

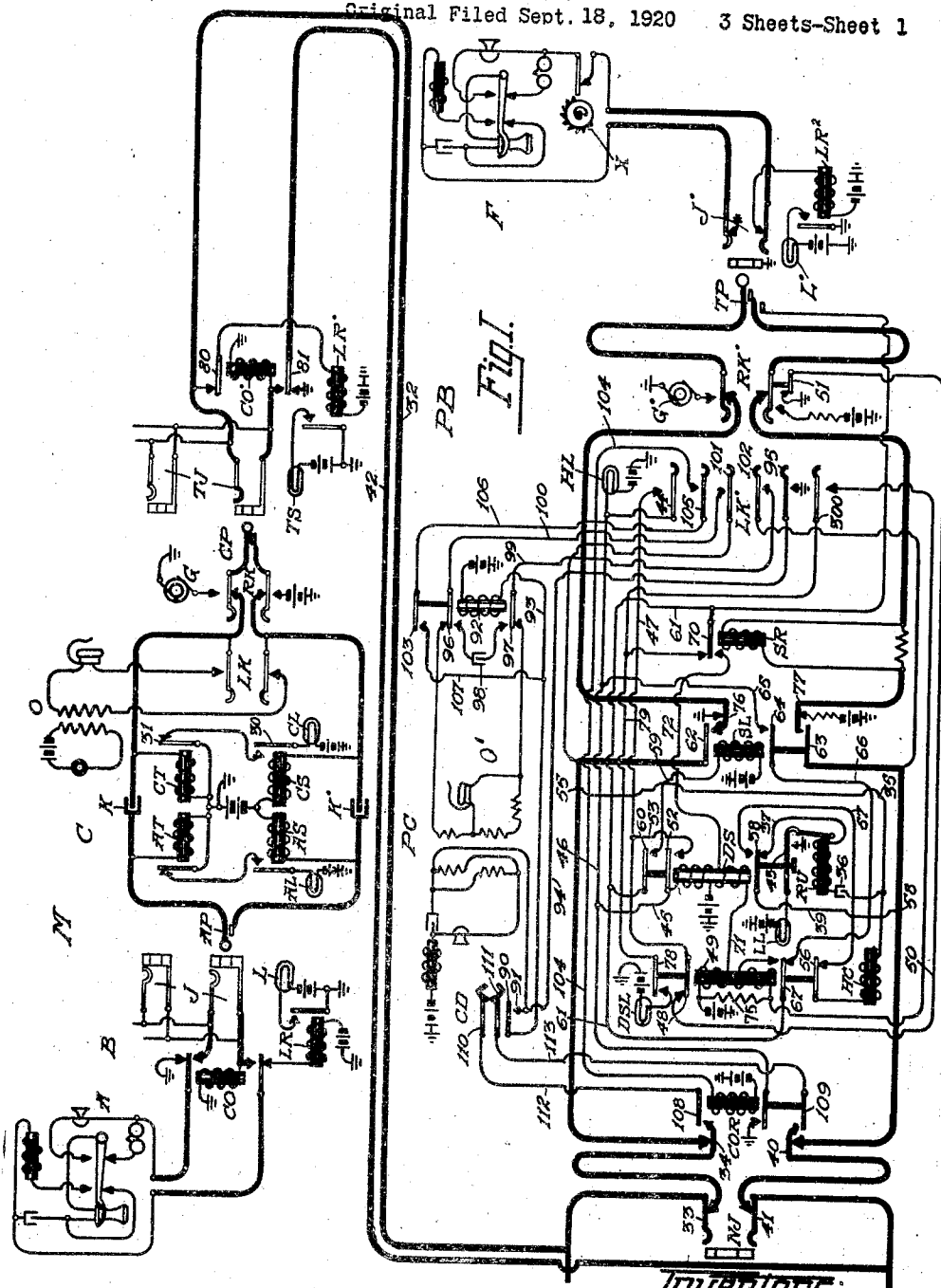
April 3, 1928.

H. D. CURRIER ET AL

1,664,665

TELEPHONE SYSTEM

Original Filed Sept. 18, 1920 3 Sheets-Sheet 1



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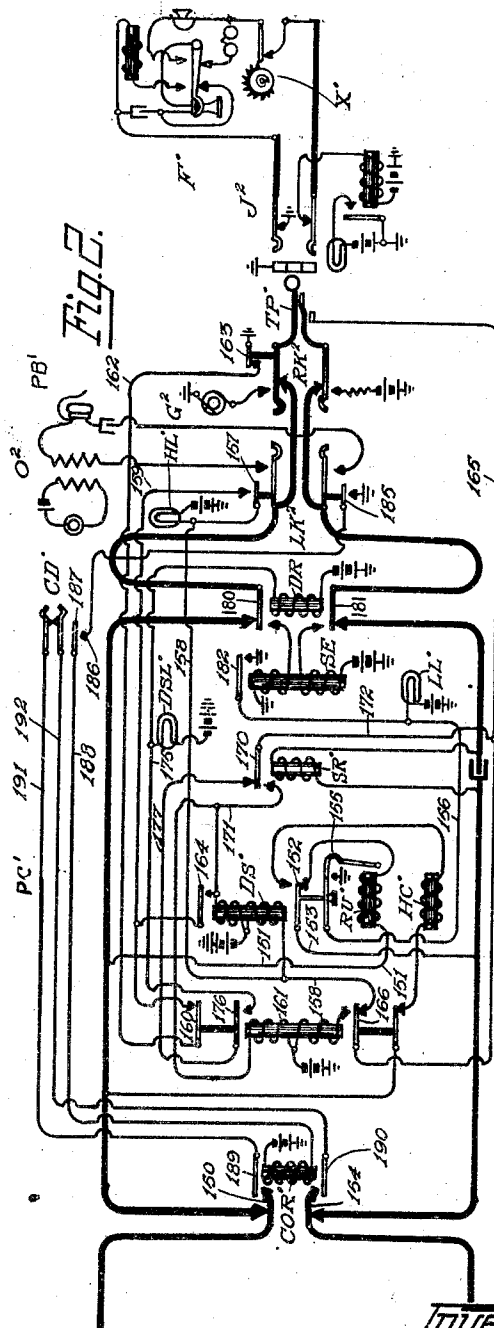
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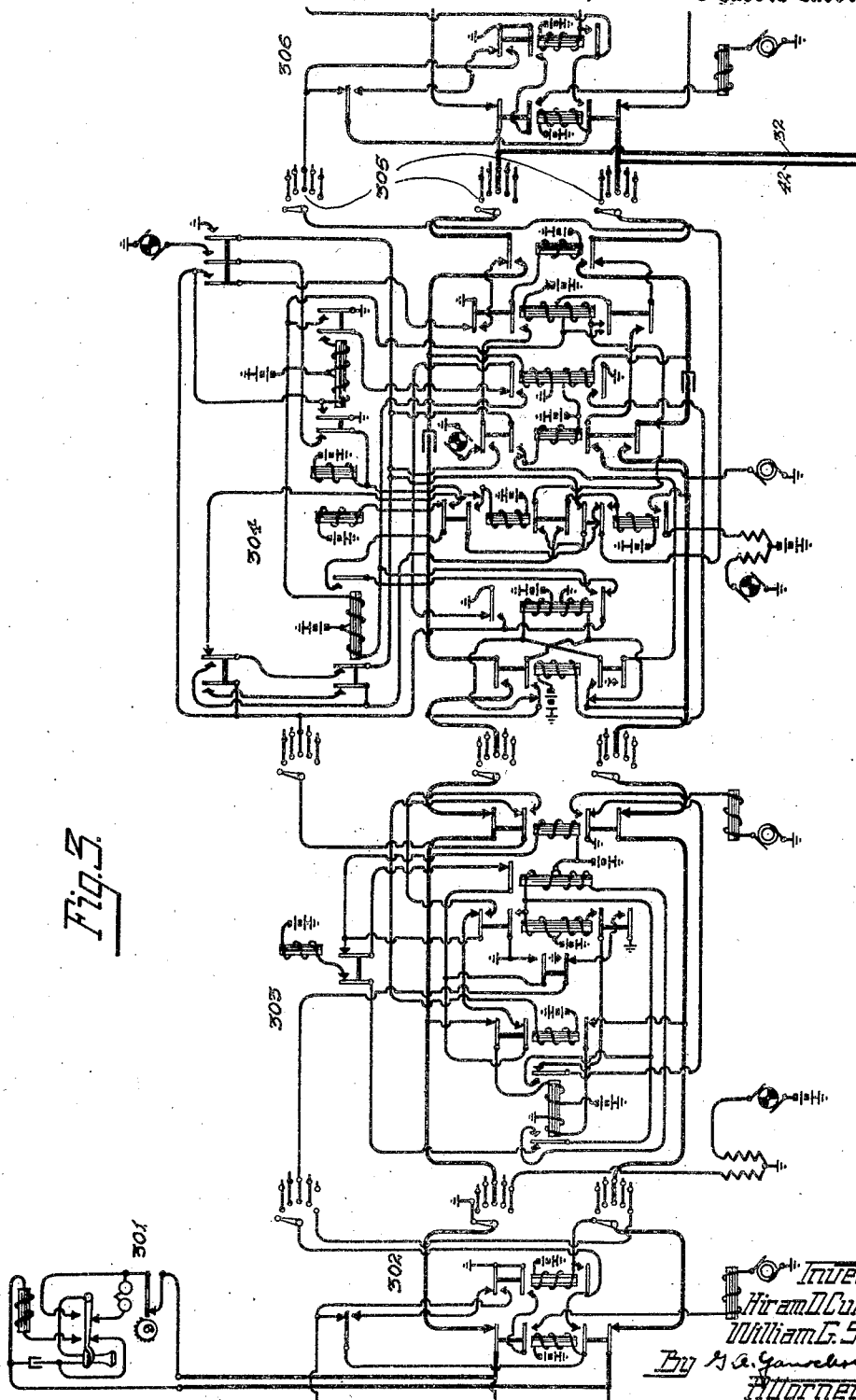
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TELEPHONE SYSTEM

Original Filed Sept. 18, 1920

3 Sheets-Sheet 3



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1,664,665

# UNITED STATES PATENT OFFICE.

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## TELEPHONE SYSTEM.

Original application filed September 18, 1920, Serial No. 411,289. Divided and this application filed  
March 9, 1925. Serial No. 13,963.

Our invention relates to telephone systems and has to do more particularly with trunk circuits for use with private branch exchange systems in which the trunk circuits  
5 are used between local private branch exchange substations and manual exchanges or automatic exchanges.

A feature of our invention is the provision of means whereby the private branch exchange operator may, by the use of a calling device, dial from her position and actuate  
10 the apparatus at the automatic exchange to select the wanted called line without the plug of the trunk circuit being in a local line jack.  
15

Another feature of our invention is that the operator may actuate the central office exchange switches with the plug of the trunk inserted in a local subscriber's line jack,  
20 either when the local subscriber has his receiver on or off the switchhook.

A further feature of our invention is the provision of means whereby the instant the private branch exchange subscriber replaces  
25 his receiver upon the switchhook, means are actuated in the trunk circuit to clear the line through to the main exchange, so that, should the private branch subscriber again remove his receiver before the trunk plug is removed from the local jack, the trunk will again be seized and extend the connection  
30 through to the main exchange, and in the event that the private branch exchange substation is equipped with a calling device, the subscriber may again actuate the automatic  
35 apparatus to seize another called line as wanted. In the event that the trunk circuit was used to extend a connection to a main manual exchange, when the private branch exchange subscriber removes his receiver the trunk is again extended to the said main exchange and the main exchange operator sig-  
40 naled.

Another feature of our invention is the  
45 provision of means so that after the private branch exchange subscriber hangs up and clears the trunk to the main exchange, should another call be extended from the main exchange to the branch exchange before the  
50 plug is taken down, the call lamp of the trunk circuit will be operated, but not the bell of the private branch exchange subscriber.

The above features, as well as others of our invention, will be more particularly  
55 pointed out in the ensuing specification and appended claims.

This application is a divisional application of our application 411,289, filed September 18, 1920, and issued April 7, 1925, as  
60 U. S. Patent No. 1,532,652.

For a better understanding of our invention, reference may be had to the accompanying drawings, in which

Fig. 1 illustrates one embodiment of our  
65 invention as applied thereto;

Fig. 2 illustrates another embodiment of our invention; and

Fig. 3 illustrates an automatic exchange system adapted to operate in connection with  
70 our invention.

Referring now more in general to our invention as illustrated in Fig. 1, we show a calling substation A terminating at the main exchange M in a line circuit B, comprising  
75 the usual line relay LR, cut-off relay CO, line signal L and the multiple jacks J.

The cord circuit C located at the main exchange M is shown for use in extending connections from the line circuit B and com-  
80 prises an answering plug AP and a calling plug CP, the two plugs AP and CP being connected by the heavily marked conductors, the said conductors having the condensers K and K' interposed therein. Associated  
85 with the answering end of the cord circuit C is the answering tip supervisory relay AT and an answering sleeve supervisory relay AS, the two relays controlling the answering supervisory lamp AL. Associated with  
90 the calling end of the cord circuit C is a calling tip supervisory relay CT and a calling sleeve supervisory relay CS, the two relays controlling the calling supervisory lamp CL. A listening key LK is also shown  
95 which, when actuated, connects the operator's set O to the cord conductors. A ringing key RK is also shown which, when actuated, connects the ringing generator G to ring the call bell of the called-for line, or to the trunk  
100 circuit.

The calling plug CP is adapted for connection to the multiple jacks of other telephone lines terminating at the switchboard in the same exchange, or for connection to  
105 the trunk jacks TJ, which are located at the

operator's position, and which are terminals of trunk circuits PC. The trunk circuits PC extend to a private branch exchange switchboard PB, and the said jacks TJ are connected to the said trunk circuits PC, which terminate at the private branch exchange PB over the heavily marked conductors 32 and 42.

The private branch exchange trunk PC is provided with a ring-up relay RU, which relay operates when ringing current is applied from a distant exchange. The ring-up relay RU, upon energization, brings about the lighting of the line lamp LL, to notify the operator at the private branch exchange board that a call awaits her attention. A listening key LK' is provided which, when actuated, connects the operator's set O' to the trunk conductors for the usual purposes. A combined disconnect and guard relay DS is also provided which is energized upon the actuation of the listening key LK' to bring about the effacement of the line signal LL when the operator answers the call. A sleeve relay SL is also provided, which relay is energized when the operator inserts the trunk plug TP into the local line jack J' of the wanted station at the private branch exchange. A ringing key RK' is also provided which, when actuated, connects ringing generator G' to signal the called-for station at the private branch exchange. A supervisory relay SR is also provided which is energized when the party at the called private branch exchange substation answers. A holding relay 49 is also provided, which energizes upon the energization of the supervisory relay SR to bring about the effacement of the holding lamp HL and also disconnects the holding coil HC from across the trunk conductors, the said holding coil being bridged across the trunk conductors upon the energization of the relay DS. A disconnect signal DSL is also provided for the usual disconnect signaling purposes. An operator's disconnect relay 92 and a trunk cut-off relay COR are provided and are brought into operation in connection with the trunk circuit PC when the private branch exchange operator O' is extending a connection from the local private branch exchange substation to an automatic main exchange. A calling device CD is also provided which is used by the operator in extending a connection to a main automatic exchange. A night jack NJ is also provided for the usual purposes. To the right of the private branch exchange trunk PC we show a local private branch exchange substation F, terminating thereat in the jack J', a line relay LR<sup>2</sup> and a line signal L'.

In Fig. 2 we illustrate a modified form of trunk circuit in which, upon the energization of a relay of the trunk circuit PC' after

the branch exchange subscriber replaces his receiver and wishes to recall, the removal of the receiver brings about the lighting of the line lamp to notify the operator that the local subscriber wishes to recall. The trunk circuit PC' is provided with apparatus similar to that mentioned in connection with the trunk circuit PC of Fig. 1.

Having described in general the apparatus which embodies our invention, we will now describe more in detail the operation of the system as illustrated.

Assuming now that the subscriber at the substation A at the main exchange initiates a call, the removal of the receiver at the substation closes an energizing circuit for line relay LR of the subscriber's associated line circuit B, and the said relay LR, upon energization, closes its alternate contact, establishing a circuit through the line lamp L, which lamp L is now lighted. The operator at the main exchange noting the lighted line signal L inserts the answering plug AP of one of her cord circuits C into the answering jack J of the calling line A, and the insertion of the said plug AP establishes a series energizing circuit for the answering supervisory relay AS of the cord C and the cut-off relay CO of the line circuit L, traced from battery through the winding of the relay AS, sleeve contacts of the connected plug AP and jack J to ground through the winding of the cut-off relay CO. The relay CO upon energization opens the energizing circuit of the line relay LR, which relay LR now restores and effaces the line signal L. The answering tip supervisory relay AT is also energized over the line to prevent the premature lighting of the answering supervisory lamp AL. The operator of the cord circuit C now actuates her listening key LK to connect her operator's set O to the cord conductors and inquires the wants of the calling subscriber at the substation A.

Assuming that it is the subscriber F located at the private branch exchange PB that is desired, the operator now inserts the calling plug CP into a trunk jack TJ leading to the private branch exchange PB at which the subscriber F is located. The insertion of the said plug CP into the jack TJ establishes an energizing circuit for the calling sleeve supervisory relay CS, and the cut-off relay CO', from battery through the winding of the relay CS, normal contact of the ringing key RK, sleeve contacts of the connected plug CP and trunk jack TJ, through the winding of the relay CO' to ground. The closing of alternate contact 30 of the relay CS closes a circuit for the calling supervisory lamp CL from battery, through the winding of the said lamp CL, alternate contact 30, normal contact 31 of the calling tip supervisory relay CT to ground, the lamp CL remaining lighted un-

til the private branch exchange operator answers the call, at which time the calling tip supervisory relay CT energizes to efface the supervisory signal CL. The operator at the main exchange now operates the ringing key RK to connect ringing generator G to the trunk circuit. Ringing current is thus extended over the trunk conductors, which circuit may be traced from the ungrounded pole of the generator G, tip contacts of the connected plug CP and trunk jack TJ, trunk conductor 32, normal contact 33 of the night jack NJ, normal contact 34 of the dialing relay COR, conductor 35, condenser 36, through the winding of the ring-up relay RU, conductor 37, normal contact 38 of the disconnect relay DS, conductor 39, normal contact 40 of the dial relay COR, normal contact 41 of the night jack NJ, trunk conductor 42, sleeve contacts of the connected trunk jack TJ of the plug CP to battery and ground at the alternate contact of the ringing key RK.

The closing of alternate contact 43 of the relay RU closes an energizing circuit of the line lamp LL from battery through the lamp LL, to the grounded alternate contact 43 of relay RU. The operator noting the lighted line lamp LL now actuates her listening key LK'. The closure of alternate contact 44 of listening key LK' establishes an energizing circuit for the disconnect relay DS, traced from battery through the upper winding of the relay DS, conductors 45, 46, alternate contact 44 of listening key LK', conductor 47, normal contact 48 of relay 49, conductor 50 to ground at normal contact 51 of the ringing key RK'. The closing of alternate contact 44 of key LK' establishes a circuit for the holding lamp HL, traced from battery through the said lamp HL, closed contact 44 of key LK', conductor 47, normal contact 48 of relay 49, conductor 50 to ground at normal contact 51 of ringing key RK'. If the call proceeds no further than the operator, the circuit is cleared by the operator at the branch exchange actuating the ringing key RK', which opens the circuit of relay DS and allows it to restore to normal. The relay DS upon energizing unlatches the alternate contact 43 of the relay RU, allowing it to restore to efface the line signal LL. The relay DS now closes a locking circuit for itself from battery through its upper winding, its alternate contact 52, conductors 53 and 47, normal contact 48 of relay 49, conductor 50, to ground at normal contact 51 of the ringing key RK'.

The closing of alternate contact 38 of the relay DS bridges the holding coil HC across the trunk conductors from the point 55, over conductor 35, through the winding of the holding coil HC, normal contact 56 of the relay 49, conductor 57, alternate contact 38 of relay DS, conductor 39 to the point 58.

When the holding coil HC is thus bridged across the trunk conductors, the relay CT of the cord circuit C at the main exchange operates to open its normal contact 31, thus opening the circuit of the calling supervisory lamp CL, to thus efface the said lamp CL and notify the operator at the main exchange that the operator has answered the call. Assuming that it is the private branch exchange station F that is wanted by the calling subscriber A at the main exchange, the operator at the private branch exchange inserts the trunk plug TP into the jack J', and this insertion of the plug TP closes an energizing circuit for the sleeve relay SL, traced from battery through the winding of the said relay SL, conductor 59, alternate contact 60 of the relay DS, conductor 61, the sleeve of the plug TP to ground at the sleeve of the jack J'. The relay SL upon energization closes its alternate contacts 62 and 63, thereby closing the trunk conductors through to the called substation. The closing of alternate contact 64 of the sleeve relay SL multiplies the ground from the sleeve of the jack J' to the relay DS, this multiple ground connection to the relay DS being traced from battery through the upper winding of the relay DS, conductors 45, 46 and 65, alternate contact 64 of relay SL, conductor 66, normal contact 67 of relay 49, conductor 61, through the sleeve of the trunk plug TP to ground at the sleeve of the jack J', for purposes as will be presently described. The ground from the sleeve of the jack J' also extends to the holding lamp HL, traced from battery through the lamp HL, conductors 46 and 65, alternate contact 64 of relay SL, conductor 66, normal contact 67 of relay 49, conductor 61, sleeve of the plug TP to ground at the sleeve of the jack J', the said lamp HL remaining lighted until the subscriber F answers.

The operator now actuates the ringing key RK' to connect generator G' to signal the called-for station F, the ringing circuit being traced from the ungrounded pole of the generator G', tip contacts of the plug TP and the jack J', through the condenser and call bell of the called station F, the ring contacts of the jack J' and plug TP, through the alternate contact of the ringing key RK' to battery and ground.

The opening of normal contact 51 of the ringing key RK' opens the locking circuit of the relay DS, but due to the fact that the ground from the sleeve of the jack J' is also multiplied through the upper winding of the relay DS, as just described, the relay remains energized during the time that the ringing key is actuated. The party at the station F, in response to his call signal, removes his receiver from the switchhook, bringing about the energization of the super-

visory relay SR. The circuit for relay SR extends over the called line F.

The closing of alternate contact 70 of the supervisory relay SR establishes an energizing circuit for the relay 49, traced from battery through the upper winding of the relay 49, conductor 71, through the lower winding of the relay DS, conductor 72, alternate contact 70 of the relay SR, conductor 61, through the sleeve contact of the trunk plug TP to ground at the sleeve of the jack J'. The opening of normal contacts 48 and 67 of the relay 49 opens the locking circuit through the upper winding of the relay DS, but the series energizing circuit through the upper winding of relay 49 and the lower winding of relay DS permits the continued energization of the said relay DS. The opening of normal contact 56 of the relay 49 also removes the holding coil HC from across the trunk conductors. The closing of alternate contact 67 of the relay 49 establishes a locking circuit for relay 49 from battery, through the resistance 75 and the lower winding of the relay 49, alternate contact 67 of the relay 49, conductor 61, through the sleeve of the trunk plug TP to ground at the sleeve of the jack J'. The opening of normal contact 67 of relay 49 opens the energizing circuit of lamp HL, which is now effaced, and notifies the operator at the private branch exchange PB that the party at the private branch substation F has answered. The subscriber A at the main exchange and the party at station F of the private branch exchange are now in conversational circuit. The said talking circuit may be traced over the heavily marked conductors.

Assuming that the subscriber at substation A and the party at the private branch exchange station F have finished conversation, the restoration of the receiver at the station F of the private branch exchange opens the energizing circuit of the supervisory relay SR, and the opening of alternate contact 70 of the said relay SR interrupts the ground connection from the sleeve of the jack J', and the relay DS thus restores to normal. The relay DS upon de-energization opens its alternate contact 60, which opens the energizing circuit of the sleeve relay SL, which relay restores. The opening of its alternate contacts 62 and 63 interrupts the trunk conductors. The closing of its normal contacts 76 and 77 places the local private branch exchange battery upon the trunk conductors, extending to the substation.

The closing of normal contact 70 of the sleeve relay SR now closes an energizing circuit for the disconnect signal DSL, traced from battery through the filament of the said disconnect signal DSL, alternate contact 78 of the relay 49, conductor 79, normal contact 70 of the relay SR, conduc-

tor 61, through the sleeve of the trunk plug TP to ground at the sleeve of the jack J'. The disconnect signal lighting notifies the private branch exchange operator that the subscriber has replaced his receiver upon the switchhook.

The relay 49 remaining energized to ground at the sleeve of the jack J' through its locking contact 67, prevents the holding coil HC from being bridged across the trunk conductors, and the calling tip supervisory relay CT of the cord circuit C is thus deenergized and upon restoration its normal contact 31 is again closed to light the calling supervisory lamp CL, which lighted signal CL notifies the main exchange operator that the private branch exchange station F has replaced his receiver. The subscriber at the main exchange substation A replacing his receiver, opens the circuit through the answering tip supervisory relay AT, which relay upon restoration closes a circuit through the answering supervisory lamp AL, which lamp AL is lighted to notify the operator that the subscriber at substation A has replaced his receiver. The operator at the main exchange noting the two lighted signals AL and CL now withdraws the answering plug AP and calling plug CP from the respective jacks J and TJ to open the circuits of relays AS and CS of the cord circuit C, which relays AS and CS upon deenergization efface the supervisory signals AL and CL. Relays CO and CO' also restore, thus placing the apparatus at the main exchange in condition for use in establishing other connections. The private branch exchange operator at PC, noting the lighted disconnect signal DSL, withdraws the trunk plug TP from the jack J', which opens the locking circuit of the relay 49. The relay 49 upon deenergization restores and opens its alternate contact 78 to efface the disconnect signal DSL. The private branch exchange trunk circuit PT is now at normal and available for use in establishing other connections.

Assuming now that the subscribers have replaced their respective receivers upon their respective switchhooks and that the party at the private branch exchange substation F again removes his receiver before the trunk plug TP has been removed from the jack J', this removal of the receiver brings about the energization of supervisory relay SR, traced from battery through normal contact 77 of sleeve relay SL through the winding of said relay SR, ring contacts of the connected plug TP and jack J' through the closed contacts of the substation switchhook, back through the tip contacts of the connected plug TP and jack J' to ground at normal contact 76 of relay SL. The relay SR upon energization closes its alternate contact 70, establishing an energizing circuit for the relay DS, 130



traced from battery through the upper winding of relay 49, conductor 71 through the lower winding of relay DS, conductor 72, alternate contact 70 of relay SR, conductor 61, through the sleeve of the plug TP to ground at the sleeve of the jack J'. The relay DS upon energization closes its alternate contact 60, establishing an energizing circuit for the sleeve relay SL, traced from battery through the winding of relay SL, conductor 53, alternate contact 60 of relay DS, conductor 61, sleeve contact of the plug TP to ground at the sleeve of the jack J'. The relay SL upon energization closes its alternate contacts 62 and 63 and thus extends the station F at the private branch exchange PB to main exchange, the main exchange battery thus holding the relay SR energized. The line relay LR' at the main exchange will now operate, providing the plug CP has been withdrawn from the jack, over a circuit traced from battery through the winding of relay LR', normal contact 80 of relay CO', conductor 32, normal contacts 33 and 34, alternate contact 62 of relay SL, tip contacts of the plug TP and jack J', through the closed contacts of the substation F, ring contacts of the jack J' and plug TP, through the winding of relay SR, alternate contact 63 of relay SL, normal contacts 40 and 41, conductor 42, to ground at normal contact 81 of relay CO. The line relay LR' upon energization closes its alternate contact to light the trunk signal TS, which notifies the operator at the main exchange that a private branch exchange station is calling. The relay SR upon energization also opens the circuit of the disconnect signal DSL, which also gives the private branch exchange operator an indication that the party at the station F has called. The closing of contact 300 of key LK' when the operator, for any reason, actuates the key LK' while the plug TP is in jack J', after the subscribers have replaced their receivers, operates to shunt out relay 49, thereby deenergizing the same.

Assuming that the subscribers have replaced their receivers and the operator at the main exchange desires to extend another call to the branch exchange before the plug TP is taken down, the main exchange operator applies ringing current to the trunk circuit and operates the relay RU as before described, causing the lamp LL to glow, thus notifying the private branch exchange operator that another call is being extended to the branch exchange. The operator again operates her listening key and completes the connection. The ringing current applied to the trunk circuit by the main exchange operator did not reach the substation F even though the plug TP was in the jack J', for the reason that the trunk circuit was open at contacts 62 and 63 of relay SL.

The branch exchange operator may extend a connection to the main exchange by operating her listening key, even though the trunk plug TP is not in a jack.

Assuming now that a call is extended from an automatic exchange as illustrated in Fig. 3 to the private branch exchange PB, the ringing current which is applied from the automatic exchange extends over the trunk conductors 32 and 42 and operates the ring-up relay RU of the branch exchange trunk PC, which was seized by the connector of the automatic exchange. The relay RU upon energizing closes its alternate contact 43 to light the lamp LL and the operator at the branch exchange PB in response to the signal actuates her listening key LK'. The actuation of the key LK' closes a circuit for relay DS and the closing of its alternate contact 38 bridges the holding cord HC across the trunk conductors to operate ringing control means at the main automatic exchange to disconnect ringing current from the trunk circuit. The operation of the trunk circuit PC is the same as that described in connection with a manual connection as just described.

When the trunk circuit is used in connection with a main automatic exchange, it may terminate at the main automatic exchange in a line switch of the usual type and in the banks of rotary connectors or straight line connectors such as is described and illustrated in the U. S. Patent No. 1,194,741, issued August 15, 1916, to Harry H. Ide. In this case the conductors 32 and 42 leading to the main exchange will not be included in the apparatus, the trunk circuit being connected directly to the conductors leading to the automatic exchange, and, therefore, the operation of the trunk circuit at the branch exchange will not affect the apparatus at the manual main exchange.

The operation of the trunk PC when a private branch station calls a main exchange subscriber of an automatic exchange, is as follows: Assuming now that the operator at the private branch exchange PC wishes to extend a connection to a subscriber at an automatic exchange, she actuates her listening key LK', which closes a circuit for the disconnect relay DS, traced from battery through the upper winding of the relay DS, conductors 45 and 46, alternate contact 44 of the listening key LK', conductor 47, normal contact 48 of relay 49, conductor 50 to ground at normal contact 51 of the ringing key RK'. The closing of alternate contact 38, upon the energization of DS, bridges the holding coil HC across the trunk conductors, as previously described, thus operating a switch to connect the trunk to either a selector switch or a connector switch, depending upon the size of the exchange. The operator now operates her calling device CD to send the required number of impulses to operate the main automatic exchange equipment to



select the contacts of the main exchange automatic subscriber's substation. Upon the first movement of the dial off normal, its shunt spring contacts 90 and 91 are closed and remain closed until the dial returns to normal after having transmitted its first set of impulses. The closing of shunt springs 90 and 91 establishes an energizing circuit for the relay 92 associated with the operator's set from battery through the winding of relay 92, conductor 93, closed shunt springs 90 and 91, conductor 94, to ground at alternate contact 95 of the listening key LK'. The relay 92 upon energization closes its alternate contacts 96 and 97 and bridges the condenser 98 across the trunk conductors over conductors 99 and 100, and through alternate contacts 101 and 102 of the listening key LK' to the trunk conductors. The closing of alternate contact 103 of the relay 92 also establishes an energizing circuit for the trunk cut-off relay COR, traced from battery through the winding of said relay COR, conductor 104, alternate contact 105 of the listening key LK', conductor 106, alternate contact 103 of relay 92, conductors 107 and 93, closed contacts 90 and 91, conductor 94 to ground at alternate contact 95 of listening key LK'. The relay COR upon energization closes its alternate contacts 108 and 109 and disconnects the trunk apparatus and now extends the dial contacts 110 and 111 over conductors 112 and 113, through alternate contacts 108 and 109 to the trunk conductors. The impulses from the calling device are now transmitted over the trunk conductors, and after the first set of impulses the dial restores to normal, and upon said restoration the shunt contacts 90 and 91 are opened, and this removes the ground connection extending from alternate contact 95 of listening key LK' from relay COR and relay 92 associated with the trunk operator's set. Relay COR being a quick-acting relay, restores before relay 92, due to its slow-to-release construction, and the said relay 92 is momentarily held energized and the condenser 98 bridged across the trunk conductors through alternate contacts 96 and 97 of relay 92 to take up the discharge from the line so as to overcome the discharge into the operator's set. At the beginning of each set of impulses the shunt contacts 90 and 91 are closed to energize relays COR and 92, and after each set of impulses, relays COR and 92 deenergize for purposes as just described. After the last set of impulses, relays COR and 92 deenergize due to the opening of shunt springs 90 and 91, and the operator's set O' is now connected to the trunk conductors through normal contacts 96 and 97 of relay 92 and alternate contacts 101 and 102 of the listening key LK'. The relay DS is held energized due to the closing of contact 44 of the listening key LK' and locked

up through its alternate contact 52 as already described. The holding coil HC is bridged across the trunk conductors upon the closure of alternate contact 38 of relay DS to hold the apparatus at the automatic exchange in its actuated position. The operator's set O' being bridged across the trunk conductors, she may now converse with the called subscriber at the main exchange, and to connect the said subscriber with the station F, she inserts the trunk plug TP into the jack J' of the station F and the operation of the apparatus of the trunk circuit PC is the same as previously described. When the party at the station F answers, the apparatus is held in its operative position through the now closed switchhook contacts. Upon termination of conversation and when the party at substation F replaces his receiver the opening of the switch hook contacts opens the circuit of the apparatus at the automatic exchange, bringing about the restoration of the said apparatus, as is well understood, if such apparatus is of the type that is restored by the calling subscriber. The trunk circuit is cleared, as before mentioned, so that it may be used for further calls.

Should the party at the station F call, the operator would insert the trunk plug into the jack J', and now should the operator dial out to select a substation at a main automatic exchange, the relays DS, SR, SL and 49 will be operated, but during the dialing operation relay COR is energized and relay SR restores, having its battery circuit opened at contacts 34 and 40 of relay COR, but relays DS, SL and 49 will remain energized over circuits as previously described. The relays COR and 92 energize and deenergize, as previously described, before and after each set of impulses, and the condenser bridged across the trunk conductors takes up the surge of the line battery due to the energization and deenergization of relay COR, thus smoothing out the make and break wave of the battery through the substation F. The operator can dial with the plug TP in the jack J' and the receiver on or off the hook at the substation.

Assuming that the private exchange substation F is provided with a calling device X, when the trunk circuit is connected to the jack J' relays SR, SL, DS and 49 are operated to extend the subscriber's line through to the main exchange. The subscriber F operating his calling device X opens and closes the trunk circuit, thereby operating the automatic switches at the main exchange. The relay SR may follow the impulses and open the circuit of relay DS, but this relay is sufficiently slow-acting to remain energized during the impulsing. When the subscriber F replaces his receiver, he releases the automatic equipment and clears out the trunk circuit PC.

Referring now to Fig. 2, we illustrate a modified form of our invention whereby when the subscriber at the substation F' of the private branch exchange replaces his receiver, the energizing of a relay brings about instantaneous disconnection. When the subscriber of the private branch exchange substation F' recalls before the plug TP' is withdrawn from the local jack J<sup>2</sup>, he is immediately enabled to signal the operator. It is understood that the trunk PC' terminates at the main exchange in equipment similar to that shown in Fig. 1, in which the trunk PC terminates. Assuming now that the call is extended to the private branch exchange PB', the ringing current from the main exchange extends over the trunk conductors, through normal contact 150 of the relay COR', conductor 151, through the winding of said relay RU', normal contact 152 of relay DS', conductor 153, normal contact 154 of relay COR', from there back to the main exchange. Relay RU' upon energization closes its alternate contact 155, which closes an energizing circuit for the line lamp LL' of the private branch exchange trunk PC', from ground through alternate contact 155 of relay RU', conductor 156, through the lamp LL' to battery.

The operator at the private branch exchange circuit PC' noting the lighted line signal LL', now actuates her listening key LK<sup>2</sup> to connect her operator's set O<sup>2</sup> to the trunk conductors. The closing of alternate contact 157 of the listening key LK<sup>2</sup> closes an energizing circuit for the relay DS', traced from battery through the lower winding of the relay DS', conductor 158, alternate contact 157 of the listening key LK<sup>2</sup>, conductor 159, normal contact 160 of the relay 161, conductor 162 to ground at normal contact 163 of the ringing key RK<sup>2</sup>. The closure of alternate contact 152 of the relay DS' bridges the holding coil HC' across the trunk conductors for purposes as previously described in connection with Fig. 1. The closing of alternate contact 164 of the relay DS' closes the locking circuit for the relay DS', traced from battery through the upper winding of the said relay DS', alternate contact 164, normal contact 160 of the relay 161, conductor 162 to ground at normal contact 163 of the ringing key RK<sup>2</sup>. The relay DS' upon energization unlatches the contact 155, which is in its alternate position, allowing the said contact to restore and efface the line signal LL'. The operator of the private branch exchange PB', having been informed that it is the party at the substation F that is wanted, now inserts the trunk plug TP' into the jack J<sup>2</sup> of the local line. Upon the insertion of the trunk plug TP' into the jack J<sup>2</sup>, permanent ground upon the sleeve of the jack J<sup>2</sup> now extends

through the sleeve of the trunk plug TP', over conductor 165, through normal contact 166 of relay 161, conductor 158, through the lower winding of the relay DS' to battery. This ground through the lower winding of the relay DS' holds the said relay DS' energized when the ringing key RK<sup>2</sup> is actuated. An energizing circuit for the holding signal HL' is also closed, the circuit being traced from battery through the holding signal HL', conductor 158, normal contact 166 of the relay 161, conductor 165, the sleeve of the trunk plug TP', to ground at the sleeve of the jack J<sup>2</sup>, the said lamp HL' remaining lighted until the subscriber at the local station F' answers. The ringing key RK<sup>2</sup> is now actuated to send ringing current to the called local station F', ringing current being traced from the ungrounded pole of the generator G<sup>2</sup>, alternate contact of the ringing key RK<sup>2</sup>, tip contacts of the connected plug TP' and jack J<sup>2</sup>, through the condenser and call bell of the substation F', the ring contacts of the jack J<sup>2</sup> and plug TP', to battery and ground through the alternate contact of the ringing key RK<sup>2</sup>. The ringing key RK<sup>2</sup> upon actuation has its normal contact 163 opened, opening the initial energizing circuit of relay DS' extending through the upper winding of the relay DS', but as the ground from the sleeve of the jack J<sup>2</sup> is now extended through the lower winding of the said relay DS', the said relay is held energized when the ringing key RK<sup>2</sup> is actuated.

The subscriber, in response to his call signal, removes his receiver from the switchhook, and the closing of the switchhook contacts permits the energizing of the supervisory relay SR', the said current for energizing said supervisory relay SR' being fed from the main exchange battery. The closing of alternate contact 170 of the supervisory relay SR' closes an energizing circuit for the relay 161, traced from battery through the upper winding of the said relay 161, conductor 171, alternate contact 170 of the relay SR', conductors 172 and 165, the sleeve of the plug TP', to ground at the sleeve of the jack J<sup>2</sup>. The relay 161 upon energization closes its alternate contact 166, establishing a locking circuit for the said relay, traced from battery, through the winding of the said relay, its alternate contact 166, conductor 165, the sleeve of the plug TP', to ground at the sleeve of the jack J<sup>2</sup>. The closing of alternate contact 170 of the relay SR' also closes the holding circuit for the relay DS', traced from battery through the upper winding of the said relay, conductor 171, alternate contact 170 of relay SR', conductors 172 and 165, the sleeve of the trunk plug TP' to ground at the sleeve of the jack J<sup>2</sup>. The opening of normal contact 166 of the relay 161 brings about the

effacement of the holding signal HL', which notifies the operator at the private branch exchange PB' that the local subscriber at F' has answered. During conversation relays 161, DS' and SR' are in an energized condition.

After having finished conversation, the subscriber at the station F' replaces his receiver, opening the circuit of the supervisory relay SR' at the switchhook contacts, and the closing of normal contact 170 of the relay SR' establishes an energizing circuit for the disconnect signal DSL' from battery through the lamp DSL', conductor 175, alternate contact 176 of relay 161, conductor 177, normal contact 170 of relay SR', conductors 172, 165, the sleeve of the plug TP' to ground at the sleeve of the jack J<sup>2</sup>. The closing of normal contact 170 of relay SR' also establishes an energizing circuit for the disconnect relay DR, traced from battery through the winding of the said relay DR, conductor 175, alternate contact 176 of the relay 161, conductor 177, normal contact 170, conductors 172 and 165, the sleeve of the trunk plug TP' to ground at the sleeve of the jack J<sup>2</sup>.

The relay DR upon energizing opens its normal contacts 180, 181, opening the continuity of the trunk conductors, and should the subscriber at the private branch exchange F' recall, the removal of his receiver from the switchhook brings about the energization of the supervisory recall relay SE, traced from battery through the lower winding of the said relay SE, alternate contact 181 of relay DR, the ring contacts of the connected plug TP' and jack J<sup>2</sup>, through the closed contacts of the switchhook at the station F', back through the tip contacts of the connected plug TP' and jack J<sup>2</sup>, through alternate contact 180 of relay DR, to ground through the upper winding of the said relay SE. The relay SE upon energization closes its alternate contact 182, which again lights the line lamp LL', to ground at alternate contact 182 of relay SE, notifying the operator at the private branch exchange trunk PC' that the substation F' is recalling. The operator now actuates her listening key LK<sup>2</sup> to connect her operator's set O<sup>2</sup> to the trunk conductors, and to extend the connection to the main exchange she now withdraws the trunk plug TP' from the jack J<sup>2</sup>, which withdrawal opens the locking circuit of the relay 161, which allows the said relay to restore to normal. The closing of normal contact 160 of the relay 161 again closes an energizing circuit for relay DS' over a path as previously described. Relay 161 upon deenergization also opens the energizing circuit of the relay DR at its alternate contact 176. The relay DR upon deenergization opens its alternate contacts 180 and 181, allowing the said supervisory recall relay

SE to restore, and the opening of its alternate contact 182 effaces the line signal LL'. The operator now again inserts the trunk plug TP' into the jack J<sup>2</sup>, bringing about the energization of the supervisory relay SR' and the relay 161, as previously described. The closing of normal contacts 180 and 181 of the relay DR now closes the continuity of the trunk conductors and extends the said private branch exchange substation F' to the main exchange, and the operation of the circuit from this point on is readily apparent from the previous description.

Should the operator wish to extend a connection to a main automatic exchange, she actuates her listening key LK<sup>2</sup>, and the closure of alternate contact 185 of the ringing key LK<sup>2</sup> extends ground to contacts 186 and 187 of the shunt springs of the calling device CD'. The shunt springs 186 and 187 are closed, extending the ground from alternate contact 185 to the listening key LK<sup>2</sup>, through the now closed contacts 186 and 187, over conductor 188, through the winding of the trunk cut-off relay COR' to battery. The closing of alternate contacts 189 and 190 of the relay COR' now connects the calling device impulse springs over conductors 191 and 192, through alternate contacts 189 and 190, directly to the trunk conductors leading to the main automatic exchange. After the called-for party at the main automatic exchange has been selected and answers, the operation of the trunk circuit PC' is the same as previously described, and a further description of its operation is not deemed necessary.

The trunk PC', of course, is arranged so that the subscriber F' can dial his own connection. Connections can also be extended to the branch exchange while the plug is in a jack, without ringing the connected subscriber. In general, the circuit is capable of use in establishing the same connections as more fully explained in connection with trunk circuit PC of Fig. 1.

Referring to Fig. 3, 301 represents an automatic sub-station, 302 an individual line switch, 303 an automatic selector switch, 304 an automatic connector switch, 305 the bank terminals of the connector switch, and 306 an automatic line switch or an automatic selector switch associated with the private branch exchange trunk PC and the conductors 32 and 42 leading from the connector switch contacts 304 are connected to the trunk circuit PC as is well understood. Of course, any number of selectors may be inserted in the system according to the size of the automatic exchange.

In working out our invention we have employed preferred circuit arrangements all of which tend to make an efficient operating system, but it is to be understood that va-

rious changes and modifications may readily be made without departing from the spirit and scope of our invention. Therefore, we do not desire to be limited to the exact arrangement shown and described, but aim to cover all such changes and modifications as come within the spirit and scope of the appended claims.

What we claim as new and desire to secure by United States Letters Patent, is:

1. A telephone system including a calling subscriber's line, a called subscriber's line, automatic switches and a trunk circuit provided with a manual terminal for interconnecting said subscribers' lines, automatic means in the trunk circuit for clearing the same when the called subscriber replaces his receiver so that a second call may be extended from said automatic switches to said trunk circuit without operating the call bell at the called substation, and means for said trunk circuit for denoting a recall by the called subscriber.

2. A telephone system including a calling subscriber's line, a called subscriber's line, automatic switches and a trunk circuit provided with a manual terminal for interconnecting said subscribers' lines, and automatic disconnect means for said trunk circuit operable by the called subscriber so that the trunk circuit is cleared before the trunk circuit terminal is disconnected from the called subscriber's line, thereby permitting the called subscriber to operate his automatic dial to effect a second connection or permit another subscriber to operate the automatic switches and extend a call to said trunk circuit without signaling the called subscriber.

3. A telephone system including a calling subscriber's line, a called subscriber's line, automatic switches, and a trunk circuit provided with a manual terminal for interconnecting said subscriber's line, and subscriber-controlled means in said trunk circuit for clearing the same so that the called subscriber may actuate his calling device to effect a second connection or the operator may actuate her calling device to effect a second connection prior to the time that the trunk circuit terminal is disconnected from the called subscriber's line.

4. A telephone system including a trunk circuit provided with a manual terminal for connection to a called subscriber's line, automatic switches accessible to said trunk circuit, an automatic calling device, and operator's means for operating said calling device to control said automatic switches while said trunk circuit is connected to said subscriber's line, said means being operable whether the called subscriber has his receiver on or off the switchhook.

5. A telephone system including a trunk circuit provided with a manual terminal for

connection to a subscriber's line, automatic switches accessible to said trunk circuit, a calling device associated with said trunk circuit, means for connecting said calling device to said trunk circuit to actuate said automatic switches to effect a connection, and means for said trunk circuit operable to bridge a condenser across the trunk circuit between the sets of impulses of the called number.

6. A telephone system including a calling subscriber's line, a called subscriber's line, automatic switches and a trunk circuit provided with a manual terminal for interconnecting said subscriber's lines, a dial for each subscriber's substation, means in said trunk circuit for clearing the same when a called subscriber replaces his receiver so that he may again remove his receiver and operate the dial at the substation to operate the automatic switches to effect a second connection before the plug in the trunk circuit is disconnected from the called subscriber's line, and automatic means for said trunk circuit for denoting a recall by the called subscriber.

7. A telephone system including a calling subscriber's line, a called subscriber's line, a trunk circuit provided with a manual terminal for connection to said called subscriber's line, automatic switches adapted to be connected to said trunk circuit, means for informing the operator at the trunk circuit that an automatic switch has been connected to the said trunk circuit, a signal for said trunk circuit operable when said trunk circuit is connected to a called subscriber's line, a disconnect signal, automatic means for severing the strands of the trunk circuit, and subscriber controlled means for operating said automatic means and said disconnect signal.

8. A telephone system including a called subscriber's line, a calling subscriber's line terminating at an automatic exchange, a trunk circuit having a manual terminal for connection to a subscriber's line, automatic switches at said automatic exchange for connecting said calling subscriber to said called subscriber via said trunk circuit, a disconnect relay, and means operable by one of said subscribers when he signals for disconnection for operating said disconnect relay for disconnecting his line from the other of said subscriber's lines and for again effecting an operation of said relay to connect the said subscriber's line to the trunk circuit when the subscriber signals for a recall.

9. A telephone system including a calling subscriber's line and a called subscriber's line, a private branch exchange having a trunk circuit provided with a manual terminal for connection with said called subscriber's line, automatic switches adapted to connect said subscriber's lines via said trunk

circuit, a relay for said trunk circuit, a second relay for said trunk circuit, means controlled by said called subscriber for disconnecting his line from the trunk conductor leading to said automatic switches and for bridging the battery at the private branch exchange across his line, whereby when he removes his receiver to institute a recall he energizes the said second relay to cause the operation of said first relay to again connect his line to the automatic exchange over the said trunk conductors.

10. A telephone system including a main exchange, a private branch exchange, automatic switches at said main exchange and a trunk circuit having a manual terminal at said private branch exchange for connecting a subscriber at the said automatic exchange, a relay for said trunk circuit controlled by the subscriber at the private branch exchange and operable to connect either the battery at the private branch exchange or the battery at the main exchange across the said subscriber's line.

25 11. A telephone system including a calling subscriber's line terminating at a main exchange, automatic switches at said main exchange, a called subscriber's line terminating at a private branch exchange, a trunk circuit at said private branch exchange provided with a manual terminal for connection to said called subscriber's line, said automatic switches and said trunk circuit for interconnecting the said subscriber's lines, a relay controlling the connection of said calling subscriber's line to said called sub-

scriber's line, and a second relay controlled over said called subscriber's line, said second relay being adapted when said called subscriber replaces his receiver, to operate said first relay to disconnect said subscriber's lines, said relay upon the subsequent removal of said subscriber's receiver operable to again connect the subscriber's lines.

12. A telephone system including a calling subscriber's line terminating at a main exchange, a called subscriber's line terminating at a branch exchange, automatic switches at said main exchange and a trunk circuit at said branch exchange provided with a manual terminal for interconnecting the said subscriber's lines, dialing means for the operator at said trunk circuit, subscriber's dialing means, means controlled by said called subscriber for disconnecting his line from the trunk conductors leading to the said automatic switches, upon the replacing of his receiver upon its switchhook, means operable to again connect his line to the said automatic exchange, means whereby the said called subscriber may then dial to operate the said switches at said main exchange and means whereby the operator at the said trunk circuit may be informed of the recall and operate her dialing means to operate the said automatic switches at said main exchange.

Signed by us at Chicago, in the county of Cook and State of Illinois, this 4th day of March, 1925.

HIRAM D. CURRIER.  
WILLIAM G. SHULL.