Nov. 17, 1925.

1,561,598

G. R. EATON

TELEPHONE SYSTEM

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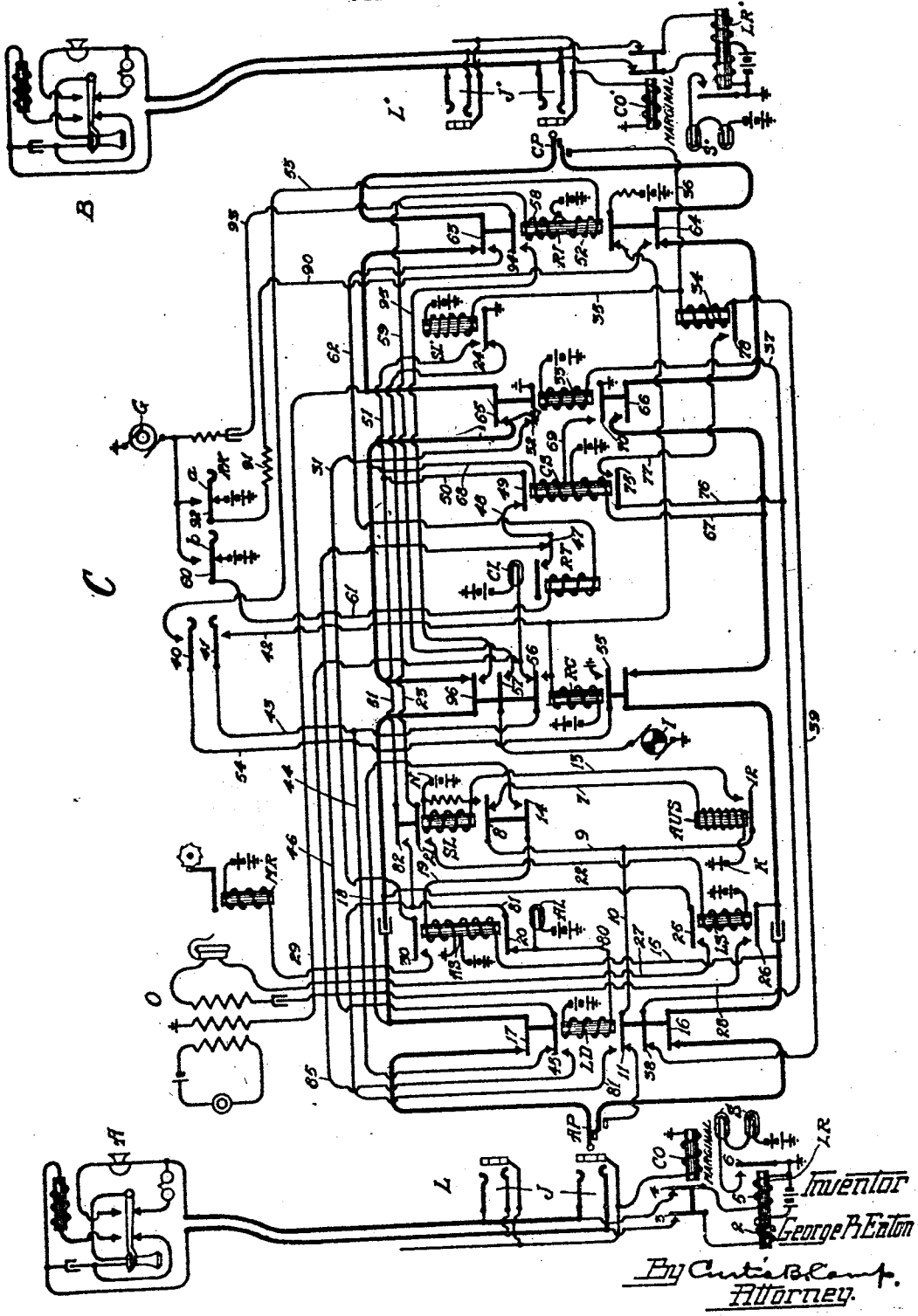

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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

Application filed December 31, 1921. Serial No. 526,196.

To all whom it may concern:

Be it known that I, GEORGE R. EATON, a citizen of the United States of America, and resident of 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 telephone systems in which manual link circuits are provided for interconnecting telephone lines as calling and called lines, and has to do more particularly with the so-called multiple line lamp systems in which automatic listening, automatic ringing, secret service, instantaneous disconnect, etc., are provided, and an object of my invention is the provision of an improved system of the above character.

In multiple line lamp systems of the above type there will be times when more than one operator may start to make connection with a calling line at substantially the same time, and therefore, means must be provided for preventing more than one operator from connecting to a calling line, and to this end my invention is particularly directed. In systems of the above character more or less difficulty has been found in connection with line circuits, using low resistance cut off relays, two or more operators being connected to a calling line at the same time and trying to answer the same call, the result being that both plug into jacks of the called line. A feature of my invention is the provision of means in the cord circuits of my invention operating in connection with low resistance cut off relays associated with the line circuits of a calling line to produce a positive bar so that more than one operator cannot establish a talking connection with a calling line.

The above feature, as well as others not specifically pointed out above, will be more particularly pointed out in the ensuing specification.

Referring now more in general to my invention as illustrated, it comprises a calling substation A connected at the exchange with a well-known line circuit L, comprising the multiple answering jacks J, a low-wound cut-off relay CO, line relay LR and multiple line lamps S. To the right of the drawing, I show a called substation B connected to a line circuit L′, similar to L, having the usual line relay LR′, cut-off relay CO′, multiple calling jacks J′ and multiple line lamps S′. The line circuits L and L′ shown are provided with multiple line lamps S one for each jack so that when a call is initiated a line signal appears before each jack J, and any one of a plurality of operators may seize this call to the exclusion of the others.

The cord circuit C illustrated in the drawing is arranged for interconnecting the telephone lines A and B, and comprises an answering plug P and a calling plug CP connected by the heavily marked talking conductors. The answering end of the cord circuit C comprises an answering supervisory relay AS for the usual supervisory purposes controlling the answering supervisory lamp AL and the cord C is also provided with an auxiliary sleeve relay AUS and a sleeve relay SL for the purpose of excluding any other operator that may attempt to seize the call after one operator has already established connection to the calling line. An operator's listening relay LS is also provided which, when operated, connects the operator's set O to the talking conductors of the cord C. A link disconnect relay LD is energized when the subscriber at a calling substation replaces his receiver upon the switchhook to dissociate the cord circuit connected with his line from his associated line circuit, giving the subscriber instantaneous recall facilities.

The calling end of the cord circuit C comprises the calling supervisory relay CS for the usual supervisory purposes controlling the calling supervisory lamp CL. A ringing control relay RC is also provided, energized upon the depression of either of the ringing key plunger *a* or *b* of the ringing key RK to connect the constantly rotating interrupter I in circuit with the ringing interrupter relay RI.

For the purpose of my invention, I have ascertained that the following voltages and resistances for the different relays will bring about the successful operation of the operator's non-interference feature of my invention, although others will equally serve. The cut-off relay CO of the line circuit L may be wound to the resistance of 35 ohms, the auxiliary sleeve relay AUS of the cord circuit C to 1000 ohms resistance and is to be connected to an eight-volt battery current;

the joint resistance of sleeve relay SL and its non-inductive shunt may be of 206 ohms resistance and connected to the exchange battery of twenty-four volts. The operation of the operator's non-interference feature in connection with these resistances and voltages will be more fully hereinafter described.

Having described in general the apparatus employed in a preferred embodiment of my invention, I will now describe more in detail the operation of the system as illustrated in the accompanying drawing.

Assuming that the subscriber at the substation A initiates a call, the removal of the receiver at the substation A establishes an energizing circuit for the line relay LR of the line circuit L traced from battery through its winding 2, normal contact 3 of cut-off relay CO, through the closed switch-hook contacts, normal contact 4 of relay CO to ground through the winding 5 of relay LR, and the closing of contact 6 causes the line signals S to be lighted at the different associated jacks J, each at a different operator's position. The first operator to seize the call by the insertion of her answering plug AP into one of the jacks J closes an energizing circuit for the auxiliary sleeve relay AUS of the cord circuit C and the cut-off relay CO of line circuit L, traced from the 8-volt battery K through the winding of the relay AUS, conductor 7, normal contact 8 of the sleeve relay SL, conductors 9 and 10, normal contact 11 of the link disconnect relay LD, sleeve contacts of the connected plug AP and jack J to ground through the winding of the cut-off relay CO. The relay CO energizing opens its normal contacts 3 and 4 to allow relay LR to restore and efface the line signals S. The auxiliary sleeve relay AUS is also energized over this circuit and the closure of its alternate contact 12 establishes an energizing circuit for the sleeve relay SL, traced from battery through the windings of relay SL, conductor 13, alternate contact 12 of relay AUS, conductors 9 and 10, normal contact 11 of relay LD, sleeve contacts of the connected plug AP and jack J to ground through the winding of relay CO. The relay SL upon energization closes its alternate contact 8, establishing a locking circuit for itself traced from battery through the winding of relay SL, its alternate contact 8, conductors 9 and 10 to ground through the cut-off relay CO, over the previously described path. The opening of normal contact 8 of relay SL upon its energization opens the energizing circuit of relay AUS and the relay AUS now restores. The closing of alternate contact 14 of the relay SL establishes an energizing circuit for the answering supervisory relay AS traced from battery through the lower winding of relay AS, conductor 15, normal contact 16 of relay LD, ring contacts of the connected plug AP and jack J, through the substation, back through tip contacts of the connected plug AP and jack J, normal contact 17 of relay LD, conductor 18, alternate contact 14 of relay SL, conductor 19 to ground through the upper winding of relay AS. The relay AS upon energization opens its normal contact 20 to prevent the premature lighting of the answering supervisory lamp AL. The closing of alternate contact 21 of relay SL establishes an energizing circuit for the operator's listening relay LS, traced from battery through the winding of relay LS, conductor 22, alternate contact 21 of relay SL, conductor 23 to ground at normal contact 24 of the sleeve relay SL'. The relay LS upon energization closes its alternate contacts 25 and 26 to connect the operator's set O over conductors 27 and 28 to the cord conductors of the cord circuit C. The relay AS upon energization also establishes an energizing circuit for the meter relay MR, traced from battery through the winding of meter relay MR, conductor 29, alternate contact 30 of relay AS, conductor 31, to ground at normal contact 32 of the relay 33, and the relay MR is energized over this circuit and registers a connection.

Should a second operator insert an answering plug into another jack J of the calling line subsequent to the insertion of the plug AP of the cord circuit C, such second operator would not be connected to the calling line for reasons that will now be described. The sleeve relay SL of the first cord when energized is held up through its locking circuit from the twenty-four volt battery N through its winding, and through the sleeve contacts of the connected plug AP and jack J to ground through the 35-ohm resistance cut-off relay CO. The current from battery N passing through the sleeve relay SL to ground through the cutoff relay CO establishes a potential at the sleeve of the jack J. Now, when a second operator attempts to answer the call subsequent to the insertion of the plug AP of the cord C, the insertion of the second plug AP connects the 1000-ohm resistance auxiliary sleeve relay AUS of the second cord to the sleeve of the second jack J, which is multipled to the sleeve of the first jack J into which the plug AP of the first cord C has been inserted. The circuit arrangement is now such that relay AUS of the second cord circuit does not receive sufficient current to operate. The relay AUS of the second cord circuit failing to operate, the operator's set remains disconnected from the second cord circuit. I have found that this arrangement works out very satisfactorily by connecting one terminal of the relay AUS to an eight-volt battery and by using the resistance heretofore mentioned.

The relay AUS of the second cord failing

to operate, the second operator is unable to communicate with the calling subscriber because her operator's set is not connected due to the failure of the operator's listening relay LS of the second cord to be energized, and the second operator receiving no response withdraws the answering plug AP of the second cord from the connected jack. The first operator being connected with the calling subscriber at substation A as just described, now inquires the want of the calling subscriber thereat.

Assuming that the subscriber at the substation B is wanted, the operator tests the jack J' of the called line in the usual manner, and, if busy, she receives the customary click in her head set. Assuming that the line is idle, the operator inserts the calling plug CP into the jack J' of the called substation B, thus establishing an energizing circuit for the sleeve relay SL', for relays 33 and 34 and for the cut-off relay CO' of the line circuit L'. The circuit of relay SL' may be traced from battery through its winding, conductors 35 and 36, sleeve contacts of the connected plug CP and jack J' to ground through the winding of relay CO' and the circuit of relays 33 and 34 may be traced from battery through the winding of relay 33, conductor 37, normal contact 38 of link disconnect relay LD, conductor 39, through the winding of relay 34, conductor 36, sleeve contacts of the connected plug CP and jack J' to ground through the winding of the cut-off relay CO'. The relays SL', 33 and 34 operate over these circuits respectively due to the low resistance of the cut-off relay CO'.

The relay SL' energizing opens its normal contact 24 to open the energizing circuit of the operator's listening relay LS and the relay LS now restores to open its alternate contacts 25 and 26 disconnecting the operator's set O from the cord conductors. The relay 33 energizing opens its normal contact 32 to open the energizing circuit of the meter relay MR. The cord circuit C is equipped with two-party automatic ringing for signaling the two subscribers on the party line and the operator now depresses the ringing key plunger *b*, assuming that this is the key plunger for ringing the called line B, and this actuation also closes the end spring contacts 40 and 41 momentarily. The closure of alternate contact 41 of the end springs of the ringing key RK now establishes an energizing circuit for the ringing control relay RC, traced from battery through the winding of relay RC, conductor 42, alternate contact 41 of the end spring conductors 43 and 44, normal contact 45 of the relay LD, conductor 46, normal contact 47 of the ringing trip relay RT, conductor 48, normal contact 49 of calling supervisory relay CS, conductors 50 and 51 to ground at alternate contact 24 of sleeve relay SL'. The momentary closure of the end spring contact 40 establishes an energizing circuit for the ringing interrupter relay RI, traced from battery through the lower winding 52 of relay RI, conductor 53, closed contact 40 of the end springs, conductor 54 to ground at alternate contact 55 of relay RC. The energization of relay RI immediately upon the actuation of a key plunger of the ringing key RK brings about an instantaneous first ring, as is readily apparent from the foregoing description.

The relay RC upon energization establishes a locking circuit for itself traced from battery through the winding of relay RC, its alternate contact 56, conductors 43 and 44, normal contact 45 of relay LD, conductor 46, normal contact 47 of relay RT, conductor 48, normal contact 49, conductors 50 and 51 to ground at alternate contact 24 of relay SL'. The closing of alternate contact 57 of relay RC closes an energizing circuit for the interrupter relay RI traced from battery through the upper winding 58 of relay RI, conductor 59 through alternate contact 57 of relay RC to ground through the constantly rotating interrupter I. The relay RI is thus intermittently energized through the agency of constantly rotating interrupter I to intermittently apply ringing current to the called line, the said ringing current being traced from the ungrounded pole of the generator G, the closed contact 60 of the ringing key plunger *b*, conductor 61, through the winding of the ringing trip relay RT, conductor 62, alternate contact 63 of ringing interrupter relay RI, tip contacts of the connected plug CP and jack J', through the condenser and call bell at the called substation B back through the ring contacts of the connected plug CP and jack J', alternate contact 64 of relay RI, conductor 90, resistance 91 to battery and ground at normal contact 92 of the ringing key plunger *a* of the key K. The subscriber at the calling substation A also receives an audible tone notifying him that the subscriber at the called substation B is being signaled, the said signal being traced from the generator G over conductor 93, alternate contact 94 of relay RI, conductor 95, alternate contact 96 of relay RC, and over the tip conductor of the cord circuit C to the calling substation A. If a second substation is connected to line L' and is to be signalled the operator will depress key plunger *a*, thus connecting the ringing current from the generator G, through alternate contact 92 of the key plunger *a*, resistance 91, conductor 90, alternate contact 64 of relay RI, ring contacts of the plug CP and the connected jack and through the call bell of the other second party, back through the tip contacts of the connected plug CP and

jack, alternate contact 63 of relay RI, conductor 62, through the winding of ringing trip relay RT, conductor 61 to battery and ground at normal contact 60 key plunger *b* of the ringing key RK. The depression of *a* thus transmits ringing current over L′ in a direction the reverse of that transmitted by the operation of plunger *b* so that the usual two party selective ringing is provided.

The subscriber at the substation B in response to his call bell removes his receiver from its switchhook, and, should he remove the said receiver from its switchhook during a ringing period, the exclusion of the condenser and call bell from the ringing circuit permits the energization of the relay RT, and the opening of normal contact 47 of said relay RT opens the locking circuit of the ringing control relay RC and the relay RC de-energizing its alternate contact 57 opens the intermittent energizing circuit of the ringing interrupter relay RI, which restores, preventing further application of ringing current to the called substation. The relay RI upon restoration again closes its normal contacts 63 and 64 and establishes an energizing circuit for the calling supervisory relays CS, traced from battery through the lower winding of relay CS, conductor 67, alternate contact 66 of relay 33, normal contact 64 of relay RI, ring contacts of the connected plug CP and jack J′ through the now closed contacts at the substation switchhook, back through the tip contacts of the connected plug CP and jack J′, normal contact 63 of relay RI, alternate contact 65 of relay 33, conductor 68, through the upper winding of relay CS, conductor 69 to ground at alternate contact 70 of the relay 33. Should the subscriber at the called substation B answer during a silent period, that is, when the interrupter relay RI is de-energized, the closed condition of contacts 63 and 64 establishes an energizing circuit for the calling supervisory relay CS over the circuit just traced, and the relay CS upon energization by contact 49 opens the locking circuit of the ringing control relay RC, and upon the relay RC restoring its alternate contact 57 is opened to prevent further energizations of the relay RI and further application of ringing current is prevented. Before the subscriber at the called substation B answers, the relays 33 and 34 are under the control of the calling subscriber at substation A, as this subscriber controls the energization of relay LD, whose contact 38 controls the original energization of the relays 33 and 34. When the subscriber at the called substation B answers the relay CS energizes, as previously described, and the closing of its alternate contact 75 removes the control of relays 33 and 34 from the calling subscriber at substation A, by closing a circuit which may now be traced from battery through the winding of relay 33, conductor 76, alternate contact 75 of relay CS, conductor 77, alternate contact 78 of relay 34, through the winding of relay 34, conductor 36, sleeve contacts of jack J′ and plug CP, to ground through cut-off relay CO′.

The subscriber at the calling substation A and the subscriber at the called substation B are now in conversation, circuit being traced over the heavily marked conductors.

When the subscribers at substations A and B have finished conversation, they replace their receivers upon their respective switchhooks. The replacing of the receiver at the calling substation A opens the energizing circuit of the answering supervisory relay AS at the switchhook contacts and the relay AS de-energizing closes its normal contact 20, establishing an energizing circuit for the link disconnect relay LD, traced from battery through the winding of relay LD, conductor 80, normal contact 20 of relay AS, conductor 81, alternate contact 82 of relay SL, conductor 51 to ground at alternate contact 24 of the relay SL′. The link disconnect relay LD energizing opens its normal contacts 16 and 17 and disconnects the cord conductors from the line circuit L, and the opening of normal contact 11 opens the energizing circuit of sleeve relay SL and the cut-off relay CO of line circuit L, which relay CO restores, but a substitute energizing circuit is established for the relay SL, traced from battery through the winding of relay SL, its alternate contact 8, conductors 9 and 10, alternate contact 11 of relay LD, conductor 81, alternate contact 82 of relay SL, conductor 51 to ground at alternate contact 24 of relay SL′. The closing of normal contact 20 of relay AS establishes a circuit for the answering supervisory lamp AL, traced from battery through the lamp AL, normal contact 20 of relay AS, conductor 81, alternate contact 82, conductor 51 to ground at alternate contact 24 of relay SL′. The opening of normal contact 38 of relay LD does not affect the relays 33 and 34 because they were given an alternate circuit through contact 75 under the control of the called subscriber at the substation B as previously described. It is seen that as soon as the calling subscriber at substation A replaces his receiver, his line is by relay LD instantly disconnected from the cord conductors to place his line circuit L at normal so that he may immediately recall by removing his receiver, which call will appear as an original call on the board.

When, now, the called subscriber at substation B replaces his receiver upon the switchhook, the opening of the switchhook contacts opens the energizing circuit of the calling supervisory relay CS and the open-

ing of its alternate contact 75 opens the energizing circuits of the relays 33 and 34, and the relay 33 restoring its alternate contacts 65 and 66 are opened to disconnect the cord conductors from the line circuit L′ of the called substation B. Relay SL′ is now the only relay connected to the sleeve strand, and (due to the high resistance) the cut-off relay CO′ of the line circuit L′ fails to remain energized, and it restores, thus placing the line circuit L′ of the called line at normal to permit the called subscriber at B to immediately recall, if he wishes to do so, without waiting for the removal of the plug CP from the jack J′. The closure of normal contact 49 of relay CS upon its de-energization establishes a circuit for the calling supervisory lamp CL traced from battery through the lamp CL, conductor 85, alternate contact 45 of relay LD, conductor 46, normal contact 47 of relay RT, conductor 48, normal contact 49 of relay CS, conductors 50 and 51, to ground at alternate contact 24 of the sleeve relay SL′. The operator noting the two lighted supervisory signals AL and CL knows the conversation has terminated and withdraws the plugs AP and CP from their respective jacks J and J′. The withdrawal of the plug from the jack J′ opens the energizing circuit of sleeve relay SL′ and the opening of its alternate contact 24 opens the energizing circuits of relays LD and SL and opens the circuits of the supervisory lamps AL and CL and the withdrawal of the plug AP from the jack J now places the apparatus in condition for use in establishing other connections.

Should the called subscriber B replace his receiver before the calling subscriber A upon the termination of conversation, the relay CS restores, but relays 33 and 34 are maintained energized through normal contact 38 of relay LD, and when the calling subscriber replaces his receiver relay LD will energize to open the circuit of relays 33 and 34, and the operation of the circuit from this point will be the same as already described.

Assuming that a connection has been established with the called subscriber at substation B as before described, and that the calling subscriber at A replaces his receiver before the subscriber at B answers, the replacing of the receiver at A opens the energizing circuit of relay AS and the closing of its normal contact 20 establishes an energizing circuit for the link disconnect relay LD, and the relay LD energizing opens its normal contact 45, interrupting the locking circuit of the ringing control relay RC. The relay RC now restores, and the opening of its alternate contact 57 opens the circuit including the ringing interrupter relay RI and the interrupter I, thus preventing further application of ringing current to the called line. The operation of the circuit from this point on upon disconnection is obvious from the previous description.

While I have indicated a plurality of batteries it is to be understood that in practice there will be a single 24-volt battery with the understanding that the battery K described as an 8-volt battery would actually be an 8-volt tap from the general exchange battery of 24-volts, not only for the reason of eliminating the provision of a separate source, but so that variations due to different conditions of charge may be substantially proportionate in the 24-volt circuits and the 8-volt circuits. It will be seen that the margin obtained is secured by adjusting the potential on the return which is common to the two connections of different voltages in such a way as to neutralize the effect of the low voltage tap. It is apparent that if the resistance of relay CO were increased a higher potential would exist on the jack contact and when the second cord was connected this potential would produce a "back" flow through relay SL, the 8-volts being overcome, while if the resistance of CO were decreased, the potential at the jack would be decreased and the 8-volt tap would transmit a certain amount of current through relay AUS.

It will also be observed that inasmuch as the cut-off relay CO is of but 35 ohms whereas the relay AUS is of 1000 ohms, the battery K will hardly pass enough current for the relay CO to energize it so that the latter will ordinarily operate only upon the connecting in circuit of the relay SL. It would no doubt be possible to produce a construction and adjustment of relays CO, AUS and SL so that they would operate under the above conditions, but one of the advantages of my invention is found in securing the desired operation of the elements in conjunction with low wound and relatively inefficient cut-off relays of types heretofore used and in extensive employment, and I accordingly arrange my circuits in such a manner as to avoid the necessity of any careful adjustments of such relays.

While I have illustrated and described a particular embodiment of my invention, it is to be understood that I do not wish to be limited to the particular structure illustrated and described, but I intend to cover all such 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. In a telephone system the combination with a telephone line, of link circuits having low potential battery connections and relays connected by their terminals to the active side of said connections to be energized thereby on connection to said line.

higher potential battery connections for said link circuits, instrumentalities effective on the connection of a first link circuit with said line to connect the active side of said high potential connection to said line, said instrumentalities including adjusting means to establish a potential of polarity to oppose the active side of said low potential battery connection, means for employing said potential to prevent the energization of a second of said relays when its link circuit is connected to said line, and operators' means to groups of link circuits for connection to said cord circuits responsive to said relays.

2. In a telephone system, the combination of a central exchange, a telephone line terminating at the central exchange in a plurality of terminals, a plurality of link circuits at the central exchange, an operator's set common to and normally disconnected from each link circuit, a relay associated with each link circuit operating upon connection thereof with a line, a second relay for each link circuit actuated upon the operation of said first relay and for opening the circuit of said first relay and also to permit automatic connection of said operator's set to that link circuit wherein said second relay operated, and opposing potential means controlled by said second relay and rendered effective upon its energization to prevent the operation of a relay similar to the first of another link circuit when connected with the same line.

3. In a telephone system, the combination of a central exchange, telephone lines each terminating at the exchange in a plurality of terminals, positions having each a plurality of link circuits for interconnecting said lines, an operator's set for each position adapted for connection with each of its link circuits, a sleeve relay associated with each link circuit operating upon connection of a link circuit with a calling line to control the connection of an operator's set in circuit, a second sleeve relay for each link circuit actuated upon the operation of its associated first sleeve relay and to open the circuit of the first sleeve relay, means controlled by said second relay for connecting said operator's set in circuit, and means rendered effective upon the energization of said second relay to prevent the operation of the relay of another link circuit similar to said first sleeve relay when connected with the same line.

4. In a telephone system, the combination of a central exchange, a telephone line terminating at the exchange in a plurality of terminals, a plurality of link circuits at different positions for connecting to said line, an operator's set for each position adapted for connection with each of its link circuits, a sleeve relay for each link circuit, a special potential battery connection associated with said sleeve relays to energize the same when connection is made with a line, a second sleeve relay for each circuit operated upon the actuation of its associated first sleeve relay to open the circuit of said first sleeve relay, means controlled upon the energization of said second sleeve relay to connect the operator's set in circuit, and means rendered effective upon the energization of said second sleeve relay to place an opposing potential upon the terminal of the said line to prevent the relay of another link similar to said first sleeve relay from operating when connected with the same line, said potential opposing the potential of said special battery connection.

5. In a telephone system, the combination of a central exchange, a telephone line terminating at the exchange in a plurality of terminals, a low wound cut-off relay connected with said terminals, a plurality of link circuits for connecting to said line, an operator's set adapted for connection with said link circuits, a sleeve relay and a special battery connection associated therewith and a series circuit for said cut-off relay and said sleeve relay when connection is made with a line, a central source of current, contacts controlled by said sleeve relay closed upon actuation to close a circuit for a second sleeve relay and said central source of current, and contacts controlled by said second sleeve relay for opening the circuit of said first sleeve relay, current controlling means rendered effective upon the energization of said second sleeve relay for placing an opposing potential upon said terminal of the line to render ineffective the special battery to cause the operation of the first sleeve relay of a second link circuit when connected with the same line.

6. In a telephone system, the combination of a central exchange, telephone lines terminating at the exchange in a plurality of terminals, a plurality of link circuits at the exchange, each provided with an answering terminal adapted for connection purposes with the terminal of a line, an operator's set for connection with each of said lines, a low wound cut-off relay for each of said lines, a sleeve relay for each link circuit, a low potential battery connection associated with said sleeve relay, a circuit including said sleeve relay and said cut-off relay from said low potential connection when connection is made with a line, a high potential battery connection, contacts of said sleeve relay closed upon its operation to close an energizing circuit for a second sleeve relay and said cut-off relay from said second battery connection to place a predetermined potential upon the terminal of said line for rendering ineffective the first battery connection of a second link circuit to cause the operation of the first sleeve relay of said

second link circuit when the same is connected to the line subsequent to the connection of the first link circuit.

7. The combination with a telephone line connected with a cut-off relay at the exchange, of a link circuit for connection with said line, said circuit having a pair of relays, the first adapted to be energized in circuit with said cut-off relay when said link circuit is connected with said line, and said second link circuit relay to be connected with said cut-off relay responsive to the energization of the first, a circuit for said first relay including a contact of said second relay, a circuit for said second relay having a different battery voltage from that of said last circuit means for causing said cut-off relay to actuate its switch contacts responsive only to the connection of said second relay, and connections automatically effective on the energization of said cut-off relay to prevent the effective operation of another link circuit thereafter applied to said line.

8. In a telephone system, the combination with telephone lines having terminals at the exchange, of link circuits for connection therewith distributed among different operators' positions, relays one for each said link circuit and operators' listening connections controlled by them, means including a line terminal effective by the connection of a first link circuit to a line to energize the relay of such circuit, switching apparatus responsive to such energization to place an adjusted battery voltage on said terminal, means for connecting thereafter the relay of another link circuit to said terminal, and normal battery connections for said relays of voltage and polarity corresponding to said adjusted battery voltage.

9. In a telephone system including a calling telephone line terminating in a plurality of operators' positions, a link circuit at each operator's position, a pair of relays individual to said link circuit, one of said relays operable when its associated link circuit is connected to said line, and the other of said pair of relays then operable providing a pair of relays in another link circuit connected to said line has not operated, and energizing circuits of different battery voltages for said pair of relays including a contact of said pair of relays.

10. In a telephone system including a calling telephone line appearing at different operators' positions, link circuits at said operators' positions for connecting to said line, an operator's telephone set for said link circuits at each operator's position and normally disconnected from said link circuits, a pair of relays individual to said link circuits and operable upon the connection of the link circuit associated with said pair of relays with said line to effect the automatic connection of the operator's set associated with said link circuit, provided another link circuit is not already connected to said calling line, and energizing circuits of different battery voltages for said pair of relays including contacts of said pair of relays.

11. In a telephone system including a calling telephone line terminating in different operators' positions, link circuits at each operator's position, a telephone set for each operator and normally disconnected from said link circuits, a pair of relays individual to said link circuits for effecting automatic connection of said operator's telephone set to an associated link circuit when the same is connected to said calling line, means for preventing more than one operator's set from being connected in circuit with said telephone line at the same time, and energizing circuits of different battery voltages for said pair of relays.

12. A telephone system including a circuit having multiple answering jacks, a link circuit for connecting said first circuit via one of said jacks, a second circuit adapted to be connected to said first circuit via another of said jacks, and a test relay for said second link circuit having its one terminal connected to a battery of a potential different than the voltage of the regular exchange battery and its other terminal connected to the answering plug of said second link circuit, said first battery being near enough to the potential on said jacks to prevent operation of said relay.

13. A telephone system including multiple answering jacks, a link circuit provided with an answering terminal a battery having a predetermined pressure connected through a resistance in said link circuit to one of said jacks when the answering terminal of said link circuit is connected to said one of said jacks, a second link circuit provided with an answering terminal, and a second battery of a different pressure adapted to be connected to another of said jacks through a test device in said second link circuit when the answering terminal of said second link circuit is connected to said other of said jacks.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 28th day of December, 1921.

GEORGE R. EATON.