification. The invention is not limited in its application to the particular system shown in the drawings but is generally applicable to automatic signaling systems.

Referring to the drawings:

Fig. 1 shows a traffic schematic of an automatic telephone system comprising two dial offices and a master office;

Fig. 2 shows a two-way trunk circuit TC1 in dial office 1 associated with a trunk T1 to a second dial office;

Fig. 3 shows a two-way trunk circuit TC2 connected to the trunk T1 in the second dial office;

Fig. 4 shows a rotary, non-numerical trunk selecting switch RS associated with the trunk circuit TC2 of Fig. 3;

Fig. 5 shows a two-way trunk circuit TC3 associated with a trunk T2 between the second dial office and the master office;

Fig. 6 shows a two-way trunk circuit TC4 connected to the trunk T2 in the master office; and

Fig. 7 shows the positional relation of Figs. 2 to 6, inclusive.

General description

The two dial offices and the master office are each of the common battery type, the apparatus of the various circuit units being connected to the battery through one or more individual fuses in usual and well-known manner. In accordance with the usual practice, each battery symbol in Fig. 2 represents the same battery in office 1; each battery symbol in Figs. 3, 4 and 5 represents the same battery in office 2; and each battery symbol in Fig. 6 represents the same battery in the master office. In Figs. 2 and 3, the individual fuses for trunk circuits TC1 and TC2 are shown, but the fuses for the other circuits are not shown.

The subscribers' stations in offices 1 and 2 are of the type which includes a dial or other impulse sender for directly controlling the selector switches through which desired connections are established. The line-finder, selector and connector switches are of the two-motion step-by-step type. For a description of the structure of such switches and their operation when employed as selectors and connectors, reference may be had to pages 53 to 65, inclusive, of "Automatic Telephony" by Smith and Campbell, 2nd edition, published in 1920. Reference may be had to the pat-

ent to R. L. Stokely No. 1,799,654, April 7, 1931, for a description of such a switch when employed as a line finder. The line-finder, selector and connector switches are each represented by a set of brushes and one or two sets of terminals, the associated magnets, relays and other apparatus being omitted.

In response to the origination of a call by a subscriber in office 1 or office 2, an idle line finder, LF1 or LF2, is operated to connect the calling line to a first selector switch, FS1 or FS2. The dialing of the first digit directly operates the associated first selector switch to select a desired group of trunks and to automatically select an idle trunk in the selected group. If the called line is in the same office, the impulses created by the dialing of the succeeding digits of the called subscriber's number directly control a second selector SS1 or SS2, and a connector, C1 or C2, to complete the connection with a calling line in usual and well-known manner.

All outgoing calls from office 1 are routed through office 2 to an operator's position in the master office. By dialing a single digit, the first selector FS1 is operated to connect the calling line to a two-way trunk circuit TC1, over a trunk T1 to a two-way trunk circuit TC2 in office 2. The connection is further extended by the operation of a non-numerical switch RS which is individual to trunk circuit TC2 to select an idle two-way trunk circuit TC3 associated with a trunk T2 leading to the master office. The two-way trunk circuits such as TC3 may also be seized by first selectors FS2 in office 2 on outgoing calls originated by subscribers in office 2. Each of the trunks T2 terminates at the master office in a two-way trunk circuit TC4, seizure of a trunk T2 in the dial office 2 being effective to operate an answering signal at an operator's position. On a call from a subscriber in office 1 or in office 2 to the master office, the connection is under the joint control of the calling subscriber and the answering operator.

On calls from the master office, to subscribers in either of offices 1 or 2, seizure of a trunk circuit TC4 conditions the trunk circuit TC3 and associated incoming selector IS2. When the operator dials the first digit, the dial impulses are repeated through trunk circuits TC4 and TC3 to control the group selecting operation of the selector IS2. If the called subscriber is in office 2, the impulses created by the dialing of the succeeding digits of the called subscriber's number effects the operation of a connector C2 to complete the connection with the called line. If the called subscriber is in office 1, the terminals selected by switch IS2 are associated with a two-way trunk circuit TC2 and the impulses created by the dialing of the succeeding digits of the called subscriber's number are repeated through trunk circuits TC4, TC3, TC2 and TC1 to control the operation of an incoming selector IS1 and a connector C1 in office 1 to complete the connection with the called subscriber's line. On a call from the master office to a line in office 1 or to a line in office 2, the connection is under the sole control of the calling operator.

Detailed description

The operations involved in the establishment of connections over trunks T1 and T2 will now be explained in detail.

Assume that the subscriber at station A1 originates a call to the master office, that a line finder LF1 connects the calling line to the first

selector FS1, that the subscriber dials a digit which directs the selector S1 to the group of trunks leading to dial office 2 and that the two-way trunk circuit TC1, shown in detail in Fig. 2, is seized for use on the call. The selector FS1 is represented in Fig. 2 by a set of four brushes and the single set of terminals to which the trunk circuit TC1 is connected. Upon seizure of trunk circuit TC1, the connection from the calling line is extended through the two upper brushes of selector FS1, conductors 11 and 12, outer back contacts of relay 23, left windings of repeating coil RC1, inner back contacts of relay 23, to the windings of relay 17. Relay 17, which is thereupon operatively energized, closes a circuit for operating relay 16. Relay 16 connects ground potential to test conductor 13 which is multipled to the test terminals of trunk TC1 in the banks of all selectors having access to this trunk. The ground potential thus connected to the test terminal of selector FS1 holds this selector and the associated line finder LF1 under the control of the calling subscriber and prevents the seizure of trunk TC1 by any other selector having access thereto.

The subscribers' lines to which the line finder LF1 has access may be entitled to different classes of service and the trunk circuit TC1 is arranged to transmit either one of two class-of-service tones to the answering operator in the master office in case a call is originated from a line in the one or the other of these two classes. If the call is from a line in one of these two classes, the line-finder and selector circuits LF1 and FS1 connect ground through brush 10 to completely operate relay 27 in the trunk circuit TC1. If the call is from a line in the other of these two classes, the line-finder and selector circuits LF1 and FS1 connect ground through a resistor to brush 10 to partially operate relay 27, in which case only the upper contact of relay 27 is actuated. In either case, relay 27 closes a circuit for operating relay 25. Relay 25 closes a circuit for operating the start relay 29 of the tone interrupter 30.

The aforementioned connection of ground potential through the front contact of relay 16 to conductor 13 also effects the operation of relay 19. With relays 17 and 19 operated, the windings of relay 15 are disconnected from the conductors 31 and 32 of trunk T1 and a bridge comprising the low-resistance, lower winding of relay 18 is connected across conductors 31 and 32 to effect the operation of marginal relay 50 of trunk circuit TC2 at the other end of trunk T1. The circuit for operating relay 50 is traced from battery through fuse F3, upper winding of relay 50, inner upper back contact of relay 49, upper left winding of repeating coil RC2, outer upper back contact of relay 49, upper back contact of relay 40, conductor 32, upper back contact of relay 26, upper right winding of repeating coil RC1, inner front contact of relay 19, lower front contact of relay 17, lower winding of relay 18, outer front contact of relay 19, lower right winding of repeating coil RC1, inner lower back contact of relay 26, conductor 31, lower back contact of relay 40, outer lower back contact of relay 49, lower left winding of repeating coil RC2, inner lower back contact of relay 49, through the lower winding of relay 50 to ground. Relay 18 of trunk circuit TC1 does not operate since the relay is polarized and the current through its lower winding is not in the operating direction. Relay 50 closes a circuit for operating relay 51. Relay 51 closes a circuit for operating relay 53.

With relays 50 and 53 operated, a bridge com-

prising the right windings of repeating coil RC2 and the lower, low-resistance winding of relay 42 is closed across conductors 55 and 56 of the rotary selector circuit RS. If all of the trunks connected to the bank of selector RS are busy, relay 60 is operated due to the release of the all-trunks-busy relay 99 shown in Fig. 5. In this case, relay 60 prevents the operation of the line relay 61, the switch RS does not operate to hunt for an idle trunk, and an all-trunks-busy tone is transmitted through condenser 93, lower front contact of relay 60, lower winding of relay 61, lower back contact of relay 62, to conductor 55 and thence to the calling line. If one or more of the trunks accessible to the rotary selector RS are idle, relay 60 is normal and the closing of the bridge across conductors 55 and 56 effects the operation of line relay 61. If the trunk connected to the terminals then engaged by the brushes of selector RS is busy, the terminal engaged by test brush 73 is connected to ground and the stepping magnet 70 is actuated in a circuit which includes the interrupter contact of magnet 70, the upper front contact of relay 61, and brush 73. The brushes are thereby advanced by the operation of magnet 70, step by step, until brush 73 engages the test terminal of an idle trunk, whereupon cut-off relay 62 is operated in a circuit from battery through the winding and interrupter contact of magnet 70, winding of relay 62, to ground at the lower front contact of relay 61. The magnet 70 is marginal and does not operate in series with relay 62. Relay 62 disconnects relay 61 from conductors 55 and 56 and connects these conductors to brushes 71 and 72, thus completing a circuit for operating line relay 89 of the seized trunk circuit TC3. This circuit is traced from battery through the right winding of relay 89, inner upper back contact of relay 87, upper left winding of repeating coil RC 3, upper back contacts of relays 87 and 80, conductor 78, terminal and brush 72, upper front contact of relay 62, conductor 56, thence through the bridge comprising the low-resistance winding of relay 42, conductor 55, lower front contact of relay 62, brush 71 and terminal, conductor 77, lower back contacts of relays 80 and 87, lower left winding of repeating coil RC3, inner lower back contact of relay 87, through the left winding of relay 89 to ground. Relay 89 closes circuits for operating relays 84 and 90. Relay 84 connects ground to test conductor 79 to hold cut-off relay 62 and rotary selector circuit RS after relay 61 releases and to guard the trunk circuit TC3 against seizure by any other rotary selector or by any of the two-motion directionally controlled selectors such as FS2. Relay 90 closes a circuit for operating the motor start relay MS of the tone and ringing interrupter and relay 84 closes a path from a code ringing conductor through condenser 91 to conductor 78 to transmit ringing tone to the calling subscriber as an indication that an operator in the master office is being signaled. Relay 90 interchanges the connections between the windings of relay 86 and conductors 97 and 98 of trunk T2 leading to the master office thereby effecting the operative energization of both windings of the polarized relay 100 of trunk circuit TC4. Although the windings of relays 86 and 100 are connected in a normally closed circuit over trunk T2, the current is not strong enough to operate the marginal relay 86 and is in the non-operating direction with respect to relay 100. The operation of relay 100 closes a circuit for operating relay 101; relay 101 closes a circuit for operating relay

102; and relay 102 closes a circuit for operating relay 103. Relay 101 also closes a circuit for lighting answering lamp 113. Relay 103 closes a circuit for lighting busy lamp 114 and connects a busy potential, through resistor 116 and the lower winding of relay 105, to the sleeve of jack 112.

When an operator answers the call by inserting the plug of a cord in jack 112, a circuit is closed from battery in the operator's position circuit through the sleeve conductor of the answering cord and jack 112 and the upper winding of relay 105. Reference may be had to the patent application of R. E. King et al. Serial No. 243,347, filed December 1, 1938, for a disclosure of cord and position circuits arranged for cooperation with the trunk circuit TC4. Relay 105 operates, closing a circuit for operating relay 106. Relay 106 closes a circuit for operating relay 107; closes a short circuit around the high-resistance, upper winding of relay 100, thereby causing the operation of relay 86 of trunk circuit TC3; and opens the circuit through the winding of relay 101 to release this relay and extinguish lamp 113. Relay 107 closes a holding circuit for relay 102 and completes a talking connection between the right windings of repeating coil RC 4 and the line conductors of jack 112.

The aforementioned operation of marginal relay 86, when the call is answered, closes a circuit for operating relay 80. Relay 80 disconnects condenser 91 from conductor 78, to end the transmission of ringing tone to the calling subscriber, and interchanges the connections between the windings of relay 89 and the conductors 77 and 78 so as to reverse the current through the lower winding of polarized relay 42 of trunk circuit TC2 and thereby cause the operation of relay 42. Relay 42 closes a circuit for operating relay 40. Relay 40 interchanges the connections between the windings of relay 50 and conductors 31 and 32 of trunk T1 thereby reversing the current through the lower winding of polarized relay 18 of trunk TC1. Relay 18 operates, closing a circuit for operating relay 24. Relay 24 closes a circuit for holding relay 16 and opens the circuit through relay 25. After relay 24 operates and before relay 25 releases, the upper left winding of repeating coil RC1 is connected to condenser 28 and a tone is transmitted therethrough to the answering operator to indicate the class of the calling line, one class of service tone being transmitted if relay 27 is only partially operated, another class of service tone being transmitted if relay 27 is completely operated, and a third class of service being indicated by the transmission of no tone if relay 27 is neither partially nor completely operated.

The talking connection between the calling line and the operator in the master office includes the repeating coils RC1, RC2, RC3 and RC4. The connection is under the joint control of the calling subscriber and the answering operator. When the calling subscriber releases the connection, relay 17 releases, thereby opening the short circuit around the upper, high-resistance winding of relay 18 to cause the release of relay 50 of trunk circuit TC2. Relay 50 opens the short circuit around the upper, high-resistance winding of relay 42 thereby causing the release of relay 89 of trunk circuit TC3. The release of relay 89 causes the release of relay 90 thereby restoring the current over trunk T2 to its normal direction to effect the release of relay 100 of trunk circuit TC4 in the master office. When relay 100 releases, it connects ground to the

lower, low-resistance winding of relay 105 thereby causing the lighting of a supervisory lamp in the operator's cord circuit as a disconnect signal.

When the operator disconnects, relay 105 releases. The release of relay 105 causes the release of relay 106 and the release of relay 106 causes the release of relay 107. Relay 101 reoperates if relay 100 has not released. The release of relay 106 opens the short circuit around the upper, high-resistance winding of relay 100 thereby causing the release of relay 86 of trunk circuit TC3. The release of relay 86 causes the release of relay 80. When relay 80 releases, the current through conductors 77 and 78 is restored to normal direction to effect the release of relay 42 of trunk circuit TC2. The release of relay 42 causes the release of relay 40. When relay 40 releases, the current through conductors 31 and 32 is restored to normal direction to effect the release of relay 18 of trunk circuit TC1. The release of relay 18 causes the release of relay 24.

When both the subscriber and the operator have released the connection, the release of both relays 17 and 24 of trunk circuit TC1 causes the release of relay 16. The release of relay 16 causes the release of relay 19 and disconnects ground potential from the test terminal of selector FS1, thereby effecting the return of the line finder LF1 and selector FS1 to normal in usual and well-known manner. The release of both of relays 50 and 40 in trunk circuit TC2 causes the successive release of relays 51 and 53. The release of both of relays 89 and 80 in trunk circuit TC3 causes the release of relay 84. Relay 84 disconnects ground potential from conductor 79 to effect the release of relay 82 of rotary selector RS. The release of relays 101 and 107 causes the release of relays 102 and 103 thereby restoring trunk circuit TC4 to normal.

Assume now that an operator in the master office inserts the plug of a cord in jack 112 to initiate a call to a subscriber in dial office 1. Relay 105 operates in a circuit including the sleeve conductor of jack 112 to battery in the operator's position circuit. Relay 105 closes a circuit for operating relay 106. Relay 106 closes a short circuit around the upper winding of relay 100 to effect the operation of relay 86 of trunk circuit TC3, closes a circuit for operating relay 107, and connects ground to the lower winding of relay 105 to effect the lighting of a supervisory lamp in the operator's cord circuit. Relay 107 closes a circuit for operating relay 102, connects the winding of relay 108 through the upper right winding of repeating coil RC4 to the tip of jack 112, and connects ground at the inner lower front contact of relay 106 through resistor 115 and the lower right winding of coil RC4 to the ring of jack 112. Relay 102 closes a circuit for operating relay 103. Relay 103 lights the busy lamp 114. The operation of relay 86 closes a circuit, including back contacts of relays 84 and 90, through the winding of relay 87. Relay 87 operates, thereby connecting its winding to sleeve conductor 95 of the associated incoming selector IS2 and extending ground potential to conductor 79 to mark the trunk circuit TC3 as busy in the bank of selectors FS2 and RS. Relay 87 closes a bridge, comprising the winding of relay 88 and resistor 92 in parallel, across conductors 93 and 94 of selector IS2 to prepare the selector for operating by dial impulses. The selector IS2 connects a holding ground potential to sleeve conductor 95 in usual manner to hold relay 87.

When the calling operator operates the dial key in the position circuit, battery is connected through the tip conductor of the operator's cord, upper conductor of jack 112, outer upper front contact of relay 107, upper right winding of repeating coil RC4, through the winding of relay 108 to ground. Relay 108 operates, closing a circuit for operating relay 109 and connecting the tip of jack 112 to repeating coil RC4 independent of the contact of relay 107. Relay 109 closes a circuit for holding relay 102 operated and connects the winding of relay 110 through the lower right winding of repeating coil RC4 to the ring conductor of jack 112. When the operator's dial circuit functions to connect battery through the ring conductor of the cord to the lower conductor of jack 112, relays 110 and 111 operate. Relay 111 locks under control of relays 108 and 106, and opens the circuit through the winding of relay 107. Relay 107 releases, disconnecting the ring of jack 112 from condenser 104. Relay 107 connects ground to the winding of relay 110, thereby short-circuiting the upper winding of relay 111 to prepare relay 110 for response to dial impulses. With relays 110 and 111 operated, the bridge comprising the lower winding of relay 100 is disconnected from trunk T2 and the impulse repeating contacts of relay 110 are connected across the conductors 97 and 98. When the operator dials the number of a called subscriber, relay 110 is alternately released and reoperated. Corresponding impulses are transmitted by the contacts of relay 110 over trunk T2 to the trunk circuit TC3. When dialing is completed, the release of the operator's dial key disconnects battery from the tip of the cord, releasing relay 108. Relay 108 opens the connection between repeating coil RC4 and the tip of jack 112, short-circuits the contacts of relay 110, and releases relays 109 and 111. The release of relay 109 disconnects the winding of relay 110 from the ring of jack 112 and opens the holding circuit of relay 102. The release of relay 111 disconnects the contacts of relay 110 from trunk T2 and reestablishes the bridge comprising the winding of relay 100 across the conductors 97 and 98. The release of relay 111 also causes the reoperation of relay 107 and completion of the talking connection between jack 112 and repeating coil RC4. Relay 107 recloses the operating circuit of relay 102 and relay 102 reoperates. Since relay 103 is slow in releasing it remains operated during the transfer from dialing to talking connections.

Relay 86 of trunk circuit TC3 is alternately released and reoperated by the dial impulses transmitted over conductors 97 and 98 by the contacts of relay 110. When relay 86 releases in response to the first impulse of a train, it opens the bridge across conductors 93 and 94, and closes a circuit including the inner lower back contact of relay 90 and an upper front contact of relay 87 for operating the slow-to-release relay 85. With relay 85 operated, the reoperation of relay 86 closes a bridge comprising resistor 96 across conductors 93 and 94 in place of the bridge comprising the winding of relay 88. Relay 85 remains operated while each train of impulses is being repeated by relay 86. The release of relay 85 after each digit reconnects the winding of relay 88 across conductors 93 and 94 for receiving supervisory signals.

The first train of impulses repeated by relays 110 and 86 control the operation of the incoming selector IS2 to select a corresponding group of

trunks. The selector thereupon operates automatically to select an idle trunk in the selected group. On a call to dial office 1, seizure of trunk circuit TC2 extends the connection from trunk circuit TC3 through conductors 93 and 94, conductors 57 and 58, back contacts of relays 54 and 53, right windings of repeating coil RC2, inner back contacts of relay 53, to the windings of relay 43. Relay 43 operates, closing a circuit for operating relay 52. Relay 52 closes a circuit for energizing the upper, polarizing winding of relay 54; closes a circuit for operating relay 49; and connects ground to conductor 59 to prevent seizure of trunk circuit TC2 by any other selector, to hold the selector IS2, and to hold relay 87 of trunk circuit TC3. With relays 43 and 49 operated, a bridge is closed across trunk T1 to operate relay 15 of trunk circuit TC1 in office 1. This bridge is traced from conductor 31 through the inner lower front contact of relay 43, inner lower back contact of relay 44, outer lower front contact of relay 49, lower left winding of repeating coil RC2, inner lower front contact of relay 49, resistor 48, lower winding of relay 54, outer lower back contact of relay 44, inner upper front contact of relay 49, upper left winding of repeating coil RC2, outer upper front contact of relay 49, upper back contact of relay 44, and the upper front contact of relay 43 to conductor 32. Relay 43 is alternately released and reoperated in response to the dial impulses repeated by relays 110 and 86 upon the dialing of the succeeding digits of the called subscriber's number. When relay 43 releases in response to the first impulse of each train, it closes a circuit for operating relay 44 and, being slow in releasing, relay 44 remains operated until all of the impulses in the train have been received by relay 43. Relay 44 disconnects the bridge comprising the lower winding of relay 54 from conductors 31 and 32. When relay 43 reoperates at the end of the first impulse, conductor 31 is connected through a lower front contact of relay 44 and resistor 46 to battery and conductor 32 is connected through an upper front contact of relay 44 and resistor 45 to ground. The windings of relay 15 of trunk circuit TC1 are thereby energized in separate grounded circuits over conductors 31 and 32 during the transmission of impulses. When the last impulse of each train has been received, relay 44 releases to reconnect the lower winding of relay 54 across trunk T1. Relay 43 is thus effective to repeat the received impulses to relay 15 of trunk circuit TC1.

The operation of relay 15 of trunk circuit TC1, upon seizure of trunk circuit TC2 by selector IS2 as above described, closes a circuit for operating relay 14. Relay 14 connects ground potential to conductor 13 to mark trunk circuit TC1 busy in the bank of selector FSI, closes a circuit for operatively energizing relay 23 and closes a circuit for energizing the lower polarizing winding of relay 26. Relay 23 closes a bridge across conductors 33 and 34 of incoming selector ISI. This bridge is traced from conductor 33 through the back contact of relay 21, outer lower front contact of relay 23, lower left winding of repeating coil RC1, inner lower front contact of relay 23, upper winding of relay 26, inner upper front contact of relay 23, upper left winding of repeating coil RC1, outer upper front contact of relay 23, and through the outer front contact of relay 15 to conductor 34 of selector ISI. The selector ISI is thereby prepared for response to dial impulses in usual manner. Relay 15 is alternately re-

leased and reoperated in response to dial impulses repeated by relays 110, 86 and 43. When relay 15 releases in response to the first impulse of each train, it closes a circuit for operating relay 21 and, being slow in releasing, relay 21 remains operated until all of the impulses in the train have been received. When relay 15 reoperates at the end of the first impulse, the loop across conductors 33 and 34 includes resistor 22 and the front contact of relay 21 instead of the bridge comprising the winding of relay 26.

The first train of impulses received and repeated by relay 15 is effective to directively operate selector ISI to select a group of connector switches. Selector ISI is then operated automatically to select an idle connector in the selected group and to extend the connection from conductors 33 and 34 to this connector. The impulses created by the dialing of the last two digits of the called subscriber's number are repeated by relays 110, 86, 43 and 15 to control the operation of the connector to complete connection with the called line in usual manner. If the line is idle, the called station is signaled. If the call is answered the connector functions in well-known manner to reverse the direction of current through conductors 33 and 34 and the upper winding of relay 26 thereby effecting the operation of this relay. Relay 26 thereupon interchanges the connections between the windings of relay 15 and conductors 31 and 32 to reverse the current through the lower winding of relay 54 of trunk circuit TC2. Relay 54 is thereby operated and in turn effects the reversal of current through conductors 57 and 58, 93 and 94 and the winding of relay 88 of trunk circuit TC3. Relay 88 operates, closing a circuit for operating relay 90. Relay 90 effects the reversal of current through conductors 97 and 98 to operate relay 100 of trunk circuit TC4. The operation of relay 100 disconnects ground from the lower winding of relay 105 to extinguish the supervisory lamp in the operator's cord circuit.

The talking connection between the operator and the called subscriber includes the repeating coils RC4, RC3, RC2 and RC1. The connection is under the sole control of the operator.

If the called subscriber restores the telephone to normal before the operator disconnects, the connector restores the direction of the current through conductors 33 and 34 to successively release relays 26, 54, 88, 90 and 100 and thus cause the lighting of the supervisory lamp in the operator's cord circuit. When the operator disconnects, relays 105, 106, 107, 102 and 103 are released. The release of relay 106 opens the short circuit around the upper winding of relay 100 thereby causing the release of marginal relay 86 in trunk circuit TC3. The release of relay 86 opens the operating circuit of relay 87 and opens the bridge across conductors 93 and 94 thereby causing the release of relay 43 of trunk circuit TC2. When relay 43 releases, it causes the release of relay 52. Relay 52 releases relay 49 and disconnects the busy ground from conductor 59 thereby effecting the return of the selector IS2 to normal in usual and well-known manner and the release of relay 87 of trunk circuit TC3. The aforementioned release of relay 43 also opens the bridge across conductors 31 and 32 thereby releasing relay 15 of trunk circuit TC1. The release of relay 15 causes the release of relays 14 and 23 thereby opening the

bridge across conductors 33 and 34 to release the line relay of the connector switch. If at that time the called subscriber has failed to hang up, the connector switch and the selector IS1 are held operated. When the called subscriber hangs up, the connector and incoming selector switches are restored to normal in usual and well-known manner.

The trunk circuit TC3 may be seized by a selector FS2 on a call to the master office from a subscriber in office 2 in which case the trunk circuit functions in similar manner to that hereinbefore described on a call from office 1 to the master office except that relays 82 and 83 function, in similar manner to relays 25 and 27 of trunk circuit TC1 to transmit the one or the other of two class-of-service tones or to transmit no tone to the answering operator.

Each of the two-way trunk circuits TC1, TC2 and TC3 is provided with a normally-operated make-busy relay which releases upon operation of the fuse through which its winding is connected to battery. Referring first to trunk circuit TC3, relay 81 releases if the fuse individual to this trunk circuit operates. The release of relay 81 connects ground to sleeve conductor 79 to prevent seizure of trunk circuit TC3 by any selectors such as RS and FS2. An alarm call will thereupon be initiated automatically to the master office to indicate a trouble in the dial office.

The normally-operated make-busy relay 41 of trunk circuit TC2 releases if the fuse F4 operates thereby connecting ground to conductor 59 to guard this trunk circuit against seizure by any selector having access thereto. The lower contacts of relay 41 close a short circuit across conductors 31 and 32 thereby causing the operation of relay 50 of trunk circuit TC2 and the operation of relay 15 of trunk circuit TC1. Relay 50 effects the extension of a trouble call to the master office. Relay 15 closes a circuit for operating relay 14. Relay 14 connects ground to conductor 13 to guard against seizure of trunk circuit TC1 by any selector in office 1.

The normally-operated make-busy relay 20 of trunk circuit TC1 releases if the fuse F2 operates thereby connecting ground to conductor 13 to guard the trunk TC1 against seizure in office 1 and closes a short circuit across the inner ends of the right windings of repeating coil RC1 thereby operating relay 15 of trunk circuit TC1 and operating relay 50 of trunk circuit TC2. Relay 15 performs no useful function at this time but relay 50 closes the circuit for operating relay 51 and effects the extension of a trouble call to the master office. Relay 51 connects ground to conductor 59 to guard against seizure of trunk circuit TC2 by any selector having access thereto.

A separate fuse is provided for each of relays 15 and 50 of trunk circuits TC1 and TC2 to insure the release of the make-busy relays 20 and 41 if the fuse associated therewith operates. If the same fuse was used to connect relay 15 to battery as is used to connect relay 20 to battery, the operation of this fuse would not insure the release of relay 20 because this relay would then be connected in series with the lower winding of relay 15, conductor 32 of trunk T1 and the upper winding of relay 50, to battery. By providing a separate fuse for relay 15, such a holding circuit for relay 20 is eliminated. For a like reason a separate fuse is provided for relay 50 in trunk circuit TC2. If fuse F1 of selector TC1 or fuse F3 of trunk TC2 operates, the trunk

will not be guarded against seizure but since these fuses are each individual to one relay, there is smaller probability of operation of either of these fuses.

The foregoing description of the operation resulting from operation of the fuse F2 of trunk circuit TC1 or from the operation of the fuse F4 of trunk circuit TC2 presumes that the trunk T1 is not in use when the fuse operation occurs. Obviously, however, the operation of the fuse F2 or F4 may occur at the same time that seizure of the trunk is being effected in either office or after seizure has occurred.

It is particularly to be noted that the provision of a separate fuse for the line relay of each of trunk circuits TC1 and TC2 and the provision of contacts on the make-busy relay in each of these trunk circuits, to simulate seizure if the circuit becomes inoperative due to the blowing of the fuse F2 or the fuse F4, is effective to guard the trunk T1 against seizure at either end whenever such a fuse operation occurs. This is particularly important in case the fuse F4 of trunk circuit TC2 operates because if the trunk circuit TC1 were not then guarded against seizure, a calling subscriber in unattended office 1 would be unable to make a master office call during times of light traffic if the trunk circuit TC1 were first choice in the banks of all of the selectors through which the calling subscriber's line may be connected to a trunk to the tandem dial office.

Although the invention has been described in detail in its application to trunk circuits arranged for loop signaling, it is, of course, applicable to systems and trunk circuits arranged for composite signaling, simplex signaling or any other type of signaling.

What is claimed is:

1. In a telephone system comprising a first office and a second office, a two-way trunk between said offices and automatic means in each of said offices for seizing said trunk on a call to the other of said offices, means in said first office operatively responsive to seizure of said trunk in said second office for marking the trunk busy, and means in said second office for automatically simulating seizure of said trunk in said second office.

2. In a telephone system comprising a first office and a second office, a two-way trunk between said offices and automatic means in each of said offices for seizing said trunk on a call to the other of said offices, means in said first office operatively responsive to seizure of said trunk in said second office for marking the trunk busy, and means in each of said offices for automatically simulating seizure of said trunk.

3. In a multioffice telephone system, a trunk between two offices, a first two-way trunk circuit, a second two-way trunk circuit, said first trunk circuit terminating said trunk in one of said offices and said second trunk circuit terminating said trunk in the other of said offices, selector switches in the one office having access to said first trunk circuit, selector switches in the other office having access to said second trunk circuit, means in said first trunk circuit operative upon seizure of said second trunk circuit by a selector for preventing seizure of said first trunk circuit by a selector, and means automatically effective if said second trunk circuit becomes inoperative for simulating seizure of said second trunk circuit.

4. In a multioffice telephone system, a trunk

between two offices, a first two-way trunk circuit, a second two-way trunk circuit, said first trunk circuit terminating said trunk in one of said offices and said second trunk circuit terminating said trunk in the other of said offices, selector switches in the one office having access to said first trunk circuit, selector switches in the other office having access to said second trunk circuit, means in said first trunk circuit operative upon seizure of said second trunk circuit by a selector for preventing seizure of said first trunk circuit by a selector, means in said second trunk circuit operative upon seizure of said first trunk circuit by a selector for preventing seizure of said second trunk circuit by a selector, and means in each of said trunk circuits automatically effective if the trunk circuit becomes inoperative for simulating seizure by a selector having access thereto.

5. In a telephone system, a first office, a second office, a two-way trunk between said offices, selectors in said first office, selectors in said second office, each of said selectors being operable to select said trunk on an outgoing call, means in each of said offices operatively responsive to seizure of the trunk by a selector in the other office for marking the trunk busy to selectors in the called office, means in each of said offices operatively responsive to seizure by a selector in the same office for marking the trunk busy to other selectors in the same office, and means comprising a make-busy relay in each of said offices for automatically marking the trunk busy in the same office and for simulating seizure of the trunk by a selector in the same office so as to effect a busy marking of the trunk in the other office.

6. In a telephone system comprising a trunk and an associated two-way trunk circuit, selectors for seizing said trunk circuit on outgoing calls, means responsive to seizure of said trunk circuit by a selector for closing a bridge across the conductors of said trunk and for marking said trunk circuit busy to the other selectors, and a make-busy relay automatically operative if said trunk circuit becomes unserviceable for marking said trunk circuit busy to all of said selectors and for closing a bridge across the conductors of said trunk.

7. In a telephone system comprising a trunk and an associated two-way trunk circuit, selectors for seizing said trunk circuit on outgoing calls, means responsive to seizure of said trunk circuit by a selector for sending a seizure signal over said trunk and for marking said trunk circuit busy to the other selectors, a fuse for supplying electrical energy to said trunk circuit, and a relay effective upon the blowing of said fuse to send a seizure signal over said trunk and to mark said trunk circuit busy to said selectors.

8. In a telephone system comprising a trunk and an associated two-way trunk circuit, selectors for seizing said trunk circuit on outgoing calls, means responsive to seizure of said trunk circuit by a selector for sending a seizure signal over said trunk and for marking said trunk

circuit busy to the other selectors, a relay in said trunk circuit for receiving a seizure signal incoming over said trunk, a fuse individual to said relay for supplying electrical energy thereto, another fuse, said other fuse being individual to said trunk circuit for supplying electrical energy thereto, and means comprising a relay effective upon the blowing of the last-mentioned fuse to transmit a seizure signal over said trunk and to mark said trunk circuit busy to said selectors.

9. In a multioffice telephone system comprising an interoffice trunk and an associated two-way trunk circuit at each end of said trunk, selectors for seizing said trunk circuits on outgoing calls, means in each of said circuits operatively responsive to seizure by a selector on an outgoing call for sending a seizure signal over the trunk and for marking the trunk circuit busy to other selectors, a relay in each of said circuits operatively responsive to a seizure signal incoming over the trunk for marking the circuit busy to selectors having access thereto, fuses individual to each of said circuits for supplying electrical energy thereto, one of the fuses for each circuit being individual to said relay, and relay means in each of said circuits effective upon the blowing of a fuse individual thereto for marking the trunk busy to selectors having access thereto and for sending a seizure signal over the trunk.

10. In a telephone system comprising a first office and a second office, a two-way trunk between said offices, automatic means in each of said offices for seizing said trunk on a call to the other of said offices, means in said first office operatively responsive to seizure of said trunk in said second office for marking the trunk busy, and means in said second office for automatically simulating seizure of said trunk to cause the operation of said busy marking means in said first office.

11. In a telephone system comprising a first office and a second office, a two-way trunk between said offices, automatic means in each of said offices for seizing said trunk on a call to the other of said offices, means in each of said offices operatively responsive to seizure of said trunk in the other of said offices for marking the trunk busy, and means in each of said offices for automatically simulating seizure of said trunk to cause the operation of the busy marking means in the other of said offices.

12. In a telephone system comprising a first office and a second office, a two-way trunk between said offices, automatic means in each of said offices for seizing said trunk on a call to the other of said offices, means in each of said offices operatively responsive to seizure of said trunk in the other of said offices for marking the trunk busy, and means in each of said offices for automatically simulating seizure of said trunk to cause the operation of the busy marking means in the other of said offices and for simultaneously marking said trunk busy in the office in which seizure is simulated.

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