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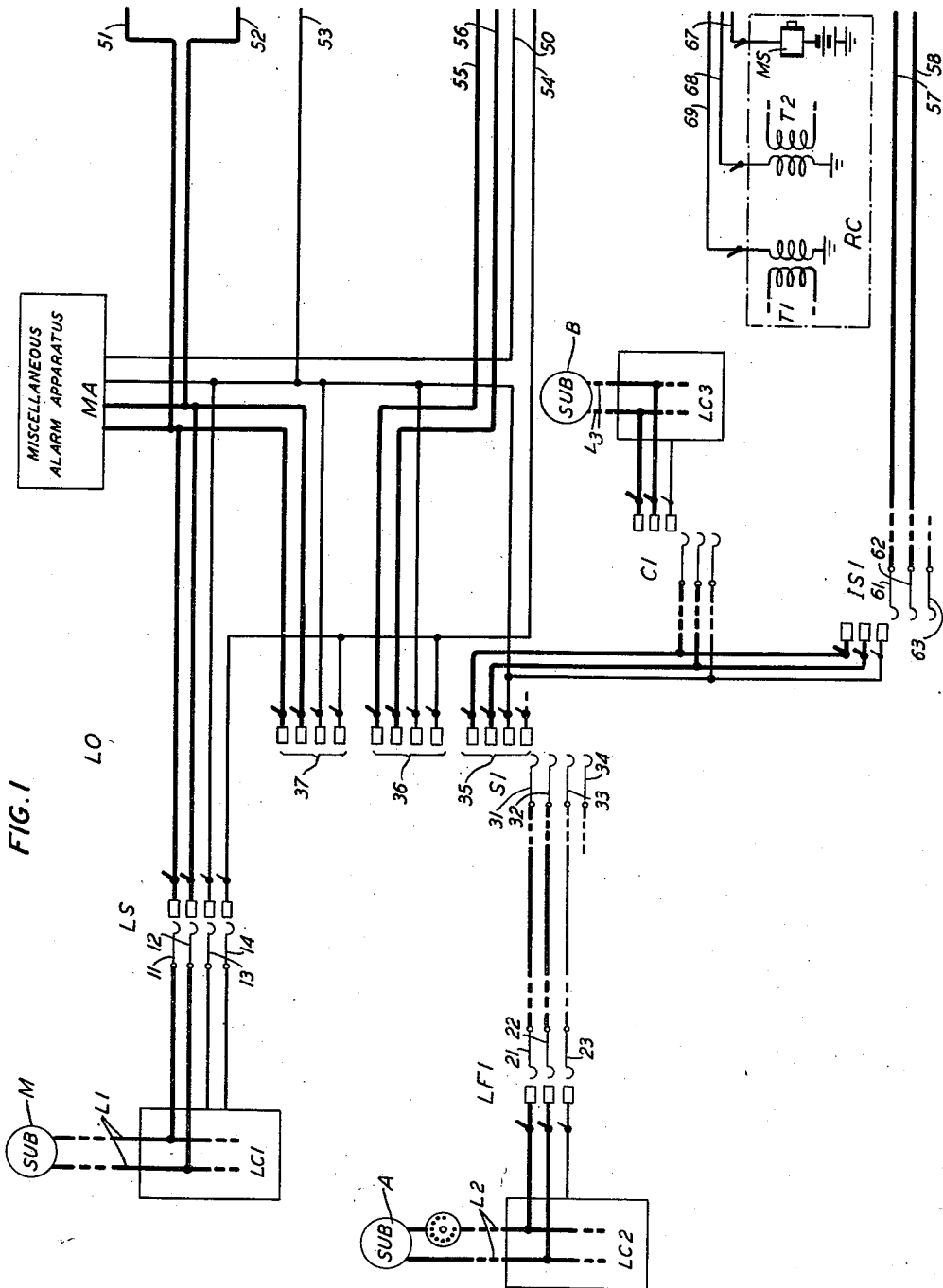
J. BAUMFALK ET AL

2,268,635

TELEPHONE SYSTEM

Filed July 5, 1940

4 Sheets-Sheet 1



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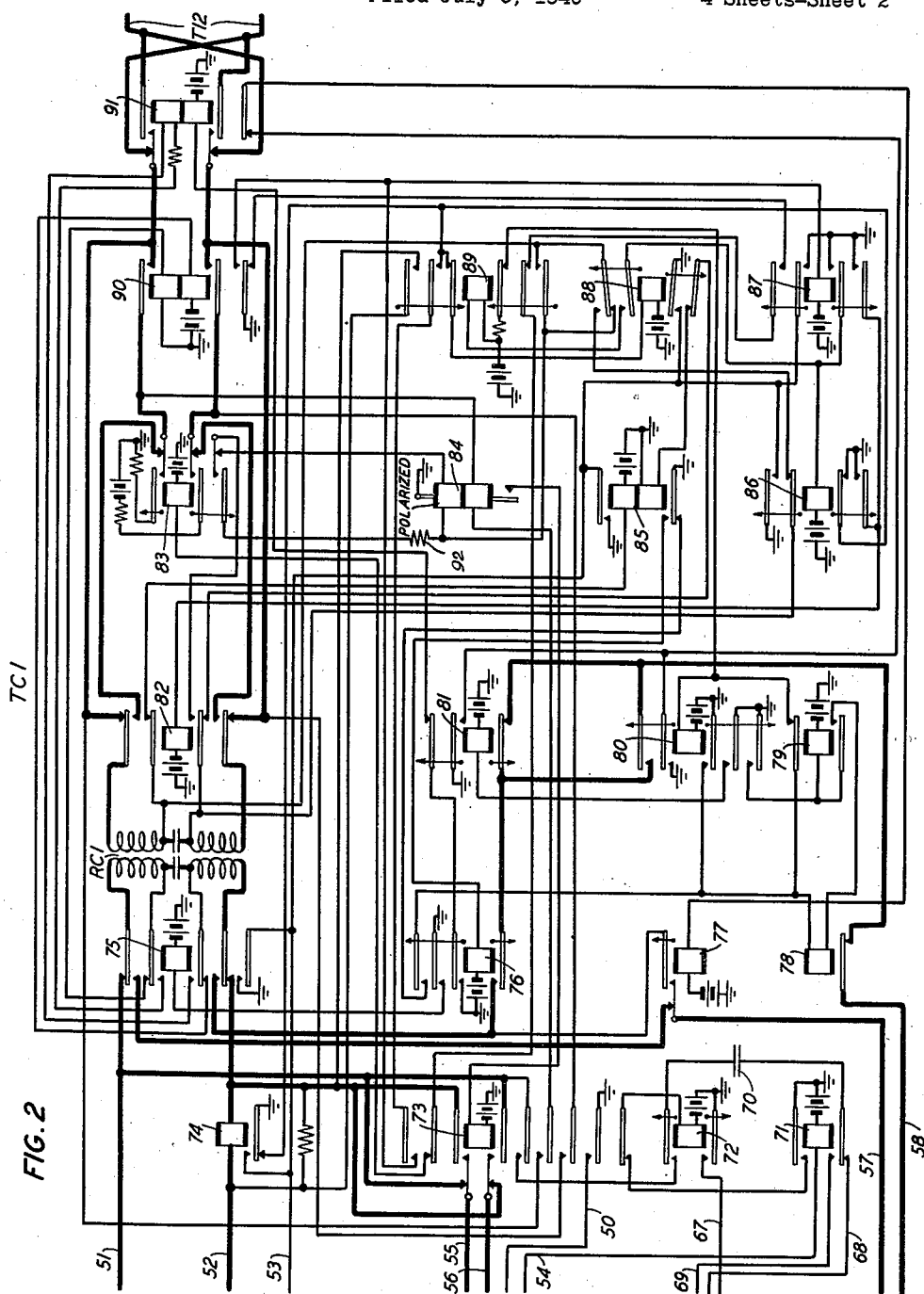
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4 Sheets-Sheet 2



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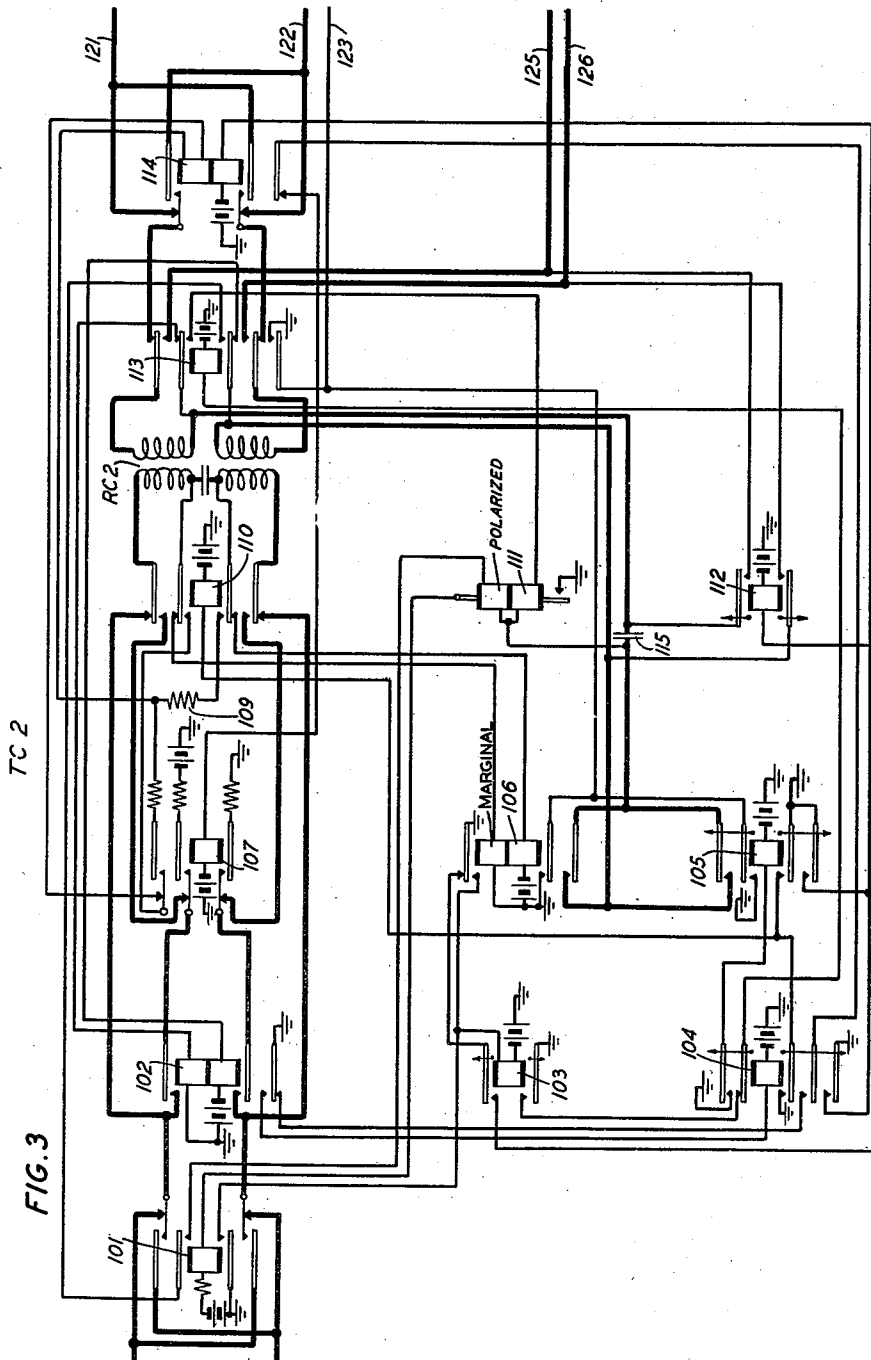
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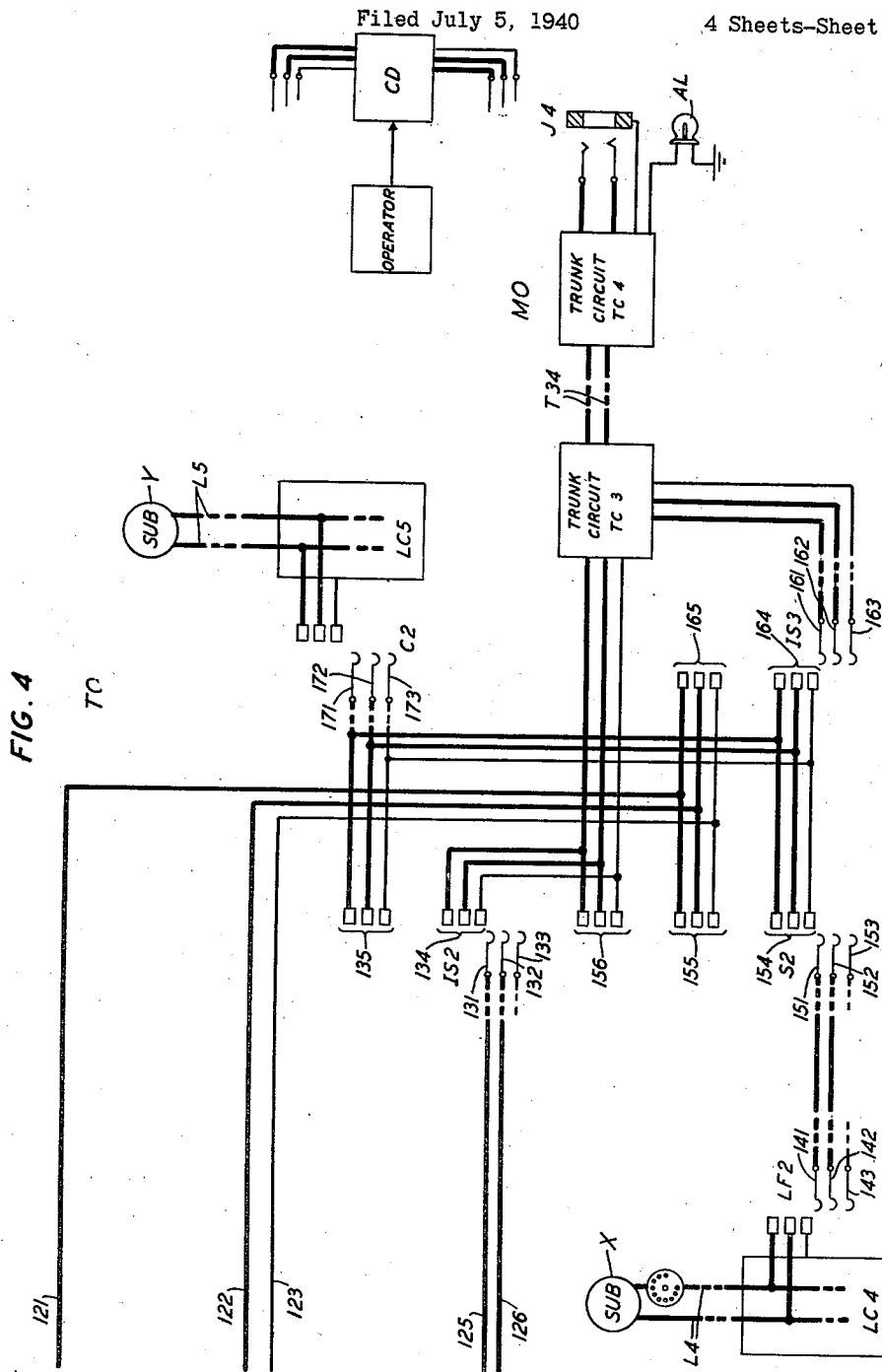
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TELEPHONE SYSTEM

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,268,635

TELEPHONE SYSTEM

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Application July 5, 1940, Serial No. 344,026

10 Claims. (Cl. 179-26)

This invention relates to telephone systems and particularly to systems comprising a local unattended automatic office, a tandem unattended automatic office and a master office.

Objects of the invention are the provision of means for facilitating the completion of calls from subscribers in an unattended office through a tandem unattended office to an operator in a master office, a minimization of the operations required at calling stations for establishing such connections, and the provision of an efficient trunking arrangement between these offices.

A feature of the invention is a telephone system comprising an unattended local office, an unattended tandem office, trunks between said offices, a trunk circuit for each of said trunks in the local office having two sets of conductors through which a calling line may be connected to the trunk, and an incoming group selector associated with each of these trunks in the tandem office, each of the trunk circuits in the local office being arranged to automatically control the operation of the associated incoming selector in the tandem office to select a predetermined group of terminals in its bank responsive to seizure of the trunk circuit through one but not the other of its two sets of conductors. According to this feature the incoming selector associated in the tandem office with a trunk seized in the local office is automatically operated to select a group of trunks leading to a master office when a calling line is connected to the associated trunk circuit through one of two paths of access and is operated in response to dial impulses from the calling station when a calling line is connected thereto through the other of the two paths of access.

Another feature of the invention is a telephone system comprising local and tandem unattended offices and an attended master office and a trunk circuit in the local unattended office associated with a trunk to the tandem unattended office, the trunk circuit having two sets of conductors through which it may be selected for use responsive to the first digit dialed by a calling subscriber, and having means operatively responsive to seizure through one but not the other of these sets of conductors for transmitting a directive impulse over the trunk to the tandem office without further dialing by the calling subscriber. According to this feature, the trunk circuit is connected to terminals in two different levels of the banks of local selectors, the dialing of the first digit of subscribers' numbers on a call to a station in the tandem office effecting seizure of

the trunk circuit through one level of a selector and one of the two sets of conductors, and the dialing of another digit, for instance the digit 0, on a call to an operator in the master office, effecting seizure through another level and the other set of conductors. The impulse transmitted to the tandem office effects the selective operation of the incoming selector associated with the trunk to select a group of terminals connected to trunks between the tandem and master offices.

Another feature of the invention is a telephone system comprising local and tandem unattended offices and an attended master office, the local unattended office comprising both dial and manual stations, dial stations being connected to trunks to the tandem office responsive to the dialing of one digit, and manual stations being connected thereto responsive to removal of the receiver to originate a call, each of the trunk circuits associated with trunks to the tandem office being connected through a first set of conductors to terminals in one level of local selectors for seizure on calls to subscribers in the tandem office, and through a second set of conductors to terminals in another level of these selectors for seizure on calls to an operator in the master office, to terminals in the banks of line switches associated with manual stations, and to the alarm sender apparatus which is effective when a trouble condition exists in the local unattended office to originate an alarm call to the master office, the trunk circuit being provided with relay means responsive to seizure through the second set of conductors for automatically transmitting a selective impulse to the associated incoming selector in the tandem office to effect selection of the group of trunks between the tandem and master offices.

A clear and complete understanding of the invention will be facilitated by considering a telephone system in which the invention is embodied, one such system being shown in the drawing which forms a part of this specification. The invention is not limited in its application to the particular system shown but is generally applicable to systems comprising local and tandem unattended offices and a master attended office.

Referring to the drawings:

Fig. 1 shows, in an unattended local central office LO, a manual subscriber's station M, line L1 and line circuit LC1, an automatic subscriber's station A, line L2 and line circuit LC2, a subscriber's station B, line L3 and line circuit LC3, a line switch LS individual to the line L1, a line

finder LF1 having access to a group of lines including the line L2, a first selector S1 associated with the line finder LF1, an incoming selector IS1, miscellaneous alarm apparatus MA, and a ringing and tone circuit RC;

Fig. 2 shows a two-way trunk circuit TC1 associated with a trunk T12 between the unattended local central office LO and an unattended local and tandem central office TO, the trunk circuit TC1 being connected to the incoming selector IS1 of Fig. 1 and to terminals in the banks of selector S1 and other similar selectors;

Fig. 3 shows, in the local and tandem office TO, a two-way trunk circuit TC2 associated with trunk T12; and

Fig. 4 shows, in the local and unattended office TO, an incoming selector IS2 associated with the trunk circuit TC2 of Fig. 3, subscribers' stations X and Y, lines L4 and L5 and line circuits LC4 and LC5, a line finder LF2, a first selector S2, a connector C2, an incoming selector IS3, and a two-way trunk circuit TC3 associated with the incoming selector IS2; Fig. 4 also shows a trunk T34 between the local and tandem unattended office TO and a master office MO, and in the master office a two-way trunk circuit TC4 and jack J4 and a cord CD at an operator's position.

The subscriber's station M represents manual, common battery stations which are equipped with individual line switches for connecting the associated lines with trunks on originating calls. The stations A, X and Y represent common battery stations, each provided with a dial or other impulse sender for controlling the establishment of desired connections. The station B may be either a manual station or a dial station. The lines L1, L2 and L4 are also connected to terminals in the banks of connector switches for receiving incoming calls; the line L3 is also connected to terminals in the banks line-finder switches if it is a dial subscriber's line or to a line switch if it is a manual line; and the line L5 is also connected to terminals in the banks of line-finder switches.

Each line switch LS is a single-motion rotary switch of the general type disclosed in "Automatic Telephony" by Smith and Campbell, 2nd edition, pages 51 and 52, and has access to a group of trunks only one of which is shown. In addition to the talking and test brushes 11, 12 and 13, the line switch LS is provided with a brush 14 for giving a class-of-subscriber indication to the selected trunk.

The line-finder, selector and connector switches LF1, S1, IS1 and C1 in the local unattended office and LF2, S2, IS2, IS3 and C2 in the local and tandem unattended office are all of the two-motion step-by-step type. Each of the line-finder, selector and connector switches is represented in the drawing by a set of brushes and one, two or three sets of terminals, all of the magnets, relays and other associated apparatus being omitted. The three sets of terminals 35, 36 and 37 of selector S1 represent, respectively, a level giving access to a group of connectors including the connector C1 for completing local calls, a level corresponding to the first digit of the subscriber's numbers in the local and tandem office and giving access to a group of trunks including trunk T12, and a level, usually "0" level, giving access to the same group of trunks on calls to an operator in the master office. The three sets of terminals 154, 155 and 156 of selector S2 represent, respectively, a level giving access to a group of connectors including the connector C2

for completing local calls, a level corresponding to the first digit of the subscriber's numbers in the local office LO and giving access to the group of trunks including trunk T12, and a level, usually "0" level, giving access to a group of trunks including trunk T34 on calls to an operator in the master office. The two sets of terminals 134 and 135 of incoming selector IS2 represent, respectively, a level giving access to the group of trunks including trunk T34 and a level giving access to a group of connectors C2. The two sets of terminals 164 and 165 of incoming selector IS3 represent, respectively, a level giving access to the group of connectors C2, and a level giving access to the group of trunks including trunk T12 for completing calls from the master office to the local office LO. The selector switch has, in addition to the line and test brushes, a fourth brush through which the class of the calling subscriber connected thereto may be indicated to the selected trunk for use on calls to the master office. Reference may be had to the aforementioned 2nd edition of Automatic Telephony, pages 53 to 65, for a complete description of such switches when used as selectors and connectors. Reference may be had to the patent to R. L. Stokely No. 1,799,654, April 7, 1931, and the patent to T. L. Dimond, No. 2,210,068, granted Aug. 6, 1940, for a complete description of such switches when used as line finders and for a description of the line circuits of the lines connected to the banks of line-finder switches.

The miscellaneous alarm apparatus includes an alarm sender for seizing an outgoing trunk and may be similar to that disclosed in the patent to J. N. Walters, No. 2,262,595, granted Nov. 11, 1941.

The two-way trunk circuit TC1 connects the associated trunk T12 through conductors 51 and 52 to a set of terminals in the banks of each of a group of line switches LS, to a set of terminals in the "0" or other master office level of each of the first selectors S1, and to the miscellaneous alarm apparatus MA, connects the trunk T12 through conductors 55 and 56 to a set of terminals in another level of each of the selectors S1, which level corresponds to the first digit of subscribers' numbers in the local and tandem office, and connects trunk T12 through conductors 57 and 58 to the incoming selector IS1. The trunk circuit comprises a repeating coil RC1, relays for repeating dial impulses on outgoing calls, relays for repeating dial impulses on incoming calls, and supervisory and other control relays as hereinafter described in detail. It also includes means comprising a relay 74 for automatically causing the transmission of an impulse over trunk T12 to advance the brushes of the associated incoming selector IS2 in office TO to select the first level of its banks and a trunk therein, such as trunk T34, leading to the master office; and includes means comprising relays 71 and 72 for controlling the transmission of a class of subscriber signal to the answering operator on calls to the master office.

The two-way trunk circuit TC2 connects the trunk T12, through conductors 125 and 126, to the incoming selector IS2 and, through conductors 121, 122 and 123, to terminals in the banks of local selectors S2 and incoming selectors IS3. It comprises a repeating coil RC2, relays for repeating impulses on incoming calls, relays for repeating impulses on outgoing calls, and supervisory and other control relays as hereinafter described.

The two-way trunk circuit TC3 connects the

trunk T34 to the incoming selector IS3 and to sets of terminals in the banks of local selectors S2 and incoming selectors IS2 and comprises means for transmitting signals to, and receiving signals from, the master office. The two-way trunk circuit TC4 in the master office connects the trunk T34 to jacks J4 and comprises means for receiving seizure and supervisory signals from the office TO and for transmitting seizure, selective and supervisory signals to the office TO. The trunk circuits TC3 and TC4 may be similar to the trunk circuits TC3 and TC4 shown in detail in the patent to R. B. Buchanan et al., No. 2,233,282, granted Feb. 25, 1941.

Assume first that a call is initiated at station A, that the line L2 is connected through a line finder LF1 to the associated first selector S1 and that the brushes of switch S1 are advanced under control of the train of impulses created by the dialing of the first digit of the number of the station with which connection is desired to select the corresponding group of terminals, and that the brushes are thereupon automatically advanced in the selected group to select and seize the first unguarded set of terminals. If the subscriber at station A is calling another station B in the same office, the selector S1 is operated in response to the impulses created by the dialing of the first digit of the called subscriber's number to select a group of terminals, represented by the terminals 35, and is automatically operated to select an unguarded set of terminals therein. Upon selection of an unguarded set of terminals, for instance the terminals 35, the calling line is connected through brushes 31, 32 and 33 to a connector C1 having access to the called line; and the dialing of the last two digits of the called subscriber's number effects the operation of the connector to select the set of terminals to which the called line is connected.

If, however, the subscriber at station A is calling a subscriber in the local and tandem office TO, the selector S1 is operated in response to the train of impulses created by the dialing of the first digit of the number of the called station to select the group of terminals represented by the terminal set 36, and is automatically operated to select an unguarded set of terminals therein. Upon selection of an unguarded set of terminals, for instance the terminals 36, the calling line is connected through brushes 31, 32, 33 and 34 and conductors 55, 56, 53 and 54 to the trunk circuit TC1. Upon engagement of the brushes of selector S1 with terminals 36, a circuit is closed for operating relay 90 of trunk circuit TC1. This operating circuit is traced from battery through the lower winding of relay 90, inner lower back contact of relay 75, lower left winding of repeating coil RC1, outer lower back contact of relay 75, inner lower back contact of relay 73, conductor 56, terminal and brush 32 of selector S1, brush 22 and terminal line finder LF1, through one conductor of line L2 and the station A, back through the other conductor of line L2, terminal and brush 21 of line finder LF1, brush 31 and terminal of selector S1, conductor 55, inner upper back contact of relay 73, outer upper back contact of relay 75, upper left winding of repeating coil RC1, inner upper back contact of relay 75 and through the upper winding of relay 90 to ground. Relay 90 closes a circuit for operating the slow-to-release relay 87. Relay 87 closes a circuit for operating the slow-to-release relay 86, closes a circuit for operating relay 82, and connects ground, through conductor 53, to the ter-

minal engaged by test brush 33 of selector S1 to hold this selector and the line finder LF1 in usual manner and to prevent selection of trunk circuit TC1 by another selector or by a line switch or by the miscellaneous alarm apparatus MA. Relay 86 also connects ground to conductor 53 and closes the operating circuit for relay 82. Relay 82 disconnects the windings of relay 85 from the conductors of trunk T12 and closes a circuit over trunk T12 for operating relay 106 of trunk circuit TC2. This circuit is traced from battery through the lower winding of relay 106, inner lower back contact of relay 110, lower left winding of repeating coil RC2, outer lower back contact of relay 110, lower back contact of relay 101, lower conductor of trunk T12, upper back contact of relay 91, upper front contact of relay 90, inner upper back contact of relay 83, upper front contact of relay 82, upper right winding of repeating coil RC1, upper front contact of the normally operated relay 88, upper winding of polarized relay 84, outer lower back contact of relay 83, inner lower front contact of relay 82, lower right winding of repeating coil RC1, outer lower front contact of relay 82, inner lower back contact of relay 83, inner lower front contact of relay 90, inner lower back contact of relay 91, upper conductor of trunk T12, upper back contact of relay 101, outer upper back contact of relay 110, upper left winding of repeating coil RC2, inner upper back contact of relay 110, and through the upper winding of relay 106 to ground. Relay 106 closes a circuit for operating slow-to-release relay 103, connects ground to conductor 123 to prevent seizure of trunk circuit TC2 by a local selector S2 or an incoming selector IS3, and bridges condenser 115 across the inner ends of the right windings of repeating coil RC2. Relay 103 closes a circuit, including the upper back contact of relay 104, for operating relay 113. Relay 113 also connects ground to conductor 123, disconnects the right windings of repeating coil RC2 from conductors 121 and 122, and closes a bridge across conductors 125 and 126 leading to the incoming selector IS2. This bridge may be traced from conductor 125 through the outer upper front contact of relay 113, upper right winding of repeating coil RC2, inner upper front contact of relay 113, lower winding of polarized relay 111, outer lower front contact of relay 106, lower right winding of repeating coil RC2, middle lower front contact of relay 113 to conductor 126. The line relay (not shown) of selector IS2 is thereby operated to prepare for selective operation of this switch responsive to dial impulses from the calling station A. When the subscriber at station A dials the next digit of the called subscriber's number, relay 90 releases and reoperates in response to each impulse of the train, thereby repeating these impulses through its inner front contacts to the incoming line relay 106 of trunk circuit TC2. Relay 106 in turn repeats these impulses at its outer lower front contact to the line relay of incoming selector IS2. When relay 90 releases in response to the first impulse of the train, it closes a circuit from ground through its lower back contact, the outer upper front contact of relay 87, outer lower back contact of relay 89 and the outer upper back contact of relay 73, for operating slow-to-release relay 83. Relay 83 disconnects the bridge comprising the right windings of repeating coil RC1 and the upper winding of relay 84 from trunk T12 and closes separate grounded circuits over the conductors of trunk T12 to insure the reoperation of the line

relay 106 of trunk circuit TC2 after each impulse. At its inner lower front contact, relay 83 connects battery to the upper conductor of trunk T12 to energize the upper winding of relay 106; and, at its upper front contact, relay 83 connects ground to the lower conductor of trunk T12 to energize the lower winding of relay 106. The release of relay 106 in response to the first impulse of the train closes a circuit, through its back contact and the upper front contact of relay 103, for operating slow-to-release relay 112. Relay 112 short-circuits the right windings of repeating coil RC2 to insure the reoperation of the line relay of selector IS2 after each impulse. Relays 87 and 86 of trunk circuit TC1 and relay 103 of trunk circuit TC2 are slow in releasing and remain operated during the response of relays 90 and 106 to dial impulses. Relay 83 of trunk circuit TC1 and relay 112 of trunk circuit TC2 are also slow in releasing and remain operated until after the last impulse of the train has been received by relays 90 and 106, respectively. The selector IS2 is operated in response to this train of impulses to select a corresponding level of its terminal bank. When the last impulse of this series has been received, the release of relay 83 reconnects the upper winding of relay 84 across the conductors of trunk T12 to hold relay 106 operated, resistance 92 being momentarily connected in parallel with the upper winding of relay 84 during the continuity action of the springs of relay 83 to prevent operation of relay 84. The release of relay 112 reconnects the lower winding of relay 111 in series with the right windings of repeating coil RC2 across conductors 125 and 126 to hold the line relay of selector IS2 operated. After completion of group selection the brushes 131, 132 and 133 of selector IS2 are advanced in usual manner to select an unguarded set of terminals in the selected level.

Assume first that the selector IS2 is operated to seize the set of terminals 135 connected to a connector switch C2 having access to the called line L5 in office TO. A circuit is thereupon closed through the brushes 131 and 132 of selector IS2 for operating the line relay (not shown) of the seized connector; and this relay is controlled by the impulses created by the dialing of the last two digits of the called subscriber's number to select the called line. A test of this line is made to determine whether it is idle or busy and, if idle, ringing current is connected to the line in usual manner. When the call is answered at the called station Y, the connector reverses the current in the circuit through the brushes 131 and 132 of selector IS2, conductors 125 and 126 and the lower winding of relay 111 of trunk circuit TC2 to cause the operation of this relay. Relay 111 closes a circuit for operating relay 101. Relay 101 interchanges the connections between the windings of relay 106 and the conductors of trunk T12 so as to reverse the current through these conductors and thereby cause the operative energization of the upper winding of polarized relay 84. Relay 101 also closes a circuit for holding relay 103 and closes a short circuit around the upper, high resistance winding of relay 111. Relay 84 closes a circuit for operating relay 73. Relay 73 interchanges the connections between the windings of relay 90 and conductors 55 and 56, thereby reversing the current through these conductors to effect any desired supervisory operation, such, for instance, as charging for the call. Relay 73 also closes short circuits around the inner front con-

tacts of relay 90 and causes the release of relay 72 as hereinafter described on a call to the master office; but the closing of these circuits and the release of relay 72 are of no utility on a call from station A to station Y. The talking connection includes the windings of repeating coils RC1 and RC2 and is under the control of the calling subscriber. If the called subscriber replaces the receiver before the connection is released, the connector effects a reversal of current through conductors 125 and 126 and the lower winding of relay 111 to cause the release of this relay. The release of relay 111 causes the release of relay 101 and the release of relay 101 reverses the current through the conductors of trunk T12 to release relay 84. The release of relay 84 causes the release of relay 73, thereby reversing the current through conductors 55 and 56. When the connection is released by the calling subscriber, relay 90 releases, causing the successive release of relays 87 and 86. With both of relays 87 and 86 released, the holding and guarding ground potential is disconnected from conductor 53 to cause the release of the selector S1 and line finder LF1, these switches being restored to normal in usual manner. The release of both of relays 87 and 86 also causes the release of relay 82, thereby reconnecting the windings of relay 85 through the right windings of repeating coil RC1 to the conductors of trunk T12. The aforementioned release of relay 90 opens the bridge across the conductors of trunk T12 to effect the release of the line relay 106 of trunk circuit TC2. The release of relay 106 causes the successive release of relays 103 and 113, thereby opening the bridge across conductors 125 and 126 to cause the release of the line relay of the connector C2 and thereby effect the restoration of this switch and the incoming selector IS2 to normal in usual manner.

If now the subscriber at station A originates a call to the master office, the selector S1 is operated in response to the dialing of the first digit, for instance 0, to select the group of terminals represented by the terminal set 37, and is automatically operated to select an unguarded set of terminals therein. Upon selection of a set of terminals, for instance the set 37, the calling line is connected through brushes 31, 32, 33 and 34 and conductors 51, 52, 53 and 54 to the trunk circuit TC1. Relays 74 and 90 are thereupon operated in a circuit which includes conductors 51 and 52, brushes 31 and 32 of selector S1, brushes 21 and 22 of line finder LF1, and the calling line L2. Relay 71 may or may not be operated depending upon the class of service to which the subscriber at station A subscribes. The operation of relay 90 causes the successive operation of relays 87, 86 and 82 of trunk circuit TC1 and the successive operation of relays 106, 103 and 113 of trunk circuit TC2 as hereinbefore described. Relay 74 connects ground to conductor 53 and opens the normally closed energizing circuit of relay 88, thereby causing the release of relay 88. Relay 88 is slow in releasing so as to maintain the bridge across the conductors of T12 for a long enough time to insure the operation of relay 106 of trunk circuit TC2 and the operation of the line relay of the incoming selector IS2. When relay 88 releases, it opens the bridge across the conductors of trunk T12 to cause the successive release of relay 106 of trunk circuit TC2 and the line relay of the incoming selector IS2. The release of relay 83

also causes the operation of slow-to-operate relay 89. Relay 89 short-circuits the winding of relay 74 to cause its release and recloses the bridge across the conductors of trunk T12 to reoperate relay 106 of trunk circuit TC2 and the line relay of the incoming selector IS2. In this manner relays 74, 88 and 89 function to transmit an impulse over trunk T12 to cause the incoming selector IS2 to be stepped up to the first level of its bank without further dialing on the part of the calling subscriber. The selector IS2 thereupon hunts for and seizes an unguarded set of terminals, such as the terminals 134 connected to a trunk circuit TC3 and trunk T34 leading to the master office MO. The trunk circuit TC4 in the master office is thereby operated to light an answering lamp AL and when the call is answered by insertion of the plug of the cord CD in jack J4, the lamp AL is extinguished and the trunk circuit TC3 operates to reverse the current through the brushes 131 and 132 of selector IS2, conductors 125 and 126 and the lower winding of polarized relay 111. Relay 111 operates closing the circuit for operating relay 101. Relay 101 reverses the current through the conductors of trunk T12 to operate relay 84 of trunk circuit TC1. Relay 84 closes a circuit for operating relay 73 but relay 73 is ineffective to reverse the current through conductors 51 and 52 and the calling subscriber's line. Relay 73 closes a circuit including condenser 70 and the one or the other of conductors 68 and 69 for transmitting a class-of-calling station indication to the answering operator, the tone signal being terminated by the release of relay 72. Relay 73 also closes short circuits around the inner lower front contacts of relay 90 and closes a circuit including the back contact of relay 74 and a front contact of relay 89 for holding relay 87 operated to maintain the connection of holding ground to conductor 53.

The talking connection includes the repeating coils RC1 and RC2 and is under the joint control of the calling subscriber and the answering operator. If the calling subscriber replaces the receiver before the operator disconnects, relay 90 releases but relays 84, 73, 87, 86 and 82 are held operated and the selector S1 and line finder LF1 cannot restore to normal. The release of relay 90 inserts the high resistance lower winding of relay 84 in the bridge across trunk T12 causing the release of relay 106; but relay 111 is held operated by its two windings in series through the inner upper front contact of relay 101, the resistance of the upper winding of relay 111 being high enough to cause the release of the line relay in the trunk circuit TC3 and thereby transmit a supervisory signal to the master office. When the operator disconnects, the reversal of current over trunk T34 causes the successive release of relays 111, 101, 84 and 73. The release of the connection by the calling subscriber, after the operator has disconnected, causes the successive release of relays 90, 87, 86 and 82 in trunk circuit TC1, and the successive release of relays 106, 103 and 113 in trunk circuit TC2. The release of relay 87 causes the release of relay 89; and relay 89 closes the circuit for operating relay 88. When the connection is released by both the calling subscriber and the operator, the trunk circuits, TC1, TC2, TC3 and TC4 are normal and the selectors S1 and IS2 and the line finder LF1 are all restored to normal in usual and well-known manner. If the subscriber at the manual station M initiates a call, the line switch LS is controlled

by line circuit LC1 to connect line L1 to an idle trunk circuit TC1 and trunk T12 leading to office TO, relays 74, 88 and 89 of trunk circuit TC1 operating in the manner above described to send an impulse over trunk T12 to operate the incoming selector IS2 and thereby extend the connection over a trunk T34 to the master office MO.

If a trouble exists in office LO for a long enough interval, the miscellaneous alarm apparatus MA operates in the manner described in the aforementioned patent to J. N. Walters to seize trunk circuit TC1 and trunk T12 leading to office LO, relays 74, 88 and 89 being operated to automatically control the operation of the incoming selector IS2 to extend the connection over a trunk T34 to the master office. When the call is answered, relay 111 of trunk circuits TC2 and relays 84 and 73 of trunk circuit TC1 are operated in succession. Relay 73 connects ground to conductor 50 to cause the transmission of a tone from the miscellaneous alarm circuit MA to the answering operator in the master office to indicate the character of the trouble.

If the subscriber at station X in the office TO originates a call, a line finder LF2 is operated to connect the line L4 to a first selector S2. The selector is controlled by the impulses created by the dialing of the first digit of the called subscriber's number to select a corresponding group and an unguarded set of terminals therein. If the called subscriber is in the same office, the selected set of terminals connects to a connector switch C2 having access to the called line; and the connection is completed by the dialing of the remaining digits of the called number in the usual manner. If the selector S2 selects a group and a set of terminals therein leading to a trunk circuit TC3 associated with a trunk T34 leading to the master office MO, the call is completed as described in the aforementioned patent to Buchanan et al.

If, on a call from station X, the selector S2 is operated to select a group and a set of terminals therein connected to a trunk circuit TC2 associated with a trunk T12 leading to the office LO, the line relay 102 of trunk circuit TC2 is operated by the current in a circuit from battery through its lower winding, inner lower back contact of relay 113, lower right winding of repeating coil RC2, outer lower back contact of relay 113, inner lower back contact of relay 114, conductor 122, terminal and brush 152 of selector S2, brush 142 of the line finder LF2, through one of the conductors of line L4 and the telephone at station X, back through the other conductor of line L4, terminal and brush 141 of line finder LF2, brush 151 and terminal of selector S2, conductor 121, upper back contact of relay 114, outer upper back contact of relay 113, upper right winding of repeating coil RC2, inner upper back contact of relay 113 and through the upper winding of relay 102 to ground. Relay 102 closes a circuit for operating slow-to-release relay 104. Relay 104 closes a circuit for operating slow-to-release relay 105, opens a point in the operating circuit of relay 113 to prevent the operation of this relay in case the trunk T12 is seized in the local office LO before it is marked busy in this office due to seizure in office TO, closes a circuit for operating relay 110, and closes a circuit for energizing the lower polarizing winding of relay 114. Relay 105 connects condenser 115 across the right windings of repeating coil RC2, closes a holding circuit for relay 110, closes a circuit for maintaining the energization of the lower winding of relay 114,

and connects ground through conductor 123 to the terminal engaged by the test brush 153 of selector S2 to hold the selector S2 and the line finder LF2 in the usual and well-known manner. Relay 110 disconnects the windings of relay 106 from the windings of repeating coil RC2 and closes a bridge across the conductors of trunk T12, to cause the operation of incoming line relay 85 of trunk circuit TC1. This bridge includes the upper winding of relay 114, the left windings of repeating coil RC2, back contacts of relay 107, front contacts of relay 102, and back contacts of relay 101. Relay 85 connects ground to conductor 53 to guard against seizure of trunk circuit TC1 by a selector or line switch or by the miscellaneous alarm apparatus in the local office LO. Relay 85 also closes a circuit for operating slow-to-release relay 76. Relay 76 closes the circuit for energizing the lower biasing winding of relay 91 and closes a circuit for operating relay 75. Relay 75 connects ground to conductor 53 and closes a bridge across conductors 57 and 58 to operate the line relay, not shown, of incoming selector IS1. This bridge is traced from conductor 57 through the back contact of relay 77, outer upper front contact of relay 75, upper left winding of repeating coil RC1, inner upper front contact of relay 75, upper winding of relay 91, inner lower front contact of relay 75, lower left winding of repeating coil RC1, middle lower front contact of relay 75, lower front contact of relay 76, lower back contact of relay 81, back contact of relay 78 to conductor 58. The operation of the line relay of selector IS1 prepares the selector for response to dial impulses in the usual manner. When the subscriber at station X dials the next digit of the called subscriber's number, relay 102 is alternately released and reoperated by each impulse of the train. The release of relay 102 in response to the first impulse opens the bridge across the conductors of trunk T12, to release relay 85 of trunk circuit TC1, and closes a circuit through the middle lower front contact of relay 104 and outer lower back contact of relay 114 for operating relay 107. Relay 107 disconnects the left windings of repeating coil RC2 from the contacts of relay 102 and connects battery and ground to these contacts so that when relay 102 reoperates at the end of the first impulse, the line relay 85 of trunk circuit TC1 is reoperated by the energization of its windings in separate grounded circuits over the conductors of trunk T12, thereby insuring the reoperation of this relay at the end of each impulse.

Relays 77, 78, 79 and 80 constitute an impulse correcting repeater, controlled by relay 85 for transmitting corrected dial impulses to the line relays of incoming selector IS1 and succeeding switches through which connection with the called line is established. The release of relay 85, closes a circuit through the outer upper front contact of relay 76 and a back contact of relay 79 for operating relay 80. Relay 80 is fast in operating and slow in releasing. Relay 80 locks under control of relay 79, closes a circuit including the lower back contact of relay 91 for operating slow-to-release relay 77, closes a circuit for operating slow-to-release relay 81 and closes a circuit for operating relay 79. Relay 77 closes a bridge across conductors 57 and 58 which excludes the windings of repeating coil RC1 to insure the reoperation of the line relay of selector IS1 between dial impulses. Relay 77 remains operated during the repeating of each trained impulses. Relay 81 opens the energizing circuit for

the lower winding of relay 91 and closes a circuit for holding relay 77. Relay 79 opens the operating circuit of relay 80 and connects its winding in series with the winding of relay 78. When relay 80 releases, it opens the bridge across conductors 57 and 58, thereby transmitting an impulse to the line relay of selector IS2. If relay 85 has not reoperated before relay 80 releases, relay 79 is held operated and relay 78 is operated by the current in a circuit including the windings of these relays in series. When relay 85 reoperates at the end of the impulse, relays 78 and 79 release. The release of relay 78 closes the bridge across conductors 57 and 58 to reoperate the line relay of selector IS1. Relay 81 is slow in releasing and if the frequency of the dial impulses is high enough, for instance ten or eleven impulses per second, relay 81 remains operated while the train of impulses is being received and repeated to the selector IS1. In this case the bridge across conductors 57 and 58 is opened each time relay 80 releases and closed when relay 78 releases. Each succeeding release of relay 85 causes the reoperation of relays 80, 79 and 78 to repeat the impulses to the line relay of selector IS1 and thereby advances the brushes 61, 62 and 63 to the level corresponding to the digit dialed. If the impulses are being transmitted at a low rate, for instance eight or nine impulses per second, relay 81 releases before the next impulse causes the reoperation of relay 80; in which case the bridge across conductors 57 and 58 is closed at the back contact of relay 81 to end each impulse, relay 85 having reoperated to release relays 78 and 79 before relay 81 releases. The incoming selector IS1 is automatically operated to select an unguarded set of terminals in the selected group, the selected set of terminals being connected to a connector switch C1 having access to the called line.

The impulses created by the dialing of the last two digits of the called subscriber's number by the subscriber at station X causes the operation of relays 102 and 107 of trunk TC2. Relays 85, 77, 78, 79, 80 and 81 of trunk circuit TC1 operate as hereinbefore described to repeat these impulses through conductors 57 and 58, and brushes 61 and 62 of selector IS1, to connector C1 to effect the selection of the called line in the usual manner. The connector C1 makes the usual busy test and if the line is idle connects a ringing current source to the line to signal the called station. When the call is answered connector C1 functions in the usual manner to reverse the current through conductors 57 and 58 to operatively energize the upper winding of relay 91. Relay 91 interchanges the connections between the windings of relay 85 and the conductors of trunk T12, thereby reversing the current through these conductors to operatively energize the upper winding of relay 114. Relay 114 interchanges the connections between the windings of relay 102 and conductors 121 and 122, thereby reversing the current through these conductors to perform any desired supervisory operation, such for instance as charging for the call. The talking connection includes repeating coils RC2 and RC1 and is under the control of the calling station. When the called subscriber replaces the receiver the connector again reverses the current through conductors 57 and 58 to cause the release of relay 91. Relay 91 reverses the current through the conductors of trunk T12 to cause the release of relay 114; and relay 114 reverses the current over the conductors 121 and 122. When the call-

ing subscriber at station X replaces the receiver to release the connection, relay 102 releases causing the successive release of relays 104, 105 and 110 and the disconnection of the guarding potential from conductor 123. The release of relay 102 opens the bridge across the conductors of T12 to release relay 85 of trunk circuit TC1. The release of relay 85 causes the successive release of relays 76 and 75. Since relay 85 does not reoperate, relay 78 is operated in series with relay 79 to hold open the bridge across conductors 57 and 58 so as to cause the release of the line relay in the connector switch C1, the connector C1 and selector IS1 being thereby restored to normal in the usual and well-known manner.

The operator in the master office may call a subscriber in office TO or a subscriber in office LO. In either case the trunk circuits TC4 and TC3 operate as described in the aforementioned patent to R. B. Buchanan et al. to repeat dial impulses. The first train created by the dialing of the called subscriber's number operates the associated incoming selector IS3 to select a corresponding group and an unguarded set of terminals therein. On a call to a station Y in office TO, the succeeding trains of dial impulses effect the operation of a connector switch C2 to complete the connection in usual manner. On a call to a station B in office LO, the terminals selected by switch IS3 are connected to a trunk circuit TC2 and the succeeding train of impulses are repeated by trunk circuits TC4, TC3, TC2 and TC1 to operate the associated incoming selector IS1 and a connector C1 in office LO to complete the connection with line L3. The operation of trunk circuits TC2 and TC1 on such a call is similar to that hereinbefore described on a call from station X in office TO to station B in office LO.

In the above-described system, the trunks between the tandem and master offices are connected to terminals in the first level of incoming selectors IS2 associated with trunks from the local office, and each of the trunk circuits TC1 in the local office are arranged to automatically transmit a single impulse to the associated incoming selector in the tandem office on calls from the local to the master office. The trunks between the tandem and master offices may, however, be connected to any desired level of these incoming selectors in the tandem office, each of the associated trunk circuits in the local office being arranged to automatically transmit as many impulses, on calls to the master office, as are needed to directly control the incoming selector to select the level in which the trunks to the master office are connected.

Although the trunk circuits TC1 and TC2 are arranged for direct current, loop signaling, the invention is applicable to trunk circuits arranged for any type of signaling, for instance composite, simplex, or alternating current signaling.

What is claimed is:

1. In a telephone system, a first central office, a second central office, a trunk between said offices, two paths of access to said trunk in said first office, an incoming group selector connected to said trunk in said second office, subscribers' lines in said offices, subscriber controlled means in said first office for seizing said trunk through either one of said paths of access as desired, and means associated with said trunk and operative only if said trunk is seized over a certain one of the two paths of access for automatically operating said incoming selector to select a predetermined one of the groups to which it has access.

2. In a telephone system, a first central office, a second central office, a group of trunks between said offices, subscribers' lines in said offices, subscriber controlled group selector switches in said first office for establishing connections between calling lines and called lines or trunks, means for connecting a calling line to a selector switch, two paths of access to each of the trunks of said group, one path of access comprising terminals in one group in the banks of said group selectors, the other path of access comprising terminals in a different group in the banks of said group selectors, incoming group selectors in said second office one for each of said trunks, and means in said first office for each of said trunks effective upon seizure of the associated trunk through one but not the other of said paths of access for automatically causing the selective operation of the associated incoming selector in the second office to select a predetermined one of the groups to which it has access.

3. In a telephone system, a first central office, a second central office, a trunk between said offices, two paths of access to said trunk in said first office, an impulse controlled incoming group selector connected to said trunk in said second office, subscribers' lines in said offices, subscriber controlled means in said first office for seizing said trunk through either one of said paths of access as desired, and means associated with said trunk for automatically transmitting an impulse over said trunk upon seizure of said trunk through one but not through the other of said two paths of access for operating said selector to select a set of terminals in the first group of its bank.

4. In a telephone system, a first office, a second office, subscribers' lines in each of said offices, trunks between said offices, impulse controlled group selectors in said first office, impulse controlled incoming group selectors in said second office, each of said trunks being connected to terminals in two different groups in the banks of said group selectors in said first office and to an incoming selector in said second office, a third office and an operator's position therein, trunks between said second office and said position, the last mentioned trunks being connected to a group of terminals in the bank of each of said incoming group selectors in the second office, means responsive to the origination of a call at a subscriber's station in said first office for connecting the calling line to one of said group selectors in the first office, means including an impulse sender at the calling station for operating said one group selector to select one of said two groups on a call to a subscriber in said second office and to select the other of said two groups on a call to the operator in the third office and to select a set of terminals in the selected group, the selected terminals being connected to an idle one of said trunks between said first and second offices, and individual means for each of said trunks between the first and second offices responsive to the selection of the trunk in one of said two levels of the bank of a group selector in said first office but not to the selection of said trunk in the other of said two levels for transmitting an impulse over the trunk to the associated incoming selector in the second office to operate the selector to select the group of terminals to which are connected the trunks between said second office and said operator's position without further operation of the impulse sender at the calling station.

5. In a telephone system, a local unattended office, a local and tandem unattended office, a master office, subscribers' lines in each of said unattended offices, an operator's position in the master office, first selectors in said local unattended office and means for connecting a calling line to a first selector, combined interlocal and master office trunks between said unattended offices, said combined interlocal and master office trunks being connected to terminals in one level of said selectors for use on calls to subscribers in said local and tandem office and to terminals in another level of said selectors for use on calls to an operator in the master office, subscriber controlled means for operating a selector connected to a calling line to seize an idle one of said combined interlocal and master office trunks through either of the levels to which said trunks are connected, incoming selectors terminating said combined interlocal and master office trunks in said local and tandem office, first selectors in said local and tandem office, master office trunks between said local and tandem unattended office and said operator's position, said master office trunks being connected to the first level of said incoming selectors and to a level of the first selectors in the local and tandem office, and means associated with each of said combined interlocal and master office trunks in said local unattended office effective only upon seizure of the trunk through the level used for calls to the master office for automatically causing the operation of the associated incoming selector in the local and tandem office to select said group of master office trunks and an idle trunk therein.

6. In a telephone system, a first unattended office, a second unattended office, subscribers' lines in each of said offices, impulse controlled selector switches for establishing connections between calling and called lines, trunks between said offices, each of said trunks being connected to two levels in the banks of selectors in said first office and to an impulse controlled incoming selector in said second office, an operator's position, trunks to said position connected to a group of terminals in the bank of each of said incoming selectors in the second office, means responsive to the origination of a call at a subscriber's station in said first office for connecting the calling line to a selector having access to the trunks to the second office and having access to other switches in the first office, means including an impulse sender at the calling station for operating the connected selector to seize an idle one of said trunks through either of said levels, as desired, or to seize another selector switch through which connection with a called line in the first office may be established, individual means in the first office for each of said trunks automatically effective responsive to selection of the trunk through one but not the other of said levels of a selector in the first office to directly control the operation of the associated incoming selector in the second office to select the group of terminals to which are connected the trunks to the operator, and individual means associated with each of said trunks in said first office for repeating dial impulses from the calling station to operate the associated incoming selector in the second office to select another switch through which connection with a called line in the second office may be established.

7. In a telephone system, a first unattended office, a second unattended office, subscribers' lines in each of said offices, two-way trunks be-

tween said offices, an operator's position, trunks from said second office to said position, impulse controlled switches including local and incoming selector switches in each of said offices for establishing connections between calling lines and called lines or between calling lines and said position, each of said two-way trunks being connected to an incoming selector in the second office to terminals in a level of local selectors in said second office and to terminals in two different levels of the banks of selectors in the first office, means including means responsive to the origination of a call for connecting the calling line to a local selector, means including an impulse sender at the calling station for operating the connected selector to extend the connection to another selector in the same office on a call to another line therein or to extend the connection through an idle one of said two-way trunks to the associated incoming selector in the other of said first or second offices, means for each of said trunks in the second office for repeating impulses to the associated incoming selector in the first office to effect the completion of a connection with a called line in the first office, means for each of said trunks in the first office for repeating impulses to the associated incoming selectors in the second office to effect the completion of a connection with a called line in the second office, and means for each of said trunks in the first office automatically effective in response to selection of the trunk through one but not the other of the two levels to which it is connected in the banks of the local selectors in the first office to control the operation of the associated incoming selector in the second office to select the group of trunks leading to said operator's position.

8. In a telephone system, a first unattended office, a second unattended office, subscribers' lines in each of said offices, some of the stations in said first office being dial stations and others being manual stations, impulse controlled selector switches for completing desired connections, trunks between said offices, each of said trunks being connected to an incoming selector in said second office and to terminals in two levels of the banks of selectors in said first office, means responsive to the origination of a call at a manual station for connecting the calling line to one of said trunks, means responsive to the origination of a call at a dial station in said first office for connecting the calling line to a selector in said first office, an operator's position, trunks to said position connected to the terminals in one of the terminal groups in the banks of the incoming selectors in said second office, individual means in the first office for each of said trunks between the first and second offices for repeating dial impulses from a connected calling dial station to control the group selecting operation of the associated incoming selector in the second office, individual means in the first office for each of said trunks between the first and second offices automatically effective in response to the connection of a manual subscriber's line to the trunk or in response to the connection of a dial subscriber's line to the trunk through the terminals in one but not through the terminals in the other of the two levels of a selector in the first office to directly control the group selecting operation of the associated incoming selector in the second office to select said group of trunks to said operator's position.

9. In a telephone system, a first office, a second

office, subscribers' lines and dial stations in said first office, selector switches in said first office, means for connecting each calling line to an idle one of said switches, trunks between said offices, said trunks connected to terminals in two different levels of said switches, said switches operatively responsive to the dialing of a first digit at a connected dial station to select the one or the other of said levels according to the digit dialed and to select an idle one of said trunks, other means in said first office for seizing an idle one of said trunks, incoming selectors in said second office, each of said incoming selectors connected to one of said trunks, an operator's position, a group of trunks connecting said position to one of the levels of each of said incoming selectors, and means responsive to seizure of a

trunk between said first and second offices through one but not the other of the levels of one of said selector switches or by said other means for selectively operating the associated incoming selector to select an idle trunk in said groups of trunks to said operator's position.

10. In a telephone system, according to claim 9, means associated with each of said trunks in said first office effective upon seizure by one of said selector switches through said other level for repeating the impulses created by the dialing of a second digit at a connected dial station to selectively operate said incoming selector in said second office.

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