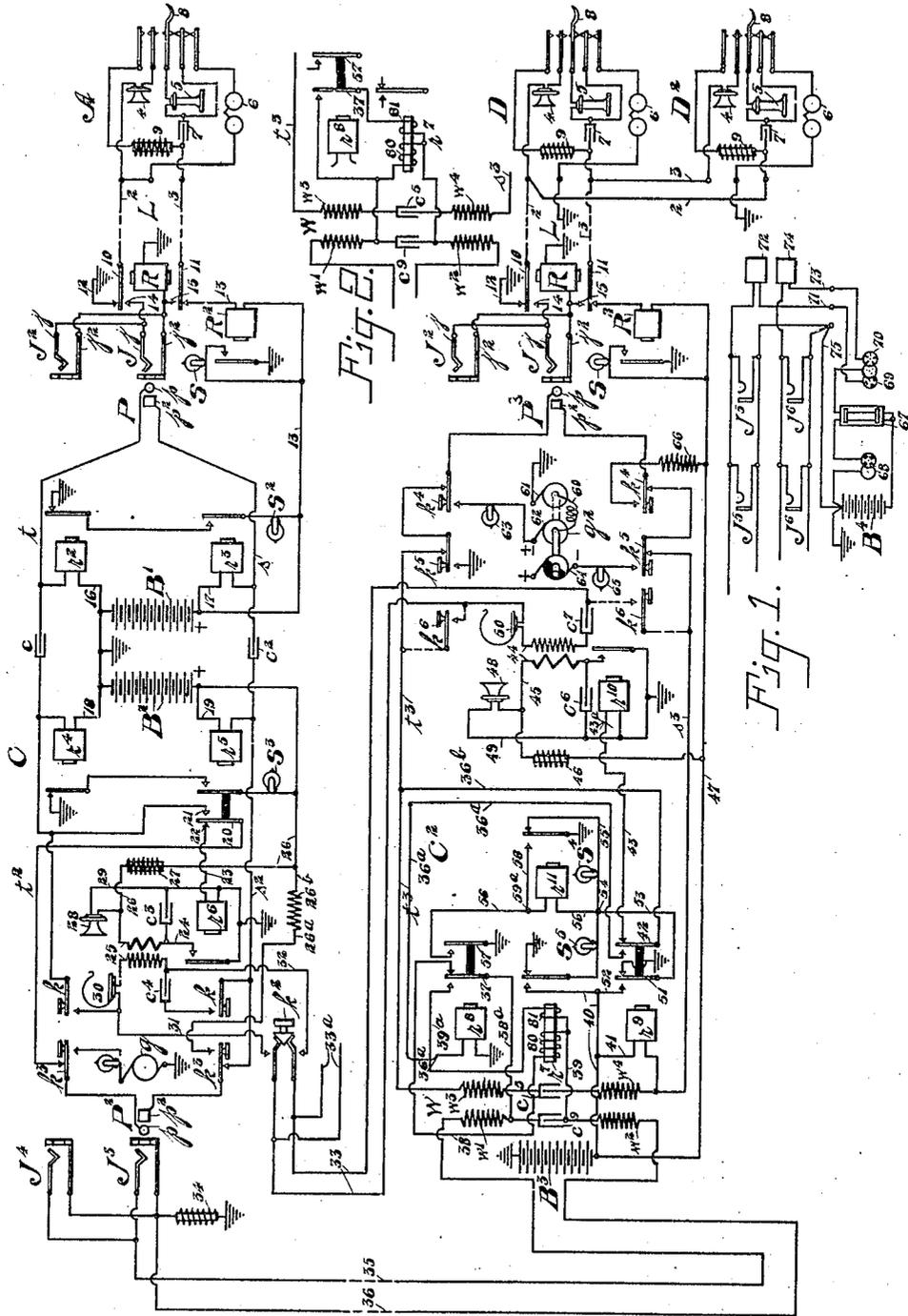


W. W. DEAN.
TELEPHONE TRUNKING SYSTEM.
APPLICATION FILED JULY 12, 1902.



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UNITED STATES PATENT OFFICE.

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TELEPHONE TRUNKING SYSTEM.

No. 851,500.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, WILLIAM W. DEAN, a citizen of the United States of America, and a resident of Chicago, county of Cook, and State of Illinois, have invented a certain new and useful Improvement in Telephone Trunking Systems, of which the following is a specification.

In an application filed by me July 14, 1902, Serial No. 115,405, I have described, shown and claimed a trunking system for use in connection with two wire circuits in which the trunk relay was provided with two windings, one of which is of such high resistance as to preclude the operation in series with it of the supervisory relay in the A cord circuit, and the other of which was included with the tip trunk relay during conversation to maintain the same operated.

This invention relates to a trunking system in which the trunk relay is provided with a high and with a low resistance winding, the high resistance winding being connected in the metallic circuit of the trunk line at the time that it is desired to operate the signal in the A cord circuit and at other times to be removed from the circuit and a low resistance winding connected therein in place of the same whereby the supervisory relay connected in series with the low resistance winding receives sufficient current to operate the same.

My invention also comprises means for properly receiving the busy click without disturbance to the subscribers and for placing the operator's connecting circuit in condition for conversational purposes upon the connection of the same with the telephone line.

My invention is shown in the accompanying drawing in which

Figure 1 indicates a diagram of subscribers' lines terminating at different switchboard sections and the means for connecting them together for conversation, and Fig. 2 is a diagram of a modification.

Referring to Fig. 1, L designates one of the plurality of subscribers' lines terminating at the central office C. This line extends in two limbs 2 and 3 from the subscriber's station A to the said central office C where it is fitted with suitable answering and multiple jacks or connection terminals J, J². At the subscriber's station, the usual telephone instruments are provided, and consists of a

transmitter, 4, a receiver, 5, a ringer or call bell, 6, and the condenser 7. The switch hook 8 is adapted in its normal position and when the receiver is placed thereon, to open the circuit through the transmitter 4 and receiver 5; and to close it through the call bell 6 and condenser 7. A retardation coil 9 is connected at the sub-station when the hook is raised, in parallel with the receiver 5, and condenser 7, to provide a path transparent to steady currents but opaque to voice currents. The line conductors 2 and 3 include respectively the armatures or springs 10 and 11 of the cut-off relay R which is permanently legged to ground from the sleeve contacts j¹, j², of the jacks J, J². The armature or spring 10 is normally connected with ground through the conductor 12, while the opposite armature 11, is normally connected with conductor 13 containing the line relay R² for the line, said conductor leading to the live or ungrounded pole of the central battery B', the opposite pole of which is grounded. The line relay R² controls through its armature the circuit of the line signal S. The forward contacts 14 and 15 of the cut-off relay R are adapted to connect the jacks and the switchboard section of the line with the external line circuit when the said cut-off relay is energized. This, it is to be understood, is a typical two-wire line circuit and is the particular kind with which I prefer to use my trunk circuits, although I do not wish to so limit the use of the invention in all respects.

At the central office C, the usual operator's cord circuit is provided, said cord circuit having an answering plug P and a calling plug P², each being provided with a tip contact p and a sleeve contact p² adapted to register with like contact surfaces j and j² in the jacks of the line when the plug is inserted therein. The tip contacts of the plugs are connected together by means of the tip strands t and t² of the cord circuit and the interposed condenser c, while the sleeve contacts are likewise connected by the sleeve strands s and s² and the interposed condenser c². A conductor 16 extends from the grounded pole of the battery B' to the tip strand t and contains the winding of the tip supervisory relay r² associated with the answering plug P, while the live pole of the battery is connected by means of conductor 17 with the answering sleeve strand s and in-

cludes the winding of the sleeve supervisory relay r^2 . These relays r^2 and r^3 serve to control the circuit of the supervisory lamp S^2 associated with the answering plug P , the former relay serving to normally close said circuit of the lamp, while the latter relay normally opens the same. The battery B^2 is associated with the opposite or calling end of the cord circuit and is connected by conductors 18 and 19 with the tip and sleeve strands t^2 and s^2 respectively, the former conductor including the winding of the supervisory relay r^4 , while the latter conductor includes the similar relay r^5 . These relays serve in a manner similar to the relays r^2 and r^3 , to control the circuit of the supervisory lamp S^3 associated with the calling plug P^2 .

The relays r^2 and r^4 are conveniently referred to as the "tip relays" and relays r^3 and r^5 as the "sleeve relays", since they are connected with and operated by current flowing over the corresponding strands of the cord circuit. The tip strand t^2 of the calling and testing plug P^2 is normally open through the extra spring or movable contact 20 of the sleeve relay r^5 , but is adapted to be closed by the said spring and its forward contact 21, when the relay is energized. The back contact 22 of this extra spring 20 is connected through the medium of conductor 23 with one side of the high resistance and high impedance relay r^6 , known as the "test relay", the other side of which is grounded. The armature of this relay is likewise grounded and its forward contact is connected with the primary winding of the operator's induction coil 25 by means of conductor 24. The other end of the said primary winding is connected through the medium of conductor 26 to the live pole of the battery B^2 , a retardation coil 27 being included in this circuit. The operator's transmitter 28 is joined on one side to conductor 26, intermediate her primary coil and the coil 27, and on the other side through conductor 29 to ground. A condenser c^3 is included in the operator's local circuit to facilitate talking and is connected as shown. The secondary winding of her induction coil 25 is adapted to be included together with her receiver 30 and a condenser c^4 in a bridge between the strands of the cord circuit by means of any suitable key and indicated diagrammatically by k , k . Branch connections 31 and 32 lead from opposite sides of the receiver and secondary to an order key k^2 connected with an order circuit or wire 33 leading to the office C^2 . A grounded alternating current ringing generator g is adapted to be connected through a resistance lamp with the tip strand t^2 of the cord circuit by means of the tip ringing key spring k^3 , the sleeve contact k^3 of said key being connected with battery lead 26 through wire 26^a and resistance 26^b.

A trunk circuit is shown extending be-

tween the central offices C and C^2 , said trunk circuit being fitted at the outgoing end with multiple jacks such as J^3 and J^4 , or any number, and with a retardation coil 34 connected to ground from the sleeve side of the circuit. The trunk extends in two limbs 35 and 36 to the central office C where it is provided with suitable means for testing the condition of the wanted line, for ringing the desired subscriber, and with signals to enable the operator to properly attend the connection. The tip and sleeve trunk conductors 35 and 36 terminate at the incoming office in the windings w' and w^2 of the repeating coil W , said windings being connected through interposed condenser c^5 . A trunk relay r^7 is provided with a high resistance winding 80 connected upon one side by means of a branch 39 with the inner end of the repeating coil winding w^2 and upon the other terminal with a conductor 38 leading to the back contact of the spring 37 of the tip relay r^8 , said spring being joined by a conductor 38^a with the inner end of the repeating coil winding w' . This winding 80 of the trunk relay is therefore normally connected in series between the trunk conductors 35 and 36. A low resistance winding 81 of said trunk relay is connected at one terminal with the conductor 39 and at the other with a conductor 39^a leading to the forward contact of the spring 37 of tip relay r^8 . When the tip relay operates therefore the low resistance winding 81 is substituted for the high resistance winding 80. A tip relay r^9 is legged to ground from the tip strand t^3 of the trunk circuit by conductors 36^a and 36^b through the contacts of sleeve relay r^8 during conversation and controls through its spring 37 and forward contact a short circuit composed of conductors 38 and 39 of the high resistance trunk relay r^7 . The sleeve relay r^9 is connected on one side with the live pole of the battery B^3 by means of conductors 40 and 41 and on the other side with the sleeve strand s^3 . This incoming end of the trunk circuit is provided with a testing apparatus similar to that described for the cord circuit at the central office C . Except that the tip strand t^3 is complete and is connected by conductor 36^b with spring 42 of the sleeve relay r^9 while the forward contact of said spring is connected with the tip relay. The back contact of spring 42 is joined by conductor 43 with the common high resistance and impedance test relay r^{10} , the opposite terminal of which is grounded. The armature of this test relay serves when actuated to ground one side of the primary winding of the operator's induction coil 44, which winding is connected on the other side with a conductor 45 containing the resistance and impedance coil 46 and joined to conductor 47 leading directly to the live pole of the battery B^3 . The operator's transmitter 48 is in a conductor 49 leading from conductor 45 to ground. A condenser

c^6 is connected between conductor 49 and the side of the primary that is adapted to be grounded. The operator's receiver 50 together with the secondary of her induction coil and condenser c^7 are connected permanently with the order circuit or wire 33 leading to the central office C. The forward contact of spring 51 of sleeve relay r^9 , is connected by conductor 52 with the conductor 40 leading from the live pole of battery B^3 . The spring 51, which is normally grounded, is connected by conductor 53 leading to point 54, and thence by conductor 55 through the ringing lamp S^4 to the normal contact of the grounded armature of locking relay r^{11} . The locking relay r^{11} is connected in a conductor 56 extending from point 54 to the forward contact of grounded spring 57 of tip relay r^8 . The forward contact of the locking relay armature is joined by conductor 58 with conductor 56 at point 59^a.

The guard and disconnecting lamp S^5 is connected between the point 54 and the armature of trunk relay r^7 , the back contact of which is grounded. The forward contact of the trunk relay r^7 is connected by conductor 40 with the live pole of the battery B^3 . This incoming end of the trunk is equipped for selectively ringing subscribers upon a party line. It comprises the ringing key contacts k^4 , k^4 , and k^5 , k^5 , placed in the strands of the trunk cord and adapted when actuated to suitably connect the alternating current generator g^2 with the plug P^3 . This ringing generator comprises the armature 60, the grounded brush 61, the brush 62 from which the alternating current is directed through resistance lamp 63 to tip key spring k^4 , when depressed, and brush 64 from the split commutator ring which is adapted to deliver a current of negative pulsations only through lamp 65 to the sleeve key k^5 when the key is operated. The sleeve contact of key k^4 when operated connects the sleeve of the plug to battery lead 47 through resistance coil 66 to maintain the cut-off relay of the line operated during ringing, and to prevent the relay r^9 from being chattered by the ringing current. The subscriber's line shown in connection with this office is of the "party line" type and is connected to subscribers D and D². The apparatus at these stations is similar to that at the station A, and are likewise indicated, except that the bell 6 at station D is connected between the sleeve conductor 3 and ground, while at station D² the bell is connected between the tip conductor 2 and ground. The same type of normally disconnected jacks, J, J², line relay, R², cut-off relay R, and the line signals S are employed and are designated by the same reference characters. The battery B^3 furnishes current for the operation of these various relays, and signals, as well as for talking.

In tracing the circuits hereinafter, the plan for pointing out the path for current from the live or ungrounded pole of the battery to the ground only will be followed for convenience, it being understood that the return current will seek the grounded pole of the battery and that the circuit will therefore be complete.

The operation is as follows: The A subscriber desiring a connection with a subscriber located at another exchange removes his receiver from the hook and thereby closes a path for current between the limbs 2 and 3 of his line through the transmitter 4 and retardation coil 9, the condenser 7 and receiver 5 being connected in parallel with the retardation coil. The closing of this circuit permits current to flow from the battery B' through conductor 13, line relay R^2 , spring 11 of cut-off relay R, limb 3 of the telephone line, through retardation coil 9 and transmitter 4 at the sub station, and thence over limb 2 back to the central office and spring 10 of cut-off relay R through conductor 12 to ground. The line relay R^2 is thus operated and closes the circuit of the signal lamp S to ground from the conductor 13. The operator upon seeing the line signal exposed inserts the answering plug P into the answering jack J of the subscriber's line and connects her telephone with the cord circuit by depressing the listening key k , k , to receive the order from the subscriber. The insertion of the plug P closes a circuit through the cut-off relay R from the live pole of the battery B' through conductor 17, sleeve supervisory relay r^3 , sleeve strand s , sleeve contacts p^2 and q^2 of the plug and jack, thence through the winding of the cut-off relay R to ground. The operation of this relay disconnects the armatures 10 and 11 from the ground wire 12 and from the battery lead 13 and connects them through the forward contacts 14 and 15 of said armatures to the normally disconnected jacks J, J². The operation of the supervisory relay r^3 over the path just traced serves to close through its armature and front contact the circuit of the supervisory signal S^2 which is associated with the plug P, but it is prevented from glowing, by the operation of the tip supervisory relay r^2 which is connected in the conductor 16 and receives current over telephone line and the tip strand t of the cord circuit and through the conductor 16 to the grounded pole of the battery B' , as soon as the cut-off relay R is operated. The supervisory signal S^2 therefore remains inert while the battery B' furnishes current over the metallic telephone line for the operation of the supervisory relays and for conversational purposes. The operator's transmitter 28 is receiving current at this time from the battery B^2 over the conductor 26 through retardation coil 27, thence through the transmitter 28 and over conduc-

tor 29 to ground. When sound waves strike the transmitter 28, the current flowing there-through is varied which causes a variation of the charge in the condenser c^3 and a corresponding surge of current through the primary of her induction coil 25. These induce voice currents in the secondary which are transmitted to the line and the operator is therefore able to converse with the calling subscriber.

Upon learning that a subscriber in the exchange C^2 is desired, the A operator depresses the order key k^2 to connect her telephone with the order wire or circuit 33 and repeats the number of the wanted subscriber to the B operator whose head telephone 50 is permanently connected with the said order wire. The latter operator designates to the A operator the trunk to be used for the connection and proceeds to test the condition of the wanted line with the tip of the plug of the incoming trunk named. If the line is idle no "click" will be received, but if busy the sleeve contacts of the jacks of the line will be connected with the live pole of a battery through the sleeve contact and strand of the inserted plug. A complete circuit will therefore be established from the sleeve contact of the tested jack, which it is assumed is connected with the live pole of the battery, through the tip of the plug P^3 , tip strand t^3 , conductor 36^b spring 42 and back contact of sleeve relay r^9 conductor 43 through the common high resistance and impedance test relay or responsive device r^{10} to ground. This test relay will therefore operate and ground through its armature and front contact one side of the primary of the operator's induction coil 44, the other side of which is connected by conductor 45 through resistance 46 and conductor 47 to the live pole of the battery B^3 . The completion of this circuit will permit a flow of current therethrough which will induce a current in the secondary of the said induction coil and produce a click in the receiver 50 of the operator's set. The operator's receiver will respond to this click at all times even though the order circuit should be open at the A exchange since the electrostatic capacity of her circuits and that of the order circuit is ample for the purpose of producing the click. The test relay r^{10} is of such high resistance as to vary the current upon the tested lines but slightly and is also of such high impedance that its current builds up slowly and thereby prevents a sudden alteration of current on the lines. The subscriber or subscribers whose lines are tested are therefore not disturbed by a sudden or large variation of current through their instruments. It is apparent that any other suitable test responsive device or indicator may be employed and that the operator's telephone in series with a suitable retardation coil may replace the test relay if prefer-

able. I consider the arrangement shown and described, however, as the best suited for my purpose. Upon finding the line idle the plug P^3 is inserted in one of the multiple jacks of the wanted subscriber's line. The A operator having received the number of the trunk to be used inserts the calling plug P^2 of her cord circuit in the jack J^3 at her section of the trunk designated. The insertion of the plug P^2 closes a circuit from the live pole of the battery B^2 at the A office through conductor 19 sleeve supervisory relay r^5 , sleeve strand s^2 of the cord circuit sleeve contacts of the plug and jack and through retardation coil 34 to ground. This has the effect of positively operating the sleeve supervisory relay r^5 which attracts its armatures and cuts out the test relay r^6 , and completes the tip strand of the cord circuit through armature 20 and its forward contact 21. The closing of this tip strand permits current to flow from the battery B^2 over the sleeve strand of the cord circuit, sleeve conductor 36 of the trunk line through the winding w^2 of the repeating coil W at the B exchange through high resistance winding 80 of the trunk relay r^7 thence over conductor 38 the back contact and armature 37 of tip relay r^8 , conductor 38^a of the winding w' and back to the A exchange thence over conductor 35 and through supervisory relay r^4 to the opposite pole of the battery B^2 . The trunk relay r^7 is therefore operated but owing to the high resistance of the winding 80 the supervisory relay r^4 does not receive sufficient current to operate and the supervisory lamp S^3 is lighted by current flowing from the live pole of the battery B^2 over its local circuit. This light indicates to the A operator that the called subscriber has not yet responded.

The insertion of the incoming trunk plug into the jack of the wanted line, closes a circuit from the live pole of the battery B^3 over conductors 40 and 41 through sleeve relay r^9 and thence over the sleeve strand s^3 of the flexible end of the trunk through the sleeve contacts of the plug P^3 and the jack of the called subscriber and thence to the cut-off relay R of the wanted line to ground, thus operating both the sleeve relay r^9 and the cut-off relay R, the latter serving to disconnect the line relay R^2 of the line to render the line signal inoperative and to connect the normally disconnected jacks with the limbs of the line extending to the sub stations. The operation of sleeve relay r^9 disconnects the test relay r^{10} and closes the tip relay circuit to the other side of battery B^3 through the spring 42 and its forward contact and thereby establishes the circuit for battery current for conversation. It also completes the circuit of the ringing lamp S^4 from the battery B^3 over conductor 40, conductor 52, the forward contact and spring 51 of the sleeve relay, conductor 53 to point 54 and thence

through the ringing lamp S^4 over conductor 55 through the back contact and armature of locking relay r^{11} to ground. This lamp is therefore lighted and indicates to the operator that the called subscriber has not removed his telephone from its hook. The operation of the trunk relay r^7 at this time opens through its armature and back contact the circuit of the guard and disconnecting lamp S^5 to thereby prevent its operation. Upon the insertion of the trunk plug P^3 the B operator rings the wanted subscriber. If the subscriber D is the one desired, the ringing key k^5 , k^5 , is depressed which throws ringing current upon the sleeve strand connected with the plug P^3 and operates the subscriber's bell over the following path: from ground at the generator g^2 , brush 61, armature 60 of the generator, brush 64 through resistance lamp 65, key k^5 , thence over the sleeve strand of the cord to the plug P^3 over the sleeve limb 3 of the telephone line to the station D and thence through condenser 7 and bell 6 to ground, the receiver 5 being at this time upon the hook 8 and therefore completing the circuit between the condenser 7 and bell 6.

It will be noticed that just previous to the depression of the ringing key k^5 , the cut-off relay R was receiving a negative current through its coils from the battery B^3 . At the instant the ringing key k^5 is depressed this path of current from the battery B^3 is broken, but a new path is immediately established through the relay R from the negative source of pulsating ringing current. The relay R is so constructed as to be maintained in continuous operation when this negative pulsating current is passing through its windings, and as pulsations are used of the same direction as the current furnished by the battery B^3 , the relay R is prevented from even momentarily releasing its armatures at the moment the ringing key was depressed.

The bell 6 at the subscriber's station may be of the ordinary polarized type as the presence of the condenser 7, which is connected directly in the ringing circuit permits the operation of such a bell from the pulsating source of ringing current. The tip spring of ringing key k^5 is grounded at this time to provide a path to ground for the return current if the subscriber should respond during ringing. Should the subscriber B^2 be the one desired the ringing key k^4 , k^4 , is depressed which serves to connect the generator g^2 with the tip strand of the cord circuit to operate the bell at the station D². The ringing circuit may be traced as follows: from ground at the generator g^2 brush 61, armature winding 60 of the generator, brush 62 through resistance lamp 63, spring k^4 in the tip strand of the cord circuit thence over the tip strand and tip conductor 2 of the line to the station D² and thence through condenser 7 and nor-

mally closed contacts of the hook 8 and through bell 6 to ground. The bell is thus operated. To maintain the cut-off relay R operated during ringing, the inner contact of the sleeve spring k^4 is connected through a resistance coil 66 with the battery lead 47 extending to the live pole of the battery B^3 . This prevents the de-energization of cut-off relay R while ringing.

It is apparent that the arrangement of the ringing keys is such that either key may be used to call a subscriber at whose station the apparatus is connected in the manner shown at A, which shows the arrangement which I preferably use where but one subscriber is placed upon the line. In this case, the ringing circuit would be complete over the subscriber's metallic circuit, the current returning to the grounded side of the ringing generator by means of the grounded key k^5 or battery contact of the ringing key k^4 . The subscriber having been called responds by taking up his receiver and thereby closes a path for current between the limbs of his line from the main battery B^3 over conductors 40 and 41, sleeve strand s^3 of the incoming end of the trunk line 3 of the telephone line, thence through retardation coil 9 and transmitter 4 at the sub station, thence over limb 2 of the telephone line back to the central office and over tip strand t^3 of the incoming end of the trunk including spring 42 and its forward contact of sleeve relay r^9 , through conductor 36^a and tip relay r^8 to ground. This relay is therefore actuated and closes through its armature 37 and front contact the shunting circuit of the high resistance winding 80 of the trunk relay r^7 said circuit including the low resistance winding 81, the conductor 39^a, the forward contact and spring 37 of the tip relay, conductor 38^a to the tip conductor 35 of the trunk line. At the same time the circuit through the high resistance winding is opened at the spring 37 and back contact of the tip relay r^8 ; although the trunk circuit is maintained operated by this low resistance winding, the supervisory relay r^4 in the A cord circuit receives sufficient current to operate the same which serves to open the circuit of the supervisory signal S^2 which indicates to the A operator the response of the called subscriber. The lamp S^2 is thus prevented from operating by the return of the armature of the trunk relay r^7 to its back contact. The closing of spring 57 of tip relay r^8 upon its forward contact, however, completes the circuit of the locking relay r^{11} as follows: from the live pole of the battery B^3 , conductors 40 and 52, front contact and armature 51 of sleeve relay r^9 , conductor 53 to point 54 thence through the winding of locking relay r^{11} and over conductor 56 to the forward contact of spring 57 of tip relay r^8 and to ground. The locking relay r^{11} therefore operates and opens through its arma-

ture and back contact the circuit of the ringing lamp S^4 , which is extinguished and indicates to the operator that the called subscriber has responded to his ring. The closing of the armature of the locking relay r^{11} upon its forward contact completes a locking circuit for said relay from the point 59^a through conductor 58 the forward contact and armature of the relay to ground. This circuit and relay are therefore locked and ringing lamp S^4 locked out during the remainder of the connection, and can only be released when the sleeve relay r^9 is de-energized, which occurs when the plug P^3 is pulled out. Should the tip and sleeve contacts of the plug be crossed when the plug is inserted in a jack and the locking and other relays operated, they will be immediately released by the opening of the sleeve strand in ringing and no confusion would result therefrom. The subscribers are now connected together for conversation and the supervisory signals at both exchanges are extinguished. The battery B' is furnishing current over the answering end of the A cord circuit to the A subscriber's line for talking purposes and for the operation of the supervisory relays, the battery B^2 is furnishing current over the trunk line for the operation of the supervisory relays associated with the answering end of the A cord circuit and the battery B^3 is sending current over the incoming end of the trunk and to the sub-station D to furnish current for talking and for the operation of the several relays. The voice currents are transmitted inductively from the subscribers' line L to the trunk circuit through the condenser c and c^2 in the A cord circuit, and from the trunk circuit to the incoming end thereof and the subscriber's line connected therewith through the medium of the repeating coil W. The condenser c^5 between the windings w^3 and w^4 of the repeating coil at the incoming end of the trunk prevents the flow of steady current therethrough but permits a free passage of the voice currents.

At the termination of the conversation the subscribers return their receivers to their hooks with the result that in the case of subscriber A the tip supervisory relay r^2 connected with the A cord circuit is de-energized and closes through its armature and back contact the circuit of the supervisory signal S^2 thus indicating to the operator that the subscriber A has returned his receiver to the hook. This serves to open the circuit through the low resistance winding 81 and to close it through the high resistance winding 80 which while maintaining the trunk relay operated deprives the supervisory relay 24 in the A cord of operating current which is thus de-energized and lights the signal lamp S^3 to indicate the return of the called subscriber's telephone to its hook. The A operator seeing both signals exposed in her cord circuit

takes down the connection with the result that the trunk relay r^7 is deprived of current which permits its armature to close through its back contact a circuit of the disconnecting lamp S^5 from the live pole of the battery B^3 to conductors 40 and 52, forward contact and armature 51 of sleeve relay r^9 , conductor 52 to point 54 thence through armature and back contact of trunk relay to ground. This signal is lighted whereupon the B operator withdraws the trunk plug P^3 and thus restores all parts including the locking relay r^{11} to normal position. The disconnecting lamp S^5 serves also as a guard lamp in case the A operator inserts the calling plug P^2 of her cord circuit into a wrong jack for the reason that the trunk relay of that trunk will be operated while the sleeve relay belonging thereto is not operated. A circuit will therefore be completed from the live pole of the battery over conductor 40, the forward contact and armature of the trunk relay, through the lamp S^5 to point 54, thence over conductor 53, armature 51 and back contact of sleeve relay r^9 to ground. This lamp will therefore glow and indicate to the B operator that a mistake has been made.

The order circuit 33 as is indicated by the branching lines 33^a connects the B operator with several A operators either at the same or at different exchanges. The A operator is also provided with a plurality of keys k^2 to connect herself with the different B operators.

Although I have described the method of making connections through the medium of an order circuit, I do not wish to so confine the invention for it is apparent that the A operator is able by means of her testing apparatus to test the condition of the trunks before her until an idle trunk is found. Upon so testing and finding an idle trunk she may insert the calling plug P^2 of her cord circuit with the result that the trunk relay r^7 operates and lights the lamp S^5 which acts as a calling lamp from the A operator to the B operator. The B operator may depress her listening key k^6, k^6 , to receive the order from the A operator. It will also be understood that had the subscriber A called for a connection with another subscriber in the same exchange, the line of that subscriber would have been tested in the ordinary manner by means of the cord plug P^2 and the subscriber would have been called by the ringing generator g .

Fig. 2 shows in diagram a modification of the arrangement of the windings of the trunk relay in which the high resistance winding 80 is merely short circuited by the low resistance winding 81 when the tip relay operates, the remainder of the operation being the same as in the previous figure.

The ground connections heretofore referred to, it will be understood, may and in practice usually are one and the same, or

they may be the common office return, although it is found by experience, that it is practically necessary to place a dead ground upon one side of the common battery. It is also apparent that the other poles of the batteries may be grounded so far as the operation of the system is concerned, the only variation necessary from that shown in the drawing being to remove the present ground connections and replace them by other conductors and replace the ground upon the opposite pole of the battery.

While I have described several forms and several different ways of carrying out my invention, I would have it understood that the invention is not so limited, as it is apparent that various changes and substitutions may be made therein and still come within its scope and principle. But

What I do claim as my invention and desire to secure by Letters Patent is:—

1. The combination with a trunk line adapted to connect with a calling telephone line at its outgoing end and a called telephone line at its incoming end, of a supervisory signal associated with its outgoing end placed in condition to operate by current flowing over a portion of the talking circuit when connection is established at said end, a trunk relay at the incoming end actuated when connection is established at the outgoing end of the trunk by current flowing over the metallic circuit of said end, a signal at said incoming end whose actuation depends upon said trunk relay, means for removing the resistance of said relay from the trunk to permit a sufficient flow of current therein to render said supervisory signal inoperative, and further means for maintaining said relay energized during conversation by current flowing over the metallic circuit of said outgoing end, substantially as described.

2. The combination with a trunk line adapted to connect with a calling telephone line at the outgoing end and a called telephone line at its incoming end, of a supervisory signal associated with the outgoing end placed in condition to operate by current flowing over a portion of the talking circuit when a connection is established at said end, a trunk relay at the incoming end having a high resistance winding and a low resistance winding, the high resistance winding being connected in the metallic circuit of the outgoing end of the trunk to limit the flow of current therein when connection is established with said end, a signal at said incoming end whose actuation depends upon said trunk relay, and means for connecting the low resistance winding in the metallic circuit of the outgoing end of the trunk when the called subscriber responds, whereby a sufficient flow of current is provided thereover to render the supervisory signal inoperative and

the said relay is maintained actuated during conversation, substantially as described.

3. The combination with a trunk line adapted to connect with a calling telephone line at the outgoing end and a called telephone line at its incoming end, of a supervisory signal associated with the outgoing end placed in condition to operate by current flowing over a portion of the talking circuit when connection is established at said end, a trunk relay at the incoming end having a high resistance winding and a low resistance winding, the high resistance winding being normally connected in the metallic circuit of the outgoing end of the trunk to limit the flow of current therein, a signal at said incoming end whose actuation depends upon said trunk relay, and means for removing said high resistance winding and substituting the low resistance winding in the metallic circuit when the called subscriber responds, whereby a sufficient flow of current over the trunk is permitted to render said supervisory signal inoperative and at the same time the relay is maintained operated, substantially as described.

4. The combination with a trunk line adapted to connect with a calling telephone line at the outgoing end and a called telephone line at its incoming end, of a supervisory signal associated with the outgoing end placed in condition to operate by current flowing over a portion of the talking circuit when a connection is established at said end, a trunk relay at the incoming end having a high resistance winding and a low resistance winding, the high resistance winding being normally connected in the metallic circuit of the outgoing end of the trunk to limit the flow of current therein, a signal at said incoming end whose actuation depends upon said trunk relay, and means for cutting out said high resistance winding and cutting in the low resistance winding when the called subscriber responds, whereby a sufficient flow of current over the trunk is permitted to render said supervisory signal inoperative, substantially as described.

5. The combination with a trunk line adapted to connect with a calling telephone line at the outgoing end and a called telephone line at its incoming end, of a supervisory signal associated with the outgoing end placed in condition to operate by current flowing over a portion of the talking circuit when a connection is established at said end, a trunk relay at the incoming end having a high resistance winding and a low resistance winding, the high resistance winding being normally connected in the metallic circuit of the outgoing end of the trunk to limit the flow of current therein, a signal at said incoming end whose actuation depends upon said trunk relay, and means for opening the cir-

cuit of said high resistance winding and completing the circuit through the low resistance winding, whereby a sufficient flow of current in the trunk is permitted to render said supervisory signal inoperative and the relay is maintained actuated, substantially as described.

6. The combination with a trunk line adapted to connect with a calling telephone line at its outgoing end and a called telephone line at its incoming end, of a supervisory signal associated with the outgoing end placed in condition to operate by current flowing over a portion of the talking circuit, a trunk relay at the incoming end having a high resistance winding and a low resistance winding connected permanently with one side of the outgoing end of the trunk, a signal at said incoming end whose actuation depends upon said trunk relay, and means for alternately connecting the other terminals of said windings with the other side of the outgoing end of the trunk, the high resistance winding being normally connected in the circuit to limit the flow of current therein when connection exists at the outgoing end of the trunk, the alternate connection being made when the called subscriber responds, whereby an increased flow of current is permitted in the trunk and the relay is maintained actuated, substantially as described.

7. The combination with a trunk line adapted to connect with a calling telephone line at the outgoing end and a called telephone line at its incoming end, of a supervisory signal associated with the outgoing end placed in condition to operate by current flowing over a portion of the talking circuit when a connection is established at said end, a trunk relay at the incoming end having a high resistance winding and a low resistance winding, the high resistance winding being connected in the metallic circuit of the outgoing end of the trunk to limit the flow of current therein, a signal at said incoming end whose actuation depends upon said trunk relay, and a relay actuated when the subscriber responds for depriving the said high resistance winding of operating current and for cutting the low resistance winding in the circuit of the outgoing end of the trunk, whereby a sufficient flow of current in the trunk is permitted to render the supervisory signal inoperative and the said relay is maintained operated, substantially as described.

8. The combination with a trunk line adapted to connect with a calling telephone line at the outgoing end and a called telephone line at its incoming end, of a supervisory signal associated with the outgoing end placed in condition to operate by current flowing over a portion of the talking circuit when a connection is established at said end, a trunk relay at the incoming end having a high resistance winding and a low resistance

winding, the high resistance winding being connected in the metallic circuit of the outgoing end of the trunk to limit the flow of current therein, a signal at said incoming end whose actuation depends upon said trunk relay, a relay responsive to current in the called line when the subscriber answers for opening the circuit of the high resistance winding and rendering active the low resistance winding, whereby a sufficient flow of current over the outgoing end of the trunk is permitted to render the supervisory signal inoperative, and the relay is maintained actuated, substantially as described.

9. The combination with a trunk line adapted to connect with a calling telephone line at the outgoing end and a called telephone line at its incoming end, of a supervisory signal associated with the outgoing end placed in condition to operate by current flowing over a portion of the talking circuit when a connection is established at said end, a trunk relay at the incoming end having a high resistance winding and a low resistance winding, the high resistance winding being connected in the metallic circuit of the outgoing end of the trunk to limit the flow of current therein, a signal at said incoming end whose actuation depends upon said trunk relay, a relay responsive to current in the line when the subscriber answers for substituting the low resistance winding for the high resistance winding, whereby the supervisory relay is rendered inoperative and the relay is maintained actuate during conversation, substantially as described.

10. The combination with a trunk line adapted to connect with a calling telephone line at the outgoing end and a called telephone line at its incoming end, of a supervisory signal associated with the outgoing end placed in condition to operate by current flowing over a portion of the talking circuit when a connection is established at said end, a trunk relay at the incoming end having a high resistance winding and a low resistance winding, the high resistance winding being connected in the metallic circuit of the outgoing end of the trunk to limit the flow of current therein, a signal at said incoming end whose actuation depends upon said trunk relay, a central source of current adapted to be included in the metallic circuit of the incoming end of the trunk and the called line when the subscriber responds, said source furnishing current to charge the substation transmitters for talking purposes, a relay connected at the incoming end in the path of current from said source flowing in the line during conversation, the armature of said relay being connected with one side of the outgoing end of the trunk, its forward contact being connected with one terminal of the low resistance winding and its back contact connected with the corresponding ter-

minal of the high resistance winding, and the opposite terminals of said windings being permanently connected with the other side of the outgoing end of the trunk, whereby when a called subscriber responds a low resistance winding is connected in the trunk in place of the high resistance winding and current is permitted to flow over the trunk in sufficient quantity to render the supervisory signal inoperative while the trunk relay is maintained operative, substantially as described.

11. The combination with a trunk line, of a cord circuit adapted to be connected with said trunk line at its outgoing end, and a called subscriber's line with which its incoming end is connected, of a relay at said incoming end actuated by current flowing over a portion of the talking circuit upon the insertion of the trunk plug in the jack of the called line, a trunk relay actuated by current over the outgoing end of the trunk when connection is established at said end, and by current over the same path but through an auxiliary winding of the relay when the called subscriber responds, the path of the current through said auxiliary winding being of lower resistance than the former path, a signal at the incoming end whose actuation depends upon said two relays, a supervisory relay associated with the outgoing end of the trunk when said cord circuit is connected therewith, said relay being in series with the trunk relay and capable of being actuated by current through the low resistance winding of said trunk relay but not by current through the high resistance winding thereof, substantially as described.

12. The combination with a trunk line, of a cord circuit adapted to be connected with said trunk line at its outgoing end, and a called subscriber's line with which its incoming end is connected, of a disconnect signal for said incoming end, a relay actuated by current over a portion of the talking circuit when connection is established with the called line to place said signal in condition to operate, and a second relay operated by current over the trunk when connection is established at the outgoing end through a high resistance path, and by current thereover through an auxiliary winding of said relay and low resistance path when the called subscriber responds, said latter relay serving when actuated to render said signal inoperative, a supervisory relay associated with the outgoing end of the trunk when said cord circuit is connected therewith, said relay being in series with the trunk relay and capable of being actuated by current through the low resistance winding of said trunk relay but not by current through the high resistance winding thereof, substantially as described.

13. The combination with a trunk line, of a cord circuit adapted to be connected with said trunk line at its outgoing end, and a

called subscriber's line with which its incoming end is connected of a disconnect signal for the incoming end of the trunk, a relay actuated over a portion of the talking circuit when connection is established with the called line to place said signal in condition to operate, and a trunk relay having a high resistance winding and a low resistance winding actuated by current over the trunk and through the high resistance winding when a connection is established at its outgoing end means for substituting the low resistance winding for the other winding when the called subscriber responds, said trunk relay serving when actuated to render the disconnect signal inoperative, a supervisory relay associated with the outgoing end of the trunk when said cord circuit is connected therewith, said relay being in series with the trunk relay and capable of being actuated by current through the low resistance winding of said trunk relay but not by current through the high resistance winding thereof, substantially as described.

14. The combination with a trunk line, of a cord circuit adapted to be connected with said trunk line at its outgoing end, and a called subscriber's line with which its incoming end is connected, of a disconnect signal for the incoming end of the trunk, a relay actuated over a portion of the talking circuit when the trunk is connected with the called line to place said signal in condition to operate, a trunk relay having a high resistance winding and a low resistance winding and serving when actuated to prevent the operation of said signal, and a third relay connected with the incoming end of the trunk and actuated when the called subscriber responds, for substituting the low resistance winding for the high resistance winding upon said second relay whereby the latter is maintained operated during conversation, a supervisory relay associated with the outgoing end of the trunk when said cord circuit is connected therewith, said relay being in series with the trunk relay and capable of being actuated by current through the low resistance winding of said trunk relay but not by current through the high resistance winding thereof, substantially as described.

15. The combination with a trunk line, of a cord circuit to connect with its outgoing end and a subscriber's line with which its incoming end is adapted to connect, a supervisory signal associated with the cord circuit and placed in condition to operate by current flowing over a portion of the talking circuit when the cord is connected with the trunk, a relay associated with the incoming end of the trunk and adapted to be operated over a portion of the talking circuit when the trunk is connected with the called line, a testing circuit for said incoming end of the trunk normally completed over one strand thereof and

through normal contacts of said relay, said testing circuit being severed and the trunk circuit being placed in condition for talking by the actuation of said relay, a ringing signal for the incoming end of the trunk placed
 5 in condition to operate by the actuation of said relay, a second relay responsive to current in the line when the subscriber answers his call for rendering said ringing signal inert, said ringing signal being thereafter controlled through the contacts of said first
 10 named relay, a trunk relay at the incoming end of the trunk actuated by current over the outgoing end and from the cord circuit when the cord circuit is connected with said
 15 outgoing end, the resistance of said relay being high to prevent a sufficient flow of current over the metallic circuit of the outgoing end of the trunk to render the said supervisory signal inoperative, and means operated
 20 by said second relay to remove the resistance of said relay and to permit a flow of current over the metallic trunk line to render said supervisory signal inert when the called subscriber responds, said relay serving at the
 25 same time to substitute a low resistance winding in said metallic circuit of the trunk in place of the high resistance winding, a second signal at said incoming end of the trunk
 30 placed in condition to operate by the actuation of said first named relay, means for actuating said signal when the trunk relay is de-energized and the first named relay is energized to give a disconnect indication and
 35 further means for actuating said signal to give a guard indication when the trunk relay is energized and the first named relay is de-energized, and a source of current at the incoming end of the trunk to furnish current
 40 for the operation of said relays and signals and for the operation of the transmitters for talking purposes, substantially as described.

16. The combination with a trunk line, of
 45 a cord circuit to connect with its outgoing end and a called subscriber's line with which its incoming end is adapted to connect, a supervisory signal associated with the cord circuit, a relay at the incoming end of the trunk actuated over a part of the talking
 50 circuit when connection is made with the line, a testing circuit completed through the normal contacts of said relay, a second relay normally disconnected from the trunk and therefore not in condition to operate by current
 55 flowing over the line when the called subscriber responds, said first named relay serving when actuated to sever the test circuit and to connect said second relay with the trunk, and means for controlling the supervisory signal associated with the other end of
 60 the trunk by said second relay, substantially as described.

17. The combination with a trunk line, of

a cord circuit to connect with its outgoing
 65 end and a called subscriber's line with which its incoming end is adapted to connect, a supervisory signal associated with the cord circuit, a relay at the incoming end of the trunk actuated over a part of one side of the talking
 70 circuit, a testing circuit from the tip of the trunk plug completed through the normal contacts of said relay, a second relay associated with the talking circuit and normally disconnected from the strand of the trunk cord, and means for severing the test-
 75 ing circuit and connecting the second relay with the trunk cord, when the first named relay is actuated, whereby said second relay is placed in condition to operate by current in the line when the subscriber responds, and
 80 means actuated by said latter relay for controlling the supervisory signal, substantially as described.

18. The combination with a trunk line, of
 85 a cord circuit to connect with its outgoing end and a called subscriber's line with which its incoming end is to connect, a signalling apparatus associated with the incoming end of the trunk, including a relay normally disconnected from one side and a second relay
 90 actuated over the sleeve strand of the trunk cord when connection is made with the line, a testing circuit normally completed through the contacts of said latter relay, and means for connecting the first named relay with one
 95 side of the trunk cord and for disconnecting said testing circuit when the connection is established with the called line, substantially as described.

19. The combination with a trunk line, of
 100 a cord circuit to connect with its outgoing end and a called line with which its incoming end is adapted to be connected, a testing circuit comprising a portion of the tip cord, said circuit being of high resistance and retardation,
 105 a relay adapted to be actuated over the sleeve strand of the trunk cord when connection is made with the line, the normal contacts of said relay being included in the testing circuit, a second relay adapted to be energized by current over the tip strand of the trunk cord when a called subscriber responds, said relay being normally disconnected from
 110 said strand but adapted to be connected therewith upon the operation of said first named relay, whereby when connection is established with the line circuit the testing circuit is severed and the second relay is connected with the tip strand, substantially as
 115 described.

Signed by me at Chicago, county of Cook,
 State of Illinois, this 12 day of June 1902.

WILLIAM W. DEAN.

Witnesses:

ROBERT LEWIS AMES,
 G. BEDER.