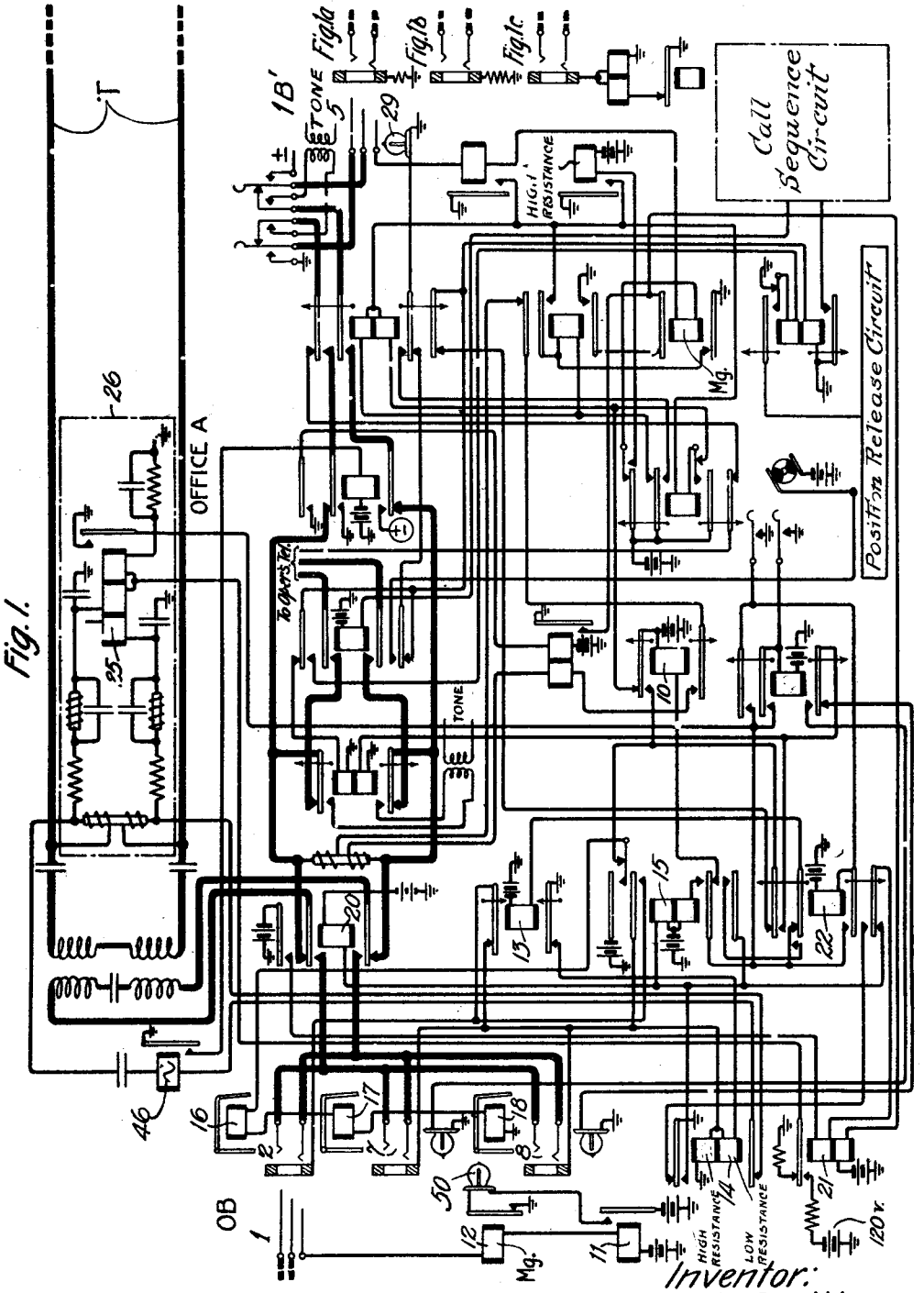
May 17, 1927. 1,629,008

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TELEPHONE SYSTEM

Filed June 29, 1925 2 Sheets-Sheet 1



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TELEPHONE SYSTEM

Filed June 29, 1925 2 Sheets-Sheet 2

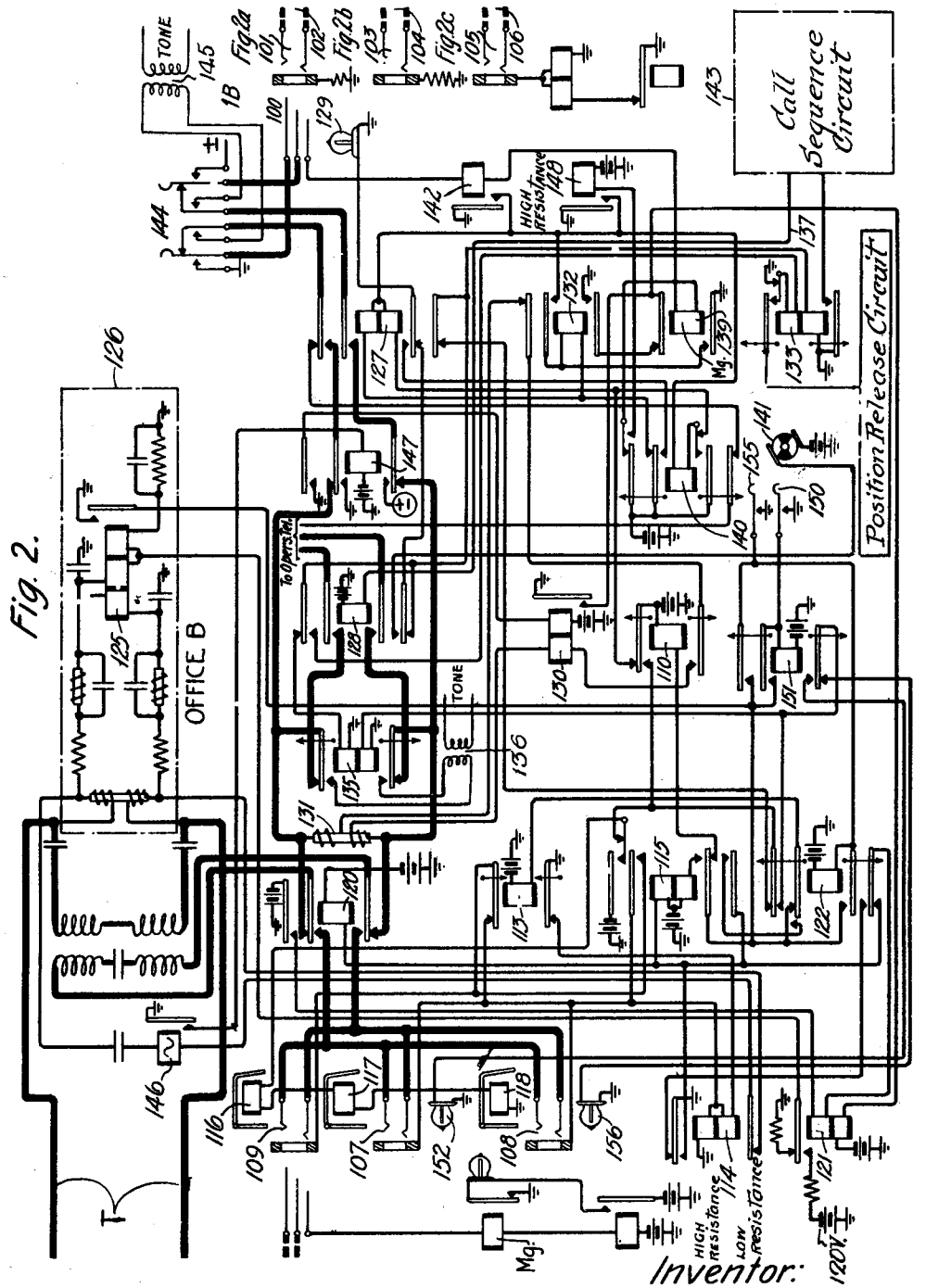


Fig. 2.

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Patented May 17, 1927. 1,629,008

UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

Application filed June 29, 1925. Serial No. 40,237.

This invention relates to telephone systems and more particularly to improvements in two-way straightforward toll line systems.

In toll line systems generally it is necessary to provide toll line equipment to handle different kinds of traffic, such as "through" connections, "repeater" or "delayed" operators' connections, and service for these various types of connections in both directions over the same toll line.

It is an object of this invention to provide a greatly simplified two-way straightforward toll line circuit arranged for use in systems requiring these various kinds of traffic.

Another object of this invention is to provide such a two-way straightforward toll line circuit that may also function satisfactorily with different types of "through" connecting circuits, such as a connection including a ringdown toll line, a switching trunk or a "built-up" connection including one or more other two-way straightforward toll line circuits of the same kind.

To attain these and other objects of the invention, there is provided in accordance with one feature thereof means for preventing false signaling when the straightforward toll line circuit is connected through a special operator's position such as a repeater or delayed operator's position. In case the call originating operator, i. e., the one originally connected with the straightforward toll line circuit for the extension of a connection therethrough, disconnects before the special operator, false signals are prevented from being sent back over the toll line to the incoming end thereof for it is evident that ordinarily, a signal would be transmitted to indicate that a connection in the opposite direction was desired when the outward end of the toll line is connected up. This feature also includes means for preventing the same kind of false signals from being transmitted from the call originating end of the toll line in case the special operator disconnects before the call originating operator.

Another feature of the invention is the provision of means in the two-way straightforward toll line circuit whereby in a built up connection, which includes one or more such straightforward toll line circuits in series, complete switchhook supervision from the called subscriber's station is effected, i. e., if the called subscriber operates his switchhook to recall the originating operator, a signal at the outward end of the first straightforward toll line circuit in the connection responds.

Another feature of the invention is the provision of means in a two-way straightforward toll line circuit, whereby in built up connections or connections involving but a single straightforward toll line disconnect signals are simultaneously operated in the straightforward toll line circuits involved and at any circuit connected to the last straightforward toll line circuit in the connection, when the originating operator disconnects. Another feature of the invention is the provision of means in a two-way straightforward toll line circuit whereby, if a connection intended for a special operator has been transferred from the inward operator's position to this special operator's position, a tone is transmitted back to the call originating operator's position until the special operator answers the call.

The invention has been illustrated in the accompanying drawings, in which Fig. 1 shows the circuit arrangement at one end of a two-way straightforward toll line with a portion of a standard cord circuit at the position of an operator originating a call; Figs. 1^a, 1^b, and 1^c show respectively a ringdown toll line, a switching trunk and the outgoing end of another straightforward toll line to which type of connecting circuit the calls incoming over the toll line shown in Fig. 1 may be routed; Fig. 2 shows a circuit arrangement at the opposite end of said straightforward toll line shown in Fig. 1 and portions of the various types of connecting circuits whereby the toll line may be extended beyond this point, such as a ringdown toll line, shown in Fig. 2^a, a switching trunk, shown in Fig. 2^b, and the out-

going end of another straightforward toll line shown in Fig. 2.

Referring now to the drawings in general, toll connections may be extended from an originating operator's position OB by inserting plug 1 into a multiple jack 2 of a straightforward toll line equipment at an office A, through the toll line proper T leading to the straightforward toll line equipment at an office B, where at an inward operator's position 1B the connection may be extended by insertion of plug 100 into jack 101 to a ringdown toll line 102 or into jack 103 of a switching trunk 104, or into jack 105 of another straightforward toll line 106. If the call is intended for a special operator's position the connection may be extended from a jack such as 107 to a repeater operator's cord, or from a jack such as 108 to a delayed operator's cord. On the other hand, if a connection is desired in the opposite direction, i. e., from office B to office A, the connection may be extended from an originating operator's position in the office B. The operator may insert her plug into jack 109 to connect with the toll line T to office A and from there the extension may then be made in the same manner as the extension of a connection from office B beyond, i. e., through plug 5 at the inward operator's position 1B' to the various types of connecting circuits or through jack 7 or 8 to special operator's cords.

To fully understand the functioning of the invention, as represented in these drawings, it is deemed sufficient to describe in detail the extension of a connection in one direction only and first, how the straightforward toll line circuit illustrated operates when a call originates through the operator's position OB and extends through the toll line T to a ringdown toll line 102 or a switching trunk 104, or another straightforward toll line circuit 106 and, second, how it functions if the connection is extended from the toll line T to a repeater or delayed operator's position through jacks 107 or 108.

Referring then to the drawings in order to extend the connection from the originating operator's position OB, the first action will be to insert plug 1 into jack 2. A circuit will then be completed as follows: from battery, winding of relay 11, winding of marginal relay 12, sleeve contacts of plug 1, jack 2, upper armature and back contacts of relay 13, partly through the upper high resistance winding of relay 14 to ground, but primarily through the lower low resistance winding of relay 14 to ground at the lower armature and back contact of relay 13.

The operation of relay 14 closes an obvious energizing circuit for relay 15 at its upper armature and front contact and the operation of relay 15 closes an energizing circuit for busy signal 16 associated with jack 2, busy signal 17 associated with jack 7 and busy signal 18 associated with jack 8, as follows: battery, upper outer armature and front contact of relay 15, windings of signals 16, 17 and 18 in series to ground. The operation of relay 14 also closes a circuit for relay 20, as follows: battery, winding of relay 20, upper armature and front contact of relay 14 to ground. The operation of relay 20 disconnects the inward end of the toll line leading to the inward operator's position 1B' at this office and terminating in plug 5, and connects the toll line to jacks 2, 7 and 8 at the outward operator's position OB and the repeater and delayed operator's positions respectively. The operation of relays 14 and 20 close a circuit for the operation of relay 21 as follows: battery, upper outer armature and front contact of relay 20, upper winding of relay 21, lower outer armature and back contact of relay 22, upper armature and front contact of relay 14 to ground. Relay 21 in operating provides a connection for current from a 120-volt battery source to a circuit leading to the office B, as follows: 120 volt battery, armature and front contact of relay 21, middle winding of relay 25, a composite leg (over the tip conductor) of toll line T, through the network enclosed in box 26, through the corresponding network 126 at the opposite end of the toll line T, the middle winding of relay 125 to ground at the armature and back contact of relay 121. Relay 25 at the originating end of the toll line does not operate at this time since approximately equal current flows through the differentially connected middle and right hand windings of this relay to ground at the armature and back contact of relay 121 and at the opposite end of the right hand winding of relay 25. However, relay 125 at the distant end operates and provides a circuit for the operation of relays 113 and 110. The circuit for relay 113, is as follows: battery, winding of relay 113, upper inner armature and back contact of relay 122, armature and front contact of relay 125 to ground, while the circuit for relay 110 is as follows: battery, winding of relay 110, lower inner armature and back contact of relay 115, armature and front contact of relay 125 to ground. The operation of relay 113 by opening the connection between its upper armature and back contact disconnects the sleeve circuit of the multiple jack 108 from ground through the windings of relay 114, in order to prevent interference in case an outward operator at office B attempts to extend a connection over the toll line in the opposite direction by inserting her plug in jack 108. The operation of relay 110 closes a circuit for making the outward end of the toll line at this office busy. This circuit is as follows: battery,

upper armature and front contact of relay 110, upper make-before-break contacts of relay 115, signals 116, 117 and 118 in series to ground. The operation of relay 110 also closes a circuit for the lighting of the line lamp 129 associated with the plug 100 at the inward operator's position 1B as follows: battery, upper armature and front contact of relay 110, upper outer armature and back contact of relay 122, lower outer armature and back contact of relay 127, lower outer armature and back contact of relay 128, lower inner armature and back contact of relay 127, lamp 129 to ground. The lighting of this lamp notifies the inward operator at the 1B position that the extension of a connection is desired on this toll line.

The operation of relay 110 further closes a supervisory bridge circuit across the tip and ring conductors of the toll line. This bridge including a winding of relay 130 may be traced as follows: from the tip conductor, through the upper winding of retardation coil 131, upper outer armature and back contact of relay 132, lower armature and front contact of relay 110, left hand winding of relay 130, lower winding of retardation coil 131 to the ring conductor. The purpose of this bridge for supervisory functions will be apparent as the description proceeds. The operation of relay 110 also closes an energizing circuit for relay 133 from battery at the upper armature and front contact of this relay through the upper outer armature and back contact of relay 122, lower outer armature and back contact of relay 127, lower winding of relay 133 to ground. The operation of relay 133 closes connections at its armatures and front contacts to a call sequence circuit, indicated with a box 143 and which is of the well known type for assigning the inward operator's telephone circuit to busy toll lines in succession. The actual connection of the operator's telephone circuit to this toll line will be described later. The last action produced by the operation of relay 110 is the closing of a circuit for relay 135, as follows: battery, upper armature and front contact of relay 110, upper outer armature and back contact of relay 122, lower outer armature and back contact of relay 127, upper outer armature and back contact of relay 128, upper winding of relay 135 to ground. The operation of relay 135 prepares a connection at its armatures and front contacts from a source of tone current 136 to the tip and ring conductors of the toll line and a tone from this source is therefore now transmitted over the toll line T to the originating operator at position OB in office A to indicate to this operator that the call has been registered at the inward operator's position 1B at office B and that the operator at this latter office is not yet free to answer the call.

When the inward operator at 1B is available for the call on this particular toll line, the call sequence circuit 143 such as shown and described in Patent No. 1,578,651, granted March 30, 1926, to K. M. Fetzer, functions and furnishes a connection to ground over lead 137 for the operation of relay 128, as this lead is connected to one terminal of the winding of relay 128 while the other terminal is connected to battery. As relay 128 operates, the circuit for relay 135 is broken at the upper outer armature and back contact of relay 128 and consequently relay 135 is released and the tone supplied to the originating operator is removed from the toll line which is now transferred to the 1B operator's telephone set at the inner upper and lower armatures of relay 128. The removal of the tone from the toll line indicates to the originating operator that the distant operator is ready to answer.

The operation of relay 128 also breaks the energizing circuit for lamp 129 at the lower outer armature and back contact of relay 128 and transfers the circuit for the lamp through an interrupter 141 to battery at the front contact of this armature, so that the lamp 129 will now be alternately lighted and extinguished to indicate to the inward operator that her telephone set is connected to this particular toll line.

The originating operator now transmits the details of the call to the inward operator, who then inserts plug 100 into jack 101, assuming that the connection desired is to be extended over a ringdown toll line 112 to the desired subscriber. The condition of the sleeve circuit on a ringdown toll line if idle is such as to cause the operation of relay 142 and marginal relay 139 over the following circuit: from battery, upper outer armature and back contact of relay 140, winding of marginal relay 139, winding of relay 142, sleeve terminals of plug 100 and jack 101 to ground on the sleeve of the ringdown toll line. The operation of relay 142 closes an energizing circuit for relay 127 as follows: battery, upper inner armature and back contact of relay 140, upper winding of relay 127, armature and front contact of relay 142 to ground. The operation of relay 127 transfers the tip conductor of the toll line T from the usual busy test lead through the plug 100 and jack 101 to the tip conductor of the toll line 102. It also connects the ring conductor from the toll line 102 through the jack 101 and plug 100 to the toll line T. A further action on the part of relay 127 is to open the circuit for lamp 129 from the interrupter 141 so that this lamp is now extinguished.

The operation of relay 127 also opens the circuit for 133, which now returns to normal and on the release of relay 133 the ground from the call sequence circuit at 143 for the operation of relay 128 is removed, so that relay 128 is now also released and the inward operator's telephone set is, therefore, set free from this particular toll line and will be automatically connected to some other toll line on which a call may be waiting, in accordance with the well known functioning of call sequence circuit at 143.

The operation of marginal relay 139 provides a circuit for the operation of relay 132, as follows: battery, upper inner armature and back contact of relay 140, winding of relay 132, lower armature and front contact of marginal relay 139 to ground. This marginal relay also opens at its upper armature and back contact a point in a circuit for the lower winding of relay 121, the purpose of which will hereinafter be described. Relay 132 opens the bridge circuit across the tip and ring conductors of the toll line at its upper outer armature and back contact; this bridge having previously been closed at the operation of relay 110, but as it is not needed in this type of connection the purpose of relay 132 becomes clear.

The inward operator may now ring the ringdown toll line operator at the distant end by the operation of key 144 and when this key is operated ringing tone is transmitted over the toll line T back to the originating operator, as an indication that the connection is being established. The circuit from the tone source 145 is connected to the tip and ring of the toll line at the make-before-break contacts of key 144. The originating operator now listens in to follow the establishing of the connection and when the called subscriber answers the connection between the calling and called subscribers may be established in the usual manner.

If the originating operator desires for some reason or other to rering a wanted subscriber, she may operate the ringing key associated with her toll cord in the usual manner, which transmits ringing current over the toll line to office B and operates alternating current responsive relay 146 at the office B, which is bridged across the tip and ring conductors of the toll line, as follows: tip conductor, through the network 126, winding of relay 146, lower armature and back contact of relay 114, network 126 to the ring conductor. The relay 46 at office A normally bridged across the toll line does not operate at this time since the bridge circuit therefor is open at the lower armature and back contact of relay 14 which it will be remembered is held operated at this time in the sleeve circuit of the originating operator's cord. Relay 146 in operating closes a circuit for relay 147 as follows: battery, winding of relay 147, armature and front contact of relay 146 to ground. The operation of relay 147 causes ringing current to be transmitted over the ringdown toll line to the called subscriber's bell. During this ringing interval relay 147 closes its upper outer armature and front contact so that ground is connected to the right hand winding of relay 130. Relay 130, in turn, closes a circuit through the lower winding of relay 121 whereby the source of 120 volt current is connected to the junction point between the middle and right hand windings of relay 125 and has the effect of causing the actuation of relay 25. This is caused by the fact that at this time a source of 120 volt current is connected to the junction point between the middle and right hand windings of relay 25 so that no current now flows over the line and the middle windings of relays 25 and 125, but current does flow in the right hand windings of both of these relays. Thus, relay 125 will be maintained energized and relay 25 will become energized. Upon the energization of relay 25, a circuit will be established from ground, the contact and armature of relay 25, the back contact in the inner upper armature of relay 22, winding of relay 13 to battery, causing the energization of relay 13. The sleeve circuit which is closed through the back contact and upper armature of relay 13 is, during this interval, maintained closed by the front contact and inner upper armature of relay 15. However, the ground connection through the low resistance winding of relay 14 is opened so that the resistance of the circuit for relays 11 and 12 is materially increased, whereby relay 12 releases its armature and completes a circuit for signaling lamp 50 to indicate to the operator, who is depressing her ringing key, that the apparatus at the distant end is operating properly.

When the originating operator receives a disconnect signal, as the calling subscriber hangs up his receiver, she removes plug 1 from jack 2, and relay 14 releases which causes relay 21 to release. When relay 21 releases, current from the 120 volt battery is disconnected from the composite leg so that relay 125 at the distant end of the toll line at office B will now release. This relay 125 in releasing opens the circuit for relays 110 and 113, causing them to release. The release of relay 110 opens the circuit for the busy signals 116, 117 and 118 and also opens the circuit for the bridge including relay 130, although this circuit is already disconnected from the line by the operation of relay 132 as hereinbefore described. Relay 110 also closes a circuit for relay 140 as follows: battery, upper armature and back contact of relay 110, lower make-before-break contacts of relay 140, winding of relay 140

to ground at the armature and front contact of relay 142. The operation of relay 140 closes a circuit for lamp 129 as follows: battery, upper inner armature and front contact of relay 140, lower inner armature and front contact of relay 127, lamp 129 to ground. The lighting of this lamp notifies the inward operator at position 1B that the operator at the originating position has disconnected and that this operator may now remove plug 100 from jack 101. This relay 140 also transfers the circuits for relays 139 and 142 to battery, through relay 148 so that this relay now operates in series with relays 139 and 142 and as relay 110 has released battery will be furnished to relay 127 through its lower winding in place of the battery for its upper winding formerly furnished at the upper inner armature and back contact of relay 140. Under these conditions relay 139 may release but relays 142 and 148 will remain operated and relays 127 and 140 will also remain operated on the ground furnished by the operation of the armature of relay 148. The purpose of including relays 148 in this sleeve circuit will be hereinafter described in connection with circuits extending to other connecting circuits. If the inward operator now removes plug 100 from jack 101 relays 127, 148 and 140 are released and the ringdown toll line operator will now disconnect her cord from the ringdown toll line and from the called subscriber's line.

If a connection over the straightforward toll line T is desired to a subscriber that may be reached through a switching trunk such as 104, the inward operator at position 1B inserts plug 100 in jack 103. The particular switching trunks through which a connection is to be extended may be selected by the usual call wire method well known in the art. Relay 142 will now operate, but marginal relay 139 does not operate due to the resistance conditions on the sleeve of the switching trunk. Relay 142 in operating provides an energizing circuit for relay 127 as previously traced, causing relay 127 to operate to connect the tip and ring of plug 100 to toll line T; to extinguish lamp 129, and to release relay 133, as hereinbefore described. Relay 133 in releasing disconnects ground from lead 137 so that the relay 128 is now also released. The inward operator's telephone set is, therefore, freed from this particular connection and will be automatically connected to some other toll line on which a call may be waiting.

When the distant end of the switching trunk 104 is connected to a subscriber's line, battery and ground will be connected to this trunk, as is well known in the art, causing the operation of relay 130, which it will be remembered is included in the bridge across the tip and ring conductors of the toll line. An obvious circuit will then be closed by the operation of relay 130 for the operation of relay 121, which now connects the 120 volt battery, to the middle winding of relay 125, over the composite leg to the corresponding winding of relay 25 at the originating end. Under these conditions practically no current flows over the composite leg since a 120 volt battery is connected at both ends thereof and relay 25 will therefore operate over a circuit from these 120 volt batteries to ground through its right hand winding. Relay 25 in operating closes a circuit for relay 13, while relay 10 does not operate at this time since relay 15 is already operated, as previously described. Relay 13 in operating disconnects ground from the lower low resistance winding of relay 14, but this relay remains operated through its upper winding. The resistance of the sleeve circuit to ground through this winding of relay 14 is now of such value as to release the usual marginal relay 11 in the originating operator's cord circuit, thus causing her supervisory lamp 50 to light to indicate that the toll line T has been connected to a switching trunk.

The originating operator at position OB now rings the called subscriber connected at the opposite end of the switching trunk by operating the usual ringing key in the cord circuit used in this connection. This applies ringing current over the toll line T, which causes the operation of relay 146 in office B while relay 46 at the originating end does not operate at this time since it is disconnected from the circuit at the lower armature and back contact of relay 14 which is operated at this time. Relay 146 in operating provides a circuit for the operation of relay 147 and the operation of this relay transmits ringing current over the switching trunk, resulting in the ringing of the called subscriber's bell. Relay 147 also provides at its upper outer armature and front contact a holding circuit for relay 130 during the ringing period.

When the called subscriber answers, battery and ground previously mentioned as connected to the switching trunk will be removed, thus causing the release of relay 130, which in turn releases relay 121, which now opens the circuit supplying battery from the 120 volt source to the composite leg at the armature and front contact of this relay. This removal of the current from the composite leg causes the relay 25 at the originating end of the toll line to release, since equal currents are now flowing through its two windings. The release of relay 25 causes the release of relay 13. This latter relay now connects ground to the lower winding of relay 14 and the resistances of the two windings of this relay are of such value that the marginal relay 12 in the originating

operator's cord circuit operates to extinguish the supervisory lamp 50 thereat, thus notifying the originating operator that the called subscriber has answered and that the connection may be completed between the calling and called subscribers.

When at the termination of the conversation between the subscribers the called subscriber replaces the receiver upon the switchhook, battery and ground are again connected to the switching trunk 104, causing relay 130 to again operate. The operation of this relay now closes an obvious circuit for the operation of relay 121 and this relay 121 in operating closes the circuit for current from the 120 volt battery to the composite leg to cause the operation of relay 25. This relay in operating causes the reoperation of lamp 50 in the manner hereinbefore described, and this signal now serves as an indication to the originating operator that the called subscriber has hung up his receiver.

If the called subscriber instead of hanging up his receiver permanently, moves his switchhook up and down, to recall the originating operator, it will be seen that the supervisory lamp 50 will be correspondingly lighted and extinguished.

If the originating operator disconnects, relay 14 releases, which in turn causes the release of relay 21 and if the connection to the called subscriber's line is still intact and the called subscriber's receiver is on the hook, relay 15 will remain operated since it is locked up under control of the relay 25 as this relay remains operated due to the operation of relay 121 as hereinbefore described. The holding of relay 15 operated prevents a false signal from appearing at the inward cord 1B′ of the toll line at the office A; that is, relay 10 will be prevented from operating at this time and consequently lamp 29 will not light as it ordinarily would when relay 121 is operated. However, relay 125 will release as soon as relay 21 releases even though relay 121 is operated as current from the 120 volt battery will be approximately equally divided between the middle and right hand windings of relay 125 and since these windings are differentially connected this relay releases. Relay 125 in releasing opens the circuit for relays 110 and 113 which then release. The release of relay 110 releases the busy signals 116, 117 and 118 and opens the circuit for relay 130 and furnishes battery for the operation of relay 140. The opening of the circuit for relay 130 transmits a disconnect signal to the toll switching trunk at the distant office, so that the operator at this end of the switching trunk will be notified that an originating operator has disconnected in a manner well known in the art. The operation of relay 140 closes an obvious circuit for signal lamp 129 which in lighting now notifies the operator at 1B that the originating operator at OB has disconnected. The inward operator now removes plug 100 from jack 103 and the associated relays return to normal. It should be noted that in this case the method of transmitting a disconnect signal is different from that employed in ringdown toll line connection as previously described but relays 130, 139, 142, 140 and 147 while functioning in the same manner as before do not have the same effect on the switching trunk circuit as they did on a ringdown toll line. When relay 130 releases on the release of relay 110 relay 121 will also release and therefore relay 25 will release and cause the release of relay 15 so that the circuits at the outward end of the toll line T will now also be restored into normal condition.

In case the extension of a connection from the toll line T requires a built-up connection including two or more straightforward toll lines, such as toll line T, the inward operator at position 1B will insert her plug 100 in jack 105 of the two-way straightforward toll line 106 and the functioning of the circuits are the same as when a connection is extended through a ring down toll line, i. e., relays 139 and 142 are operated and the apparatus at the outgoing and incoming ends of the second straightforward toll line then function the same as the first straightforward toll line, up to the point where the called subscriber's line is seized. At this time the sleeve resistance of the outward end of this second straightforward toll line circuit 106 is changed in the same manner as the sleeve resistance was changed on the operation of relay 13 when plug 100 was inserted in jack 103 of a switching trunk so that relay 139 is released. This relay in releasing provides a circuit for the operation of relay 121 as follows: battery, lower winding of relay 121, upper armature and back contact of relay 139, lower armature and front contact of relay 132 to ground. The operation of relay 121 causes, as hereinbefore described, the operation of signal 50 at the originating operator's cord circuit to indicate that the connection has been extended to the called subscriber's line. The originating operator may now ring the called subscriber in the same manner as when a connection was established over the first straightforward toll line T only. Under this condition the ringing current is transmitted to cause the operation of relay 147, which transmits ringing current over the second toll line to cause the operation of a relay similar to 147, which results in the ringing of the called subscriber in the same manner as hereinbefore described. When the called subscriber answers, ground is connected to the lower winding of the relay in the second toll line corresponding to relay 114 of the first

straightforward toll line T in the same manner as hereinbefore described and under this condition the sleeve resistance will be such as to cause the operation of relay 139 of the first straightforward toll line and the operation of this relay causes, as hereinbefore described, the extinguishing of lamp 50 at the originating operator's position to indicate that the called subscriber has answered. Therefore, in connections of this type, that is, where more than one straightforward toll line is used, complete switchhook supervision will pass to the originating operator through the various straightforward toll lines and when the subscriber disconnects the functions of these straightforward toll line circuits will be the same as the function described in connection with the disconnect signal incoming through a switching trunk.

When the originating operator removes plug 1 from jack 2 while the plug 100 at the distant end is connected to jack 105 of another straightforward trunk, relay 140 of the first trunk becomes operated as hereinbefore described, whereupon relays 142, 139 and 148 are included in series with the sleeve of plug 100. Relay 148 is of high resistance, so that relays 139 and 142 release. The latter relay, while not being adjusted to release in the same manner as relay 139, is also marginal. The armature and front contact of relay 148 now substitute for the armature and front contact of relay 142. Due to the high resistance of the sleeve circuit of plug 100, the relay of the straightforward trunk corresponding to relay 114 is released, whereupon a disconnect signal is given to the distant end of the second straightforward trunk in the manner hereinbefore described.

When the inward operator at position 1B receives a call requiring a connection extending through a repeater, this operator will, instead of inserting her plug 100 into jacks such as 101, 103, and 105, momentarily depress key 150 associated with this toll line. The operation of this key closes an obvious circuit for the operation of relay 151, which in turn closes a circuit for relay 122. This latter relay provides a locking circuit for itself to ground at the armature and front contact of relay 125. Relay 151 in operating connects battery, furnished through the operated relays 110 and 122 for the lighting of line lamp 152 associated with jack 107 at the repeater operator's position. The circuits are as follows: battery, upper armature and front contact of relay 110, upper outer armature and front contact of relay 122, lower armature and front contact of relay 151, lamp 152 to ground. The lighting of this lamp notifies the repeater operator at this position that a connection through a repeater from this particular toll line is desired. Relay 122 in operating also releases relays 113 and 133 and closes a circuit for the operation of relay 135, as follows: battery, upper armature and front contact of relay 110, upper outer armature and front contact of relay 122, lower winding of relay 135, to ground. When relay 133 releases, relay 128 is also released and the telephone set of the operator at position 1B is disconnected and lamp 129 extinguished. Relay 135 in operating sends the tone back to the originating operator at position OB, indicating to that operator that the call has been transferred to the repeater operator.

The repeater operator seeing lamp 152 lighted answers the call by inserting the plug of the repeater cord (not shown) into jack 107 associated with this lamp 152. This causes the operation of relay 114 and the operation of this relay closes a circuit for relays 115 and 120. The operation of relay 115 provides a circuit for holding the busy signals 116, 117 and 118 operated while it causes the release of relay 110. Relay 115 also establishes holding circuits for relays 122 and 151 by closing its lower outer armature to the corresponding front contact and ground of relay 114 so that in case the originating operator disconnects before the repeating operator has disconnected these relays will not release but perform certain functions that will be hereinafter described. Relay 115 in operating also locks up under the control of relay 125, in order to prevent relay 110 from operating and cause certain operations at the inward operator's position 1B in case the repeater operator disconnects before the originating operator disconnects, as will hereinafter be described. Relay 120 in operating transfers the tip and ring conductors of the straightforward toll line T from the end of the circuit terminating at the inward operator's position 1B to the jack 107 of the repeater operator's position and also closes the circuit for the upper winding of relay 121, but this relay does not operate at this time as relays 114 and 122 are operated. The release of relay 110 opens the circuit for the lamp 152 at its upper armature and front contact and causes the release of relay 135 to disconnect the tone from the toll line. The connection is now ready for the extension through the repeater operator's position.

If a connection is desired through a delayed operator's position, the key 155 is momentarily operated and the operation of this key closes the energizing circuit for relay 122, which locks up under control of ground at relay 125. The operation from this point on is the same as that described in connection with the extension through to the repeater operator's position, except that relay 151 is not operated, and consequently lamp 156 is lighted in place of lamp 152 and the delayed operator inserts the answering plug of one

of her cords in jack 108 so that the extension of the call will then be through this operator's position.

The functions of the circuits when calls are completed through a repeater operator's position or a delayed operator's position in regard to the breaking down of the connections and the prevention of false signaling will now be described. In case of a repeater connection, the originating operator rerings over the line before disconnecting, in order to cause the supervisory signal associated with the repeater cord circuit to operate as a disconnect signal. In case of a call completed through the delayed operator's position the disconnect signal is operated when the called subscriber disconnects, although the originating operator may give a disconnect signal to the delayed operator's position by reringing as in the case of a repeater connection.

When the originating operator disconnects, relay 14 releases so that relays 15, 20 and 21 are in turn released and so that the circuit for relay 46 is closed. Relay 20 in releasing transfers the toll line T from the outward end to the tip and ring of the inward end of the toll line equipment at office A. The release of relay 15 releases the busy signals 16, 17 and 18 and closes the circuit for relay 10 to the front contact of relay 25. Relay 21 in releasing opens the circuit from the 120 volt battery, thereby releasing relay 125 at the distant end of the toll line. If this release of the connection by the originating operator takes place before a repeater operator disconnects, relay 125 in releasing will not release relays 115, 122 or 120, as these relays are locked up under control of relay 114, as hereinbefore described. Therefore, as relay 122 is operated, relay 121 cannot operate and cause a false signal to be set up at the inward position 1B' as would ordinarily take place in case a connection was desired from office B to office A. A plug inserted in jack 109 or as in this case in jack 107 or 108 would cause the operation of relay 14 which would result in the operation of relay 121. It is, therefore, seen that even though a connection is made through a jack at the outward position of office B no signal is received at the inward position at office A under these circumstances. When now the repeater operator disconnects relay 114 releases and consequently all the other relays release and the circuits are restored to normal.

It is evident that the circuit functions in the same manner in the case of a connection through a delayed operator's position when the originating operator disconnects before the delayed operator, except that in that case relay 151 is not operated, as would be the case when a repeater operator is connected to the circuit.

In case the repeater operator disconnects before the originating operator disconnects, a disconnect signal is transmitted to the originating operator as follows: Relay 114 releases as soon as the repeater operator's plug is removed from jack 107 and a circuit is completed for the operation of relay 121 from the ground at the upper armature and back contact of relay 114 through the lower armature and front contact of relay 122. This relay 121 in operating connects the circuit from the 120 volt battery over the composite leg for the operation of relay 25 at the originating end of the circuit at office A. The operation of this relay closes a circuit for relay 13, as hereinbefore described, which in turn opens the circuit to ground for the lower winding of relay 14. The resistance of the sleeve circuit is now such as to cause the release of the marginal relay 12 at the originating operator's cord circuit and lamp 50 is therefore lighted as a disconnect signal.

It will be noted that the relay 115 is locked up under control of relay 125 to prevent relay 110 from operating, so as to prevent a false signal appearing at the inward operator's position 1B in office B, even though the originating operator's plug 1 is still inserted in jack 2 at this time, which would ordinarily cause relay 110 to operate and the lamp 129 to light to indicate to the inward operator at this office that a connection is desired.

When the originating operator disconnects, relay 125 is released, which in turn releases relays 151, 122, 120, 115 and 121, restoring the circuits to normal. The circuits under these conditions operate in the same manner as they do in case a delayed operator disconnects before the originating operator disconnects, except that, of course, relay 151 is not operated.

What is claimed is:

1. A two-way trunk line terminating at each end in outward and inward terminals, a signal at each inward terminal responsive to a connection established over a distant outward terminal, means associated with the inward terminals for signaling outward terminals at the same end of the line whereby a connection may be established from an outward terminal at one end of the line to the inward terminal at the other end of the line and then transferred to an outward terminal at said other end of the line and means responsive to such a connection from an outward terminal at one end to an outward terminal at the other end of the line to prevent the inward terminal signal at either end from being actuated when disconnection takes place at the opposite end.

2. A two-way trunk line terminating at each end in outward and inward terminals, a signal at each inward terminal responsive to a connection established over a distant

outward terminal, means associated with the inward terminals for signaling outward terminals at the same end of the line whereby a connection may be established from an outward terminal at one end of the line to the inward terminal at the other end of the line and then transferred to an outward terminal at said other end of the line, and means responsive to such a connection from an outward terminal at one end to an outward terminal at the other end of the line to prevent the inward terminal signal at the end to which the connection was established from being actuated when disconnection at the outward terminal from which the connection was established takes place before the disconnection at the other outward terminal.

3. A two-way trunk line terminating at each end in outward and inward terminals, a signal at each inward terminal responsive to a connection established over a distant outward terminal, means associated with the inward terminals for signaling outward terminals at the same end of the line whereby a connection may be established from an outward terminal at one end of the line to the inward terminal at the other end of the line and then transferred to an outward terminal at said other end of the line and means responsive to such a connection from an outward terminal at one end and to an outward terminal at the other end of the line to prevent the inward terminal signal at the end from which the connection was established from being actuated when disconnection at the outward terminal to which the connection was established takes place before the disconnection at the other outward terminal.

4. A trunk line having at its inward end means including a signal, a bridge circuit across the talking conductors of the line, and means for changing the electrical characteristics of the sleeve conductor at the inward end of the line characterized by the provision of means responsive to disconnection of a connection at the outward end of the line for simultaneously actuating the signal, for opening the bridge and changing the electrical characteristics of the sleeve conductor thereat.

5. A two-way trunk line terminating at each end in outward and inward terminals, a signal at each inward terminal responsive to a connection established over a distant outward terminal, and means associated with the inward terminals of said line for reoperating said signal at the inward terminal at one end of said line and for changing the electrical characteristics of the inward terminal at the same end of the line responsive when disconnection takes place at the opposite end of said line.

6. A two-way trunk line terminating at each end in outward and inward terminals, a signal at each inward terminal responsive to a connection established over a distant outward terminal, and means associated with the inward terminals of said line for reoperating said signal at the inward terminal of one end of the line, for opening a bridge circuit across the talking conductors of the line at the inward terminals at the same end of the line and for changing the electrical characteristics of the sleeve terminal of said inward terminals at the same end of the line responsive when disconnection takes place at the opposite end of said line.

7. A two-way trunk line terminating at each end in outward and inward terminals, a signal at the inward terminals responsive to a connection established over a distant outward terminal, and means associated with the inward terminals of said line for operating said signal at the inward terminals of one end of the line, for opening a bridge circuit across the talking conductors of the line at the inward terminals at the same end of the line and for changing the electrical characteristics of the sleeve terminal of said inward terminals at the same end of the line responsive when this connection takes place at the opposite end of said line.

8. A two-way trunk line terminating at each end in outward and inward terminals, a signal device at each inward terminal, means associated with the outward terminals responsive to a change in the electrical characteristics of the sleeve terminals thereof for transmitting a signal over said line to the inward terminals at the opposite end of the line, and means associated with the inward terminals responsive to said signal received over the line for operating the signal device at the inward terminals at the opposite end of the line and for simultaneously establishing a corresponding change in the electrical characteristics of the inward sleeve terminal at said opposite end of the line.

9. A trunk line having at its outward end means for transmitting a signal to the inward end and for operating a signal device at the inward end on a certain change in the electrical characteristics of the outward end when a connection is established to said outward end of the line characterized by the provision of means responsive to the disconnection of a connection at the outward end for reoperating said signal device and establishing a corresponding change in the electrical characteristics at the inward end of the line.

10. A two-way trunk line terminating at each end in outward and inward terminals, means for establishing a connection between an outward terminal at one end to the inward terminal at the opposite end of the line, means associated with the inward terminals for signaling the outward terminals

at the same end of the line, whereby a connection established to this inward terminal may be transferred from said inward terminals to said outward terminal at the same end, means for signaling the outward terminal at the connection originating end of the line, responsive to the means for transferring the connection and means for disabling said last mentioned signaling means on the establishing of a connection with the outward terminal to which a connection from the connection originating end of the line was transferred.

In witness whereof, I hereunto subscribe my name this 27 day of June A. D., 1925.

ERMY R. SMITH.