

July 19, 1932.

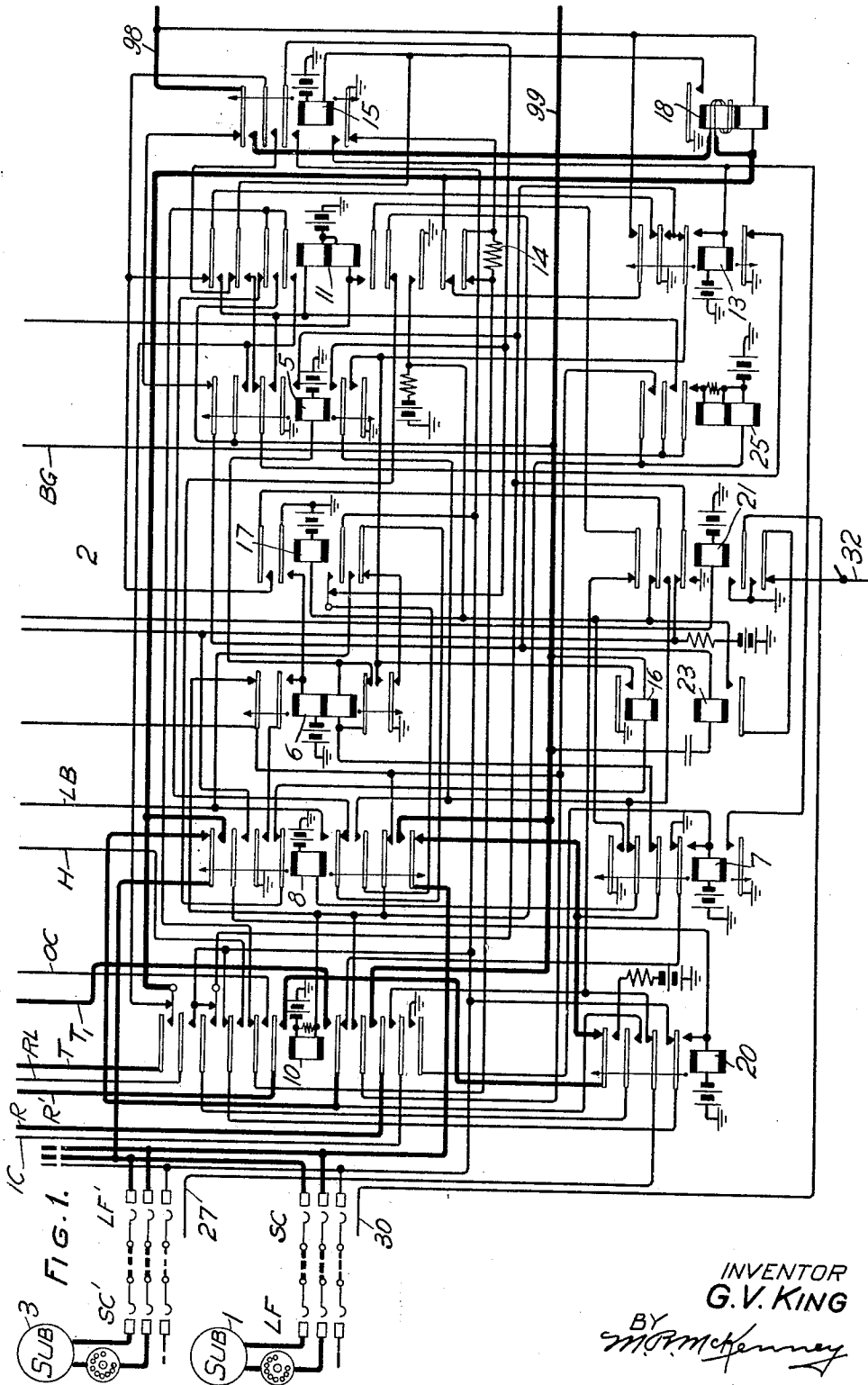
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1,868,326

TELEPHONE SYSTEM

Filed Jan. 1, 1930

2 Sheets-Sheet 1



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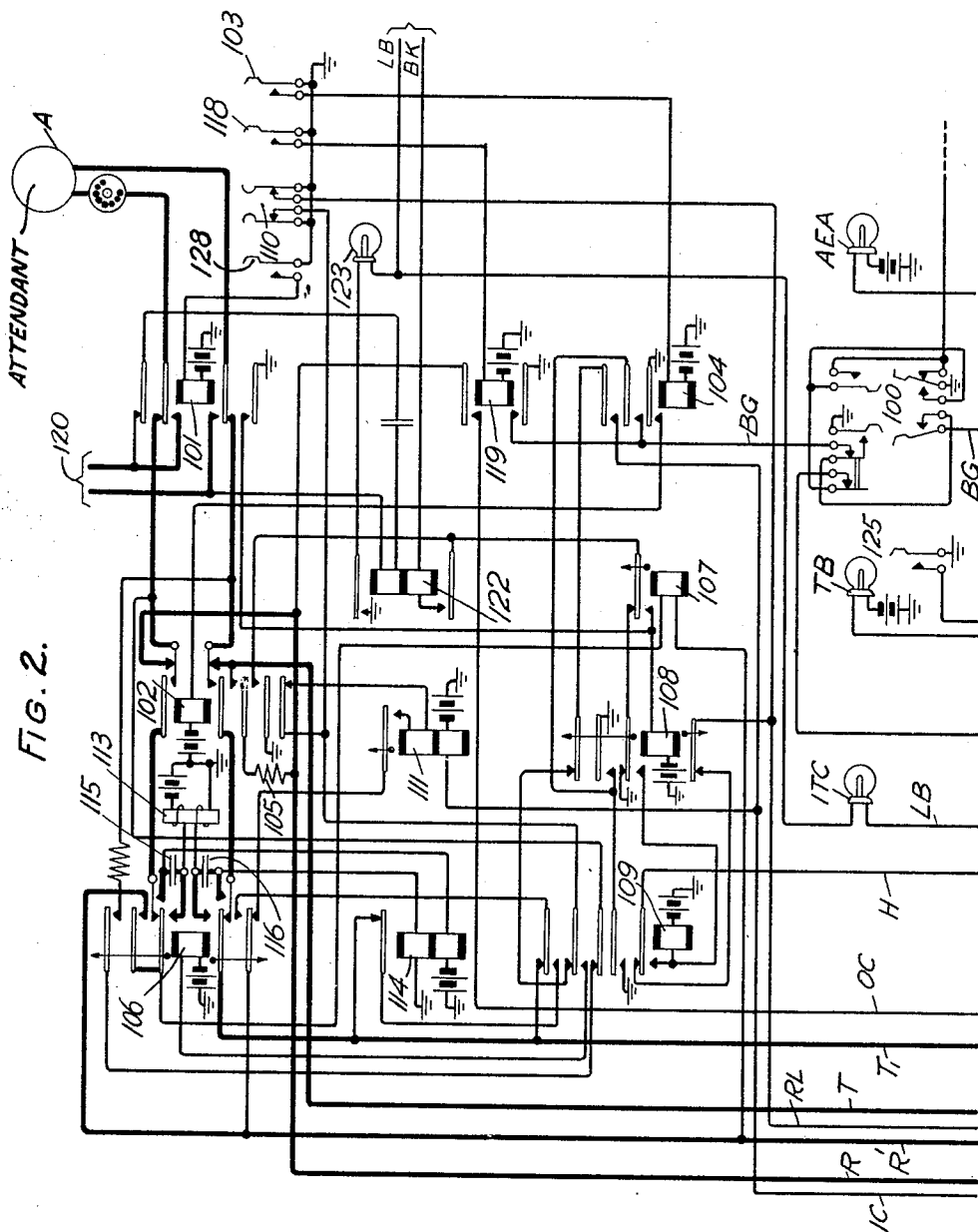
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2 Sheets-Sheet 2



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TELEPHONE SYSTEM

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This invention relates to telephone systems and particularly to private branch exchange systems.

An object of the invention is to insure greater secrecy in conversation between subscribers and to otherwise improve the service at private branch exchanges.

Heretofore telephone systems have been provided in which an operator assisting in establishing a connection between two parties is prevented from listening to the conversation between the parties by having her telephone set automatically excluded from the telephone connection when completed. In systems of this type means has also been provided whereby either subscriber may be manipulating his switchhook cause circuit changes to take place to permit the operator to again listen in by manually connecting her telephone set to the connection.

A feature of this invention is a system of this general character adapted for private branch exchange service in which the attendant may, after having established a connection from her telephone set to a private branch exchange subscriber, listen out by manipulation of keys and simultaneously automatically connect said private branch exchange subscriber's line with a waiting trunk connection from a distant central office. The private branch exchange subscriber is thereby positively assured that the attendant has listened out on the connection and secrecy secured, as conversation between the private branch exchange subscriber and the party on the telephone connected at the distant end of the trunk is prevented until the attendant has listened out.

Another feature is a system of this kind in which the attendant, after having once listened out, cannot again by her own volition connect with the established connection between the private branch exchange subscriber and the trunk.

Another feature is a system of this kind in which a private branch subscriber may by manipulating his switchhook cause circuit changes to take place in the trunk circuit to permit the attendant to again listen in on the connection by manipulating a key and

in which, when the attendant actuates said key, the connection between the private branch exchange subscriber and the trunk is split and the trunk connection held, to provide secret service between the attendant and the private branch exchange subscriber.

This invention has been illustrated in the accompanying drawings in which Fig. 1 shows a trunk circuit incoming to a private branch exchange embodying the invention, while Fig. 2 shows an attendant's telephone equipment at this exchange.

Descriptions will now be made of a call outgoing from a private branch exchange subscriber whose station is indicated at 1 through a line finder LF and selector-connector SC shown in diagrammatic form, the selector-connector having access to the trunk circuit 2 leading to the central office and an incoming call over the trunk 2 through a line finder LF' and selector-connector SC' to a private branch exchange subscriber's station indicated at 3. In this connection the attendant's equipment shown in Fig. 2 is involved. Descriptions will also be made of other functions of these circuits such as transferring an incoming call from one private branch exchange subscriber's station to another; calls originated by the attendant to a private branch exchange subscriber and to a subscriber at the central office. The functions of these circuits while so-called "night service" connections are made will also be described.

In regard to the functions of the circuits when a call is made from the subscriber at 1, the subscriber may in the usual manner connect with the trunk 2 through the line finder and selector-connector LF and SC respectively, which may be of any type well known in the art. When a connection has been established to trunk 2, a circuit will be completed for the operation of relay 5 over a loop closed through the selector-connector. This circuit may be traced from battery, winding of relay 5, lower inner armature and back contact of relay 6, second upper armature and back contact of relay 7, lower outer armature and back contact of relay 8 through the ring terminal and over the loop at the subscriber's station, back through the tip terminal of

trunk 2 upper outer armature and back contact of relay 8, lower inner armature and back contact of relay 10 to ground at the upper inner armature and back contact of relay 7. The operation of relay 5 closes at its lower outer armature and front contact, a connection to ground for the sleeve conductor through the selector-connector SC to hold this switch in operative condition as is well known in the art. This ground connection extends to the sleeve conductor from ground at the lower outer armature and front contact of relay 5 through the inner upper armature and back contact of relay 13 and the first upper make-before-break contacts of relay 10, or from ground at the upper inner armature and front contact of relay 5 through the first upper make-before-break contacts of relay 10. Relay 5 also causes the operation of relay 11 over an obvious circuit through the upper winding of relay 11, and connects a bridge across the tip and ring conductors of the trunk 2 as follows: From the tip conductor of the trunk through the upper outer armature and back contact of relay 13, fourth lower armature and back contact of relay 11, upper make-before-break contacts of relay 10, third upper armature and front contacts of relay 5 to the ring conductor of the trunk. Relay 11 in operating connects another bridge across the trunk conductors through its first and second inner upper armatures and front contacts in substitution of the bridge established by relay 5 through its third upper armature and front contact. Relay 11 also connects the ring conductor of the trunk through resistance 14 to ground as follows: from the ring conductor, the second upper armature and front contact of relay 11, the second upper armature and back contact of relay 10 through resistance 14 to ground at the lower armature and back contact of relay 15. Relay 11 also opens a circuit for relay 16 normally connected across the tip and ring conductors through its second lower armature and back contact, closing an obvious energizing circuit for relay 17, and opens the shunt circuit for the lower winding of relay 18 at its fourth lower armature and back contact. The purposes of these various established connections will become apparent as the description proceeds. Relay 17 in operating prepares a locking circuit for itself at its upper outer armature and front contact which will be controlled at the upper middle armature and front contact of relay 15 when this latter relay operates. Relay 17 also causes the operation of relay 6 over an obvious circuit. Relay 6 in operating establishes a circuit for holding relay 13 operated at a subsequent operation of this latter relay. It also disconnects ground at its lower armature and back contact from a flashing circuit as will be hereinafter described.

The ground connection applied by relay 11

to the ring conductor of the trunk originates the call at the central office whatever the type of central office this trunk may be connected to the line circuit in which it terminates should be arranged with an open tip conductor to permit the ground connection through the resistance 14 to originate the call. When the call is answered by a central office operator or is picked up by a central office switch, depending upon the type of office to which this trunk is connected, battery and ground connections are returned over the trunk to the private branch exchange. This causes the operation of relay 18 in multiple with the originating ground circuit through resistance 14. This circuit may be traced as follows: from battery on the ring conductor of trunk 2, through the bridge closed by relay 11, winding of relay 18 to ground on the tip conductor. The non-inductive shunt winding of relay 18 is open at this time at the upper outer armature and front contact of relay 15 so as to give this relay a better operating margin. Relay 15 will now operate over an obvious circuit closed by the operation of relay 18. This relay opens a ringing bridge across the tip and ring conductors as will hereinafter be described and closes the above mentioned non-inductive shunt for relay 18. Relay 15 also opens the call originating ground connection through resistance 14 at its lower armature and back contact and causes the energization of relay 13 over an obvious circuit. Relay 8 is also operated over a circuit closed by relay 15 as follows: battery winding of relay 8, third upper armature and back contact of relay 7, lower inner armature and front contact of the relay 5, upper inner armature and front contact of relay 15 to a ground on the sleeve conductor furnished through the first upper make-before-break contacts of relay 10 and the upper inner armature and front contact of relay 5 or in this case, due to the operation of relay 13, through the upper middle armature and front contact of relay 13. Relay 13 in operating provides a locking circuit for itself to ground at the lower outer armature and front contact of relay 6.

Relay 8 in operating, closes a locking circuit for itself under control of relay 17. The locking circuit extends through the third upper armature and back contact of relay 7, the second lower armature and front contact of relay 8, and the lower inner armature and front contact of relay 17 to ground on the sleeve conductor. Relay 8 in operating closes a circuit for the operation of relay 20 as follows: from battery, winding of relay 20, third upper armature and front contact of relay 8, upper inner armature and back contact of relay 21 to ground at the upper inner armature and front contact of relay 5. Relay 8 also in operating removes the ground and battery connections from the

calling subscriber's loop; the ground connection is removed from the tip conductor at the upper outer armature and back contact and the battery connection through the windings of relays 6 and 5 is removed from the ring conductor at the lower outer armature and back contact. Relay 8 at these contacts also extends the tip and ring conductors from the calling subscriber to the outgoing trunk conductors 98 and 99 leading to the central office. Relay 6, however, is held operated through its upper winding, upper inner armature and front contact to ground at the second upper armature and front contact of relay 8. Relay 5 is slow in releasing and is therefore held operated for an instant so as to maintain the holding bridge across the tip and ring conductors of the trunk while relay 8 is in the act of operating. Relay 5 is followed by the release of relay 11 and when both relays are returned to normal condition all holding bridges are removed from the trunk. The release of relay 11 closes a locking circuit for relay 17 as follows: from battery through the winding of relay 17, middle upper armature and back contact of relay 21, upper outer armature and front contact of relay 17, middle upper armature and front contact of relay 15, third upper armature and back contact of relay 11 to ground at the armature and front contact of relay 18. Another function performed by the operation of relay 8 at this time is to prepare the incoming trunk call lamp ITC, the circuit for which will be described hereinafter in connection with the calling of the attendant by a private branch exchange subscriber.

The connection to the central office is now completed and the private branch exchange subscriber may, if the central office is an automatic exchange, dial for the desired subscriber's line in the usual manner well known in the art. During the dialing relay 18 may follow the dial pulses as its windings are included in the tip conductor, but relay 15 is slow in releasing so as to hold up during pulsing to maintain the circuit conditions in trunk 2 at the private branch exchange as hereinbefore described. When the desired subscriber has been rung and answers, the talking connection is extended through and conversation between the subscribers may begin.

At the end of the conversation, if the private branch exchange subscriber hangs up first, relays 18, 15, 17, 8 and 6 will be released in the order named. Relay 16 will now be connected across the trunk conductors through contacts of relays 8, 11, 5 and 15. Relay 16 operates to hold the private branch exchange end of the trunk busy by maintaining relay 13 operated over an obvious circuit. It should be observed that the resistance of relay 16 is high so as to cause the

usual disconnect signal to be given at the central office. When the central office end of the trunk is released relays 16 and 13 in the trunk are restored and the switches SC and LF are released as the ground is removed from the sleeve conductor. If the central office end of the trunk is first to be released, relays 18, 15, 17 and 8 are restored in succession and relay 5 is reoperated over the private branch exchange subscriber's loop before relay 6 has time to release as it is slow in releasing. Relay 5 continues to hold relay 13 operated until the private branch exchange subscriber hangs up the receiver. When this occurs, relays 6, 5 and 13 are released and the switches SC and LF are restored to normal.

When the trunk 2 is seized at the central office for calls incoming to the private branch exchange, relay 16 is operated as this relay is normally bridged across the tip and ring conductor of the trunk through contacts of relays 8, 11, 5 and 15. Relay 16 in operating closes a circuit for the lighting of a trunk busy lamp TB as follows: battery lamp TB, upper inner armature and back contact of relay 21, upper inner armature and back contact of relay 13, armature and front contact of relay 16 to ground. Relay 16 also makes the sleeve terminal of the selector connector SC and others in multiple therewith busy by applying a ground at its armature and front contact to the sleeve conductor, through the contact of relay 13 hereinbefore mentioned, fourth upper armature and make-before-break contact and third upper armature and back contact of relay 10, upper inner armature and back contact of relay 20 to the sleeve conductor. This trunk is thereby prevented from being seized by a calling private branch exchange subscriber through an idle selector-connector.

Ring current is now applied at the central office causing ringing relay 23 to operate. This relay is also bridged across the tip and ring conductor of the trunk in parallel with relay 16. Relay 23 in operating closes a circuit for the operation of relay 17 from battery, winding of this relay, armature and front contact of relay 23, lower armature and back contact of relay 21 to the conductor 32 which may pass to ground through the usual alarm circuit, not shown. Relay 17 closes a locking circuit for itself to ground at the middle upper armature and back contact of relay 13. It also causes the operation of relay 6 over an obvious circuit and the lighting of the incoming trunk call line lamp ITC over a circuit as follows: from battery (not shown) over lead LB, lamp ITC, lower outer armature and front contact of relay 17, lower inner armature and back contact of relay 8, second upper armature and back contact of relay 11, second upper armature and back contact of relay 10, outer

lower armature and back contact of relay 11 to ground at the lower armature and back contact of relay 15. Relay 6 in operating establishes a ground connection for the sleeve conductor in substitution of the one established by relay 16. Relay 17 is slow to operate in order to prevent its operation on a momentary operation of relay 23, and thus prevent premature lighting of the lamp ITC on line surges that might occur for example when the trunk is seized at the central office.

On the lighting of the incoming trunk call lamp ITC the attendant responds by operating the key 100, associated with the trunk 2, to the central or so-called talking position to permit the lower springs to close with their respective inner contacts. The operation of key 100 in this manner causes energizing circuits to be closed for the operation of relays 10 and 25. The circuit for relay 10 extends from battery, winding of this relay, upper outer armature and back contact of relay 6 through the right hand made contacts of key 10 to ground. The circuit for relay 25 extends from battery, winding of this relay over the same path to ground at key 100. The purpose of the operation of relay 25 will become apparent as the description proceeds. Relay 10 connects the listening conductors T and R from the attendant's equipment to the central office end of the trunk at the upper outer armature and front contact and the third lower armature and front contact of relay 10. This relay also causes the energization of relay 7 over an obvious circuit. Relay 7 in energizing opens the circuit for relay 5 and the primary winding of relay 6. Relay 10 also prepares a path for listening conductors T' and R' to the associated line circuit end of the trunk through its lower inner armature and front contact and upper inner armature and front contact. Connections are also established by this relay for conductor IC to conductor 27, conductors H and RL to the sleeve conductor, and lead OC to the ground at relay 15, through its fourth lower armature and front contact and third, fifth and second upper armatures and front contacts respectively. The purpose of these connections will become apparent as the description proceeds. The incoming trunk call lamp ITC is extinguished by transferring the ground connection for this lamp to conductor OC. Relay 7 closes a holding circuit for relay 17 at its upper outer armature and front contact and closes an obvious circuit for the operation of relay 13 at the lower armature and front contact. Relay 13 in operating opens the original locking circuit for relay 17, grounds the original busy circuit for the selector-connector although this circuit is at present not serving this purpose but merely holds the lamp TB lighted. The selector-connector is held busy by other means at this time as will become apparent as the descrip-

tion proceeds. A locking circuit is also closed for relay 13 through its inner upper armature and front contact under control of relay 6. Relay 13 further opens the shunt path around relay 18 for purposes as will be hereinafter described.

The attendant's telephone equipment A is now connected to the tip and ring conductors of the trunk 2 towards the central office over the listening leads T and R through the contacts of relays 101, 102 and 10 and also furnishes a tripping circuit for the ringing and an operating path for relay 18. Relays 18 and 15 now operate; the latter relay closes the non-inductive winding of relay 18, and opens the circuits for relay 16 and ringing relay 23. The attendant may now determine the desired number and then operate the trunk extension key 103, thereby closing an obvious circuit for the operation of relay 104. This relay in operating closes a circuit to ground at key 110, for the lead IC over its upper outer armature and front contacts and contacts of relays 108 and 109. This connection to ground also closes an obvious circuit for the operation of relay 111. Relay 104 also causes the energization of relay 102 over an obvious circuit. Relay 102 connects a resistance bridge across the tip and ring conductors over leads T and R toward the central office to hold the trunk. This bridge extends through resistance 105 and the second lower armature and front contact of relay 102. The attendant's telephone equipment is also transferred to the leads T' and R' by the operation of relay 102 through the upper armature and front contact and lower inner armature and front contact of this relay and upper and lower inner armatures and back contacts of relay 106 and also through the winding of relay 107. Thus the attendant's telephone equipment is connected to the trunk terminating terminals of line finder LF' while the holding bridge through resistance 105 is connected across the tip and ring conductors of the trunk leading to the central office. The above mentioned ground connected to lead IC extends as noted through the fourth lower armature and front contact of relay 10, second upper armature and back contact of relay 20 to the lead 27 and the line finder LF' is thereby caused to extend the trunk connection to a selector-connector such as SC' in a manner well known in the art. The T' and R' leads are therefore now connected to the usual pulsing relay in the selector-connector SC'. Relay 107 now operates in series with the loop through the attendant's equipment, and this relay in turn causes the operation of relay 108, over an obvious circuit. Relay 108 prepares a circuit for relay 109 to be hereinafter operated and establishes a ground connection for lead BG at its upper middle armature and front contact through upper middle

armature and front contact of relay 104 and left hand contacts of key 100. The ground connection over lead BG extends through the upper middle armature and front contact of relay 25 and upper winding of relay 11 to battery, causing this relay to operate. Relay 11 provides an additional break in the circuit for relay 16 and prepares a holding circuit for the trunk to be closed later and closes an obvious holding circuit for relay 17. It also connects its own locking circuit in parallel with the awaiting extension answer lamp AEA to ground on conductor 27 through the upper outer armature and back contact of relay 21, and the second upper armature and front contact of relay 20. Conductor 27 is now grounded from the circuit in the line finder LF' as the cutoff relay has by this time operated to apply a ground to this conductor. It should be noted that on the operation of relays 107 and 108 the ground was removed from lead IC. The awaiting extension answer lamp AEA is lighted by this circuit to indicate that the attendant may now dial the desired private branch exchange subscriber in the regular manner.

When the attendant has finished dialing the desired number, she will receive either a busy or ringing tone. If a ringing tone is received in the usual manner from the selector-connector SC' the attendant may wait until the called station answers. When this occurs, the battery feed from the selector-connector SC' is opened and the station is connected to leads T' and R'. Relay 107 which was held up in the meantime now releases and causes the energization of relay 109 over an obvious circuit before relay 108 releases as this relay is slow in releasing. Relay 109 locks over a circuit completed through its upper inner armature and front contact to lead H which is supplied with a ground connection through the third upper armature and front contact of relay 10, upper inner armature and back contact of relay 20 from the sleeve conductor. Relay 109 causes the operation of relay 106 over a circuit from battery, winding of relay 106, fourth upper armature and front contact of relay 109 to ground through contacts of key 110. When relay 106 operates it short-circuits relay 107 and opens the locking circuit of relay 111. It also prepares a click bridge for the attendant's telephone set and introduces a talking bridge through condensers 115 and 116 with battery feed for the private branch exchange subscriber through coil 113 and battery feed for the attendant's telephone through relay 114. The circuits are now in talking condition for conversation between the attendant and the called subscriber, whose station is indicated at 3.

When the attendant has informed the called subscriber that an outside party is

waiting, she disconnects her telephone set and establishes a connection to the waiting outside party by releasing the trunk extension key 103. The release of this key causes the release of relay 104. Relay 104 in releasing causes the release of relay 102 and this relay transfers the attendant's telephone set back to the conductors T and R towards the central office and opens the resistance bridge through resistance 105. The attendant's telephone set is thus connected across the trunk to the central office and the attendant may communicate with the central office subscriber to inform him that the desired private branch exchange subscriber's line has been called. The key 100 is now released from the talking position and the attendant's telephone set is thereby disconnected entirely from the trunk. The release of key 100 causes the release of relays 25 and 10, the latter relay disconnecting the listening leads T and R and T' and R' as well as leads OC, IC, RL and H from the trunk. Lead BG is disconnected by the release of key 100.

Relay 10 in releasing also closes the holding bridge controlled by relay 11 and transfers the sleeve lead to the common ground circuit controlled by relay 13. It also opens the operating circuit for relay 7. Since the selector-connector SC' has already removed its battery feed, relay 7 releases at once and connects battery to the ring conductor of the line through the winding of relay 5. Relay 11 remains operated through the connection established at the second upper armature and back contact of relay 20 to ground supplied over lead 27 from the line circuit. Relay 5 now operates over the private branch exchange subscriber's loop and connects the second bridge across the trunk as hereinbefore described and also closes the operating circuit for relay 8. Relay 8 operates as hereinbefore described and disconnects ground and battery connection towards the called subscriber's line through the winding of relay 5. It also extends the connection from the called subscriber through to the trunk at the outer upper and lower armatures and front contacts and causes the operation of relay 20 over an obvious circuit. Relay 11 now releases as it was held by relay 20 and opens its holding bridge and extinguishes the awaiting extension answering lamp AEA. Relay 5 being slow in releasing maintains the holding bridge after relay 11 has released until relay 8 has operated, the purpose being to minimize the clicks through the talking conductors under these circumstances. Relay 8 in operating, also opens the circuits for relay 16 to disconnect it from the trunk. The talking connection between the called private branch exchange subscriber and the subscriber at the central office over this trunk is now completed and

the attendant's equipment excluded. This connection is held at the private branch exchange end by relay 18.

If the attendant had listened out after dialing but before the private branch exchange subscriber had answered the call, relay 11 would remain locked to ground supplied over conductor 27 to maintain the holding bridge across the trunk. Awaiting extension answering lamp AEA would have remained lighted to remind the attendant that this was the case. Under these conditions, relay 7 remains locked over the tip conductor to the winding of the pulsing relay in the selector-connector to prevent the pulsing relay and certain other relays in the selector-connector from releasing and disconnecting the ringing. When the called private branch exchange subscriber answers, the subscriber's switchhook opens the battery feed connection and cuts through to the station. Relay 7 is thus released and connects relay 5 to the line. Relay 5 energizes over the station loop and by operating relays 8 and 20, causes the awaiting extension answering lamp AEA to be extinguished and the called station to be cut through to the central office as heretofore described.

After the attendant has dialed the desired station and found it busy, the attendant restores the trunk extension key 103 and thus transfers her telephone set back to the trunk leading to the central office. The attendant then ascertains whether the central office calling subscriber decides to wait and if so, releases the switches to the called private branch exchange subscriber by operating the release key 110. As ground has already been removed from lead IC by the restoration of the trunk extension key, the release key removes the ground from lead RL and therefore from the sleeve. The selector-connector SC' and line finder LF' are then restored to normal. To prevent the trunk from releasing at the central office, the attendant now operates the key 100 to its upper position, that is, to the so-called holding position. The circuit for relay 10 is thus opened and this relay in releasing disconnects as heretofore stated all the common leads from the trunk, and recloses the bridge circuit controlled by relay 11. Relays 25 and 11 are held operated by the operation of key 100 to this holding position. After an interval the attendant may then again listen in by operating the key 100 to the talking position and redial the call in the same manner as hereinbefore described.

If the calling subscriber does not desire to wait the attendant restores the key 100 to normal, releasing relays 10 and 25. Relay 11 is also released and lamp AEA is extinguished. Relays 18, 15, 17 and 6 next release and relay 16 is again connected across the trunk. Relay 16 now operates over the central office trunk and holds relay 13 operated,

and thereby keeps the private branch exchange end of the trunk from releasing. When the central office end of the trunk is released, relays 16 and 13 are released and the trunk is restored to normal.

If an incoming trunk call is completed to a private branch exchange line and this subscriber finds it desirable to have the call transferred, the attendant is flashed. This is accomplished as follows: When the switchhook of the called subscriber is first replaced, relays 18, 15, 17, 8 and 6 are released in the order named. The circuit of relay 16 is now connected across the conductors of the trunk through contacts of relays 8, 11, 5 and 15 as hereinbefore described. Relay 16 is of such resistance as not to interfere with the giving of disconnect signals at the central office and it operates over the trunk and serves to hold relay 13 operated. The release of relay 8 splits the trunk and connects the private branch exchange subscriber's line to battery through the winding of relay 5 as hereinbefore described. When the switchhook is again removed, relay 5 operates and connects a bridge across the trunk as hereinbefore described. Relay 6 does not operate as its primary winding is short-circuited through its lower inner armature and back contact. Relay 18 now operates, causing the operation of relay 15. Relay 15 closes a path through contacts of relay 5 to reoperate and lock relay 8. Relay 8 in operating disconnects relay 5, opens the bridge through relay 16, and again connects the called private branch exchange subscriber's line to the trunk, thereby holding relays 18 and 15 operated. It should be noted at this time that relay 17 does not reoperate and a ground connection is therefore established through back contacts of relays 6 and 17 and through front contacts of relay 8 to light the incoming trunk call lamp ITC.

The circuits in the trunk 2 are now in their original state except that relays 17 and 16 are not operated and the incoming trunk call lamp ITC is lighted. These operations are now repeated to alternately light and extinguish lamp ITC and both the private branch exchange attendant and the central office operator receive flashing signals. At the termination of the flashing, the lamp ITC lights steadily. The private branch exchange attendant now answers the call by listening in on the connection as hereinbefore described. When the attendant listens in she operates the key 100 to the talking position, operates the trunk extension key 103 and removes her receiver from the switchhook. Relay 107 operates from battery over the T' and R' conductors from the trunk causing the operation of relay 108. Relay 108 removes the ground from the H lead, thus releasing relay 20 in the trunk which supplies battery for operating relay 107 as will be hereinafter described. Relay 107 in releas-

ing operates the relay 109 and releases the relay 108. Relay 109 in turn operates relay 106 which supplies transmitter battery as hereinbefore described.

5 It should be noted that in the trunk circuit relays 25, 10 and 7 will operate and cause the release of relay 8 which will split the trunk circuit and connect the attendant's set on the private branch subscriber's line side. Relay 20 is now held by the attendant's telephone and line circuit and supplies battery and ground to it over the T' and R' leads. When the trunk extension key is operated as hereinbefore described, relay 20 releases and removes the battery and ground from the T' and R' leads, the attendant's circuit now supplying transmitter battery to the called private branch exchange station and the attendant's station. The attendant now secures the information from the called subscriber that the call should be transferred and thereupon proceeds as follows: The attendant releases the line finder and the selector-connector to the called subscriber's line by operating release key 110 as hereinbefore described while the key 100 is still operated. The release key 110 removes the ground from the lead RL, it being assumed that the lead IC has already been ungrounded by the release of the trunk extension key 103 and the consequent release of relays 104 and 102. The removal of ground from lead RL opens the holding circuit for the line finder and selector-connector, allowing them to release. The removal of ground from lead RL also releases relays 109 and 106. The local end of the trunk is now normal and is ready to be set up in the regular way when the attendant re-operates the trunk extension key 103 to establish a connection to another private branch exchange subscriber's line.

The circuits are so arranged that the central office cannot flash the private branch exchange attendant and so that the momentary opening of the trunk by the central office will not cause the incoming trunk call lamp to light falsely. Both of these functions are accomplished by means of relay 6. With the called private branch exchange subscriber's receiver off the switchhook a momentary opening of the circuit at the central office releases relays 18, 15, 17 and 8. Relay 6, however, holds on its primary winding in series with relay 5 which operates over the private branch exchange subscriber's loop as soon as relay 8 releases. With relay 6 operated, the incoming trunk call lamp is prevented from lighting under these circumstances.

The attendant may originate calls over a trunk in either direction. In originating a call to the central office, key 100 is operated to the talking position and the out call key 118 is operated. The trunk circuit relays 10 and 25 operate as usual and relay 10 connects

the ground for lead OC and the operation of relay 11 opens the shunt around the resistance 14. The operation of key 118 closes an obvious circuit for the operation of relay 119. This relay in turn connects the lead OC from ground at relay 15 to the ring conductor. This ground connection to the ring conductor brings about the calling of the central office. When the central office operator answers, relays 18 and 15 are operated as hereinbefore described and the attendant may now give directions for completing the call.

If the attendant now decides to extend the connection through to the private branch subscriber, the trunk extension key 103 is operated in the usual manner and the station dials as hereinbefore described. If the attendant desires to call a private branch exchange subscriber first and then extend a connection over the trunk, she proceeds in the usual manner to call the desired subscriber and then restores the trunk extension key 103 and operates the call key 118 and proceeds as hereinbefore described. Having extended the connection in both directions, she listens out and the called stations are connected together.

These circuits are so arranged that the attendant's station may be used as a regular private branch exchange line and a private branch exchange line and number is assigned for this purpose. This is done by having leads 120 connected to a selector-connector and a line finder the same as the line of any private branch exchange subscriber. It should be noted that these leads are bridged through a relay 122, over a contact of relay 101. If the attendant's number is called the connection is established in the usual manner but instead of connecting with a trunk the connection at 120 is found. Relay 122 is operated as soon as this connection is established and this relay is locked to ground through its lower winding at the back contact of relay 108. Conductor BK is extended to the usual tone, ringing and alarm circuit to battery. Relay 122 having been operated, closes a circuit for the extension call lamp 123 and this lamp in lighting notifies the attendant that a call is waiting. The attendant answers this call by operating the extension switchboard key 128. This key closes an obvious circuit for the operation of relay 101 which switches the attendant's telephone equipment A to the selected line circuit at 120, opens the operating winding for relay 122, and causes the energization of the relay 108. Relay 108 in operating opens the locking circuit for relay 122 and causes this relay to release to extinguish lamp 123. When the call is finished, the attendant restores the key 123 to reclose the bridge for relay 122 across the line. Relay 108 is slow in releasing so that it holds up the locking circuit for relay 122 for a moment to prevent false relighting.

ing of the lamp 123 when relay 122 is again connected across the line.

These circuits are also so arranged that night calls may be made to or from a specially assigned night service station. If it is desired to prepare a connection for this purpose, the attendant dials the number at this night position in the usual manner and operates the night connection key 125 while the key 100 is still operated in the talking position. Relay 21 is then operated over an obvious circuit. Relay 21 in operating closes a connection to ground for the lead 30. This ground connection from the contacts of relay 21 enters the selector-connector circuits where it will serve to trip ringing which would otherwise continue until the call is answered at the night station. Relay 21 also disconnects the trunk busy lamp TB from the sleeve circuit and provides a ground for the sleeve circuit at its upper inner armature and front contact. This relay also opens the locking circuit for relay 11 and closes a circuit to cause the energization of relay 8. Relay 21 also opens the circuit extending from lead 32 and substitutes a direct ground for the circuit controlled by the ringing relay 23. The attendant then listens out in the usual manner leaving the key 125 operated. All relays in the trunk release except relay 21 and the connection is now ready for night calls.

When the night station originates an outgoing night call the relay 5 operates over the station loop, and operates relay 11. From this point on the establishing of an outgoing connection is the same as hereinbefore described for an ordinary private branch exchange subscriber. When calls are incoming over the trunk to the night position, relay 23 operates from ringing current and causes the operation of relay 17. This latter relay causes the operation of relays 6 and 8. Relay 18 is short-circuited at this time, so as to prevent it from disturbing the call by operating relay 15. Relay 8 cuts through the connection and extends ringing to the night station. When the call is answered, ringing is tripped either through the station loop or through the contacts of relay 5, depending on whether the answer occurs during ringing or silent intervals. From this point on, the operation is the same as for an ordinary incoming call except that the trunk lamp TB is cut off as hereinbefore explained.

If an ordinary out call is abandoned it should be noted that relay 11 is locked until the call is picked up at the central office and relays 18, 15 and 13 are operated. If the call is abandoned before being picked up at the central office, that is, if the relay 5 is released before relays 18 and 15 are operated, relay 11 is locked under control of relay 13. Under these circumstances, however, relay 15 has an operating path through the third

upper armature and front contact of relay 11 and second upper armature and back contact of relay 5 to ground at the lower armature and back contact of relay 13. Relay 15 now operates to cause the operation of relay 13 which releases relay 11. Relays 15 and 13 are then released and the circuit is restored to normal.

It should be noted that the winding of relay 10 is connected in a circuit through contacts of relays 8 and 6 so that when these relays are operated during conversation, the attendant cannot monitor in on the connection. When the private branch station is flashing relay 6 releases and the attendant can then listen in on the connection as hereinbefore described.

Although the invention has only been shown applied to a single circuit arrangement, it should be understood that it could readily be applied to a number of other systems without departing from the spirit thereof.

What is claimed is:

1. In a telephone system, two lines, an attendant's equipment, means for establishing a talking connection between the attendant's equipment and one of said lines, means operable by said attendant for establishing a talking connection between said lines, and means responsive to the operation of said last mentioned means for rendering said equipment ineffective and for preventing its reconnection to said line.

2. In a telephone system, two lines, an attendant's equipment, means for establishing a talking connection between the attendant's equipment and either of said lines, means operable by said attendant for establishing a talking connection between said lines, and means responsive to the operation of said last mentioned means for rendering said equipment ineffective and for preventing its reconnection to either of said lines.

3. In a telephone system, two lines, an attendant's equipment, means for establishing a talking connection between the attendant's equipment and either line, means operable by said attendant for establishing a connection between said lines, means responsive to the operation of said last means for rendering said equipment ineffective and for preventing its reconnection to either line, and means controlled by the subscriber of one of said lines for rendering said equipment effective.

4. In a telephone system, two lines, an attendant's equipment, means for establishing a talking connection between the attendant's equipment and either line, means operable by said attendant for establishing a connection between said lines, means responsive to the operation of said last means for rendering said equipment ineffective and for preventing its reconnection to either line,

means controlled by the subscriber on one of said lines for rendering said equipment effective, and means thereafter operable by the attendant for splitting the connection between two lines and connecting her equipment with the said one line.

5 5. In a telephone system, a trunk, a subscriber's line, an attendant's telephone equipment, means responsive to the seizure of said trunk for signaling the attendant, means for associating said attendant's telephone equipment with said trunk, means for removing the attendant's equipment from the trunk and for establishing a connection between the attendant's equipment and the subscriber's line, means operable by the attendant for establishing a talking connection between said trunk and said subscriber's line, and means responsive to the operation of said last mentioned means for rendering said telephone equipment ineffective and for preventing its reconnection to the line and to the trunk.

6. In a telephone system, a subscriber's line, a trunk, an attendant's telephone equipment, means for connecting the attendant's telephone equipment to the trunk, means for associating the attendant's telephone equipment with the subscriber's line and signaling the subscriber, means for removing the attendant's telephone equipment from the subscriber's line, means responsive to said removal and to the subscriber answering the call for connecting the line to the trunk, and means operative under control of the subscriber of said line for simultaneously disconnecting the trunk from the subscriber's line and connecting the attendant's telephone set to the subscriber's line.

7. In a telephone system, two lines, an attendant's equipment, means for establishing a talking connection between the attendant's equipment and one of said lines, means operable by said attendant for establishing a talking connection between said lines, means responsive to the operation of said last mentioned means for rendering said equipment ineffective and for preventing its reconnection to said line, and means operative under the control of the subscriber of said one line and the attendant for splitting the talking connection between said lines and for reestablishing a talking connection between the attendant's equipment and said one line.

8. In a telephone system, two lines, an attendant's equipment, means for establishing a talking connection between the attendant's equipment and either line, means operable by said attendant for establishing a connection between said lines, means responsive to the operation of said last mentioned means for rendering said equipment ineffective and for preventing its reconnection to either line, means controlled by the subscriber of one of said lines and by the attendant for splitting the connection between the two lines, for con-

necting the attendant's equipment with one of said lines and for establishing a bridge across the tip and ring conductors of the other line.

9. In a telephone system, two lines, an attendant's equipment, means for establishing a talking connection between the attendant's equipment and either line, means operable by said attendant for establishing a connection between said lines, means responsive to the operation of said last mentioned means for rendering said equipment ineffective and for preventing its reconnection to either line, means controlled by the subscriber of one of said lines and by the attendant for splitting the connection between the two lines, for connecting the attendant's equipment with one of said lines and for establishing a bridge across the tip and ring conductors of the other line, and means controllable by the attendant for reestablishing a talking connection between said lines, for rendering said attendant's equipment ineffective and for preventing its reconnection to said one line without the aid of the subscriber of said one line.

In witness whereof, I hereunto subscribe my name this 30th day of December, 1929.

GERALD V. KING.

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