

No. 848,814.

PATENTED APR. 2, 1907.

W. W. DEAN.
TELEPHONE TRUNKING SYSTEM.

APPLICATION FILED JULY 26, 1902.

2 SHEETS—SHEET 1.

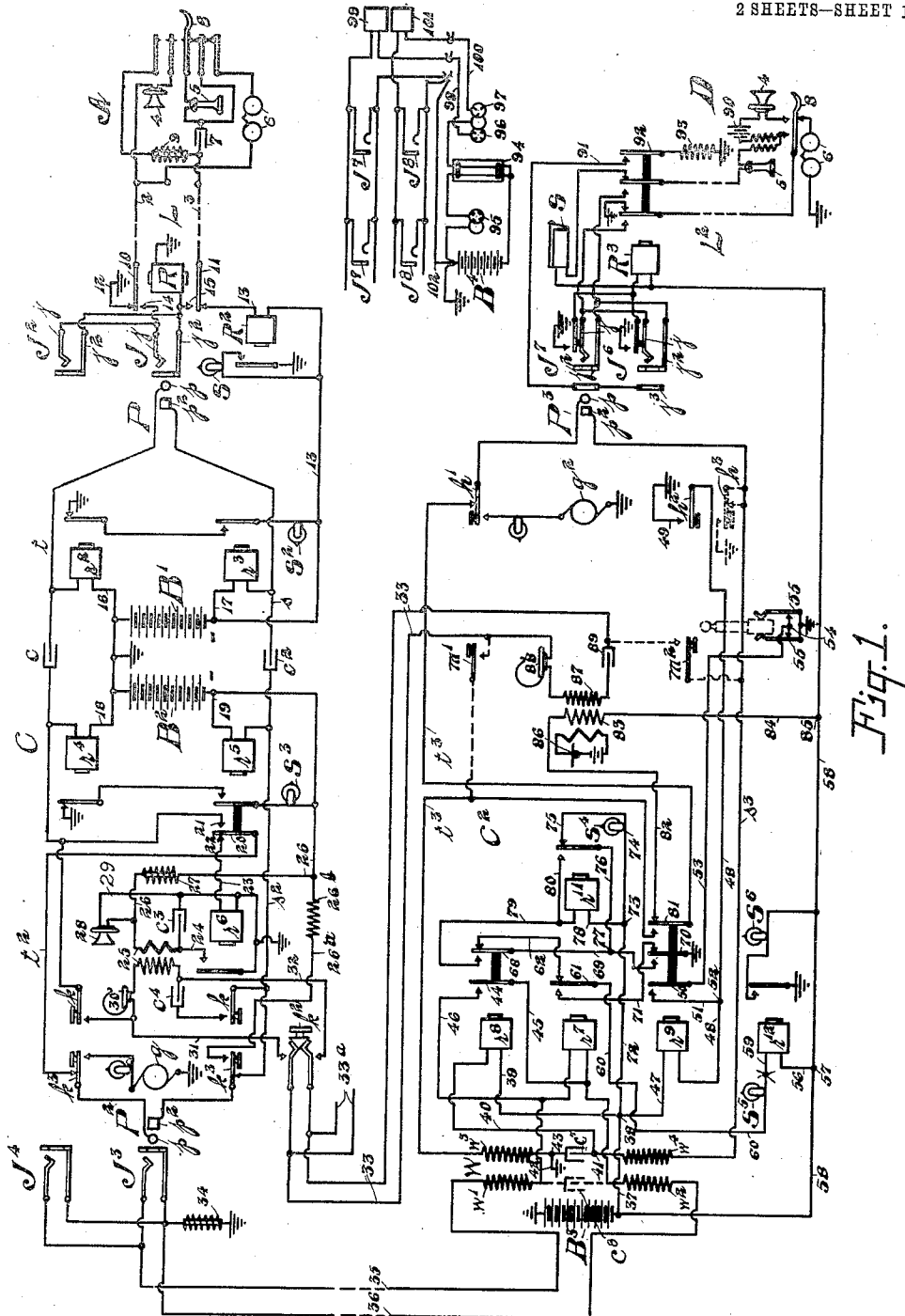


Fig. 1.

Witnesses.

R. H. Burfield

Kempster B. Miller

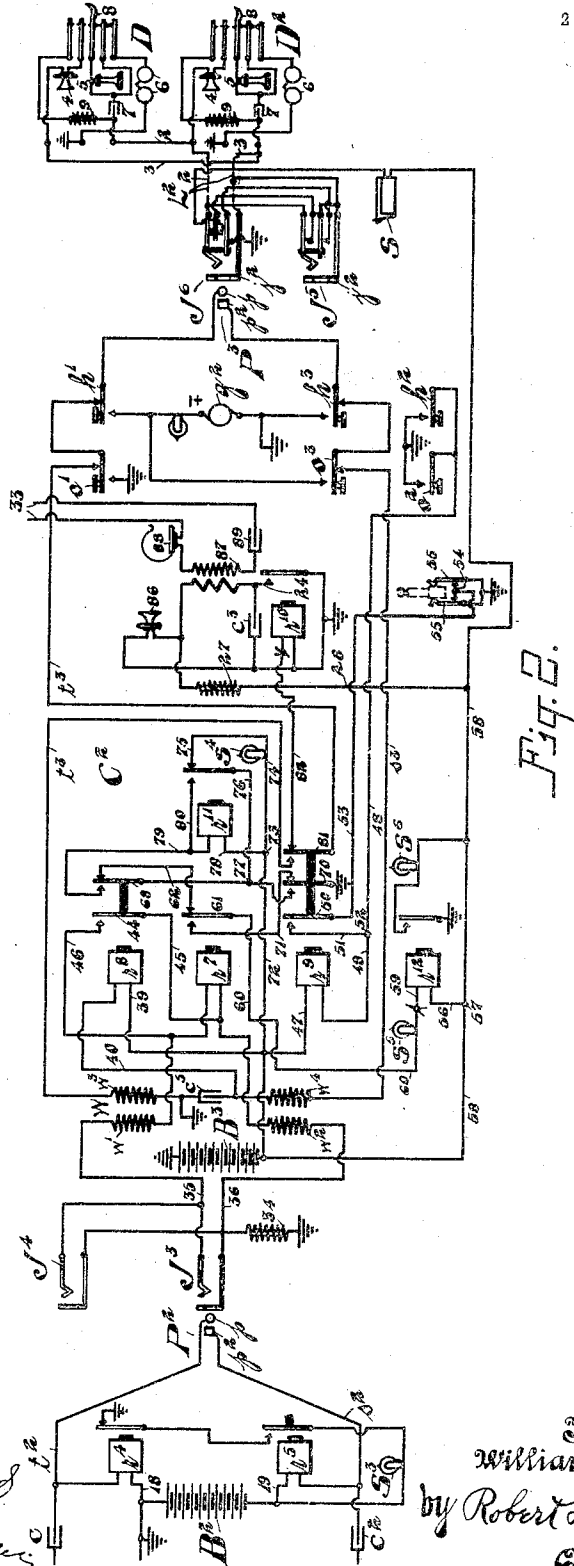
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UNITED STATES PATENT OFFICE.

WILLIAM W. DEAN, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE TRUNKING SYSTEM.

No. 848,814.

Specification of Letters Patent.

Patented April 2, 1907.

Application filed July 26, 1902. Serial No. 117,059.

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.

My invention relates to new and useful improvements in telephone trunking systems adapted for use in connecting telephone-lines together for conversation.

In an application filed by me June 28, 1902, Serial No. 113,581, I have shown and described a trunking system for use in connection with telephone-lines of the "Dunbar" or "two-wire" type in which the cut-off relays are operated over a portion of the talking-circuit.

My present invention relates to trunking-circuits designed particularly for use in connecting together lines of the two-wire or Dunbar type above mentioned with lines of a different type, although some of the features of the invention are of a more general application and may be employed with various types of lines.

One feature of my present invention is to provide means for placing the signaling apparatus associated with a trunk in condition to operate by current flowing over a circuit entirely independent of the ground connections which may exist on a subscriber's line and which, in case they are present, are apt to be faulty and at which earth-currents are liable to be found.

Other features of the invention will be particularly brought out in connection with the description and claims.

In the accompanying drawings, which represent my invention, and in which the same reference characters are used to designate like parts throughout, Figure 1 is a diagram showing subscribers' lines terminating at different offices with the trunking and other circuits extending between said offices to connect the lines together for conversation; and Fig. 2 represents a similar arrangement, except that a different called-subscriber's line is shown and is equipped with more than one subscriber's station and in which a different testing arrangement is provided.

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 consist 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 substation 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 j² 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.

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 super-

visory relay r^2 , 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 includes the winding of the sleeve supervisory relay r^3 . 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 operators' 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 . 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 between the central offices C and C^2 , said trunk-circuit being fitted at the outgoing end with multiple jacks J^3 and J^4 and with a retardation-coil 34, legged to ground from the sleeve side of the circuit. The trunk extends in two limbs 35 and 36 to the central office C^2 , 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 windings w' and w'' of the repeating-coil W, and between said windings the trunk-relay r^7 is connected, said relay being of high resistance. The opposite windings w^3 and w^4 of the repeating-coil W with an interposed condenser c^5 are connected between the tip-strand t^3 and the sleeve-spring s^3 of the flexible end of the trunk-circuit, said end being hereinafter referred to as a "trunk-cord." These strands terminate in the corresponding contacts p and p^2 of the trunk-plug P^3 . A relay r^8 is connected with the sleeve-strand of the trunk-cord by means of conductor 37, leading from the live pole of the battery B^3 to the point 38 and thence by conductor 39 to one side of the relay r^8 , the other side of which is connected by conductor 40 with the sleeve-strand s^3 of the trunk-cord at point 41, this relay being therefore adapted to respond to current in the line when the subscriber's telephone is off the hook, the return path for current being completed over the tip-strand of the cord-circuit and through the ground branch 42, connected with the tip-strand at point 43. Thus relay r^8 when actuated closes through its spring 44 a short circuit of the trunk-relay r^7 , consisting of the conductors 45 and 46, which deprives the trunk-relay of operating-current and allows its armature to return to normal position. A relay r^9 is connected on one side by conductor 47 with the point 38 on the battery-wire 37 and upon the other side by conductor 48, leading to the contact k^2 of the ringing-key, which is adapted to be grounded when actuated by the conductor 49. The spring 50 of the relay r^9 closes through its forward contact a locking-circuit for itself, the said forward contact being connected by conductor 51 with the conductor 48 at point 52 and the said spring 50 being connected by a conductor 53 with the contacts 54 of the plug-seat switch, the springs 55 of which are grounded and are separated from the contacts 54 when the plug is in the seat. When, therefore, the ringing-key is actuated, a circuit for the relay r^9 from the battery B^3 is initially closed through contacts of said key,

and as soon as actuated the locking-circuit is closed through the contacts of the plug-seat switch, the plug P^3 being at this time out of the seat and inserted in the jack of the called-subscriber's line. A pilot-relay r^{12} is connected on one side by conductor 56 with the point 57 upon the main battery-lead 58 and upon the other side by means of conductor 59, leading to the signal-lamp S^5 , which may be termed the "guard" and "disconnect" lamp. The other side of the lamp is connected, by means of conductor 60, with the armature 61 of the trunk-relay r^7 , the back contact of which is connected by conductor 62 with the back contact and spring 63 of the relay r^8 , which spring is connected with the forward contact of grounded spring 70 of the relay r^9 , whereby when the trunk-relay and the relay r^8 are deenergized and the relay r^9 is energized a path for current is provided through the pilot-relay r^{12} and the signal-lamp S^5 , this circuit occurring when the called subscriber has hung up his telephone and the operator has disconnected the cord-circuit from the outgoing end. The pilot-relay, as is understood, controls the circuit of the pilot-lamp S^6 . The forward contact of the trunk-relay r^7 is joined by conductor 71 to the back contact of the spring 70 of the relay r^9 , whereby when the trunk-relay is actuated and the relay r^9 is deenergized a complete circuit for the lamp S^5 and the pilot-relay r^{12} is closed, this taking place when the connection has been established at the outgoing end of the trunk and before connection has been made at the incoming end, whereby a call or guard indication is given by the said signals. A ringing-signal S^4 is provided, its circuit being completed over conductor 37 to the point 38, thence by conductor 72 to the point 73, and thence by conductor 74 to the lamp S^4 , which is connected upon its opposite side by conductor 75 with the back contact of the armature of the locking-relay r^{11} , said armature being joined by conductor 76 with point 77 upon the conductor 69, before described. From this arrangement it will be seen that when the relay r^9 only is energized a path for current will be completed through the ringing-lamp S^4 , which will be lighted. A locking-relay r^{11} for the ringing-lamp is connected on one side by conductor 78 with the point 73 and upon the opposite side by conductor 79, leading to the forward contact of spring 68 of relay r^8 , whereby when the tip-relay r^8 is actuated a circuit is initially closed from the battery through said relay to cause it to open the circuit of the ringing-lamp S^4 . The same movement of the armature closes a locking-circuit for itself over conductor 80 from conductor 79 through its armature and over conductor 76 through conductor 69 and spring 70 of relay r^9 to ground.

A ringing-generator g^2 is provided for the

trunk-cord and is adapted to be connected with the tip-strand thereof by means of the contact h' of the ringing-key. It will be understood that any of the usual manually-operated ringing-keys may be used in which the contacts are all actuated simultaneously by means of the ordinary key-lever. A third contact h^3 may be provided in the sleeve-strand of the trunk-cord, which when actuated is grounded to provide a free path for the return of the ringing-current in case the subscriber should respond during ringing. The tip of the trunk cord-circuit is normally connected through the movable contact 81 of the relay r^9 and its normal contact with the conductor 82, leading to the tertiary winding 83 of the operator's induction-coil and thence by conductor 84 to the point 85 upon the battery-lead 58, whereby the tip of the plug is normally connected with the live pole of the battery. When the relay r^9 is actuated, the spring 81 thereof is disconnected from the testing-circuit and completes through its forward contact the tip-strand for talking. The operator's transmitter 86 is placed in a local circuit with the primary of the induction-coil and may be charged by means of a local battery. The secondary 87 of her coil is connected in series with her receiver 88 and the condenser 89 in the order-circuit 33. The telephone-line L^2 , terminating at the central office C^2 , is provided at the substation with the usual instruments and with a grounded signaling-bell 6, a local battery 90 being provided for talking purposes. At the central office the line is furnished with multiple jacks J^6 and J^7 , as many as desired being employed, the tip-spring j serving when lifted by means of the connecting-plug to close through its associated contacts the local circuit of the cut-off relay R^3 , which when actuated serves to disconnect the subscriber's line from the signal S to connect the jacks J^6 and J^7 therewith. At the same time the testing-contacts j^3 , which are connected together and at all times insulated from the talking-circuit, are connected with ground through conductor 91, the forward contact and spring 92 of the cut-off relay R^3 , and through the five-hundred-ohm resistance-coil 93 to ground.

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 the retardation-coil 9 and transmitter 4 at the substation, 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 8 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 30 with the cord-circuit by depressing the listening-key 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 j^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 J'. 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 same time from the battery B² over the conductor 26, through retardation-coil 27, thence through the transmitter 28 and over conductor 29 to ground. When sound-waves strike the transmitter 28, the current flowing therethrough 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 C³ 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 88 is permanently connected with the said order-wire. The latter operator designates 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, the cut-off relay R^3 will not be operated, and the test-rings will be disconnected therefrom, so that a complete circuit for current through the battery B³ will not be established, and no "click" will be received by the operator. In case of a connection, however, at one of the jacks of the wanted line the cut-off relay is actuated, and the test-rings j^3 are connected to ground. Upon touching the tip of the plug P³ thereto, therefore, a complete circuit for current from the battery B³ is provided over conductor 58 84, the tertiary winding of the operator's induction-coil, conductor 82, spring 81 of relay r^9 , and the tip-strand t^3 of the cord and over conductor 91, spring 92 of the cut-off relay r^3 , and through the resistance 93 to ground. The operator will therefore receive a click in her receiver and will know that the line is busy. Assuming, however, that the line is found idle, the plug is inserted in the adjacent jack of the subscriber's line and the ringing-key actuated. The actuation of the ringing-key, as before pointed out, connects the generator g^2 with the tip side of the line and actuates the call-bell 6 at the subscriber's station. It also closes the contact h^2 to ground, which actuates the relay r^9 over local circuit from the battery B³, comprising conductors 37 and 47, the relay itself, conductor 48, to the ringing-key and thence over contact h^2 thereof and conductor 49 to ground. As soon as this relay is actuated the locking-circuit before mentioned is closed through its spring 50 and the plug-seat switch, the contacts of the latter being closed to ground owing to the fact that the connecting-plug P³ has been removed from the seat. This relay will therefore remain actuated during the remainder of the connection or until the plug P³ is withdrawn from the line and placed in the seat. A testing-circuit is opened by the spring 81 of the relay r^9 , and the tip-strand of the trunk-cord is completed thereby. Spring 70 thereof closes upon its forward contact, and thereby completes a path for current through the ringing-lamp S⁴, said path including conductors 37 72 74, the lamp itself, conductor 75, the back-contact armature of the trunk-relay r^{11} , conductor 76, to point 77, and thence over conductor 69 to the forward contact and spring 70 of relay r^9 to ground. This lamp is therefore lighted and indicates to the operator that the subscriber has not yet responded.

At substantially the same instant that the plug P³ is connected with the wanted line the plug P² of the cord-circuit at the A office is connected with the trunk, with the result that current flows over the supervisory relay r^2 to disconnect the test-relay r^6 and close the tip-strand of the cord-circuit for conversation. Current then flows over the outgoing end and actuates the trunk-relay r^7 , which

opens the circuit of the disconnecting-lamp S^5 and prevents its operation at this time. The resistance of the trunk-relay is sufficient to prevent the actuation of the tip supervisory relay r^4 in the A cord-circuit, whereby the supervisory lamp associated therewith remains actuated and indicates to the operator that the subscriber has not yet responded.

When the called subscriber responds, a path for current through the relay r^3 is provided from the live pole of the battery B^3 over conductor 37 to point 38, conductor 39 to the relay r^3 , and thence over conductor 40 to the sleeve-strand of the trunk, and over the sleeve side of the subscriber's line to the substation, and back over the tip side of the line and through the tip-strand of the trunk-cord and conductor 42 to ground. This actuates the relay r^3 , the resistance of which is high to prevent too large a current from flowing through the subscriber's instruments and closing a short circuit of the trunk-relay r^7 . The removal of the resistance of the trunk-relay permits a sufficient flow of current over the A cord-circuit to actuate the supervisory relay r^4 , and thereby opening a circuit of the supervisory lamp S^3 to indicate to the operator that the called subscriber has responded. The trunk-relay being deprived of current permits its armature to return to normal position, which would actuate the disconnect-lamp S^5 save for the fact that its circuit is opened by the spring 68 of the relay r^3 . The spring 68 closes through its forward contact the initial circuit of the locking-relay r^{11} , said circuit being completed through the battery B^3 over conductors 37 72 78, thence through the locking-relay and over conductor 79 to the forward contact of spring 68, thence by way of conductor 69 and spring 70 of relay r^3 to ground. This relay is thus actuated to render the ringing-signal S^4 inoperative and to close its locking-circuit over conductors 80, through its armature, and by way of conductors 76 69 and spring 70 to ground. This circuit remains closed through the remainder of the connection, or until the relay r^3 is deenergized.

The subscribers are now connected together for conversation. The battery B^1 is furnishing current to the A subscribers for talking and for the operation of the supervisory and other relays associated therewith, while the battery B^2 is furnishing current over the trunk-cord for the operation of the relays associated with the cord-circuit, and the battery B^3 serves to actuate the relay r^3 and the other apparatus associated with the incoming trunk. The voice-currents are transmitted inductively from one portion of the circuit to the other at the A office through the condensers in the cord-circuit, while the repeating-coil windings at the B office serve to repeat them from one portion of the circuit to the other.

In case the called subscriber's line had

been busy or the subscriber had failed to answer the plug P^3 would have been inserted in one of the jacks J^9 or J^8 of the "busy-back" or "don't-answer" apparatus. These circuits comprise an induction-coil 94, having its primary in circuit with the rapidly-rotating circuit-breaker 95 and the battery B^4 , this battery being preferably the same as battery B^3 , though shown separately for convenience. The secondary of the induction-coil 94 is connected in circuit with the rapid circuit-breaker 94 and the more slowly rotating interrupter 95. From the interrupter 96 a conductor 98 leads to the sleeve-contacts of the busy-back jacks J^9 through a fifty-ohm resistance-coil 99, while interrupter 97 is connected by conductor 100 through the resistance-coil 101 to the sleeves of the don't-answer jacks J^8 . The tips of both sets of jacks are united by conductor 102 with a grounded pole of the battery. The circuit-breaker 95 causes induced currents in the secondary circuits, which are interrupted at short intervals by interrupter 96 and at longer intervals by the interrupter 97 to cause distinctive tones at the jacks J^9 and J^8 , whereby when a trunk-plug is inserted in one or the other of the jacks a corresponding signal is transmitted to the waiting subscriber. It will be seen that when a plug is inserted the circuit of the battery B^3 over the sleeve side is interrupted by the interrupter 96 or 97, as the case may be, which alternately energizes and deenergizes the relay r^3 , whereby supervisory lamp S^3 , associated with the A cord-circuit, is flashed. At the same time the distinctive tone caused by the induction-coil 95 is sent to the waiting subscriber.

At the termination of the conversation when the A subscriber returns his receiver to the hook a supervisory signal S^2 , associated with the A cord-circuit, is lighted. When the subscriber at the A office hangs up his telephone, the relay r^3 is deprived of operating-current, which introduces the resistance of the trunk-relay r^7 into the metallic circuit of the outgoing end of the trunk, which causes the lighting of the supervisory relay s^3 in the A cord, thus indicating to the A operator that the conversation has terminated. The cord-circuit is then disconnected from the trunk, with the result that the trunk-relay is deprived of operating-current and closes, through its back contact, the circuit of the disconnecting-lamp S^5 , said circuit being completed from the live pole of the battery B^3 over conductor 58 to point 57, conductor 56, pilot-relay r^{12} , conductor 59, disconnect-signal S^5 , conductor 60, spring 61 of trunk-relay r^7 , conductor 62, spring 68 of relay r^3 , conductor 69, and spring 70 of relay r^3 to ground. The pilot-signal S^6 is simultaneously actuated to attract the attention of the operator to the disconnect-signal. The operator at the incoming end of the trunk no-

ting the disconnect-signal withdraws the trunk-plug from the called line and inserts it in the plug-seat, whereby the locking-circuit for the relay r^9 is opened, which restores all parts to normal position. The disconnect-signal S^5 serves also as a guard-lamp in case the A operator inserts the calling-plug P^2 into a wrong trunk-jack, for the reason that the trunk-relay will be operated, while the sleeve-relay is not operated. A circuit will therefore be completed from the live pole of the battery B^3 over conductor 58 to point 57, conductor 56, relay r^{12} , conductor 59, guard-lamp S^5 , conductor 60, spring 61 of trunk-relay r^7 , its forward contact, the conductor 71, and the back contact and spring 70 of relay r^9 and thence to ground. The disconnect-lamp, as well as the pilot-relay, are therefore lighted and indicate to the operator that a mistake has been made.

The order-circuit 33, as is indicated by the branch lines 33^a, connects the B operator with several A operators either at the same or different exchanges. The A operator is also provided with a plurality of keys k^2 to connect herself with the different B operators. The busy back or don't-answer apparatus is common to the various sections of the incoming trunk-board, as is indicated by the radiating lines.

Although I have described the method of making connections through the medium of the 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 several trunks before her until an idle trunk is found. Upon so testing and finding an idle trunk she may insert the plug P^3 of her cord-circuit, with the result that the trunk-relay r^7 operates and lights the lamp S^5 , which has previously been termed the "guard-lamp," but which in this method of operation acts as a calling-signal from the A operator to the B operator. The B operator upon seeing the signal S^5 would depress her listening-key m' or m^2 , which would connect her receiver in series with the repeating-coil windings w^3 and w^4 , these receiver connections being indicated in dotted lines in Fig. 1. She is therefore able to communicate with the A operator. The presence of the condenser c^8 (shown in dotted lines and in parallel with the trunk-relay r^7) permits conversation between the operators at this time. Upon learning the desired connection the B operator completes the circuit, as before described. It will also be understood that had the A subscriber 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 test-relay r^8 , and the subscriber would have been called by the ringing-generator g^2 in the usual way.

Fig. 2 shows a similar arrangement of the trunk in which the subscriber's line is provided with a plurality of substations and with connecting-jacks having series contacts therein in place of the usual cut-off relays. The trunk-circuit is provided with means for selectively calling the several stations on the line and with testing apparatus to cooperate with a special form of test-contacts employed in connection with the jacks of the line. The cord-circuit with which connection is established at the outgoing end of the trunk is indicated differently, but is supposed to be provided with the same apparatus shown in Fig. 1. In this figure the tip strand of the trunk-cord is normally connected with a test-relay r^{10} , which is of high resistance and impedance to prevent a large variation of current on the line tested. The same arrangement of operator's circuit is provided in connection with the cord-circuit shown in Fig. 1. The ringing-generator g^2 is connected, by means of contact h' of the ringing-key, with the tip side of the line, while the contact h^3 connects the sleeve side of the line to ground to provide a return-path for current in case the subscriber answers during ringing. A corresponding contact h^2 is provided which grounds one side of the relay r^9 when the ringing-key is operated to actuate said relay. The said generator can also be connected with the sleeve-spring of the cord by means of the spring o^3 of the ringing-key, the tip-spring o' , which is operated at the same time, being grounded and the spring o^2 serving to close a circuit of the relay r^9 . It will be understood that three springs in each key are operated simultaneously by the usual key-lever. The subscribers' stations are provided with apparatus of the same type as shown on line L of Fig. 1, except that the signaling-bell is grounded from one side of the line at one station and from the other side of the line at the other station. At the central office the jacks are provided with series contacts, whereby the tip side of the line is normally connected from the signaling device S with one pole of the battery B^3 , and the sleeve side of the line is normally connected with ground, the contacts in the several connections being carried through the series contacts in the jacks when the plug is inserted in one of the jacks. The testing-terminals j^2 , which are also the sleeve talking-terminals, are connected directly with one side of the talking-circuit, and when a plug is inserted in one of the jacks current from the live pole of the battery is present at the sleeve and testing contacts. When, therefore, the line is tested and is found busy, a complete path for current is provided from the test-terminal, which is raised to a potential above that of the earth and over the tip side of the line through the grounded test-relay r^{10} , which is actuated in the usual way to cause a "click"

in the operator's receiver. When the line is found idle, a trunk-plug is inserted and the proper ringing-key is actuated to ring the desired subscriber. The operation of the ringing-key serves to actuate the relay r^0 to thereby place the signaling and other apparatus in condition to operate, as described in reference to Fig. 1. The line-circuit during conversation is unprovided with ground, and no cut-off relay is used, the ground at the plug-seat switch serving to cause the necessary operation of the apparatus. Otherwise the construction and arrangement of this figure is the same as in Fig. 1 and is therefore not specifically described, as it will readily be apparent when considered in connection with the description and explanation of Fig. 1. It will be understood that the connecting apparatus of Fig. 2 may be employed in connection with Fig. 1, although where desirable the testing apparatus of Fig. 2 may be used in Fig. 1; also, the different features of Fig. 1 may be used in connection with that of Fig. 2.

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, and ground connections may be placed at the opposite poles of the several batteries instead of those shown in the diagrams, all of which is apparent to those skilled in the art. The resistance of the relay r^0 may be five hundred ohms, although the proportions may be larger without disturbing the operations of the system. It is also apparent so far as some features of the invention are concerned that the lines may terminate in single cords and plugs in place of the double cords and plugs described and that the trunks may terminate in jacks in place of the plugs and cords.

I do not wish to be limited to the exact arrangement shown, for it is apparent that various changes and modifications may be made therein and still come within the principle of the invention; but

What I do claim, and desire to secure by Letters Patent, is—

1. The combination with a trunk - line adapted to connect telephone-lines together for conversation, of a signaling apparatus for the incoming end of the trunk, a relay at said end to place said apparatus in condition to operate and adapted to be actuated during connection with the called line and before the called subscriber's response, and a locking-circuit for said relay closed by itself when actuated to maintain the same operated, substantially as described.

2. The combination with a trunk - line adapted to connect telephone-lines together for conversation, of a signaling apparatus for the incoming end of the trunk, a relay at said end actuated over a local circuit inde-

pendent of the talking-circuit and trunk-connecting means, said relay serving to place said apparatus in condition to operate, and a locking-circuit for said relay closed by itself when actuated to maintain the same operated, substantially as described.

3. The combination with a trunk - line adapted to connect telephone-lines together for conversation, of a signaling apparatus for the incoming end of the trunk, a relay at said end to place said apparatus in condition to operate, a local circuit therefor, a manually-operated switch independent of the trunk-connecting means to open and close said local circuit, said relay serving when actuated to close a locking-circuit for itself whereby the same remains actuated, substantially as described.

4. The combination with a trunk - line adapted to connect telephone-lines together for conversation, of a signaling apparatus for the incoming end of the trunk, a relay at said end to place said apparatus in condition to operate, a local circuit therefor, a ringing-key for the trunk to connect the calling-generator therewith, said key serving to open and close said local circuit, and means to cause said relay to lock itself in actuated condition after the closing of said local circuit, substantially as described.

5. The combination with a trunk - line adapted to connect telephone-lines together for conversation, of a relay at the incoming end actuated by current over the trunk from the outgoing end, a second relay at the incoming end, a signal also at the latter end whose actuation depends upon said relays, said second relay being initially actuated over a local circuit and a locking - circuit therefor to maintain the relay actuated, substantially as described.

6. The combination with a trunk - line adapted to connect telephone-lines together for conversation, of a relay at the incoming end actuated by current over the trunk from the outgoing end, a second relay at the incoming end, a signal also at the latter end whose actuation depends upon said relays, said second relay being initially actuated over a local circuit independent of the talking-circuit, and thereafter over a locking-circuit closed by itself, substantially as described.

7. The combination with a trunk - line adapted to connect telephone-lines together for conversation, of a relay at the incoming end actuated by current over the trunk from the outgoing end, a second relay at the incoming end, a signal also at the latter end whose actuation depends upon said relays, a local circuit for said second relay over which it is initially actuated, a switch independent of the trunk-plug for controlling said circuit, and a locking-circuit for said relay closed by itself when actuated, substantially as described.

8. The combination with a trunk - line adapted to connect telephone-lines together for conversation, of a relay at the incoming end actuated by current over the trunk from the outgoing end, a second relay at the incoming end, a signal also at the latter end whose actuation depends upon said relays a local circuit over which said second relay is initially actuated, a ringing-key for the trunk to connect the calling-generator thereto, said key controlling said local circuit, and a locking-circuit closed by itself to thereafter maintain the relay actuated, substantially as described.
9. The combination with a trunk-line adapted to connect telephone-lines together for conversation, of signaling apparatus for the incoming end of the trunk, a relay at said end to place said apparatus in condition to operate, a locking-circuit for said relay closed by itself when once operated, and a plug-seat switch to open said locking-circuit when the connection has been taken down and the trunk-connecting plug has been seated therein, substantially as described.
10. The combination with a trunk-circuit adapted to connect telephone-lines together for conversation, of signaling apparatus at the incoming end of the trunk, a relay to place said apparatus in condition to operate, a local circuit for said relay independent of the talking-circuit, a manually-operated switch to control said circuit, a locking-circuit for said relay closed by itself when actuated to maintain the same operated during the connection, and a plug-seat switch controlling said locking-circuit which is adapted to open the same when the connection has been severed and the trunk-connecting plug placed in the seat, substantially as described.
11. The combination with a trunk-circuit adapted to connect telephone-lines together for conversation, of a signal for the incoming end of the trunk, a relay adapted when actuated to place said signal in condition to operate, a local circuit for said relay independent of the talking-circuit, a ringing-key for the trunk adapted to connect the calling-generator therewith, said ringing-key serving when operated to close said local circuit, a locking-circuit for said relay to maintain the same operated during conversation and after the ringing-key has been returned to normal position and a plug-seat switch to control said locking-circuit whereby when the connection has been severed and the trunk-connecting plug placed in the seat, the locking-circuit is open, substantially as described.
12. The combination with a trunk-line adapted to connect telephone-lines together for conversation, of a relay at the incoming end of the trunk actuated by current over the trunk from the outgoing end, a second relay at said end, means for initially operating said latter relay during connection with a called line and before the subscriber's response, a locking-circuit for said latter relay closed by itself when actuated, means for opening said locking-circuit when the connection is severed with the called line, and a signal at the incoming end whose actuation depends upon said two relays, substantially as described.
13. The combination with a trunk-circuit adapted to connect subscribers' lines together for conversation, of a relay at the incoming end actuated by current from the outgoing end of the trunk, a second relay at the incoming end of the trunk actuated during connection with the called line, a locking-circuit therefor closed by itself when actuated, a plug-seat switch for the incoming trunk-plug controlling said locking-circuit and adapted when the plug is in the seat to open the same, and a signal whose actuation depends upon said two relays, substantially as described.
14. The combination with a trunk-circuit adapted to connect telephone-lines together for conversation, of a relay at the incoming end actuated by current from the outgoing end, a second relay at the incoming end actuated over a local circuit, a manually-operated switch independent of the trunk-connecting plug to close said circuit, a locking-circuit for said latter relay, means to open said circuit when the connection is taken down, and a signal whose actuation depends upon said two relays, substantially as described.
15. The combination with a trunk-circuit adapted to connect subscribers' lines together for conversation, of a relay at the incoming end actuated by current from the outgoing end, a second relay at the incoming end, a local circuit therefor independent of the talking-circuit, a ringing-key to connect the calling-generator with the incoming end of the trunk, said key serving when actuated to close said local circuit, a locking-circuit for the relay closed by itself when actuated, a plug-seat switch having contacts in said locking-circuit and adapted to normally open same, when a trunk-plug is seated therein and a signal whose actuation depends upon said two relays, substantially as described.
16. The combination with a trunk-line adapted to connect telephone-line circuits together, of a ringing-signal for the incoming end of the trunk, a relay actuated over a local circuit distinct from the talking-circuit to direct current through said signal to operate the same when the subscriber has been called but before his response, a ringing-key to connect the calling-generator with the incoming end of the trunk, said key serving to close the circuit of said relay to actuate the same, a second relay adapted to deprive said signal of operating-current when the subscriber responds, and a third relay for locking out said signal and means for maintaining actuating-

current through said relay during the remainder of the connection, substantially as described.

17. The combination with a trunk-line adapted to connect subscribers' lines together for conversation, of a ringing-signal for the incoming end of the trunk, a relay adapted to direct current through said signal to operate the same when the subscriber has been called but before his response, the circuit of said relay being initially closed before the subscriber responds and thereafter controlled through a locking-circuit to maintain the same operated during the connection, a second relay adapted to deprive said signal of operating-current when the called subscriber responds, and means for locking out said signal during the remainder of the connection, substantially as described.

18. The combination with a trunk-line adapted to connect subscribers' lines together for conversation, of a ringing-signal for the incoming end of the trunk, a relay adapted to direct current through said signal before the called subscriber responds, a local circuit for said relay initially closed in the operation of the ringing-key of the trunk, said relay being adapted to close a locking-circuit for itself when actuated, a plug-seat switch in said locking-circuit adapted to open the same when the trunk-plug has been returned to normal position, a second relay adapted to deprive said signal of operating-current when the called subscriber responds, and means for locking out said signal during the remainder of the connection, substantially as described.

19. The combination with a trunk-line adapted to connect telephone-lines together for conversation, of a disconnect-signal for the incoming end of the trunk, means operated by current flowing over a local circuit independent of the talking-circuit for placing said signal in condition to operate, said local circuit being closed by a switch independent of the trunk-connecting plug, and further means controlled by the connection at the outgoing end of the trunk for rendering said signal inoperative, substantially as described.

20. The combination with a trunk-line adapted to connect telephone-lines together for conversation, of a disconnect-signal for the incoming end of the trunk, a relay actuated by current over a local circuit for placing said signal in condition to operate, said local circuit being controlled by the trunk ringing-key, and a relay actuated by current over the outgoing end of the trunk when the connection exists at said outgoing end to prevent said signal from operating, substantially as described.

21. The combination with a trunk-line adapted to connect telephone-line circuits together for conversation, of a disconnect-signal for the incoming end, a relay actuated

over a local circuit initially closed by the trunk ringing-key when operated to call the wanted subscriber, said relay serving to place said signal in condition to operate, a locking-circuit for said relay closed when the relay is once actuated, a plug-seat switch in said locking-circuit to open the same when the connection is taken down and the trunk-plug is placed in the seat, and a relay energized by current over the trunk from the outgoing end when connection exists at said end to prevent said signal from operating, substantially as described.

22. The combination of a trunk-line, of 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 signal associated with the incoming end, a relay also at said incoming end adapted to be operated by current sent over the trunk-circuit, a second relay at said incoming end adapted to be operated by current flowing over a local circuit, a ringing-key initially controlling said local circuit, said circuit being thereafter controlled through contacts of said relay to maintain the relay operated, a plug-seat switch to open the locking-circuit of said relay when the trunk-plug is returned to normal position, said relays jointly controlling the said signal so as to operate the same to give a guard indication when the cord-circuit is connected with the trunk-circuit and the trunk-circuit is disconnected from the said line, or to place said signal in condition to operate so as to give a disconnect indication when the cord-circuit is disconnected from the trunk and the trunk is connected with the line, substantially as described.

23. The combination with a trunk-line, of 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 guard-signal for the incoming end of the trunk, means to actuate said signal by current sent over the trunk when the cord-circuit is connected with the trunk, and further means actuated by current sent over a local circuit when the trunk is connected with the called line to render said signal inert, said local circuit being independent of the trunk-connecting plug, substantially as described.

24. The combination with a trunk-line, of 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 guard-signal for the incoming end of the trunk, means to actuate said signal by current sent over the trunk when the cord-circuit is connected with the trunk, and further means actuated by current sent over a local circuit when the trunk is connected with the called line to render said signal inert, said local circuit being closed through contacts of the trunk ringing-key, substantially as described.

25. The combination with a trunk-line, of 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 guard-signal for the incoming end of the trunk, means to actuate said signal by current sent over the trunk when the cord-circuit is connected with the trunk, and further means actuated by current sent over a local circuit when the trunk is connected with the called line to render said signal inert, said circuit being initially controlled through contacts of the ringing-key and thereafter completed through contacts of the plug-seat switch, substantially as described.

26. The combination with a trunk-line adapted to connect telephone-lines together for conversation, of a signal at the incoming end of the trunk, a relay actuated during connection with the called line and before the subscriber's response to place said signal in condition to operate, a second relay actuated by current from over the trunk when a connection exists at the outgoing end thereof, of a third relay at said incoming end connected with the sleeve-strand of the cord-circuit and responsive to current in the line when the called subscriber answers, said relays serving to control said signal in such manner that when the first relay is energized and the other relays deenergized, the signal is actuated, substantially as described.

27. The combination with a trunk-circuit

adapted to connect subscribers' lines together, a supervisory signal associated with the outgoing end of the trunk, a high-resistance trunk-relay at the incoming end, said relay being normally disposed in the path of current over the trunk to limit the flow therein, and thereby permit the operation of said supervisory signal, a relay at the incoming end of the trunk connected with the sleeve-strand thereof, and responsive to current in the line when the called subscriber answers said relay serving to remove the resistance of the trunk-relay to permit an increased flow of current over the trunk to thereby render said supervisory signal inoperative, substantially as described.

28. In a telephone system, the combination with a telephone-line, of a trunk-circuit adapted to be connected therewith, of a ringing-signal at the incoming end of the trunk placed in condition to operate by current sent through a local circuit independent of the talking-circuit by the actuation of the ringing-key, and again rendered inoperative by current flowing over a portion of the talking-circuit when the called subscriber answers his call, substantially as described.

Signed by me at Chicago, county of Cook, State of Illinois, this 23d day of July, 1902.

WILLIAM W. DEAN.

Witnesses:

ROBERT LEWIS AMES,
GAZELLE BEDER.