Dec. 26, 1922. 1,440,111

C. SPARKS.

TELEPHONE SYSTEM.

FILED MAY 23, 1918.

2 SHEETS-SHEET 1

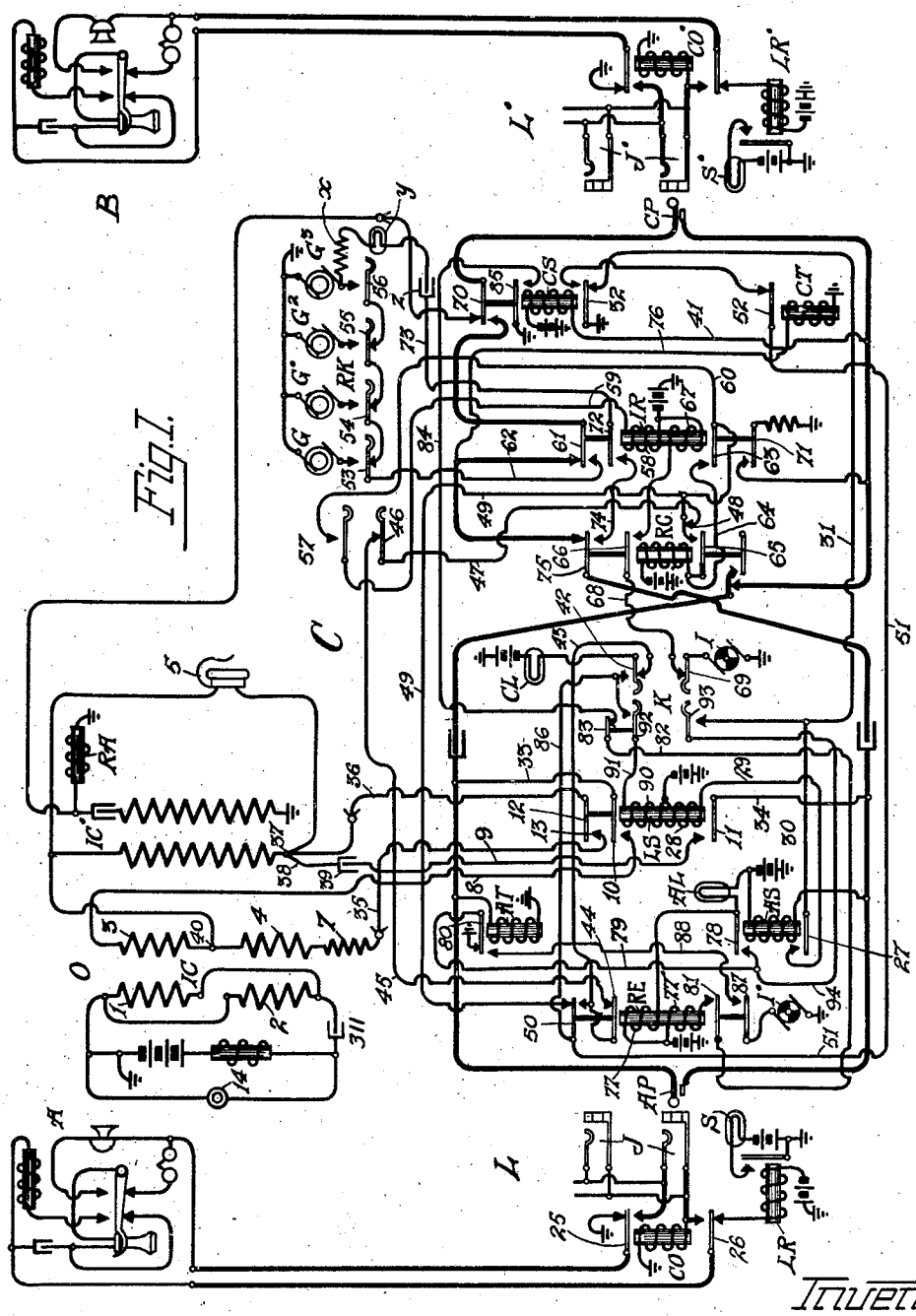

Fig. 1.

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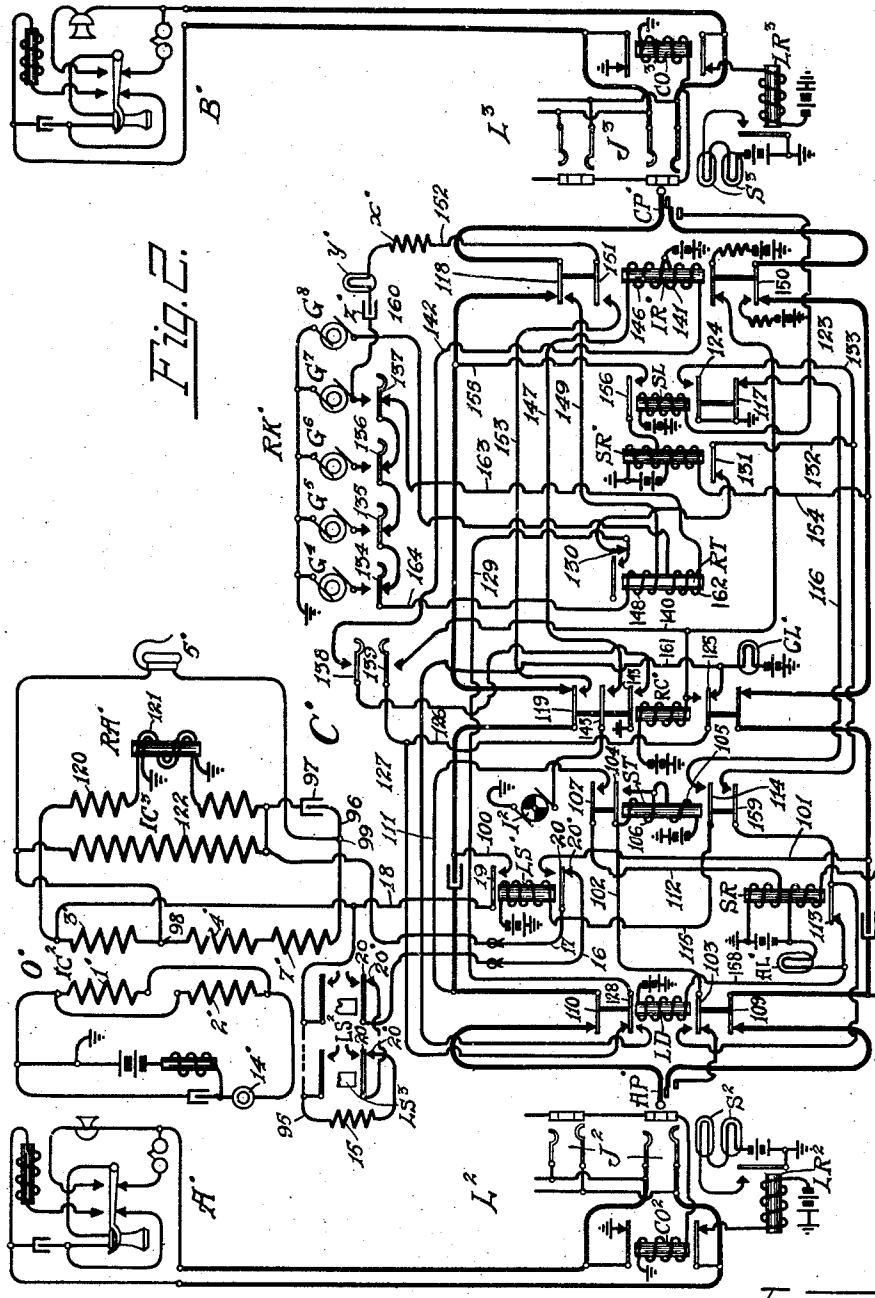
2 SHEETS-SHEET 2

Fig. 2.



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Patented Dec. 26, 1922.

1,440,111

UNITED STATES PATENT OFFICE.

CHARLES SPARKS, OF OAK PARK, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

Application filed May 23, 1918. Serial No. 236,101.

To all whom it may concern:

Be it known that I, CHARLES SPARKS, a citizen of the United States of America, residing in Oak Park, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to operators' telephone circuits, and more particularly to such circuits for use with cord circuits and trunk circuits in manual and semi-automatic telephone systems.

The object of my invention is to produce a highly efficient balanced operator's telephone circuit for reducing the side tone in the operator's head receiver, not only during the periods that the operator's telephone set is in use when the operator is completing connections between subscribers' lines, but also during the periods that the operator is not so engaged, but waiting for calls to come in.

Heretofore the operators' telephone circuits provided with side tone reducing means have been objectionable for the reason that the side tone reducing means was only effective during the time that the operator's telephone circuit was in actual use.

A feature of my invention is to arrange the operator's telephone circuit in such a manner that the side tone reducing means is always in circuit and operating to reduce the side tone in the operator's receiver.

A further object of my invention is the provision of means for automatically rendering the operator's receiver inoperative by disassociating it from the repeating coil mechanism when the operator's telephone is not in use.

A further object of my invention is the connection of the operator's receiver in a Wheatstone bridge circuit to reduce the side tone while the operator's telephone is in use for conversing with telephone subscribers and to either disassociate the operator's receiver from such Wheatstone bridge circuit when the operator's telephone is not used in conversing with subscribers, or to maintain a balance of the Wheatstone bridge circuit while the operator's telephone circuit is not in use.

The above features, as well as others, will be more fully hereinafter described in the accompanying specification and in the appended claims.

For a better understanding of my invention, reference will be made to the accompanying drawings which illustrate my invention operating in connection with telephone systems, and in which:

Fig. 1 illustrates one form of my invention operating in connection with a telephone system; and

Fig. 2 illustrates a modified form of my invention operating in connection with another form of telephone system.

Referring now more particularly to Fig. 1, I show a calling substation A and a called substation B, the said substations terminating respectively at the exchange in line circuits L and L'. The line circuits L and L' comprise respectively the usual line relays LR and LR', cut-off relays CO and CO', multiple jacks J and J', and the line signals S and S'.

The cord circuit C for interconnecting the subscribers A and B as calling and called lines, respectively, is provided with an answering plug AP and a calling plug CP, the said plugs AP and CP being connected by the heavily marked conductors. The answering end of the cord circuit C is provided with an answering sleeve supervisory relay AS and an answering tip supervisory relay AT. The answering sleeve supervisory relay AS is adapted to be energized when the answering plug AP is inserted in a jack J of a calling line, and the answering tip supervisory relay AT is energized over the line. The two relays AS and AT control the answering supervisory lamp AL. A listening relay LS is provided which is energized upon the actuation of the relay AS to connect the operator's set O of my invention to the cord conductors of the cord circuit C. A recall relay RE is also provided which is energized when the calling subscriber restores his receiver after termination of conversation to place the cord circuit in condition to allow the calling subscriber to recall, should he wish to do so. The relay RE is also energized, should the calling subscriber replace his receiver before the called subscriber answers, to disconnect ringing

current from the called line. A combined recall and manual ringing key K is provided, which key is moved to the left to seize a recall and is moved to the right to allow the operator to manually ring a called-for subscriber.

Associated with the calling end of the cord circuit C, I provide a calling sleeve supervisory relay CS which is energized when a calling plug CP is inserted into the jack of a called substation. The relay CS upon energization also opens the circuit of the relay LS which restores to disconnect the operator's set O from the conductors. A party line ringing key RK is also provided for connecting one of a plurality of ringing generators G, G', G^2, and G^3 to signal a subscriber at the called-for substation. An interrupter relay IR is energized upon the actuation of the party line ringing key RK to close a circuit for the ringing control relay RC, which relay controls the connection of ringing current to the called line and also connects the interrupter I to the interrupter relay IR. A calling tip supervisory relay CT is also provided, and is adapted to be energized upon the response of the subscriber at a called substation to interrupt the circuit of the ringing control relay RC to disconnect the ringing current from the cord circuit C. A calling supervisory lamp CL is also provided for the usual supervisory purposes.

The operator's set O of my invention comprises an induction coil IC built up of four windings, 1, 2, 3 and 4, and the usual induction coil IC' and retardation coil RA for testing purposes to produce a click in the operator's head receiver 5 when a busy line is tested, as is well known. An artificial resistance 7 is connected in circuit with the secondary windings 3 and 4 of the induction coil IC, the said resistance 7 forming one arm of a Wheatstone bridge circuit. The windings 3 and 4 of the induction coil IC form two of the other arms of the bridge, and the subscriber's line, including the circuit connecting wires 8 and 9 which extend through contacts 10 and 11 of the listening relay LS, forms the fourth arm of the said bridge circuit. The fourth arm of the Wheatstone bridge of the operator's set O extends from one terminal of the winding 3 of the induction coil IC over conductor 8, through contact 10 of relay LS, over the subscriber's line which is connected to the cord circuit C when the answering plug AP is inserted into the jack J, through contact 11 of relay LS and conductor 9 to point 37, and thence over conductor 36, through contacts 12 and 13 of relay LS and over conductor 35 to a terminal of the resistance 7. The head receiver 5 of the operator's circuit is connected across the circuit, having one terminal connected between the windings 3 and 4 of the induction coil IC, and the other terminal of the head receiver is connected to normally open spring contacts 12 and 11 of relay LS. When the relay LS is energized, the last said terminal of the operator's receiver is connected to one side of the calling line and to one terminal of resistance coil 7. The circuit of the head receiver 5 is normally open to the transmitter side of the operator's circuit when the operator's circuit is not in use, that is, when the operator is not answering calls. When the operator's set O is in use in answering calls, the receiver 5 and its circuit is connected, due to the closing of contacts 12 and 13 upon the actuation of relay LS. The receiver 5 in this case is bridged across the Wheatstone bridge circuit, comprising resistance 7, windings 3 and 4 of the induction coil IC, and the loop of the subscriber's line, to reduce the side tone in the said receiver 5 from the operator's transmitter 14, as will be more fully hereinafter described.

Somewhat similar circuits have been used to reduce the side tone effect in the operator's receiver, but these circuits have all been faulty for the reason that when the operator's set is not in use one of the arms of the Wheatstone bridge circuit is left open, namely, the arm including the subscriber's line, while the other three arms including the two windings of the induction coil and the artificial resistance 7 are left closed, thereby causing the potential across the receiver terminals to become unbalanced, and any disturbance in the vicinity of the operator's transmitter would be transmitted to the operator's receiver, giving a side tone effect. In other words, such prior circuits only reduced the side tone during the periods that the operator's set was in use. To overcome the fault of such prior circuits, I have opened up the arm of the Wheatstone bridge including the artificial resistance 7 so that the operator is not bothered with a side tone during the period when her set is not in use. Each cord circuit is provided with a pair of contacts to close this arm of the Wheatstone bridge when the arm including the subscriber's line is closed.

Referring now in general to Fig. 2, I show a modified form of an operator's set or circuit O' operating in connection with another form of telephone system from that illustrated in connection with Fig. 1. In Fig. 2, I show a calling substation A' and a called substation B', the said substations A' and B' terminating respectively at the exchange in line circuits L^2 and L^3. The line circuits L^2 and L^3 at the exchange comprise respectively the usual line relay LR^2 and LR^3, cut-off relays CO^2 and CO^3, multiple jacks J^2 and J^3, and multiple line signals S^2 and S^3. The jacks of the lines are distributed among the different operator's positions, and there

is a line signal for each jack at the different operators' positions so that when a call is initiated over any line, the line signals at the different operators' positions are lighted and any one of a plurality of operators may seize the call to the exclusion of the other operators.

The cord circuit C′ for interconnecting the substations A′ and B′ as calling and called line is provided with an answering plug AP′ and a calling plug CP′, the said plugs AP′ and CP′ being connected by the heavily marked conductors. The answering end of the cord circuit C′ is provided with a sleeve relay ST which is energized when an answering plug AP′ is inserted into a jack J^2 of a calling line. The relay ST is provided with a high and low resistance winding, and upon the actuation of relay ST the high resistance winding is shunted and thus prevents the same relay from being energized in another cord circuit should another operator attempt to answer a call. An operator of another cord attempting to seize the call after the first operator has connected to the calling line is prevented from communicating with the subscriber as the shunt of the low winding of the relay ST of the first cord prevents the relay ST of the second cord from operating. As the second operator is not connected to the calling line due to the relay ST of the second cord remaining at normal, she does not receive an answer from the calling subscriber and withdraws the answering plug of her link circuit from the connected jack. A supervisory relay SR is provided which is actuated upon the energization of relay ST, the said relay operating over the line. The relay SR upon actuation prevents the premature lighting of the answering supervisory lamp AL′. A listening relay LS′ is also provided and is actuated in response to the energization of relay ST to connect the operator's set or circuit O′ to the cord conductors. A link disconnect relay LD is provided which is energized when the calling subscriber replaces his receiver after finishing conversation to open the link conductors to allow the line circuit of the calling subscriber to restore to normal to permit the subscriber to recall. The relay LD also operates when the calling subscriber replaces his receiver and before the called subscriber answers to disconnect the ringing current from the called line.

The calling end of the cord circuit is provided with a sleeve relay SL actuated when the calling plug CP′ is inserted in the jack of a called line. The said relay SL upon energizing opens the circuit of the listening relay LS′, which relay de-energizes to disconnect the operator's set O′ from the cord conductors. A party line ringing key RK′ is provided for connecting one of a plurality of ringing generators G^4, G^5, G^6, G^7 and G^8 to signal the called-for subscriber. A ringing control relay RC′ is provided which is actuated upon the actuation of the ringing key RK′. The said relay RC′ upon actuation brings about the energization of interrupter relay IR′. The interrupter relay IR′ is intermittently energized and de-energized through the agency of the interrupter I′ to connect ringing current to the called line. A ringing trip relay RT is provided which is actuated upon the response of the subscriber at the called-for substation, should the called subscriber remove his receiver in response to the call signal during a ringing period. The relay RT upon its energization interrupts the circuit of the ringing control relay RC′ and the said relay RC′ in turn disconnects the interrupter I′ to allow the interrupter relay IR′ to restore to normal. A supervisory relay SR′ is also provided which is actuated upon the response of the called subscriber to interrupt the circuit of the relay RC′ should the called-for subscriber answer during a silent period. A calling supervisory lamp CL′ is provided and is used for the usual supervisory purposes, as is well known.

The operator's set O′ comprises an induction coil IC^2, including four windings, 1′, 2′, 3′ and 4′, and a high resistance retardation coil RA′ in association with the usual induction coil IC^3 for testing purposes to produce a click in the operator's head receiver 5′ when a line is tested and found busy. In the operator's set or circuit O′ shown in Fig. 2, I show a resistance 7′ for purposes similar to those described in connection with Fig. 1. I also show a resistance 15 equal in resistance to that of 7′, and when the operator's circuit O′ is not in use in establishing connections this resistance 15 in association with resistance 7′ brings about a balance, reducing the side tone in the operator's head receiver 5′, as will be more fully hereinafter described. The resistance 15 is common to an operator's position and is serially connected through the listening relays LS of an operator's position. In the operator's circuit O′, shown in Fig. 2, the operator's head receiver 5′ is in closed circuit with the transmitter side of the set, and I provide a Wheatstone bridge, the arms of which are the resistance 15, windings 3′ and 4′, and the loop including conductors 16 and 17 and the resistance 15, the said described bridge forming a balanced circuit for the head receiver 5′. When the operator's set O′ is connected to the cord conductors due to the actuation of relay LS′, the resistance 7′ and windings 3′ and 4′ of the coil IC^2 form arms of a Wheatstone bridge, and the fourth arm of the bridge comprises the subscriber's line and the con-

necting wires 17 and 18. The Wheatstone bridge circuit is one balanced for talking currents rather than one balanced in resistances. In the modified circuit shown in Fig. 2, instead of opening up the third arm of the bridge circuit when the operator's set is not in use, to prevent side tone, I substitute resistance 15 for the resistance of the subscriber's line, thereby maintaining a balance across the terminals of the operator's receiver.

Having described in general the preferred arrangement of the circuits and apparatus employed in my invention, I will now describe it more in detail operating in connection with the exchange systems illustrated.

Referring now more particularly to Fig. 1, and assuming that the subscriber at the calling substation A initiates a call, the removal of the receiver thereat brings about the energization of the line relay LR of the line circuit L, and the actuation of the said relay LR brings about the lighting of the line signal S. The operator associated with the cord circuit C, noting the lighted line signal S, inserts the answering plug AP of the cord circuit C into the answering jack J of the calling line. The act of inserting the plug AP into the jack J closes a series energizing circuit for the answering sleeve supervisory relay AS of the cord circuit C and the cut-off relay CO of the line circuit L from battery through the winding of the relay AS, the sleeve contacts of the connected plug AP and jack J, and through the winding of the relay CO to ground. The answering tip supervisory relay AT is energized upon the actuation of the relay CO from ground through the winding of the relay AT, tip contacts of the connected plug AP and jack J, alternate contact 25 of the cut-off relay CO, through the substation A, back through alternate contact 26 of relay CO, sleeve contacts of the connected plug AP and jack J, and through the winding of the relay AS to battery and ground. The relay AS energizing prevents the premature lighting of the answering supervisory lamp AL and the energization of the relay CO restores the line relay LR to efface the line signal S. The closing of alternate contact 27 of relay AS establishes an energizing circuit for the listening relay LS from battery through the lower winding 28 of said relay, conductor 29, alternate contact 27 of relay AS, conductor 30, and conductor 31 to ground at normal contact 32 of the calling sleeve supervisory relay CS. The closing of alternate contacts 10 and 11 connects the operator's set O to the cord conductors by way of conductors 33 and 34. The closing of normally open contacts 12 and 13 places the head receiver 5 of the operator's set in closed circuit with the transmitter side of the operator's set O and the resistance 7 is introduced to form a Wheatstone bridge circuit. The four arms of the said bridge are included in a circuit which may be traced from alternate contact 10 of relay LS, over conductor 8, through the winding 3 of the induction coil IC, the winding 4 of the coil IC, resistance 7, conductor 35, alternate contacts 12 and 13, conductor 36 to the point 37, and thence over conductor 38, through condenser 39, alternate contact 11 of relay LS, conductor 34, and the loop out over the calling line and back over conductor 33 to the alternate contact 10. The head receiver 5 is connected in the bridge at points 37 and 40 so that one-half of the bridge comprising the winding 3 of the coil IC and the loop above traced forms two arms of the bridge, and the winding 4 of the coil IC and the resistance 7 form the other two arms of the bridge. The resistance 7 is such that the loop as previously described and the said resistance 7 bring about the balance, thus reducing the side tone caused by the operator's transmitter of the set O in the receiver 5.

The operator's set O having been connected, due to the closure of alternate contacts 10 and 11 of listening relay LS, the operator now inquires the wants of the calling subscriber A, and assuming that it is the substation B that is wanted, the operator tests the multiple jack J′ of the called line by placing the tip of the calling plug CP to the sleeve of the jack J′, and if the said line is busy the operator will receive the usual busy click in her head receiver 5 in a well known manner.

Assuming now that the called line is idle, the operator inserts the calling plug CP into the jack J′ of the called line, establishing a circuit traced from battery through the winding of the calling sleeve supervisory relay CS, conductor 41, sleeve contacts of the connected plug CP and jack J′, and through the winding of the relay CO′ to ground. The relay CS, upon energizing, opens its normal contact 32, opening the circuit of the listening relay LS, which de-energizes and disconnects the operator's set O from the cord conductors. The opening of contacts 12 and 13 of the relay LS again places the head receiver circuit of the operator's set on open circuit with the transmitter side of the set. The closing of alternate contact 32 of relay CS brings about the lighting of the calling supervisory lamp CL over a circuit traced from battery through the said lamp, normal contact 42 of the key K, conductor 43, normal contact 44 of relay RE, conductor 45, normal contact 46 of the end springs of ringing key RK, conductor 47, normal contact 48 of the relay RC, conductor 49, normal contact 50

of relay RE, conductor 51, and normal contact 52 of relay CT to ground at alternate contact 32 of the relay CS. The said lamp remains lighted until the operator depresses the ringing key RK. The operator now depresses the proper ringing key plunger to its fully depressed position to close end spring contacts 46 and 57 and to connect the proper ringing generator G, G', G^2 or G^3 to signal the called subscriber at the substation B.

The closing of alternate contact 57 of the end springs establishes an energizing circuit for the interrupter relay IR traced from battery, through the upper winding 58 of the relay IR, conductor 59, alternate contact 57 of the end springs, conductor 60, conductor 49, normal contact 50 of relay RE, conductor 51, and normal contact 52 of relay CT to ground at alternate contact 32 of relay CS. The closing of alternate contact 61 of relay IR connects ringing current from the generator G, which we will assume is the ringing generator selected, through alternate contact 53, over conductor 62, through the alternate contact 61 to the line, giving an instantaneous first ring to the called subscriber when the ringing key is depressed. The closing of alternate contact 63 of relay IR closes an energizing circuit for the ringing control relay RC traced from battery, through the winding of the relay RC, conductor 64, alternate contact 63, conductor 49, normal contact 50, conductor 51, and normal contact 52 to ground at alternate contact 32 of relay CS. The closing of alternate contact 65 of relay RC establishes a locking circuit for the said relay traced from battery through the winding of the relay RC and through alternate contact 65, conductor 49, contact 50, conductor 51, and contact 52 to ground at alternate contact 32 of relay CS. The opening of normal contact 48 of relay RC effaces the calling supervisory lamp CL. The closing of alternate contact 66 of relay RC connects the constantly rotating interrupter I in circuit with the interrupter relay IR over a circuit traced from battery through the lower winding 67 of relay IR, alternate contact 66 of relay RC, conductor 68, normal contact 69 of the key K, and through the constantly rotating interrupter IR to ground. The relay IR is thus intermittently energized and de-energized to connect ringing current from the generator G to the called line over a circuit traced from the ungrounded pole of the said generator G, alternate contact 53 of the ringing key plunger, conductor 62, alternate contact 61 of relay IR, alternate contact 70 of relay CS, tip contacts of the connected plug CP and jack J', through the condenser and call bell of the subscriber at the called substation B, back through the sleeve contacts of the plug CP and jack J', and through alternate contact 71 of relay RC to ground.

The closing of alternate contact 72 of relay IR transmits a ringing tone to the calling subscriber from the generator G^3, over conductor 73, through resistance X, lamp Y, condenser Z, alternate contact 72 of the relay IR, conductor 74, alternate contact 75 of relay RC, the sleeve conductor of the cord, sleeve contacts of the connected plug AP and jack K, through the substation receiver of the calling subscriber A, back through tip contacts of the jack J and plug AP, and through the winding of the relay AT to ground, giving the calling subscriber an audible signal, notifying him that the called subscriber is being signalled. The called subscriber at the substation B is thus automatically signalled until the said called subscriber at substation B answers in response to the signal, or until the calling subscriber at substation A replaces his receiver. Upon the response of the called subscriber at substation B, and upon the de-energization of relay IR, a circuit for the calling tip supervisory relay CT is established traced from ground through the winding of the relay CT, conductor 76, normal contact 61, alternate contact 70 of relay CS, tip contacts of the connected plug CP and jack J', through the now closed contacts of the switchhook of substation B, back through sleeve contacts of the connected plug CP and jack J', conductor 41, and through the winding of the relay CS to battery. The opening of normal contact 52 of relay CT opens the locking circuit of the relay RC which de-energizes to open its alternate contact 66, disconnecting the interrupter I from relay IR. Relay IR thus restores to normal, disconnecting the ringing current from the wanted line. The subscribers are now in conversational circuit, the talking circuit being traced over the heavily marked conductors. Should the calling subscriber restore his receiver before the called subscriber answers in response to the calling signal, the relay AT would restore, due to the interrupted switchhook contacts at the calling substation A, and due to this de-energization of relay AT an energizing circuit for the recall relay RE is established, traced from battery through the upper winding 77 of relay RE, alternate contact 78 of relay AS, and conductor 79 to ground at normal contact 80 of relay AT. The relay RE upon energizing closes a locking circuit for itself traced from battery through the lower winding 77' of the relay RE, its alternate contact 81, conductor 82, normal contact 83 of the key K and conductor 84 to ground at alternate contact 85 of the relay CS.

The opening of normal contact 50 of relay RE opens the locking circuit of the

relay RC, which relay restores to disconnect ringing current as above described. The closing of normal contact 80 brings about the lighting of the answering supervisory relay AL over a circuit traced from battery through the lamp AL, alternate contact 78, and conductor 79 to ground at normal contact 80. The calling supervisory lamp CL will also be lighted from battery through the said lamp CL, normal contact 42, conductor 43, alternate contact 50, conductor 51, and normal contact 52 to ground at alternate contact 32 of relay CS. The two supervisory lamps AL and CL being lighted, indicate to the operator that the calling subscriber has replaced his receiver. Should the operator wish to ring the subscriber manually, the key K is thrown to the right to open normally closed contact 69, which disconnects the constantly rotating interrupter I. The ringing key RK is actuated in a manner as before described to energize the relays IR and RC. The relay RC closes a locking circuit for itself, as before described, but as relay IR is disconnected from the interrupter I for each application of ringing current to the called line the operator must depress her ringing key RK to close a circuit for relay IR, to close its alternate contact 61 to apply ringing current to the called line. When the key is moved to the right, a circuit is closed through the calling supervisory lamp CL traced from battery through alternate contact 42, conductor 86, conductor 51, and normal contact 52 to ground at alternate contact 32 of relay CS. When the called subscriber answers, the relay CT is energized to open the circuit of the calling supervisory lamp CL at contact 52, notifying the operator that the called subscriber has answered.

After the subscribers have finished conversation, they replace their receivers upon their respective switchhooks, thereby restoring relays CT and AT. Relay AT restoring closes an energizing circuit for the recall relay RE as previously described, and the closing of normal contact 80 of relay AT closes a circuit for the answering supervisory signal AL traced from battery through the said lamp, alternate contact 78, and conductor 79 to ground at normal contact 80. Upon the de-energization of the relay CT, a circuit for the calling supervisory signal CL is established, traced from battery through the lamp CL, normal contact 42 of the key K, conductor 43, alternate contact 50, conductor 51, and normal contact 52 of relay CT to ground at alternate contact 32 of relay CS. The operator noting the two lighted supervisory signals AL and CL, which give an indication to the operator that the subscribers have finished conversation, withdraws the plugs AP and CP from their respective jacks J and J', restoring relays AS and CS. The relay AS restoring opens the circuit of the relay RE, placing the apparatus at the cord circuit C at normal. The said cord circuit C is now available for establishing other connections. Assuming now that the subscribers have finished conversation, and before the plugs AP and CP have been withdrawn the calling subscriber wishes to recall, the removal of the receiver at the substation A again brings about the energization of the answering tip supervisory relay AT over the line as previously described, and as relay RE is locked up, and due to the closure of alternate contact 87 of said relay RE, the interrupter I' is connected in circuit with the answering supervisory signal AL over a circuit traced from battery through the lamp AL, alternate contact 78, conductor 79, alternate contact 80, conductor 88, through alternate contact 87, and through the rotating interrupter I' to ground. The supervisory lamp AL is thus caused to flash, due to the connected interrupter I', notifying the operator that the subscriber at the substation A is recalling. The operator now throws the key K to the left, opening the locking circuit of the relay RE at contact 83, causing the said relay RE to restore and open its contact 87 to disconnect the interrupter I' to efface the flashing supervisory signal AL. The closing of alternate contact 92 of the key K brings about the energization of the listening relay LS over a circuit traced from battery, through the upper winding 90 of the relay LS, conductor 91, alternate contact 92, conductor 86, conductor 51, and normal contact 52 to ground at alternate contact 32. The contacts 10, 11, 12 and 13 of the listening relay LS are closed, connecting the operator's set O to the cord conductors, and the operator now inquires the wants of the recalling subscriber.

If another subscriber, other than B is wanted, she removes the calling plug CP from the connected jack J' and inserts it into another jack of the wanted called line. When the calling plug is removed, the relay CS restores, allowing the relay LS to de-energize, disconnecting the operator's set O, and another insertion of the plug CP to another jack allows the circuit to be operated as previously described.

Assuming that it is the called subscriber that wishes to call, the winking of the receiver at the called substation B causes the supervisory lamp CL to flash, and the operator in response to the flashing signal CL actuates her key K, as before described, closing the circuit of the relay LS from battery through the lower winding 28 of relay LS, alternate contact 27 of relay AS, conductor 30, alternate contact 93 of key K, conductor 94 and conductor 79 to ground at normal contact 80 of relay AT. Relay LS energizes

to connect the operator's set O to the cord conductors, allowing her to converse with the called subscriber who is now recalling, and the operation of the apparatus in reestablishing a connection for the subscriber is readily apparent without further description.

Referring now to Fig. 2, I show a modified form of operator's circuit O', operating in connection with a telephone exchange system C'. Assuming now that the subscriber at the substation A' initiates a call, the removal of the receiver at the substation brings about the energization of the line relay LR^2, and the closing of its alternate contact lights the line lamp S^2 at a plurality of operator's positions. Assuming that it is the operator associated with the cord circuit C' that answers the call, the insertion of the answering plug AP' into the jack J^2 of the calling line establishes a series energizing circuit for the cut-off relay CO^2 of the line circuit L^2 and the sleeve relay ST, the circuit for said relays being traced from battery through the windings of the relay ST, conductor 102, closed contact 103 of disconnect relay LD, the sleeve contacts of the connected plug AP' and jack J^2 and through the winding of the cut-off relay CO^2 to ground. The closure of alternate contact 104 of relay ST closes a lower resistance circuit through the low resistance winding 105 of relay ST, the circuit being traced from battery through the winding 105 of relay ST, its alternate contact 104, over the previously traced path to ground at cut-off relay CO^2. The high resistance winding 106 of relay ST is shunted, this arrangement providing for secret service, as relay ST of a second pair of cords will not operate in series with the relay CO^2 as the shunt of the low winding of the relay ST of the cord circuit C' renders the relay ST of the second cord inoperative. The closing of alternate contact 107 of relay ST establishes an energizing circuit from the supervisory relay SR traced from battery through the lower winding of the relay SR, conductor 108, normal contact 109 of relay LD, ring contacts of the connected plug AP' and jack J^2, through the now closed contacts of the substation switchhook, back through the tip contacts of the jack J^2 and plug AP', contact 110 of relay LD, conductor 111, through alternate contact 107 of relay ST, conductor 112 and through the upper winding of the relay SR to ground.

The opening of normal contact 113 of relay SR upon its energization prevents the premature lighting of the answering supervisory relay AL'. The energization of the relay CO^2 of the line circuit L^2 opens the energizing circuit of the line relay LR^2, which relay restores to efface the line signals S^2. The closing of alternate contact 114 of relay ST establishes an energizing circuit for the listening relay LS', the circuit being traced from battery through the winding of the relay LS', conductor 115, through alternate contact 114 and conductor 116 to ground at normal contact 117 of the sleeve relay SL. The relay LS' upon energizing closes its alternate contacts 19 and 20 to connect the operator's set O' to the cord conductors. Should another operator attempt to seize the call after the operator associated with the cord circuit C' is connected thereto, the low resistance path through winding 105 of the relay ST prevents the relay ST of the second cord from operating, and the listening relay LS of the second cord failing to operate does not connect its associated operator's set O' across the cord conductors. The second operator failing to receive a response when she answers knows that the call has been answered by another operator and withdraws the plug of her cord circuit from the multiple jack of the calling line.

The operator's set O', as illustrated in Fig. 2, shows the circuit of the head receiver 5' in closed circuit with the transmitter side of the operator's set. The side tone of the operator's transmitter 14' is reduced by means of a resistance 15. The resistance 15 is serially connected through closed contacts 20 and 20' of the listening relays of the cord circuits associated with the operator's position. In the drawing, I show relays LS^2 and LS^3 for the purpose of illustration, the relay LS^3 representing the listening relay in the last cord of an operator's position with which the set O' is associated. When the operator's set is disconnected from the cord conductors of a cord circuit, a Wheatstone bridge circuit is established which may be traced from contact 20 of relay LS' over conductor 16, through the serially closed contacts 20 and 20' of the other listening relays as LS^2 and LS^3, the resistance 15, conductor 95, conductor 18, winding 3' of the coil IC^2, winding 4' of the coil IC^2, resistance 7', conductor 96, condenser 97, and the conductor 17 to the contact 20. The windings 3' and 4' and the resistance 15 and 7' form the arms of the bridge, and the head receiver 5' of the operator's set is connected across the points 98 and 99, thus forming a balancing circuit, reducing the side tone in the head receiver 5'.

When the operator's set O' is in use, that is, when it is connected to the cord conductors of a cord circuit, the normally closed contacts 20 and 20' are opened, disconnecting the resistance 15, and a substitute bridge circuit is established from the tip side of the cord conductor 100, through alternate contact 19, conductor 18, wind-

ings 3′ and 4′ of the coil IC², resistance 7′, conductor 96, condenser 97, conductor 17, alternate contact 20, conductor 101, through the connected subscriber's substation and back through conductor 100 to contact 19. As before stated, these bridges are balanced as to talking currents and not as to resistances. The arms of the bridge comprise the windings 3′ and 4′ of the coil IC², the resistance 7′ and the loop including the subscriber's line. The receiver 5′ is connected across the points 98 and 99 in this bridge, thus forming a balancing circuit and reducing the side tone of the transmitter 14′ in the receiver 5′. The relay LS′ upon energizing closes its alternate contacts 19 and 20 and opens its normal contact 20′, thus connecting the operator to the cord conductors as just described. The operator now inquires the wants of the calling subscriber and assuming that it is the subscriber at the substation B′ that is wanted, the operator tests the multiple jacks J³ of the called line by placing the tip of the plug CP′ against the sleeve of the jack J³, and if the line is busy, the sleeve will be at a battery potential, causing a flow of battery through the tip of the plug CP′, through normal contact 118 of relay IR′, normal contact 119 of relay RC′, over conductor 100, alternate contact 19 of relay LS′, conductor 18, through the winding 120 of induction coil IC³, and through the winding 121 of the retardation coil RA′ to ground. This induces an impulse in the winding 122 of the induction coil IC³ to produce a click in the operator's receiver 5′, notifying the operator of the busy condition of the line.

Assuming that the line is idle, the operator inserts the calling plug CP′ into the multiple jack J³ of the called line B′, closing a series energizing circuit for the sleeve relay SL′ of the cord circuit C′ and the cut-off relay CO³ of the line circuit L³, the circuit being traced from battery through the winding of the relay SL, over conductor 123, through sleeve contacts of the connected plug CP′ and jack J³, and through the winding of the relay CO³ to ground. The normal contact 117 assumes its alternate position upon the energization of the said relay SL, disconnecting the ground from the winding of the listening relay LS′, which causes the relay LS′ to release and disconnect the operator's set O′ from the cord conductors. The closing of alternate contact 124 of relay SL establishes a circuit for the calling supervisory lamp CL′, traced from battery through the said lamp, normal contact 125 of relay RC′, conductor 126, conductor 127, normal contact 128 of relay LD, conductor 129, normally closed contact 130 of relay RT, normal contact 131 of relay SR′, conductor 132, and conductor 133 to ground at alternate contact 124 of relay SL. The operator now depresses the proper ringing key plunger to its fully depressed position to close the end spring contacts 138 and 139, and to connect the proper ringing generator to signal the called-for subscriber at the substation B′.

The closing of alternate contact 139 of the end springs of the ringing key RK establishes an energizing circuit for the ringing control relay RC′, traced from battery through the winding of the said relay RC′, conductor 140, alternate contact 139, conductor 127, normal contact 128 of relay LD, conductor 129, normally closed contact 130, normal contact 131 of relay SR′, conductors 132 and 133, to ground at alternate contact 124 of relay SL. The relay IR′ is also energized during the interval that the key is held down over a circuit traced from battery through the lower winding 141 of the relay IR′, conductor 142, and through alternate contact 138 of end springs to ground at alternate contact 143 of relay RC′. The closing of alternate contact 118 of relay IR′ connects ringing current from generator GR′ to the called line, giving an instantaneous first ring to the called subscriber's call bell. The closing of alternate contact 125 of relay RC′ establishes a locking circuit for the said relay RC′ traced from battery through the winding of the relay RC′, its alternate contact 125, conductors 126 and 127, normal contact 128, conductor 129, normal contact 130, contact 131, and conductors 132 and 133 to ground at alternate contact 124 of relay SL. The opening of normal contact 125 of the relay RC′ brings about the effacement of the calling supervisory signal CL′. The closing of alternate contact 145 of the relay RC′ connects the constantly rotating interrupter I² to the interrupter relay IR′, the circuit being traced from battery through the upper winding 146 of the relay IR′, conductor 147, through alternate contact 145 of relay RC′, and through the constantly rotating interrupter I² to ground. The relay IR′ is thus intermittently energized and de-energized to connect ringing current from the generator G⁴ to the called line over a circuit traced from the ungrounded pole of the generator G⁴, through alternate contact 134 of the ringing plunger, through the winding 148 of the ringing trip relay RT, conductor 149, alternate contact 118 of relay IR′, tip contacts of the plug CP′ and jack J³, through the condenser and call bell at the called subscriber's substation B′, and back through the ring contacts of the jack J³ and plug CP′ to battery and ground at alternate contact 150 of relay IR′. The closing of alternate contact 151 of relay IR′ transmits ringing tone to the calling subscriber at substation A from the generator G⁷ over conductor 152, through

condenser Z′, lamp Y′, resistance X′, alternate contact 151 of relay IR′, conductor 153, alternate contact 119 of relay RC′, normal contact 110 of relay LD, tip contacts of plug AP′ and jack J², through the substation receiver, back through the ring contacts of jack J² and plug AP′, back through normal contact 109, conductor 108, and through the lower winding of battery SR to battery and ground, giving the calling subscriber at substation A′ an audible signal notifying him that the called subscriber is being signaled. The called subscriber at the substation B′ is thus automatically signalled until the called subscriber at substation B′ answers in response to his call signal or until the calling subscriber replaces his receiver.

Should the usbscriber at the called substation B′ answer during a silent period, that is, when the relay IR′ is in a de-energized condition, a circuit is closed through the supervisory relay SR′, which may be traced from battery through the lower winding of the relay SR′, conductor 154, normal contact 150 of relay IR′, ring contacts of the plug CP′ and jack J³, through the now closed contacts of the substation switchhook, back through the tip contacts of the jack J³ and plug CP′, normal contact 118 of relay IR′, conductor 155, alternate contact 156 of relay SL, and through the upper winding of the relay SR′ to ground. The opening of normal contact 131 of relay SR′ opens the locking circuit for the relay RC′, which relay de-energizes to open its alternate contact 145, and the opening of the said contact 145 disconnects the interrupter I² from the upper winding 146 of the relay IR′. The said relay IR′ now remains normal, thus preventing ringing current from being applied to the called subscriber's line.

Should the calling subscriber answer during a ringing interval, the ringing current is interrupted, due to the actuation of the ringing trip relay RT, over a circuit traced from the ungrounded pole of the generator G⁴, through alternate contact 134, upper winding 148 of relay RT, conductor 149, alternate contact 118, tip contacts of the plug CP′ and jack J³, through the now closed contacts of the substation switchhook, and back through the ringing contacts of the plug CP′ and jack J³ to battery and ground at alternate contact 150. The disconnection of the condenser at the substation permits the battery to flow through the upper winding 148 of the relay RT to bring about the energization of the relay RT. The relay RT energizing opens its normally closed contact 130 to interrupt the locking circuit of the relay RC′. The said relay RC′ restoring disconnects the ringing interrupter I² to prevent further application of ringing current to the called line. The closure of normal contacts 118 and 150 of relay IR′ brings about the energization of the supervisory relay SR′, as previously described, and the opening of normal contact 131 of the now energized supervisory relay SR′ opens the circuit of the calling supervisory lamp CL′.

The calling and called subscribers A′ and B′ are now in conversational circuit, the talking circuit being traced over the heavily marked conductors. Should the calling subscriber restore his receiver before the called subscriber has answered, the supervisory relay SR′ restores, due to the opening of the switchhook contacts at the calling substation A. The closing of normal contact 113 of relay SR′ establishes an energizing circuit for the disconnect relay LD traced from battery through the winding of the said relay LD, conductor 158, normal contact 113, alternate contact 159 of relay ST, and conductor 133 to ground at alternate contact 124 of relay SL. The opening of normal contact 128 of relay LD opens the locking circuit of the relay RC′, and the relay RC′ restoring opens the interrupter circuits of I² at its alternate contact 145, thus disconnecting ringing current from the called substation B′. The closing of normal contact 113 of SR establishes a circuit for the answering supervisory relay AL′ from battery through the said lamp, normal contact 113, alternate contact 159, conductor 133, to ground at alternate contact 124, lighting the said lamp AL′. The closing of alternate contact 128 of relay LD establishes a circuit for the calling supervisory lamp CL′ traced from battery through the said lamp, conductor 161, alternate contact 128, conductor 129, normal contacts 130 and 131, conductors 132 and 133, to ground at alternate contact 124. The two supervisory lamps AL′ and CL′ being lighted indicate to the operator that the calling subscriber has replaced his receiver.

The circuit is designed for five-party ringing, and should the ringing generator G⁸ be used, the actuation of the key which controls the ringing current for the said generator G⁸ causes any one of the key plungers which is in indicating position to be released, and this actuation of the key, controlling current from generator G⁸, actuates the end springs 138 and 139 to cause the relays IC′ and IR′ to be energized, as previously described. The path for the ringing current to the called subscriber's substation may be traced from the ungrounded pole of the generator G⁸, over conductor 160, through the lower winding 162 of the relay RT, conductor 163, to the closed ringing plunger contacts 137, 136, 135 and 134, conductor 164, through the upper winding 148 of the relay RT, conductor 149, alternate contact 118, tip contacts of the plug CP′ and jack J³, through the condenser and call bell of the

called substation, and back through the ring contacts of the jack J^3 and plug CP' to battery and ground at alternate contact 150. The current from the generator G^8 being of a low frequency does not prematurely operate the relay RT, due to the fact that the two windings 148 and 162 to a certain extent oppose each other. The disconnection of ringing current during a silent or ringing period is the same as previously described.

After the subscribers have finished conversation, they replace their receivers upon their respective switch-hooks, causing the relays SR and SR' to restore. The relay SR restoring closes its normal contact 113 and establishes an energizing circuit for the disconnect relay LD traced from battery through the winding of the relay LD, normal contact 113, alternate contact 159, and conductor 133 to ground at alternate contact 124. The relay LD energizing disassociates the calling line from the strands of the link circuit and closes a locking circuit for relay ST. The said locking circuit for relay ST extends from battery through said relay, its alternate contact 104, alternate contact 103 of relay LD, and alternate contact 159 of relay ST to alternate contact 124 of relay SL to ground. The relays SR' and ST remain energized until the connection is taken down.

The closing of normal contacts 113 and 131 of relays SR and SR' bring about the lighting of the answering and calling supervisory lamps AL' and CL', as previously described. The operator noting the two lighted signals removes the answering plug AP' and calling plug CP' from their respective connected jacks J^2 and J^3, and the removal of the plug CP' restores the relay SL, and the opening of alternate contact 124 of relay SL restores the relays LD and ST to normal. The cord circuit C' is now at normal and available for establishing other connections.

Assuming now that the subscribers have finished conversation and before the plugs AP' and CP' have been withdrawn from their respective jacks, the subscriber at the substation A wishes to recall. The removal of the receiver at the substation A brings about the energization of the line relay LR^2 of the line circuit L^2, and the closure of the alternate contact of the relay LR^2 brings about the lighting of the multiple line signals S^2, and the recall may be seized by the operator that handled the first connection by merely removing the calling plug CP' from the jack J^3, which disconnection releases the relay SL, opening the circuits of the relays LD and ST at its alternate contact 124. The relay LD upon restoring, again closes its normal contact 103, establishing a circuit for the cut-off relay CO^2 and the relay ST, as previously described. The alternate contact 114 of relay ST being closed, the relay LS' is again energized to connect the operator's set O' to the cord conductors, so she may answer the recall. As the relay LD is made slow in releasing, due to the non-inductive resistance in the answering supervisory lamp AL' being bridged across the windings of the same, the relay ST always releases first.

While I have illustrated several forms of my inventions operating in connection with certain telephone exchange systems, I do not wish to be limited to the same as various other arrangements may readily suggest themselves to one skilled in the art. I also wish it understood that the operator's circuit of my invention may be used with other exchange systems and I therefore desire to cover all changes and modifications as come within the spirit and scope of the appended claims.

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

1. A telephone system including a subscriber's telephone line, an operator's telephone set for connection to said subscriber's telephone line, an induction coil provided with a pair of secondary windings, a resistance coil, circuit connections connecting said subscriber's line, said secondary windings, and said resistance coil in a Wheatstone bridge circuit, an operator's receiver for said operator's telephone connected across said Wheatstone bridge circuit, and means for disconnecting said operator's receiver from across said Wheatstone bridge circuit when said subscriber's telephone line is disconnected from said operator's set.

2. A telephone system including a subscriber's telephone line, an operator's telephone adapted to be connected to said telephone line, a pair of induction coil windings and a resistance coil associated with said operator's telephone, automatic means for connecting said induction coil windings, said resistance coil, and said subscriber's line in a Wheatstone bridge circuit, a receiver for said operator's telephone connected across said Wheatstone bridge circuit, and means responsive to the disassociation of said operator's telephone from said subscriber's line for removing said operator's receiver from across said Wheatstone bridge circuit.

3. A telephone system including a subscriber's telephone line, an operator's telephone adapted to be associated with said telephone line, a pair of induction coil windings, a resistance coil, connections for connecting said induction coil windings, said resistance, and said subscriber's telephone line in a Wheatstone bridge circuit when said operator's telephone is connected to said subscriber's telephone line, an operator's receiver for said operator's telephone connected across said Wheatstone bridge circuit,

and automatic means for disconnecting said operator's telephone from said subscriber's line and for removing said operator's receiver from across said Wheatstone bridge circuit.

4. A telephone system including a subscriber's telephone line, an operator's telephone for connection thereto, a pair of induction coil windings, and a resistance for said operator's telephone, a transmitter and a receiver for said operator's telephone, circuit connections for connecting said induction coil windings, said resistance, and said subscriber's line in a Wheatstone bridge circuit and to connect said operator's receiver across said Wheatstone bridge circuit to prevent side tone from being transmitted from said operator's transmitter to said operator's receiver, and automatic means responsive to the disconnection of said operator's telephone from said subscriber's line to render said operator's receiver incapable of receiving side tone from said operator's transmitter.

5. A telephone system including a subscriber's telephone line, a plurality of operator's link circuits, an operator's telephone associated with said link circuits, an operator's anti-side tone telephone circuit including a receiver normally inoperatively related to the transmitter of said operator's telephone, and means included in any one of said operator's cord circuits for effectively associating said operator's transmitter and receiver when one of the cord circuits is connected to the subscriber's telephone line.

6. A telephone system including a subscriber's telephone line, an operator's link circuit for connection therewith, an operator's telephone associated with said operator's link circuit, a transmitter and a receiver for said operator's telephone, said transmitter being normally connected in a battery circuit, said receiver being normally inoperatively associated with said transmitter, and means associated with said cord circuit for operatively associating said operator's transmitter with said operator's receiver when said operator's telephone is connected to said subscriber's telephone line, so as to place said receiver in a balanced bridge circuit when the receiver is used for receiving purposes.

7. A telephone system including a subscriber's telephone line, a plurality of link circuits associated with said telephone line, an operator's telephone associated with said link circuits, said operator's telephone being provided with a transmitter normally inoperatively associated with the operator's receiver, a retardation coil and a battery normally connected in circuit with said transmitter, automatic means for connecting said operator's telephone with any one of said link circuits when said link circuit is connected to said subscriber's telephone line, means for operatively associating said operator's transmitter with said receiver when said telephone line is connected to said link circuit, and resistance devices and circuit connections for the same to place said receiver in a balanced bridge circuit so that the circuit is an anti-side-tone circuit when the receiver is being used for receiving purposes.

8. A telephone system including subscribers' telephone lines, link circuits associated with said telephone lines, an operator's telephone set including an operator's receiver and an operator's transmitter, a battery, a retardation coil and a condenser normally operatively connected with said transmitter, said receiver being normally inoperatively associated with said transmitter, automatic means for connecting said operator's telephone to one of said subscribers' lines when said line is connected to one of said link circuits, means for operatively associating said receiver with said transmitter when such connection takes place, resistance devices and circuit connections to place said devices in a Wheatstone bridge circuit and connect said receiver across said bridge to decrease the side-tone.

9. A telephone system including a subscriber's telephone line, an operator's telephone adapted to be connected thereto, resistance devices, circuit connections for connecting said devices in a Wheatstone bridge circuit, a receiver for said operator's telephone adapted to be connected across said Wheatstone bridge circuit, means for connecting said operator's telephone to said subscriber's line, and for connecting said operator's receiver across said Wheatstone bridge circuit, and means for disconnecting said operator's telephone from said subscriber's line and for disconecting said operator's receiver from across said Wheatstone bridge circuit.

10. A telephone system including a line, an operator's receiver, impedance devices, circuit connections connecting said impedance devices in a Wheatstone bridge circuit, means for connecting said operator's receiver across said Wheatstone bridge circuit with said subscriber's telephone line, and means for disconnecting said operator's receiver from said subscriber's line and from across said Wheatstone bridge circuit.

11. A system of the character described including a plurality of connecting circuits, an operator's telephone including a receiver and a transmitter, said transmitter being normally supplied with operating current, said receiver being normally inoperatively associated with said transmitter, a relay for each of said connecting circuits, and means controlled by any one of said relays for

effectively associating said operator's receiver with said operator's transmitter.

12. A system of the character described including a connecting circuit, an operator's telephone adapted to be connected to said circuit, a receiver for said operator's telephone, normally inoperatively associated with the transmitter of said operator's telephone, an induction coil, the said transmitter being normally operatively connected with the primary winding of the induction coil to effect changes therein when the said transmitter is actuated, and means associated with said connecting circuit for connecting said operator's telephone with said connecting circuit and for operatively associating said receiver with said transmitter.

13. A system of the character described including a plurality of connecting circuits, an operator's telephone associated with said connecting circuits, a receiver and a transmitter for said operator's telephone, an induction coil, the said transmitter being normally operatively connected with the primary winding of the induction coil to effect changes therein when the said transmitter is actuated, said receiver being normally inoperatively associated with said transmitter, and means in any one of said link circuits for automatically connecting said operator's telephone with said link circuit and for effectively associating said receiver with said transmitter.

14. A system of the character described including telephone lines, a connecting circuit for use in interconnecting said lines, an operator's telephone for connection to said connecting circuit, a receiver and a transmitter for said operator's telephone, means for connecting said operator's telephone to said connecting circuit, and means for disconnecting said operator's telephone from said connecting circuit and for operatively disassociating said receiver from said transmitter while maintaining said transmitter in a closed battery circuit.

15. A system of the character described including a subscriber's telephone line, a link circuit for extending connection from said telephone line, an operator's telephone including a receiver and a transmitter, means for connecting said operator's telephone to said link circuit, and automatic means individual to said link circuit for disconnecting said operator's telephone from said link circuit and for operatively disassociating said receiver from said transmitter, said transmitter however remaining in a closed battery circuit.

16. A system of the character described including a subscriber's telephone line, a link circuit for extending connection from said telephone line, an operator's telephone including a receiver and a transmitter, means for connecting said operator's telephone to said link circuit, means for automatically disconnecting said operator's telephone from said link circuit and for preventing side tone from being transmitted from said transmitter to said receiver, and means for preventing the operator's receiver from receiving side tone when the operator's telephone is connected to the said link circuit.

17. A telephone system including an operator's telephone provided with a transmitter and a receiver, an induction coil, said transmitter being normally connected in circuit with a battery and a primary winding of the induction coil, said receiver being normallv connected to a secondary winding of the induction coil at one point but being inoperatively associated with the induction coil so that the receiver is normally ineffective for receiving, a link circuit, means for associating said link circuit with said operator's telephone and rendering said operator's receiver effective, said operator's receiver being connected in a balanced circuit to reduce the side-tones from said operator's transmitter when the same is used for transmission.

18. A telephone system including an operator's telephone provided with a transmitter and a receiver, an induction coil, said transmitter being normally connected in circuit with a battery and a primary winding of the induction coil, said receiver being normally connected to a secondary winding of the induction coil at one point but being inoperatively associated with the induction coil so that the receiver is normally ineffective for receiving, a link circuit, means for associating said link circuit with said operator's telephone and rendering said operator's receiver effective, said operator's receiver being connected in a balanced circuit to reduce the side tones from said operator's transmitter when the same is used for transmission until they become substantially unnoticeable, said receiver also being connected for receiving purposes from said link circuit.

19. A system of the character described including an operator's telephone and a link circuit, said operator's telephone including a transmitter normally connected in a battery circuit, a receiver normally ineffectively associated with the transmitter, automatic means for connecting the operator's telephone to the link circuit and for rendering said receiver effective, circuit connections rendered effective when the operator's telephone is connected to the link circuit to connect means to place the operator's receiver in a balanced circuit so that when speech is transmitted by said transmitter the same is reduced in the operator's receiver but is transmitted to the link circuit.

20. A system of the character described

including an operator's telephone and a link circuit, said operator's telephone including a transmitter normally connected in a battery circuit, a receiver normally ineffectively associated with the transmitter, automatic means for connecting the operator's telephone to the link circuit and for rendering said receiver effective, circuit connections rendered effective when the operator's telephone is connected to the link circuit to place said receiver in a balanced circuit so that when speech is transmitted by said transmitter the same is substantially inaudible in the operator's receiver but is transmitted to the link circuit, said connections being such that when speech is transmitted through said link to said operator's telephone the receiver is effective to receive such speech.

21. An operator's telephone circuit including a transmitter, a receiver connected in a balanced bridge circuit so that when the operator's telephone is connected for use the current flow through the operator's receiver is reduced when the operator's transmitter is actuated, and means for rendering ineffective the operator's receiver when the operator's telephone is not connected for use.

22. A system of the character described including an operator's telephone provided with a normally charged transmitter, a circuit for connection to said operator's telephone, an operator's receiver for said operator's circuit connected in a balanced bridge circuit so that the current flow is reduced through the receiver when the operator's transmitter is actuated, until it becomes substantially unnoticeable, and means for effectively disassociating the operator's receiver from the operator's transmitter when the operator's telephone is not connected with said first circuit.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 21st day of May, 1918.

CHARLES SPARKS.