

No. 847,984.

PATENTED MAR. 19, 1907.

F. W. DUNBAR.
TELEPHONE TRUNKING SYSTEM.

APPLICATION FILED AUG. 25, 1902.

3 SHEETS—SHEET 1.

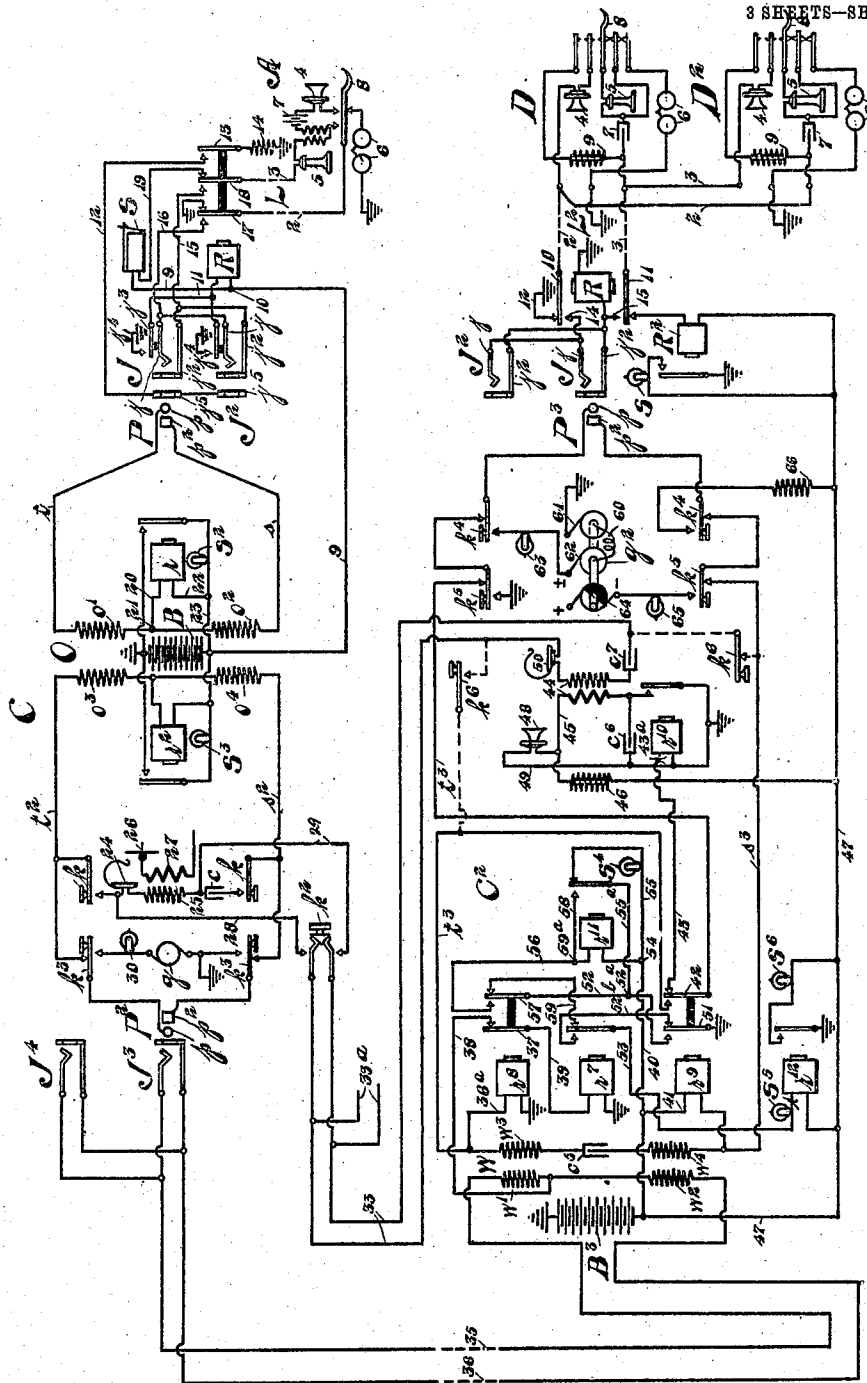


Fig. 1.

Witnesses.
R. L. Burfield
Gazelle Beder

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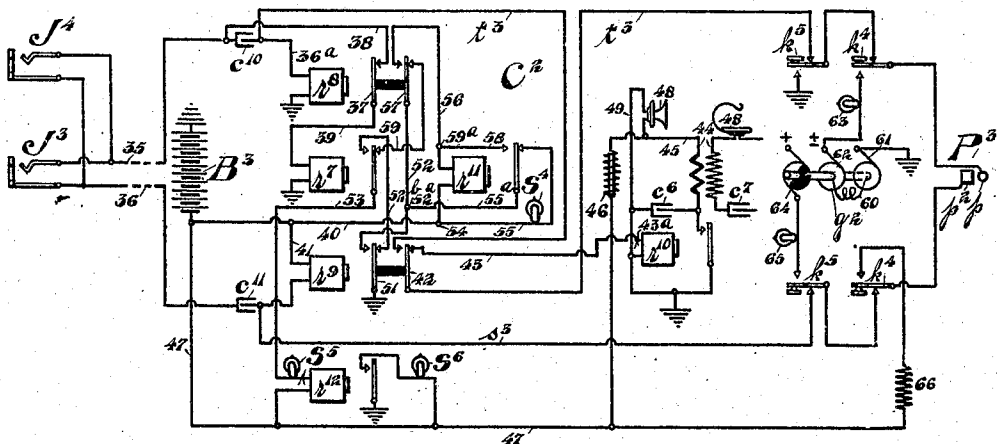


Fig. 2.

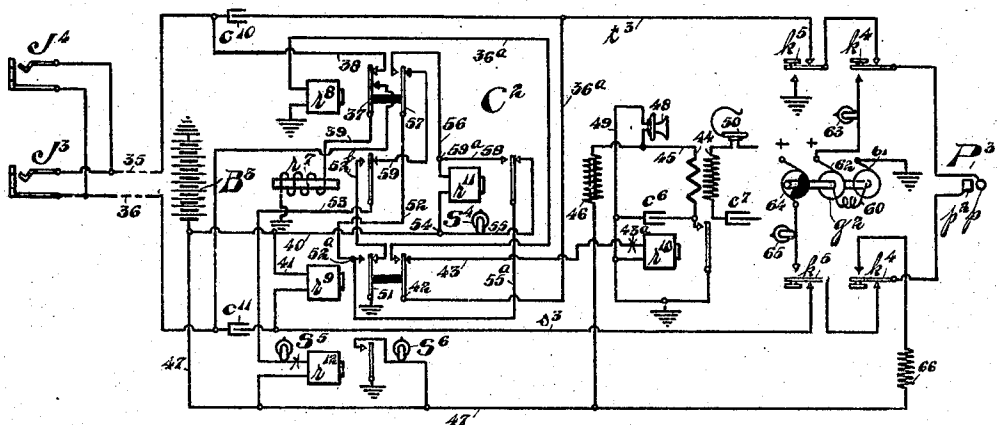


Fig. 3.

Witnesses.

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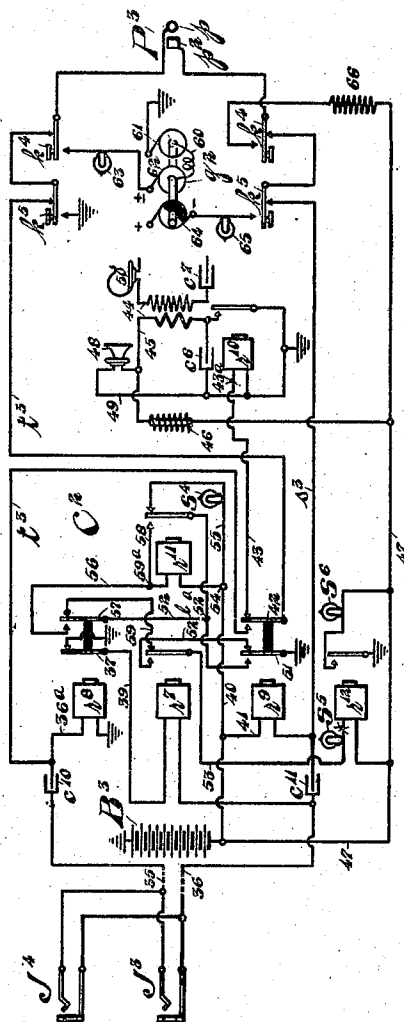


Fig. 4.

Witnesses.

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UNITED STATES PATENT OFFICE.

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TELEPHONE TRUNKING SYSTEM.

No. 847,984.

Specification of Letters Patent.

Patented March 19, 1907.

Application filed August 25, 1902. Serial No. 120,878.

To all whom it may concern:

Be it known that I, FRANCIS W. DUNBAR, 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 improvements in telephone trunking systems and apparatus whereby telephone subscribers whose lines terminate at different central offices or central stations may be connected together for conversation.

The trunking system of the present invention extends between offices at which subscribers' lines of different types terminate. At the outgoing office the subscribers' lines are provided with cut-off relays and with test-terminals connected in local circuit, and the subscribers' bells are grounded from one side of the line. The operators' cord-circuits are adapted to cooperate with the said lines and are conductively divided but inductively united through the intermediation of a repeating-coil. At an intermediate point of the repeating-coil-winding bridge a supervisory relay is legged to ground through a central battery. With this arrangement of cord-circuits when a connection is established and the subscriber's telephone is upon its hook a path for current from the central battery is provided through the supervisory relay and over the line to the subscriber's station; but when a subscriber's receiver is in use the path for said current is disrupted and the supervisory relay is inoperative. At the incoming office the subscribers' lines are provided with cut-off relays actuated over a portion of the talking-circuits, and the testing-contacts of the jacks are connected directly with one side of the talking-circuits. This trunk-circuit is adapted for use with the said subscribers' lines at the incoming office and with the special type of cord-circuit above described at the outgoing office, the connection being so arranged that the usual method of operation of trunk-circuits is obtained.

My invention is shown in the accompanying drawings, in which—

Figure 1 is a diagram of a system of the

kind above described. Fig. 2 is a diagram of a modification in which the repeating-coil at the incoming end of the trunk is replaced by condensers. Fig. 3 is a diagram of still another modification in which condensers are employed and in which the trunk-relay is actuated by current over both sides of the trunk, and Fig. 4 is a diagram of a different form of the invention in which condensers are employed at the incoming end and in which the trunk-relay is actuated by current over the opposite side of the line from that disclosed in Fig. 1.

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 J and J'. At the subscriber's station the usual telephone instruments are provided and consist of a transmitter 4, a receiver 5, a bell 6, and a local battery 7. The switch-hook 8 is adapted in its normal position and when the receiver is placed thereon to open the circuit between the limbs of the line as well as the local circuit of the transmitter and to close the tip-limb 2 through the grounded signaling-bell 6. In its uppermost position a local circuit containing the transmitter 4, local battery 7, and primary of the substation induction-coil is closed, and at the same time the main line is closed through the receiver and secondary of said coil. The cut-off relay R is energized by current from the battery B over a set of conduction including wire 9 to junction-point 10, thence through the cut-off relay R and by the switchboard conductor 11, the auxiliary springs j^3 of the jacks, and through the cooperating earth-contacts j^4 . These contacts j^3 and j^4 are closed together when a plug is inserted in a jack and the cut-off relay is actuated. The test-rings j^5 of the jacks are connected together by means of conductor 12 with the forward contact of spring 13 of the cut-off relay R, the latter being grounded through a resistance-coil 14 of suitable dimensions. The contacts j and j^2 of the jacks are normally disconnected from the line, but are connected by wires 15 and 16 with the forward contacts of springs 17 and 18 of the cut-

off relay, whereby when the cut-off relay is actuated these contacts are connected with the limbs of the telephone line. The spring 17 of the cut-off relay is normally grounded, while spring 18 is normally connected by means of conductor 19 with the line-signal S, the other terminal of which is joined by conductor 9 with the live pole of battery B, whereby when the subscriber takes up his receiver in calling the central office a complete path for current from said battery is provided over the metallic line and the line-signal S to actuate it, and thereby indicate a call.

The cord-circuit is provided with an answering-plug P and with a calling-plug P², each of which has a tip-contact *p* and a sleeve or stem contact *p*². These contacts of the answering-plug P are looped together by means of the tip-strand *t* and sleeve-strand *s* and the helices *o* and *o*² of the repeating-coil O. The plug P² is likewise connected in the loop by the tip-strand *t*², the sleeve-strand *s*², and the helices *o*³ and *o*⁴ of the said repeating-coil. A supervisory relay *r* is joined by conductor 20 with the junction-point 21 of the loop of the plug P, and its other terminal is connected by conductors 22 and 23 with the live pole of the battery B. A supervisory lamp S² is included in a circuit with the battery B by means of the armature and forward contact of said supervisory relay *r*. The opposite plug P² is associated therewith, a supervisory relay *r*² controlling supervisory signal S³ in a manner similar to the lower parts connected with the other plug of the cord-circuit. The operator's telephone sets comprise the receiver 24, adapted to be bridged across the cord-circuit by the listening-key *k*, said bridge including the secondary 25 of her induction-coil and the condenser *c*. Her transmitter 26, together with the primary 27 of her induction-coil, may be charged from the battery B. The conductors 28 and 29 serve to connect the operator's instruments with the normally open contacts of key *k*², by means of which she is able to connect her telephone with the order circuit or wire 33, leading to the other exchange. The calling-generator *g* is adapted to be connected, together with the resistance-lamp 30 between ground and the tip-strand of the calling-plug, by means of the tip-contact of key *k*³, the sleeve-contact of key *k*³ serving to ground the corresponding strand to provide a path for the ringing-current in case the subscriber answers during the process of ringing.

A trunk-circuit is shown extending between the central offices C and C², said trunk-circuit being fitted at the outgoing end with jacks J³ and J⁴ and extending to the central office C² in two limbs 35 and 36, where the trunk 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*¹ and *w*² of the repeating-coil W, and from a point between said windings a conductor 38 extends to the normal contact of spring 37 of the tip-relay *r*⁸. The said spring is connected, by means of a conductor 39, with the trunk-relay *r*⁷, the opposite terminal of which is grounded. 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-strand *s*³ of the flexible end of the trunk-circuit. These strands terminate in the corresponding contacts *p* and *p*² of the trunk-plug P³. The tip-relay *r*⁸ is legged to ground from the tip-strand *t*³ of the trunk-circuit by conductor 36^a. A sleeve-relay *r*⁹ is connected on one side with the live pole of the battery B³ by means of conductors 40 and 41 and on the other side with the sleeve-strand *s*³. This incoming end of the trunk is provided with a special testing apparatus. The forward portion of the tip-strand *t*³ is connected with spring 42 of the sleeve-relay *r*⁹, while the other portion is connected with the forward contact of said spring. The back contact of spring 42 is joined by conductor 43 with the common high-resistance and high-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 operator's induction-coil 44, which winding is connected on the opposite side with a conductor 45, containing the resistance and impedance coil 46 and joined to conductor 47, which leads directly to the live pole of the battery B³. 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 the condenser *c*⁷ are connected permanently with the order-circuit 33, leading to the central office C. The conductor 40 leads to the point 54, from which point the branch 55, containing the ringing-lamp S⁴, leads to the back contact of the armature of locking-relay *r*¹¹, said armature being connected by conductor 55^a to the point 52^a upon the conductor 52 extending between the spring 57 of tip-relay *r*⁸ and the front contact of spring 51 of sleeve-relay *r*⁹, the latter spring being grounded, as shown. The conductor 56 extends from point 54 to the front contact of spring 57 of tip-relay *r*⁸ and includes the winding of the locking-out relay *r*¹¹. The forward contact of the armature of this relay is connected to conductor 56 at point 59^a by means of conductor 58. The back contact of spring 57 of

tip-relay r^8 is joined by conductor 59 to the back contact of the armature of trunk-relay r^7 , the forward contact of which is connected by conductor 52^b with the back contact of spring 51 of sleeve-relay r^9 . The armature of the trunk-relay r^7 is connected with a conductor 53, leading to the battery-wire 47 and including the guard and disconnecting lamp S^5 and the pilot-relay r^{12} , said latter relay serving to control the circuit of pilot-signal S^6 . 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^3 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.

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 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. Normally disconnected jacks J J², line-relay R², cut-off relay R, and the line-signals S are employed. The battery B³ furnishes current for the operation of these various relays and signals, as well as for talking.

In establishing a connection the A subscriber takes up his receiver, and thereby indicates a call through the intermediation of his signal S. The operator in response to this call inserts the answering-plug P of her cord-circuit, thereby actuating the cut-off relay to render the line-signal inoperative and to connect the jack-terminals with the limbs of the telephone-line. The supervisory signal S² remains inert, for the reason that the path for current from the battery B over the telephone-line is at this time open.

Upon being informed that a subscriber in the exchange C² is desired the key k^2 is depressed to connect her telephone with the operator's instrument at the said office, who nominates the trunk to be used. Before connecting the trunk-plug with the wanted line the B operator tests the same with the tip of the incoming trunk-plug. If idle, no click will be received; but if the line is busy the sleeve-contacts of the jacks of the line will be connected with the live pole of a bat-

tery similar to the battery B³ through the sleeve-contact and sleeve-strand of the flexible cord 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 a battery through the tip of the plug P³, tip-strand t^3 , spring 42, and back contact of sleeve-relay r^9 , conductor 43, through the common high-resistance and high-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 B³. The completion of the circuit will permit a flow of current there-through 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 exchange, since the electrostatic capacity of her circuits and that of the order-circuit is ample for the purpose of producing the click.

In the three-wire system where the test-circuits are insulated from the subscriber's lines there is no danger of varying the current flowing in the line to the annoyance of the subscriber during testing; but in the two-wire system where the testing-contacts are connected directly with the talking-circuits some means is necessary or at least desirable to prevent noticeably varying the current upon lines connected for conversation when testing their condition at other sections of the switch-board. This is accomplished in the circuit described by means of the test-relay r^{10} , which is of such high resistance as to vary the current upon the tested line but slightly and which is also of high impedance, so that its current will build up slowly to thereby prevent a sudden variation of current on the line. The subscriber or subscribers whose lines are tested are therefore undisturbed by a sudden or large variation of current through their instruments. It is apparent that any other suitable test-responsive device or indicator than the relay r^{10} can be employed and that the operator's telephone can be used in place of the same or in the circuit with a retardation-coil, but the arrangement described is preferred. This relay is preferably common to all the incoming trunks at the one operator's position, as indicated by the branching lines at 43^a. Upon finding the line idle the plug P³ 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 P² of her cord-circuit in the jack of the

trunk at her section. This act completes a circuit from the live pole of the battery B over both sides of the trunk and through the branch 38 at the incoming office, spring 37 of relay r^8 , and conductor 39, through the trunk-relay r^7 to ground. The supervisory relay r^2 is therefore operated and causes the signal S^3 to become visible, thus indicating to the A operator that the called subscriber has not 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 substations. The operation of sleeve-relay r^9 disconnects the test-relay r^{10} and closes the tip-strand t^3 through the spring 42 and its forward contact, and thereby establishes the circuit for conversation. It also completes the circuit of the ringing-lamp S^4 from the battery B^3 over conductor 40 to the point 54, thence over conductor 55 and through the lamp S^4 to the back contact of the armature of locking-relay r^{11} , thence through the armature and over conductor 55^a to the point 52^a, over the conductor 52 to the front contact and armature of sleeve-relay r^9 to ground. The completion of this circuit causes the operation of the ringing-lamp S^4 and indicates to the operator that the subscriber has not yet responded. The operation of the trunk-relay r^7 at this time opens through its armature and back contact the circuit of the guard and disconnect 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 winding, 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 D² 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 normally 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 deenergization 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 substation, 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^3 , through conductor 36^a and tip-relay r^8 to ground. This relay responds to this current and opens through its spring 37 and back contact a circuit of the trunk-relay r^7 , which causes the deenergization of the supervisory relay r^2 in the A cord-circuit and the consequent retirement of the supervisory signal S^3 , thus indicating to the A operator that the called subscriber has responded. Although the trunk-relay r^7 is now deenergized and its armature engages its back contact, the guard-lamp S^5 is not operated, because its circuit is opened at the back contact and spring 57 of tip-relay r^8 . The closing of spring 57 of the tip-relay r^8 and its forward contact completes the circuit of the locking-relay r^{11} , as follows: from the live pole of the battery B^3 over conductor 40 to the point 54, thence through the locking-relay r^{11} , over conductor 56 to the forward contact and spring 57 of the relay r^8 , thence over conductor 52 through the forward contact and spring 51 of sleeve-relay r^9 to ground. The locking-relay r^{11} is therefore operated and opens through its armature 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 upon its forward contact completes a locking-circuit for said relay from the point 59^a through conductor 58, the forward contact and the armature of the relay, conductor 55^a to point 52^a, and thence over conductor 52 and the forward contact and spring 51 of sleeve-relay r^9 to ground. This circuit and the relay r^{11} are therefore locked, and the ringing-lamp S^4 is also locked out during the remainder of the connection and can only be released when the sleeve-relay r^9 is deenergized, which occurs when the plug P 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.

During conversation the local battery at the substation is furnishing current to the transmitter for conversation, the voice-currents being conducted over the metallic line and propagated in the trunk-line through the medium of the repeating-coil in the A-cord circuit, and from the trunk-line they are repeated by means of the coil W, into the called line. The battery B^3 at the B office furnishes current over the trunk-cord and the subscriber's line L^2 to the substation upon

said line for the operation of the transmitter. Thus at one exchange the subscribers are provided with local-battery transmission and at the other with common-battery transmission.

At the termination of the conversation the subscribers return the receivers to their hooks, with the result in the case of subscriber A that the supervisory relay R is operated by current over one side of the line and through the grounded signaling-bell at the substation. The supervisory signal S^2 is therefore actuated. When the subscriber D hangs up his telephone, current is cut off from the metallic line and the tip-relay r^8 is deenergized, thus closing circuit from the battery B in the A-cord circuit over the trunk-line and permitting the actuation of the supervisory relay r^2 and the supervisory signal S^3 . This indicates to the A operator that the called subscriber has replaced his telephone upon its hook. The spring 57 of the tip-relay r^8 at the incoming end of the trunk is now closed to conductor 59; but the trunk-relay r^7 , having operated the circuit of the disconnecting-lamp S^5 , is again opened. The A operator seeing both signals in her cord-circuit exposed withdraws both plugs, thus restoring all parts at her office to normal position. The withdrawal of the plug P^2 at the A exchange deprives the relay r^7 at the incoming end of the trunk of operating-current, which is therefore deenergized and permits its armature to close upon its back contact the circuit of the disconnecting-lamp S^5 and the pilot-relay r^{12} , said circuit being traced from the live pole of the battery B^3 to conductor 47 through the winding of the pilot-relay r^{12} and through lamp S^5 , thence over conductor 53, the armature and back contact of trunk-relay r^7 , conductor 59, the back contact and armature 57 of tip-relay r^8 , thence over conductor 52 to the front contact and armature 51 of the sleeve-relay r^9 to ground. The operation of the pilot-relay r^{12} lights the pilot-signal S^6 , which attracts the operator's attention and who upon observing the lighted lamp S^5 is thus informed that the A operator has taken down the connection at that exchange, and she accordingly withdraws the plug P^3 from the jack of the subscriber's line. Upon the withdrawal of the trunk-plug the sleeve-relay r^9 is deenergized and the circuit of the signal-lamp S^5 , as well as that of the pilot-relay r^{12} , opened at the front contact and armature 51 of the said relay. Both lights S^5 and S^6 are thus extinguished, and at the same time the circuit of the locking-relay r^{11} is broken at the same point, which relay is therefore deenergized and permits its armature to return to normal position. The disconnecting-signal S^5 serves also as a guard-lamp in case the A operator inserts the calling-plug P^2 into wrong trunk-jack, for the reason that the trunk-relay of that trunk will be operated, while the sleeve-relay r^9 is

not operated. A circuit will therefore be completed from the live pole of the battery B³ over conductor 47, through pilot-relay r¹² and disconnecting-lamp S⁵, through conductor 53, the armature and front contact of trunk-relay r⁷, conductor 52^b to the back contact of sleeve-relay r⁹, thence through the armature 51 to ground. The disconnecting-lamp S⁵, as well as the pilot-lamp S⁶, will therefore be lighted and will indicate to the operator that a mistake has been made. At the same time both ringing-lamp S⁴ and guard-lamp S⁵ of the trunk whose plug is inserted will operate, thus assuring the operator that the trunk has not been connected with at its opposite end. It will be noticed that the sleeve-relay spring 51 controls through its forward contact a ground branch from point 52^a and that from said point two parallel paths are normally completed to the live pole of the battery, one including conductor 55^a, the normal contacts of locking-relay r¹¹, ringing-lamp S⁴, conductors 55 and 40, while the other includes conductor 52, the normal contacts of tip-relay r⁸, conductor 59, the normal contacts of trunk-relay r⁷, conductor 47 to the battery. When ground is thrown upon these parallel paths, as by the closing of the sleeve-relay r⁹, both lamps are operated. This can only occur under these circumstances, for the reason that in normal working before the subscriber responds both the trunk-relay and the sleeve-relay are operated, the former serving to open one parallel path, which permits only the ringing-lamp to operate.

As soon as the subscriber responds the locking-relay operates and holds open the parallel path through its contact during the remainder of the connection. At the same time, although the trunk-relay is no longer operated, the tip-relay is operated, which again opens the first path, so that lamp S⁵ cannot glow. Now when the A operator takes down the connection lamp S⁵ operates; but the other parallel path remains open through locking-relay r¹¹.

The order-circuit 33, as is indicated by the branch in 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 k² to connect herself with the different B operators.

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, this being accomplished in any well-known manner and by any well-known apparatus, such as is shown in connection with jacks of line L. Upon so testing and finding an idle trunk she may insert the calling-plug P³

of her cord-circuit, with the result that the trunk-relay r⁷ operates and lights the lamp S⁵, which lamp has been previously termed the "guard-lamp;" but in this method of operation it would act as a calling-signal from the A operator to the B operator. The B operator upon seeing the signal S⁵ would depress her listening-key k⁶ k⁶, which would connect her receiver in series with the repeating-coil windings w³ and w⁴, these receiver connections being indicated in dotted lines in Fig. 1. She is therefore able to communicate with the A operator. Upon learning the desired connection the B operator completes the same, as before described. It 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 P³, and the subscriber would have been called by the ringing-generator g.

Fig. 2 shows a modification in that the repeating-coil W at the incoming end of the trunk is replaced by condensers c¹⁰ and c¹¹, and the trunk-relay r⁷ is actuated over the tip side only of the trunk, the connections otherwise being the same as in Fig. 1. It is apparent that the parts will operate in the same way and the same results will be accomplished as in the case of Fig. 1. It is therefore deemed unnecessary to describe the operation or parts in detail.

Fig. 3 represents the circuit in which condensers c¹⁰ and c¹¹ are employed in place of the repeating-coil windings and in which the trunk-relay r⁷ is actuated by current over both sides of the trunk and ground instead of merely over the tip side of the trunk and ground, as shown in Fig. 2. Otherwise the construction and arrangement is the same as in the said Fig. 2, and the operation is the same as in both Figs. 1 and 2 and does not need further description.

Fig. 4 shows the condensers employed as in the two preceding figures; but the trunk-relay is actuated by current over the sleeve side of the trunk instead of over the tip side, as in Fig. 2. The complete operation of this system also will be understood from what has been said in reference to Fig. 1.

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 in practice that it is necessary to place a dead ground upon one side of the common battery. These ground connections may be placed at the opposite pole of the several batteries instead of as shown in the diagram, all of which is apparent to those skilled in the art. The pilot-relay may have one and one-half ohms resistance and the other parts may be of the desired or usual dimensions.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination with a trunk-circuit
5 extending between different switchboard-
sections and adapted to connect subscribers'
lines together for conversation, of a trunk-
relay at the incoming end legged to ground
from the outgoing end of the trunk and ac-
10 tuated by current thereover when connec-
tion exists at the outgoing end, a second re-
lay at the incoming end of the trunk actuated
by current over a portion of the talking-cir-
cuit when connection is established with the
15 called line, and a signal at the incoming end
whose actuation depends upon said relays,
and means for disconnecting said trunk-re-
lay from the outgoing end of the trunk when
the called subscriber answers, substantially
20 as described.

2. The combination with a trunk-circuit
extending between different switchboard-
sections and adapted to connect subscribers'
lines together for conversation, of a relay at
25 the incoming end of the trunk connected to
ground from the outgoing end and actuated
by current over the trunk when connection
exists at the outgoing end but adapted to be
disconnected therefrom when the called sub-
30 scriber answers, a second relay at the in-
coming end actuated by current over a portion
of the talking-circuit when connection is es-
tablished with the called line, and a signal
whose actuation depends upon said two re-
35 lays, said signal being actuated when the
connection exists at the outgoing end only to
give a guard indication, and to act as a dis-
connect-signal when the called subscriber
has hung up his receiver and connection has
40 been severed at the outgoing end, substan-
tially as described.

3. The combination with a trunk-circuit
extending between different switchboard-
sections and adapted to connect subscribers'
45 lines together for conversation, of a discon-
nect-signal at the incoming end of the trunk
placed in condition to operate by current
over a portion of the talking-circuit when
connection is established with the called line,
50 and a trunk-relay connected between the
outgoing end of the trunk and ground and
actuated by current over the trunk when a
connection exists at the outgoing end, said
relay serving when actuated to prevent the
55 operation of said signal, and means to dis-
connect said relay from the outgoing end
when the called subscriber responds, sub-
stantially as described.

4. The combination with a trunk-circuit
60 extending between different switchboard-
sections and adapted to connect subscribers'
lines together for conversation, of a discon-
nect-signal at the incoming end placed in
condition to operate by current over a por-
65 tion of the talking-circuit when connection

is established with a called line, a trunk-re-
lay adapted when energized to prevent the
operation of said signal, said relay being ac-
tuated by current over both sides of the
trunk with suitable return when connection 70
is established at the outgoing end, and means
for disconnecting said relay when the called
subscriber responds, substantially as de-
scribed.

5. The combination with a trunk-circuit 75
extending between different switchboard-
sections and adapted to connect subscribers'
lines together for conversation, of a discon-
nect-signal for the incoming end of the trunk,
a relay actuated over a portion of the talk- 80
ing-circuit when connection is established
with a called line to place said signal in con-
dition to operate, a trunk-relay adapted
when actuated to prevent the operation of
said signal, said relay being connected at the 85
incoming office between the outgoing end of
the trunk and ground, a source of current
likewise connected at the outgoing office
when the connection is established at said 90
end, a third relay responsive to current in the
line when the called subscriber answers to
sever the connection of said trunk-relay with
the circuit, said third relay being arranged
to prevent the operation of said signal while
the trunk-relay is disconnected, substan- 95
tially as described.

6. The combination with a trunk-circuit
extending between different switchboard-
sections and adapted to connect telephone-
lines together for conversation, of a discon- 100
nect-signal for the incoming end of the trunk,
a relay placed in condition to operate by cur-
rent over a portion of the talking-circuit
when connection is established with the
called line, a trunk-relay with its coil per- 105
manently connected to ground and adapted
to be actuated over the two limbs of the out-
going end of the trunk in parallel and ground,
when a connection is established at the out-
going end, said relay serving to prevent the 110
operation of said signal, and a pilot-relay at
the incoming end actuated simultaneously
with said signal, substantially as described.

7. The combination with a trunk-circuit
extending between different switchboard- 115
sections and adapted to connect telephone-
lines together for conversation, of a guard-
signal at the incoming end, a trunk-relay ac-
tuated over both sides of the circuit of the
outgoing end of the trunk and ground when 120
the connection exists at said outgoing end,
said relay serving to place said signal in con-
dition to operate, and a second relay actu-
ated by current over a portion of the talking-
circuit when a connection is established with 125
the called line to render said signal inoper-
ative, substantially as described.

8. The combination with a trunk-circuit
extending between different switchboard-sec- 130
tions and adapted to connect telephone-lines

together for conversation, of a guard-signal for the incoming end of the trunk, a trunk-relay connected between both the outgoing ends of the trunk and ground and actuated by current thereover when a connection exists therewith at the outgoing end to place said signal in condition to operate, a second relay at the incoming end actuated by current over a portion of the talking-circuit when connection is established with the called line and normally completing the circuit of said signal, and a pilot-signal at the incoming end actuated simultaneously with said guard-signal, substantially as described.

9. The combination with a trunk-circuit extending between different switchboard-sections and adapted to connect telephone-lines together for conversation, of a cord-circuit at the outgoing end to connect with said trunk, a repeating-coil having its windings connected across said cord-circuit, a relay legged from the middle point of the windings connected with the trunk end of the cord-circuit to the live pole of a battery, a signal controlled by said relay, a trunk-relay at the incoming end of the trunk legged to ground from the outgoing end, and means to sever the connection of said trunk-relay with the trunk when the called subscriber responds, whereby both the trunk-relay and the supervisory relay at the outgoing end are rendered inoperative, substantially as described.

10. The combination with a trunk-circuit extending between different switchboard-sections and adapted to connect telephone-lines together for conversation, of a disconnect-signal at the incoming end of the trunk, a source of current at said end, a relay also at said end to place said signal in condition to operate and actuated by current from said source over a portion of the talking-circuit when connection is made with the called line, a trunk-relay at the incoming end connected between the outgoing end of the trunk and ground and actuated by current sent over the trunk from the outgoing end when connection is established at said end, said trunk-relay serving to prevent the operation of said signal when energized, a third relay at the incoming end responsive to current in the line when the called subscriber answers, said

relay serving to disconnect the trunk-relay and to prevent the actuation of said signal when energized, said current source serving to charge the transmitters for talking as well as for the operation of some of said relays, substantially as described. 55

11. The combination with a trunk-line extending between different switchboard-sections, of a cord-circuit adapted to be connected with said trunk at its outgoing end, and a called subscriber's line with which its incoming end is adapted to be connected, a supervisory relay associated with the cord-circuit and a trunk-relay associated with the incoming end of the trunk-line, said relays being adapted to be actuated simultaneously by current over the outgoing end of the trunk, ground, and through their windings in series when connection is established at the outgoing end of the trunk, of signals associated, one with each of said relays and adapted to be displayed by the actuation thereof, a second relay associated with the incoming end of the trunk actuated when connection is established with the called line to render one of said signals inoperative and a third relay associated with the same end of the trunk actuated when the called subscriber responds to render the other of said signals inoperative, substantially as described. 60 65 70 75 80

12. The combination with a trunk-line extending between different switchboard-sections, of a cord-circuit adapted to be connected with said trunk at its outgoing end, and a called subscriber's line with which said trunk is adapted to connect at its incoming end, of a supervisory relay associated with the cord-circuit, and a trunk-relay associated with the incoming end of the trunk-line, said relays being in series with the two limbs of the trunk-line in parallel, and having their circuit controlled by the position of the called subscriber's receiver-hook, substantially as described. 85 90 95

Signed by me at Chicago, county of Cook, State of Illinois, this 29th day of July, 1902.

FRANCIS W. DUNBAR.

Witnesses:

ROBERT LEWIS AMES,
GAZELLE BEDER.