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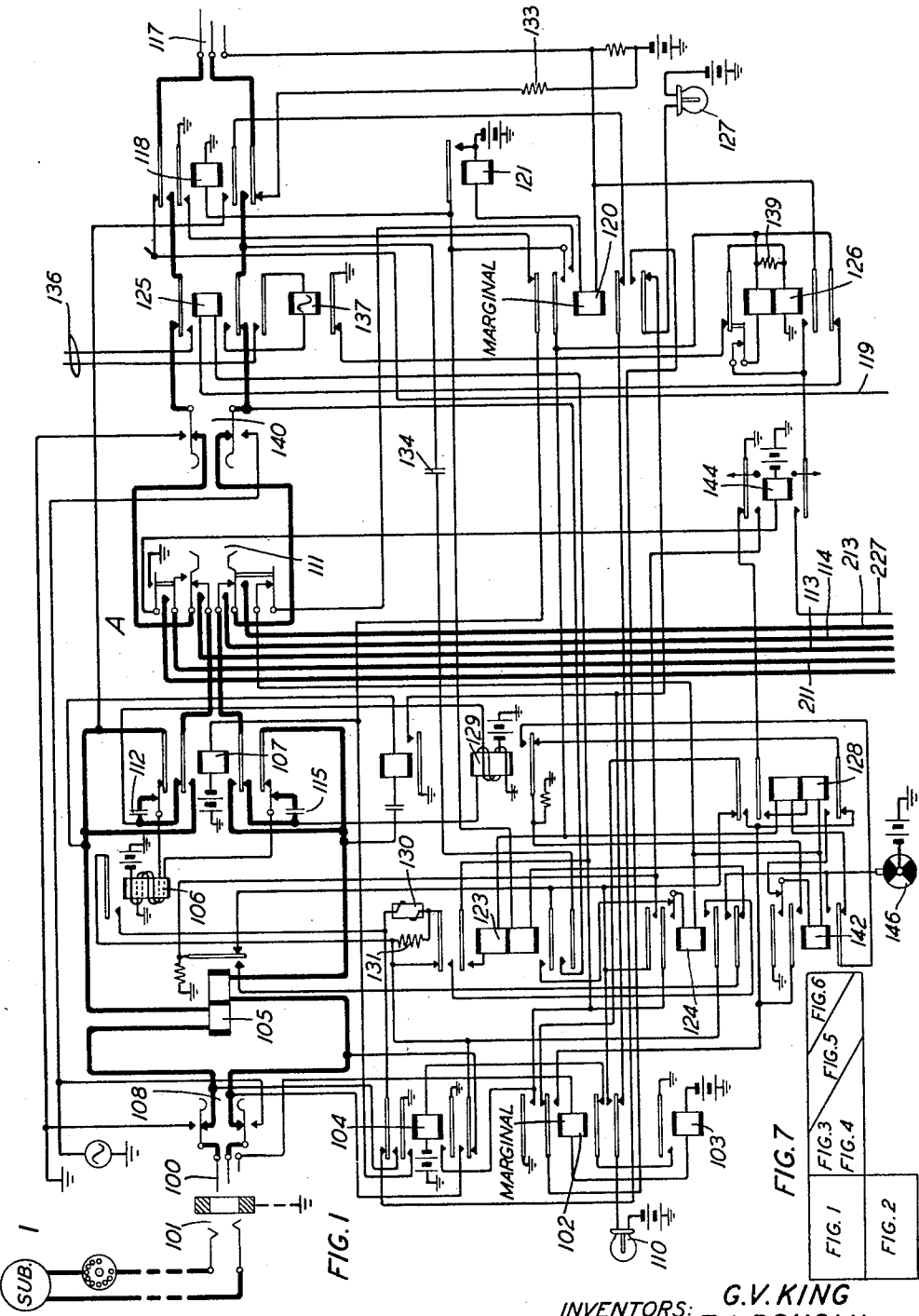
G. V. KING ET AL

1,881,669

TELEPHONE SYSTEM

Filed Feb. 24, 1931

5 Sheets-Sheet 1



INVENTORS: G.V. KING  
F.A. BONOMI

BY *W. M. McFenney*  
ATTORNEY

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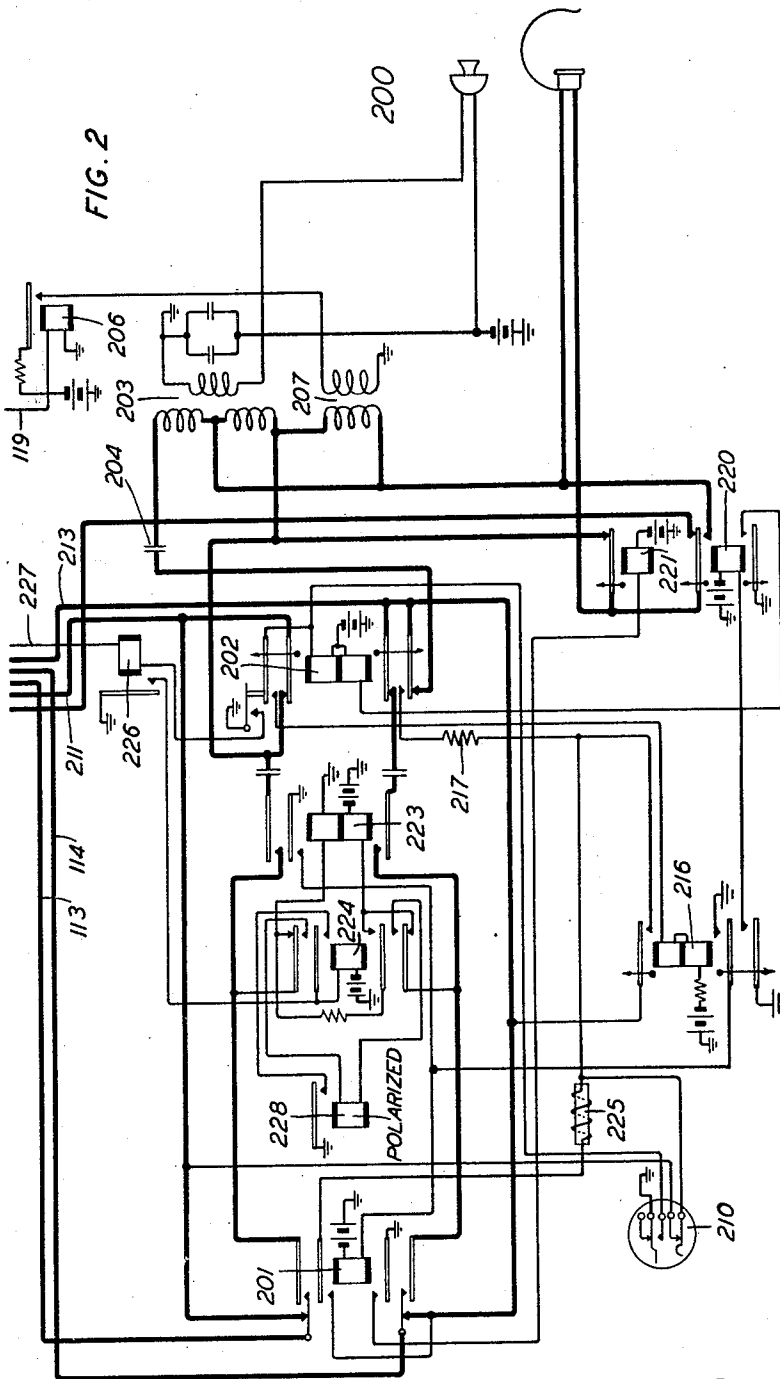
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5 Sheets-Sheet 2



INVENTORS: G.V.KING  
F.A.BONOMI

BY *M. B. McFadden*  
ATTORNEY

Oct. 11, 1932.

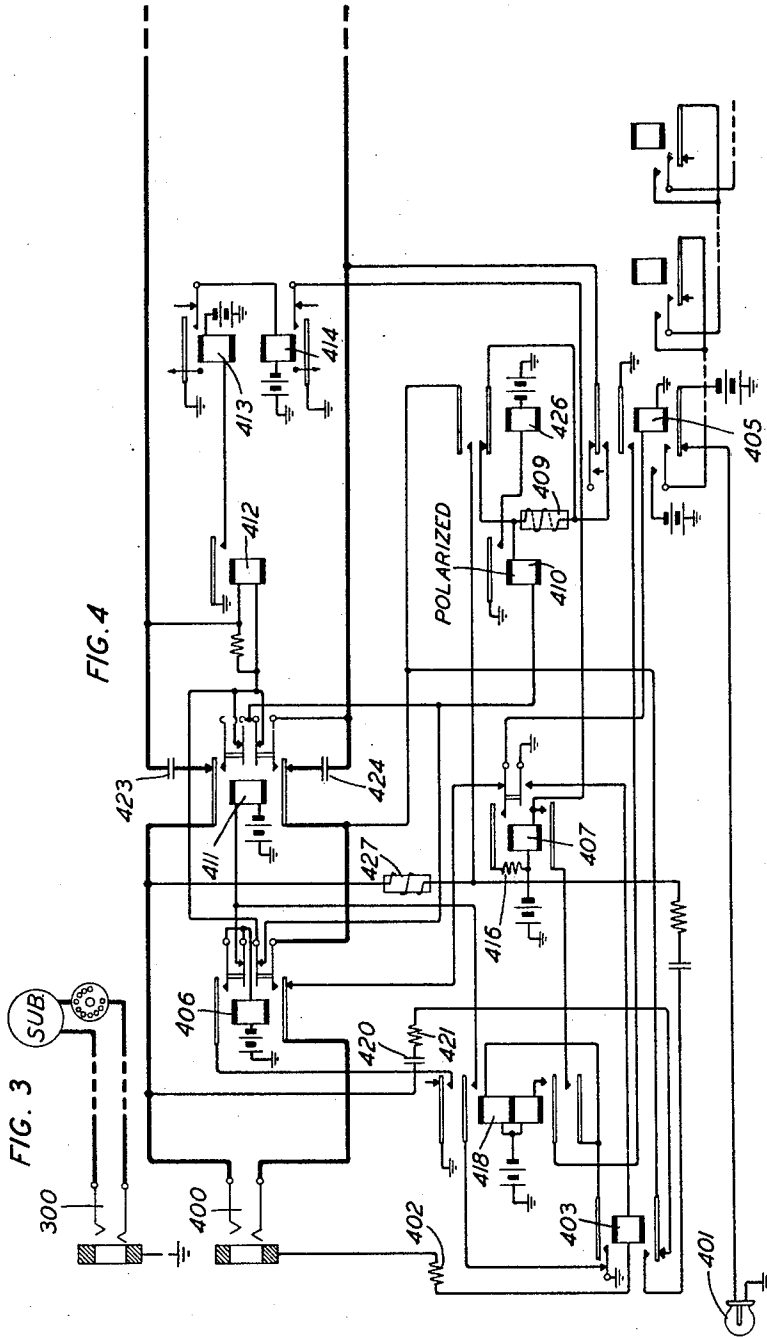
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TELEPHONE SYSTEM

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5 Sheets-Sheet 3



INVENTORS: G. V. KING  
F. A. BONOMI  
BY *M. B. McFenney*  
ATTORNEY

Oct. 11, 1932.

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TELEPHONE SYSTEM

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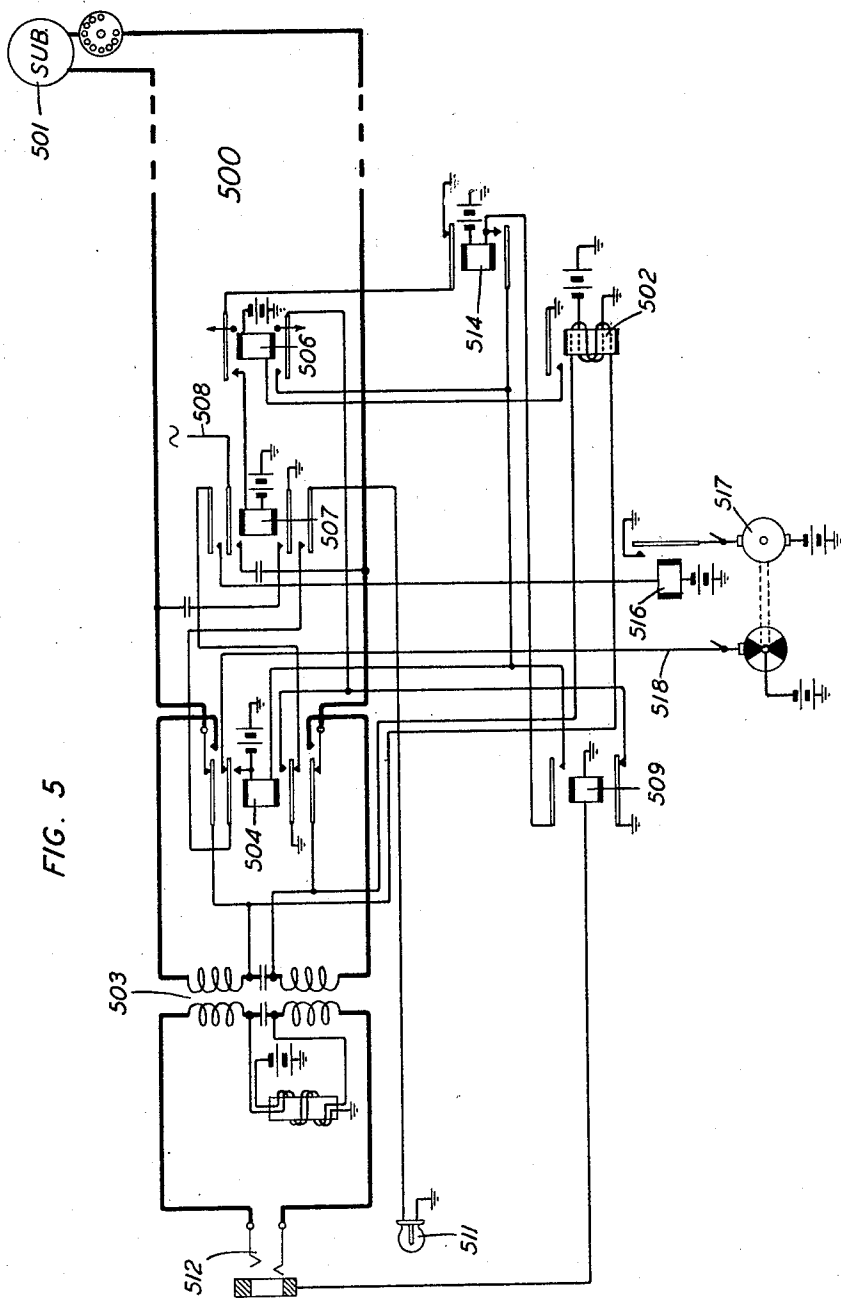


FIG. 5

INVENTORS: G.V.KING  
F.A.BONOMI  
BY  
*[Signature]*  
ATTORNEY

Oct. 11, 1932.

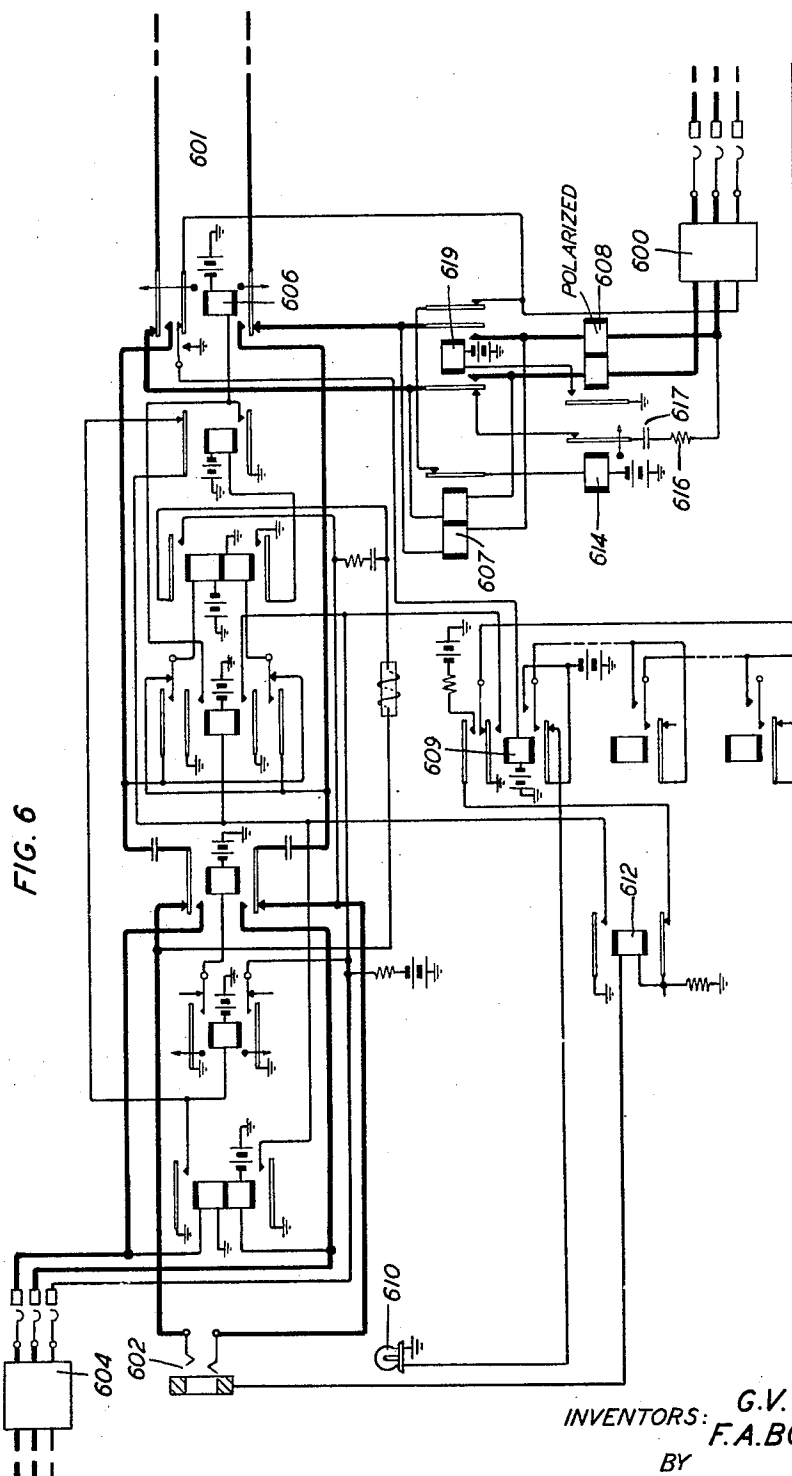
G. V. KING ET AL

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TELEPHONE SYSTEM

Filed Feb. 24, 1931

5 Sheets-Sheet 5



INVENTORS: G.V. KING  
F.A. BONOMI

BY

*W.B. McFarlane*  
ATTORNEY

## UNITED STATES PATENT OFFICE

GERALD V. KING AND FELIX A. BONOMI, OF ST. ALBANS, NEW YORK, ASSIGNORS TO  
BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPO-  
RATION OF NEW YORK

## TELEPHONE SYSTEM

Application filed February 24, 1931. Serial No. 517,688.

This application relates to telephone systems and particularly to private branch exchange systems and its object is to improve and simplify the service in systems of this character.

Exchanges of this kind are frequently provided with subscribers' lines, trunks leading to other exchanges, tie lines leading to other private branch exchanges, cord circuits for interconnecting subscribers' lines and extending connections to other exchanges, and automatic switches for extending connections from other exchanges to subscribers' lines in the private branch exchange.

A feature of this invention is an arrangement whereby a signal, in a trunk used for extending connections to and from a distant exchange, is made to flash if the calling subscriber in the private branch exchange removes the receiver to recall the trunk while the cord circuit of the private branch exchange is still remaining in the answering jack of this trunk.

Another feature of this invention is an arrangement whereby a holding bridge is removed from a tie line connected to a cord circuit while dialing is taking place and replaced between the series of impulses and whereby a ground is maintained on the sleeve circuit regardless of these actions during the dialing operation. The arrangement is such that when the tie line is connected to the cord circuit a bridge is put across the outgoing end of the tie line to signal the distant exchange and a ground is provided on the sleeve circuit. Then when the operator actuates her dial, the sleeve relay is released to cause the bridge to be removed and the tie line to be connected through for dialing, and a relay normally in the bridge is then connected in series with the tip connection for maintaining the ground connection on the sleeve circuit during dialing.

Another feature of this invention is an arrangement in a tie line seizable at a distant exchange and connected to an incoming selector at the private branch exchange whereby a path is provided from the ring conductor of the incoming selector to the tip conductor of the tie line for a dial tone

that may be applied on this ring conductor to notify the distant operator that dialing may take place, and whereby this path may be opened during dialing.

The invention has been illustrated in the accompanying drawings which may be arranged according to Fig. 7.

Fig. 1 shows a calling subscriber's line in diagrammatic form and a cord circuit at a private branch exchange;

Fig. 2 shows an operator's telephone set that may be associated with the cord circuit shown in Fig. 1;

Fig. 3 shows a called subscriber's line in diagrammatic form terminating in a jack at the private branch exchange;

Fig. 4 shows the circuit arrangement of a tie line and the terminating jack at the private branch exchange;

Fig. 5 shows a trunk terminating in a jack at a private branch exchange and in diagrammatic form a subscriber's line at a distant exchange having access to said trunk; while

Fig. 6 shows the circuit arrangement of another tie line terminating at the private branch exchange in a jack, in the circuit of an outgoing selector and in terminals of an outgoing selector.

To bring out the various features of the invention the following descriptions will be made. First, a call from the subscriber's line at 1 through the cord circuit A to the called subscriber's line shown in Fig. 3, and recalls from the calling subscriber and the called subscriber before the connection through the cord circuit has been released. Second, a call from the subscriber's line at 1 through cord circuit A over the tie line shown in Fig. 4 to a distant exchange with the operator dialing the desired subscriber's number. Third, a call for a subscriber's line in the private branch exchange incoming over the trunk shown in Fig. 5 from a distant exchange and a recall on this trunk from the distant exchange before the connection is released and fourth, a call incoming over the tie line shown in Fig. 6 to a selector 600.

In establishing a connection from the calling subscriber at 1 this subscriber removes his receiver from its switchhook and causes

the energization of the usual line relay, not shown, which in turn causes the illumination of the usual line lamp, not shown. In response to this signal the operator in charge of the cord circuit A then inserts plug 100 into jack 101 thus completing a circuit for the operation of relays 102 and 103 as follows: battery, windings of relays 103 and 102, sleeve terminals of plug 100 and jack 101 to ground. While relay 103 performs no useful function in this type of connection it may be explained here that this cord circuit may be used in other circuit connections where battery will not be furnished in the cord circuit but where the connection is cut through directly without any battery or other encumbrances. In such cases the marginal relay 102 or 120 is not operated due to a larger resistance in the sleeve circuit of an associated line. Hence relay 103, for example, would in such cases close a circuit for relay 104 and this relay would in turn close an obvious circuit for relay 107. In case the resistance is high in the sleeve circuit of the line associated with the plug 117 and marginal relay 120 thereby prevented from operating, the circuit for relay 107 will extend from ground at the upper armature and front contact of relay 118, as this latter relay operates over an obvious circuit when relay 121 operates. Relay 107 in operating would cut through the tip and ring conductors directly without any battery between the two plugs. In such cases certain temporary bridges also have to be provided and these are controlled by the operation of relay 104 or 120. For further illustration of the function of the cord circuit under these circumstances, reference may be had to our copending application, Serial No. 405,603, filed November 8, 1929, and renewed June 6, 1931. In the present case it is to be noted that relay 102 in operating prevents relay 104 from operating by opening the circuit for this relay at its lower inner armature and back contact, closed at the armature and front contact of relay 103 on its operation. Relays 105 and 106 are also operated through the circuit completed through the subscriber's loop as follows: battery, one winding of relay 106, upper outer armature and back contact of relay 107, left hand winding of relay 105, contacts of ringing key 108, tip terminals of plug 100 and jack 101 through the subscriber's loop back through the ringing terminals of jack 101 and plug 100, contacts of ringing key 108, right hand winding of relay 105, lower outer armature and back contact of relay 107 and another winding of relay 106 to ground. Relay 106 in operating performs no useful function at this time. Relay 105 in operating opens at its armature and back contact the circuit for supervisory lamp 110 to prevent it from lighting at this time.

The operator now establishes a talking con-

nection with the calling subscriber by operating the talking and dialing key 111. A connection is thereby established between the talking conductors of the cord and the operator's telephone set at 200 as follows: From the calling subscriber's set, tip terminals of jack 101 and plug 100, contacts of key 108, left hand winding of relay 105, upper outer armature and back contacts of relay 107, condenser 112, upper inner armature and back contacts of relay 107, inner made contacts of key 111, conductor 113, upper make-before-break contacts of relay 201, upper inner armature and back contact of relay 202, windings of the induction coil 203, condenser 204, lower outer armature and back contact of relay 102, lower make-before-break contacts of relay 201, conductor 114, inner lower made contacts of key 111, lower inner armature and back contact of relay 107, condenser 115, lower outer armature and back contact of relay 107, right hand winding of relay 105, contacts of key 107, ring terminals of plug 100 and jack 101 back to the subscriber's set at 1. The operator's receiver is bridged across the winding of the induction coil 203, while the transmitter is inductively connected through induction coil 203 to the above mentioned circuit for the calling subscriber's line. The calling subscriber's talking battery is supplied through the windings of relay 106 and the operator's through the windings of relay 129.

The operator now challenges the calling subscriber and learning that a connection is desired to a subscriber's station such as is shown in Fig. 3 and makes the usual busy test by touching the tip of plug 117 to the sleeve of jack 300. If the called subscriber's line is idle a ground connection will be found on the sleeve of jack 300 and no busy indication will be given to the operator. If, however, this line is busy a battery potential will be found on the sleeve of jack 300 which will be connected over the tip of the plug 117, upper outer armature and back contact of relay 118, conductor 119, winding of relay 206 to ground. Relay 206 will be operated to close a circuit for the induction coil 207, one winding of which is bridged across a winding of the induction coil 203 and thus a busy click manifestation will be made in the operator's receiver as is well known in the art.

If it is assumed that the subscriber's line shown in Fig. 3 is idle the operator releases the key 111 and inserts plug 117 into jack 300 and a circuit will be closed for the operation of relays 120 and 121 as follows: battery, windings of relays 121 and 120 in series, sleeve terminals of plug 117 and jack 300 to ground. Relay 121 in operating closes a circuit for the operation of relay 118 from battery, armature and front contacts of relay 121, winding of relay 118 to ground. Relay 121 also closes a circuit for the operation of

relay 123 from battery, armature and front  
 contact of relay 121, lower winding of relay  
 123, outer lower armature and back contact  
 of relay 124, armature and front contact of  
 5 relay 105 through a resistance to ground. Re-  
 lay 120 in operating prevents relay 107 from  
 operating by opening the connection through  
 its upper outer armature and back contact  
 for a circuit otherwise completed for relay  
 10 107 at the upper inner armature and front  
 contact of relay 118 when it operates. Relay  
 120 also causes relay 125 to operate as fol-  
 lows: battery, armature and front contact of  
 15 relay 121, upper inner armature and front  
 contact of relay 120, lower outer armature  
 and back contact of relay 126, winding of  
 relay 125, upper outer armature and front  
 contact of relay 102 to ground. Relay 120  
 also causes the supervisory lamp 127 to be  
 20 lighted over a circuit from battery through  
 this lamp, lower outer armature and front  
 contact of relay 120, upper inner armature  
 and front contact of relay 102, lower arma-  
 ture and back contact of relay 128, armature  
 25 and back contact of relay 129, through a re-  
 sistance to ground. Relay 120 also opens at  
 one point a bridge across the tip and ring  
 conductors closed at another point by the op-  
 eration of relay 118. This bridge may be  
 30 traced from the tip conductor of the cord  
 through the lower inner armature and front  
 contact of relay 118, lower inner armature  
 and back contact of relay 120, upper outer  
 armature and back contact of relay 104, arma-  
 35 ture and front contact of relay 106, lower out-  
 er armature and back contact of relay 104 to  
 the ring conductor. Relay 118 in operating  
 opens the busy test connection through lead  
 40 119 at its upper outer armature and back  
 contact and connects the tip and ring con-  
 ductors of the cord through to relay 125. Re-  
 lay 118 also opens the connection from bat-  
 tery, resistance 133 to the ring terminal of  
 45 plug 117. Relay 123 in operating provides a  
 locking circuit for itself through its upper  
 winding, upper inner armature and front  
 contact to ground at the upper outer arma-  
 ture and front contact of relay 102 and con-  
 50 nects a condenser 134 at its lower outer arma-  
 ture and front contact to the tip conductor  
 across the opening therein at the lower arma-  
 ture and back contact of relay 125. The light-  
 ing of the supervisory lamp 127 indicates that  
 55 the called subscriber has not yet removed his  
 receiver from its hook.

The operation of relay 125 disconnects the  
 plug 117 from the tip and ring conductors  
 of cord A and connects at its upper and lower  
 60 inner armatures and front contacts ringing  
 current from a source, not shown, but con-  
 nected to conductors 136, through the trip-  
 ping relay 137 and the tip and ring con-  
 ductors of plug 117 and jack 300 to the sub-  
 65 scriber's line shown in Fig. 3. Ringing tone

is transmitted back to the calling subscrib-  
 er's station through condenser 134.

When the subscriber of the line shown in  
 Fig. 3 answers this call by removing his re-  
 70 ceiver from the switchhook the tripping re-  
 lay 137 will operate in the usual manner.  
 This relay in operating removes the short cir-  
 cuit established through its armature and back  
 contact to ground for the lower winding of  
 75 relay 126 which is thereby permitted to op-  
 erate over a circuit as follows: battery, ar-  
 mature and front contact of relay 121, upper  
 inner armature and a front contact of relay  
 120, resistance 139, lower winding of relay  
 80 126 to ground. Relay 126 in operating opens  
 the circuit for relay 125 which in releasing  
 disconnects ringing current from the line  
 and short-circuits the condenser 134. The  
 relay 129 is also operated by the release of  
 85 relay 125 at this time over a circuit from  
 battery through one winding of relay 129,  
 upper inner armature and back contact of  
 relay 107, inner upper inner normal contacts  
 of key 111, ringing key 140, upper arma-  
 90 ture and back contact of relay 125, upper  
 outer armature and front contact of relay  
 118, tip terminals of plug 117 and jack 300  
 through the called subscriber's loop, ring  
 terminals of jack 300 and plug 117, lower  
 95 outer armature and front contact of relay  
 118, lower inner armature and back contact  
 of relay 125, ringing key 140, inner lower  
 normal contacts of key 111, lower inner arma-  
 ture and back contact of relay 107, the other  
 100 winding of relay 129 to ground. Relay 129  
 in operating opens the circuit for the super-  
 visory lamp 127 which is thereby extin-  
 guished to indicate to the operator that the  
 called subscriber had answered the call.  
 105 Relay 129 also closes a circuit for the opera-  
 tion of relay 128 as follows: battery, arma-  
 ture and front contact of relay 121, inner up-  
 per armature and a front contact of relay  
 120, upper winding of relay 128, lower arma-  
 ture and back contact of relay 142, armature  
 110 and front contact of relay 129 through a re-  
 sistance to ground. Relay 128 provides a  
 locking circuit for itself from battery at the  
 armature and front contact of relay 121, up-  
 per inner armature and a front contact of  
 115 relay 120, lower outer normal contacts of  
 key 111, lower winding of relay 128, upper  
 inner armature and front contact of this  
 relay to ground at the upper armature and  
 back contact of relay 144. Relay 128 in oper-  
 120 ating provides an operating path at its  
 lower armature and front contact for relay  
 142. This circuit will be described later.  
 Conversation may now begin.

When the subscriber at the calling station  
 125 replaces his receiver on the switchhook re-  
 lays 105 and 106 are released causing the op-  
 eration of relay 124 as follows: battery, up-  
 per armature and front contact of relay 121,  
 upper inner armature and front contact of re-  
 130



lay 120, lower outer normal contacts of key 111, winding of relay 124, upper make-before-break contacts of this relay, lower inner armature and front contact of relay 123, armature and back contact of relay 105 through a resistance to ground. Relay 124 in operating provides a locking circuit for itself through its upper inner armature and front contact to the ground at the upper outer armature and front contact of relay 102. Relay 124 closes a circuit for the lighting of the supervisory lamp 110 from battery through this lamp, lower outer armature and front contact of relay 102, upper outer armature and front contact of relay 124 through a resistance to ground at relay 105. The lighting of this lamp serves as a disconnect signal to the operator.

When the subscriber at the called station replaces his receiver on the switchhook relay 129 is released which causes the operation of relay 142 over a circuit as follows: battery, armature and front contact of relay 121, upper inner armature and front contact of relay 120, lower outer normal contacts of key 111, winding of relay 142, upper make-before-break contacts of relay 142, lower armature and front contact of relay 128, lower armature and back contact of relay 129 through a resistance to ground. Relay 142 in operating closes a circuit for the supervisory lamp 127 from battery through this lamp, lower outer armature and front contact of relay 120, upper inner armature and front contact of relay 102, upper inner armature and front contact of relay 142, through a resistance to ground at relay 129. The lighting of signal 127 serves as a disconnect signal to the operator. When the plugs 100 and 117 are removed from the jacks 101 and 300 respectively all relays remaining operated are released and the circuits are restored to normal.

If, before the plugs 100 and 117 are withdrawn from the jacks 101 and 300 respectively, the subscriber at the calling station wishes to recall the operator he will alternately operate and release his switchhook. This causes the alternate operation and release of relays 105 and 106. Relay 105 after release causes the operation of relay 124 as hereinbefore described and when relay 105 again operates lamp 110 is connected to an interrupter circuit as follows: from battery through this lamp, lower outer armature and front contact of relay 102, upper outer armature and front contact of relay 124, through a resistance to ground at the armature of relay 105, but as relay 105 is operated a circuit is also completed through the armature of this relay and its front contact to the lower outer armature and front contact of relay 124 to an interrupter 146 to battery. The lamp 110 is thereby alternately short-circuited by the battery through the interrupter 146 and caused to be alternately

lighted and extinguished to serve as an indication that the calling subscriber desires to recall the operator. The operator then actuates the talking and dial key 111 which opens the locking circuit hereinbefore described for relay 124 which is thereby released. Relay 124 in releasing discontinues the flashing of the lamp 110 under control of the interrupter 146. The operation of key 111 connects as heretofore described the operator's telephone set with a calling subscriber's line.

If the called subscriber desires to recall the operator he will alternately operate and release the switchhook and thereby cause the operation and release of relay 129. Relay 129 in releasing causes the operation of relay 142 as hereinbefore described and in operating completes a circuit for the supervisory lamp 127 through the interrupter 146 to battery as follows: battery, lamp 127, lower outer armature and front contact of relay 120, upper inner armature and front contact of relay 102, upper inner armature and front contact of relay 142 through a resistance to ground at the armature of relay 129. As this armature is now actuated a short circuit for the battery through lamp 127 will be provided through this armature and front contact through the lower armature and front contact of relay 142, interrupter 146 to battery to cause lamp 127 to be alternately lighted and extinguished to serve as a recall signal for the called subscriber. When the talking key 111 is operated to connect the operator's telephone set with the subscriber's line relay 142 is released by the opening of the locking circuit. From the foregoing it will be seen that either the calling or the called subscriber may by operating his switchhook cause the corresponding supervisory lamp to flash for recalling the operator.

Referring now to a connection from a calling subscriber over cord A through the tie line circuit shown in Fig. 4 to a distant private branch exchange the operator will answer the incoming call from the subscriber at 1 by inserting plug 100 into jack 101 and operate key 111 to obtain the desired number in the manner as hereinbefore described in connection with a call between the subscriber at 1 and the subscriber's line shown in Fig. 3. As the call is intended for a subscriber at a distant private branch exchange, the operator will then insert plug 117 into jack 400 of an idle tie line leading to the desired private branch exchange. An idle tie line is indicated by a lighting lamp, such as lamp 401 shown in Fig. 4. The circuit for this lamp is obvious. The immediate effect of this connection is the closing of a circuit for the operation of relay 405 as follows: battery, resistance 133, lower outer armature and back contact of relay 118, ring terminals of plug 117 and jack 400, lower armature and back contact of relay 406, upper make-before-break contact of relay 407, wind-

ing of relay 405 to ground. This relay in operating its lower armature extinguishes supervisory signal 401 to indicate that this tie line has been engaged and by closing a connection through the associated front contact, extends the battery connection to the relay corresponding to relay 405 in the next idle tie line as indicated, thereby causing the associated supervisory lamp of this tie line to be lighted. Relay 405 also closes a bridge across the tip and ring conductors of the tie line from the ring conductor, upper outer armature and front contact of relay 405, retardation coil 409, winding of relay 410, lower make-before-break contact of relay 411, winding of relay 412 to the tip conductor. The closing of this bridge causes relays not shown in the tie line at the distant private branch exchange to function and establish a circuit from battery and ground through the winding of relay 412 to cause it to operate. Relay 412 in operating closes a circuit for the operation of relay 413 which in turn closes a circuit for the operation of relay 414. Relay 414 closes a circuit for the operation of relay 407. Relay 407 opens the circuit for relay 405 but closes a holding circuit for this relay at its upper armature and front contact to battery, through a resistance 416. Relay 407 establishes a connection to ground at the upper inner make-before-break contacts for the sleeve circuit through relay 403. The closing of this circuit causes the operation of relay 403 in series with relays 121 and 120 over the sleeve circuit from battery, windings of relays 121 and 120, sleeve terminals of plug 117 and jack 400, resistance 402, winding of relay 403 to the above mentioned ground. Relay 403 in operating closes a circuit for the operation of relay 418. This relay provides a locking circuit for itself from battery through its lower winding and lower inner armature and front contact to ground at the upper inner armature and front contact of relay 405. Relay 418 also closes a locking circuit through its lower outer armature and front contact for maintaining relay 407 operated. Relays 121 and 120 in operating close circuits for the operation of relays 118 and 123 as hereinbefore mentioned. Relay 118 disconnects the busy test sleeve at its upper outer armature and back contact from the tip of the plug 117 and opens the connection to battery through resistance 133 for the ring conductor, to open the original operating circuit for relay 405. Relay 418 also connects the tip and ring conductors of the cord through to the plug 117 and the cord circuit functions as hereinbefore described in connection with the station to station call to light lamp 127. Relay 125 is operated as usual to apply ringing to the tie line, but as the tie line is not yet cut through to the distant private branch exchange this ringing will have no effect.

When the operator observes that the lamp

127 is lighted as an indication that the circuits at the distant private branch exchange are ready for dialing she will again operate dialing key 111. Relay 144 is thereby operated over an obvious circuit and the purpose thereof will become apparent as the description proceeds. The operator then moves the dial 210 from normal and a circuit is thereby completed at the off normal contact of the dial for the operation of relay 202. Relay 202 in operating opens the connection as hereinbefore described from the operator's telephone set 200 over conductors 113 and 114 towards plug 100 at its lower outer armature and back contact. This relay also opens another talking path between the connection towards plug 117 over conductors 211 and 213 at its upper inner armature and back contact. Relay 202 further closes a circuit for the operation of relay 216 from battery, windings of this relay, upper outer armature and front contacts of relay 202, off normal contacts of dial 210 to ground. Resistance 217 is also connected across the conductors 213 and 211 through the pulsing contact of dial 210. Relay 216 in operating short-circuits resistance 217, closes a circuit for the operation of relay 201 at its inner lower armature and front contact and also a circuit for the operation of relay 220 at its lower outer armature and front contact. The operation of relay 201 closes a circuit for retardation coil 225 in parallel with resistance 217 but at the present this coil is short-circuited by relay 216. Relay 207 also closes a circuit for the operation of relay 221 at its lower inner armature and front contact, opens the circuit through the tip and ring conductor extending between the plugs 100 and 117 over leads 113 and 211 for the tip and 114 and 213 for the ring conductor leaves the impulse contacts of the dial 210 connected across the conductors 213 and 211 and connects conductors 113 and 114 to the upper and lower outer armatures of relay 224. The complete circuits for the conductors 113 and 114 will be traced later. The circuit for the conductors 213 and 211 may be traced as follows: From conductor 211 through the pulsing contacts of dial 210, upper armature and front contact of relay 216, to conductor 213. Relay 220 in operating provides a locking circuit for the relay 202 through its lower winding. Relay 220 also opens the circuit through its upper armature and back contact for the operator's receiver and short-circuits it at the front contact. Relay 220 being slow in releasing will maintain the receiver short-circuited for a short time after the dial is restored to normal in order to prevent undesirable clicks in the receiver at this time, as well as to prevent the attendant from hearing the transmission of the dial pulses. Relay 221 in operating performs no useful function at this time.

It should be noted that on the operation of relay 202 relay 226 was operated, due to the operation of relay 144, over a circuit from battery, armature front contact of relay 121, upper inner armature and front contact of relay 120, upper winding of relay 126 and upper make-before-break contact of this relay, lower armature and front contact of relay 144, conductor 227, winding of relay 226, upper outer armature and front contact of relay 202 to ground. Relay 226 in operating closes an obvious circuit for the operation of relay 224. The operation of relay 224 closes an obvious circuit through the windings of relay 223 which is thereby operated. Relay 224 also bridges the relay 228 across the conductors 113 and 114 at its upper and lower outer armatures and front contacts. Battery and ground are furnished at this time as will be hereinafter described over conductors 113 and 114 to cause relay 228 to operate to provide a locking circuit for relay 224 to maintain this relay and relays 223 and 201 operated.

Referring now to the operation of the cord circuit A and the tie line shown in Fig. 4 in response to the operation of the dialing key 111, a circuit is closed through the upper winding of relay 126 as hereinbefore mentioned, due to the operation of relay 202, and to the actuation of the dial 210. Relay 126 is thereby operated to close a locking circuit for itself through the resistance 139 and its lower winding. The operation of relay 126 opens the circuit for the relay 125 which is thereby released to open the connection from the ringing source at leads 136 connected to the tip and ring conductors over plug 117 to the tie line of Fig. 4. The operation of relay 126 also connects the sleeve conductor of plug 117 to the ground on conductor 227 applied at the upper armature and front contact of relay 202 through relay 226. The resistance of the winding of relay 226 is low so as to cause the release of relay 403 in the tie line by short-circuiting the battery on the sleeve circuit in the cord. Relay 403 in releasing causes the operation of relays 406 and 411 over obvious circuits. Relay 403 in releasing also closes at its lower armature and back contact, a bridge across the tip and ring conductor of the line through conductor 420 and resistance 421 to aid in pulsing over the line. Relay 406 in operating provides a locking circuit for itself through its upper armature and front contact to ground at the upper armature and front contact of relay 418, and connects at the lower armature and front contact ring conductor to the lower armature of relay 411. Relay 406 in conjunction with relay 411 disconnects the bridge consisting of the relays 410 and 412 from the tip and ring conductor of the line and relay 411 in operating disconnects the tip and ring conductors from the condensers 423 and 424 and connects the

tip conductor through the winding of relay 412 to the distant private branch exchange and the ring conductor directly through without encumbrances. Relay 412 is thereby maintained operated.

Dial pulses are now transmitted on the return of the dial. During the pulsing the relay 412 may release and reoperate following the dialing pulses. However, on account of the slow-to-release characteristics of relays 413 and 414 the ground connection established by relay 407 for the sleeve circuit of jack 400 will be maintained during pulsing. When the dial returns to normal relay 403 will reoperate due to the release of relay 202 as will hereinafter be described, and relay 412 will be maintained operated while relay 411 will release between series. This sequence of operation and release of relays 403 and 411 is repeated until the complete number has been dialed. Thus it will be seen that the ground connection to the sleeve will be maintained during pulsing while the bridge through relays 410 and 412 will be restored across the tip and ring conductors between the series of impulses to maintain the proper circuit conditions at the distant end of the tie line.

When the dial has returned to normal after a series of impulses has been transmitted relay 216 is released. This relay in releasing removes the short circuit from the parallel combination 217 and retardation coil 225 and also causes the release of the relay 220. The release of relay 220 removes the short circuit from the operator's telephone set and causes the release of relay 202 as the original circuit for this relay is opened on the return of the dial to normal. The release of relay 202 removes the shunt through the resistance 217 for the bridge through the retardation coil 225. The retardation coil 225 now holds the connection established over the tip and ring conductors between the series of impulses. The release of relay 202 causes, as hereinbefore stated, the reoperation of relay 403 with the consequent insertion of the bridge across the outgoing end of the tie line in Fig. 4. When all the digits have been dialed the key 111 is restored causing relays 223, 201, 221, 228 and 224 to release. Relay 221 being slow in releasing will keep the receiver circuit open long enough to prevent a click through the operator's receiver due to the release of the talking key.

The called subscriber is then rung in the usual manner and in response thereto removes his receiver from the switchhook. Relay 410 is thereby operated due to a reversal of the current on the line from the distant exchange. This relay in operating causes the operation of relay 426 and relay 426 removes a short circuit from the retardation coil 409 in the bridge consisting of the relays 412 and 410 to include this coil in the bridge.

Relay 426 in operating also connects the retardation coil 427 across the tip and ring conductor towards the jack 400 to cause the operation of relay 129, which in turn causes the operation of relay 128. Relay 128 in operating causes the lamp 127 to be extinguished as a signal that the calling subscriber has answered. As hereinbefore described relay 411 releases when relay 403 is reoperated as the dialing is finished and a talking connection is now completed between the subscribers through condensers 423 and 424 and also through condensers 112 and 115, talking battery for the link separated by these two sets of condensers being furnished through the windings of relay 129, talking battery for the calling subscriber through the windings of relay 106 and talking battery for the called subscriber at the distant exchange.

When the receiver at the called station is replaced on the switchhook, relay 410 will release causing release of relay 426. Relay 426 in releasing causes relay 129 to release and relay 142 to operate. Relay 142 causes the lamp 127 to light, as hereinbefore described, as a disconnect signal. When the plug 117 is removed from jack 400 relay 403 will release causing relay 411 to operate. This causes the release of relays 412, 413, 414, 407, 405 and 418. Relay 418 in releasing causes the relays 411 and 406 to release and restore the circuit to normal. Relays 120 and 121 are also released by the removal of plug 117 from jack 400, and this in turn causes the release of relays 142, 128, 124 and 123, and the extinguishing of lamp 127. When the plug 100 is removed from jack 110, relays 102 and 103 are released.

A description will now be made of a call incoming over trunk 500 shown in Fig. 5, from a subscriber's line 501 at a distant exchange for a private branch exchange subscriber. If this trunk 500 is seized at the distant exchange, by the subscriber of line 501, the tip and ring conductors of the trunk are connected together to cause the operation of relay 502 from battery and ground, upper inner and lower outer armatures and back contacts of relay 504 and the tip and ring conductors of the trunk 500 in series. Relay 502 in operating closes an obvious circuit for the operation of relay 506 which in turn closes an obvious circuit for the operation of relay 507. Relay 507 in operating causes a ringing tone from a source connected on relay 508, not shown, to be transmitted over the ring conductor to the distant exchange. The operation of relay 506 closes a circuit for the operation of relay 504 as follows: from battery, winding of relay 504, lower armature and front contact of relay 506 to ground at the lower armature and back contact of relay 509. Relay 504 in operating provides a locking circuit for itself through its lower inner armature and front contact to ground under

the control of the relay 506. Relay 504 in conjunction with relay 507 closes a circuit for the lighting of the supervisory lamp 511, from battery, upper inner armature and front contact of relay 504, lower outer armature and front contact of relay 507, lamp 511 to ground, to indicate the presence of a call on this trunk. The operator of cord circuit A answers this call in the usual manner and extends a connection to the desired subscriber. It should be noted that relay 504 in operating establishes a talking connection through the repeating coil 503 at its upper and lower make-before-break contacts and extends the connections for relay 501 through the windings of the repeating coil 503. When the plug 100 is inserted in jack 512 to answer the call relay 509 is operated over the sleeve circuit and this relay closes a circuit for the operation of relay 514 from battery, winding of this relay, upper armature and front contact of relay 509, lower armature and front contact of relay 506 to ground at the lower inner armature and front contact of relay 504. Relay 514 opens the circuit for relay 507 which in releasing removes the ringing tone from the tip conductor of the trunk and extinguishes the lamp 511. Relay 514 in operating provides a locking circuit for itself under control of relays 504 and 506.

When the trunk is released by the subscriber of line 501 replacing his receiver on the switchhook, relay 502 is released. This relay in turn releases relay 506 which opens the locking circuit for relays 514 and 504 which now release. Relay 504 opens the talking circuit through the trunk.

If trunk 500 is again seized at the distant exchange by the subscriber of line 501 or by any other subscriber before the private branch exchange operator has removed plug 100 from jack 512, relay 502 will again operate, and cause the operation of relays 506 and 507, but due to the operation of relay 509, relays 504 and 514 will not operate at this time. A circuit is therefore closed from ground through the lower inner armature and back contact of relay 504, upper outer armature and front contact of relay 507 through a start lead to the winding of relay 516 to battery. Relay 516 operates to start an interrupter mechanism 517 to establish an interrupted circuit from battery for lead 518. Relay 516 and mechanism 517 may be common to a plurality of trunks. The circuit over lead 518 extends through the upper inner armature and back contact of relay 504, lower outer armature and front contact of relay 507 and lamp 511 to ground so that this lamp will now be alternately lighted and extinguished, to serve as a recall signal. To answer this call the operator will momentarily remove plug 100 from jack 512 to cause the momentary release of relay 509. The release of this relay causes the operation of re-

lay 504 to open the interrupted battery circuit from 518 and also the release of relay 516 to stop the interrupting mechanism. When the plug 100 is again reinserted into jack 512, relay 509 will reoperate causing the operation of relay 514 which releases the relay 507 to establish the same talking circuit connections as hereinbefore described.

The Fig. 6 shows a tie line 601 incoming from a distant exchange over which connections may be extended manually through jack 602 to the distant exchange or automatically through connector switch 604. Calls incoming over this trunk may be extended automatically over the selector switch 600 to a desired subscriber's line at the private branch exchange. The automatic switches 604 and 600 have only been indicated by boxes as they may be of any type well known in the art. To illustrate the feature of this invention relating to the transferring of a dialing tone from the ring conductor of the incoming selector 600 to the tip conductor of the tie line 601 a description will be made of an incoming call.

When tie line 601 is selected at a distant exchange a circuit is established over the tip and ring conductors, upper outer and lower armatures and back contacts of relay 606, windings of relay 607, windings of relay 608 to the tip and ring conductors of the selector 600. The selector will then function in a well known manner to apply a connection to ground for the sleeve conductor from the selector. This causes relay 609 to operate from battery, winding of relay 609, upper inner armature and back contact of relay 606, the sleeve conductor to ground at the selector 600. Relay 609 in operating opens the circuit for lamp 610 associated with jack 602 to extinguish it as an indication that line 601 is busy. Relay 609 also connects battery to the lower armature and back contact of the relay corresponding to relay 609 in the next idle tie line to light the lamp corresponding to lamp 610 of said tie line to indicate its idle condition. Relay 609 also at its upper outer armature and front contact establishes a connection to battery through a resistance and the lower armature and back contact of relay 612 to the sleeve circuit of the jacks 602 to make this jack test busy. A connection to ground is also established at the upper inner armature and front contact of relay 609 for the sleeve conductor of this tie line terminating in a sleeve terminal at the connector 604, to make this line busy for automatic selection. Relay 607 which operates in the circuit from the distant exchange opens a branch of the sleeve circuit for relay 614 to prevent this relay from operating at the seizure of the selector 600. When the selector 600 is ready for the reception of dial pulses it will provide a dialing tone over its ring conductor. This tone therefore, due to the normal condition of re-

lay 614, finds a path through resistance 616, condenser 617, armature and back contact of relay 614, left hand armature and back contact of relay 619, upper outer armature and back contact of relay 606 to the tip conductor of the tie line 601 and is transmitted to the distant exchange as an indication that dialing may begin.

During dialing relay 607 follows the impulses and relay 614 therefore operates on the first impulse. Relay 614 is slow-in-releasing so it will remain operated during dialing and thereby open the connection between the tip and ring conductor to remove the dial tone.

When the called station answers battery and ground from the incoming selector 600 are reversed to the distant exchange for supervisory purposes and relay 608 which is polarized operates. Relay 608 in operating closes a circuit for the operation of relay 619 which opens the circuit for relay 614 as well as the connection comprising the condenser 617 and resistance 616 between the tip and ring conductors. Relay 619 also short-circuits the windings of relay 607 and connects the line 601 through its armatures to selector 600 and the called subscriber's line for conversation. On disconnection either at the distant exchange or at the called subscriber's end of the circuit relay 608 is released causing the release of relay 619. The ground on the sleeve of selector 600 is also removed causing the release of relay 609. This relay in releasing removes the busy condition on the sleeve of the jack 602 and the sleeve terminal of this line at connector 604. Relay 609 in releasing relights a lamp to indicate that this line is now idle.

While this invention has been illustrated in connection with but a single system it should be understood that it may readily be applied to other systems without departing from the spirit thereof.

What is claimed is:

1. In a telephone system, a line, a cord circuit, means for establishing a connection between said line and cord circuit, a signal in said line, an interrupting device in said line, and means operative after the establishing of said connection for actuating said signal under control of said interrupting device.
2. In a telephone system, a subscriber's line, a cord circuit, a trunk, means for establishing a connection between said subscriber's line and said cord circuit through said trunk, a signal in said trunk, and means responsive to the subscriber of said line hanging up his receiver on the switchhook and thereafter removing it for actuating said signal.
3. In a telephone system, a subscriber's line, a trunk, a cord circuit, means for establishing a connection between said subscriber's line and said cord circuit through said trunk, a signal in said trunk, means for actuating



said signal in response to the seizure of said trunk by said subscriber's line, means for disabling said signal in response to the establishing of the connection between said cord circuit and said trunk, and means responsive to the abandoning of the connection by the subscriber of said line and reseizing it for actuating said signal in a different manner.

4. In a telephone system, a subscriber's line, a trunk, a cord circuit, a signal in said trunk, means for establishing a connection between said subscriber's line and said trunk, means responsive to the establishing of said connection for actuating said signal, means for establishing a connection between said cord circuit and said trunk, means responsive to said last mentioned connection for disabling said signal, an interrupter associated with said trunk circuit, and means responsive to the abandoning of the connection by the subscriber and to the reseizing thereof by said subscriber for actuating said signal under control of said interrupting device.

5. In a telephone system, a subscriber's line, a trunk, a cord circuit, a signal in said trunk, means responsive to the seizure of said trunk by said subscriber's line for actuating said signal in one manner, means responsive to the establishing of connection between said cord circuit and said trunk for disabling said signal, means responsive to the subscriber replacing his receiver on the switchhook and again removing it for actuating said signal in a different manner, means responsive to the removal of said cord circuit from said trunk for changing the operation of said signal from said second mentioned manner of operation to said first mentioned manner of operation, and means responsive to the reconnection of the cord circuit to the trunk line for disabling said signal.

6. In a telephone system, a tie line comprising tip and ring conductors and a sleeve circuit, means for connecting a bridge circuit across the tip and ring conductors of said tie line and for establishing a connection to ground for the sleeve circuit, a relay in said sleeve circuit, means responsive to the establishing of the ground connection for actuating said sleeve relay, means for releasing said relay for removing the bridge and for connecting through the tip and ring conductors of the tie line for direct current dialing, and means for maintaining said ground connection on the sleeve circuit during dialing.

7. In a telephone system, a tie line comprising tip and ring conductors and a sleeve circuit, means for connecting a bridge circuit across the tip and ring conductors of said tie line and for establishing a connection to ground for said sleeve circuit, a relay in said sleeve circuit, means responsive to the establishing of said connection to ground for actuating said relay, means for releasing said

relay, means responsive to the release of said relay for removing the bridge and for connecting through the tip and ring conductors of the tie line for direct current dialing, another relay, means responsive to the release of said first relay for including said second relay in the tip connection and for actuating said second relay, and means responsive to the operation of said second relay for maintaining said connection to ground on the sleeve circuit during dialing over said conductors.

8. In a telephone system, a tie line comprising tip and ring conductors and a sleeve circuit, a cord circuit, means responsive to the connection of the cord circuit to said tie line for connecting a bridge across the tip and ring conductors of said tie line and for establishing a connection to ground for the sleeve circuit, a sleeve relay in said sleeve circuit, a relay in said bridge, means responsive to the establishing of the said connection to ground for actuating said sleeve relay, means in said cord circuit for releasing said sleeve relay, means responsive to the release of said sleeve relay for disconnecting said bridge and for establishing connections through the tip and ring conductors for direct current dialing therethrough and for connecting said relay in series with the tip connection, means for operating said relay during dialing, and means responsive to the operation of said relay for maintaining said ground connection on the sleeve circuit during dialing.

9. In a telephone system, a tie line, a switch, a signaling path between the ring conductor of said switch and the tip conductor of said tie line, and means responsive to impulses received over said tie line to activate the switch for removing said signaling path.

10. In a telephone system, a first exchange, a second exchange, a tie line connecting said exchanges, a switch at said second exchange having tip and ring conductors connectable to the tip and ring conductors of the tie line, a signaling path between the ring conductor of the switch and the tip conductor of the tie line, and means responsive to impulses incoming over the tie line from the first exchange to actuate the switch for removing said signaling path.

11. In a telephone system, a first exchange, a second exchange, a tie line connecting said exchanges, a switch at said second exchange, a signaling path between the ring conductor of the switch and the tip conductor of the tie line, a relay responsive to the reception of impulses over the tie line to actuate the switch for the opening of said signaling path.

12. In a telephone system, a first exchange, a second exchange, a tie line connecting said exchanges, a switch at said second exchange, means at said second exchange responsive to

impulses incoming over the tip and ring conductors of the tie line to said second exchange for actuating said switch, a slow release relay, means for maintaining said relay operated during the transmission of impulses, and means operative due to the maintenance of said relay operated during the transmission of impulses for opening of said signaling path during this period.

10 In witness whereof, we hereunto subscribe our names this 20th day of February, 1931.

GERALD V. KING.  
FELIX A. BONOMI.

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