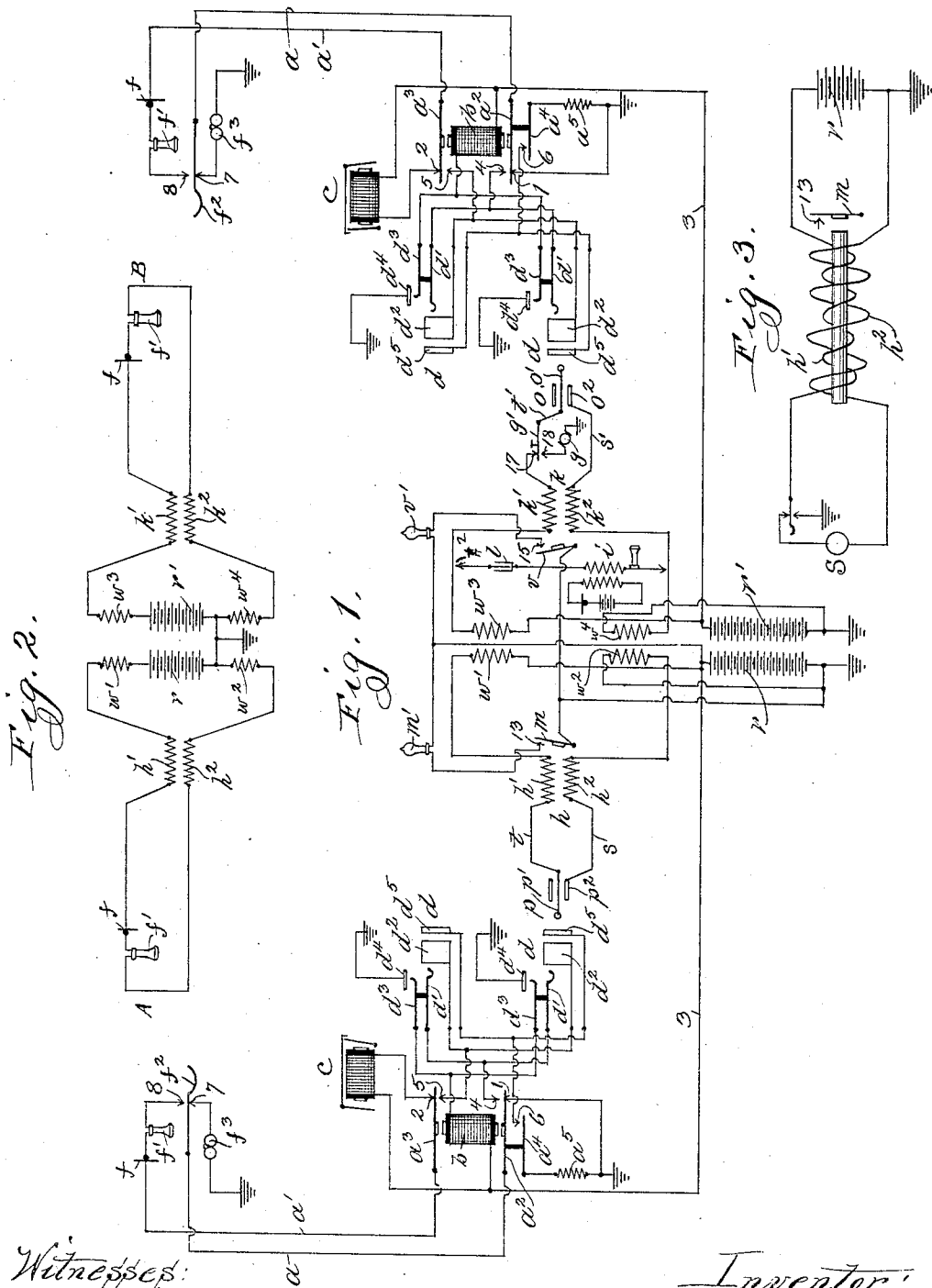


K. B. MILLER.
CENTRAL ENERGY TELEPHONE SYSTEM.

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NO MODEL.



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UNITED STATES PATENT OFFICE.

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CENTRAL-ENERGY TELEPHONE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 774,770, dated November 15, 1904.

Application filed December 19, 1900, Serial No. 40,374. (No model.)

To all whom it may concern:

Be it known that I, KEMPSTER B. MILLER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Central-Energy Telephone Systems, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to a central-energy telephone system, my object being to provide an improved form of signaling apparatus at the central station and, moreover, to provide an improved form of relay for actuating the supervisory signals.

In accordance with my invention in the preferred form thereof I employ a relay for controlling the supervisory signal, the relay being provided with two windings, one winding being included in series with each strand of the cord connectors at the central station. The windings of the relay are wound upon a single core in such a manner that when traversed by the current from the charging source of electricity the windings will neutralize each other, whereby the relay remains inert. During conversation the windings of the relay are thus traversed by the charging-current and, due to the fact that the windings are in opposition, the windings offer no appreciable impedance to the passage of the talking-currents, since the currents of self-induction induced by the talking-currents in the two windings neutralize each other. In order to actuate the relay, I provide means whereby the subscriber may send current through one of the windings of the relay to thereby energize the core thereof and operate the supervisory signal.

Instead of connecting the windings of the relay in series with the strands they may be otherwise connected without departing from the spirit of my invention, the essential feature of which in this respect is the provision of a relay having windings so related as to render the relay inert during the passage of the charging-current through both windings. My invention further contemplates the em-

ployment of a relay thus rendered inert during the passage of the charging-current and adapted to be actuated by unbalancing the relay-windings—as, for instance, by sending current through one of the windings alone.

I have described my invention in the accompanying drawings, in which—

Figure 1 is a diagram illustrating two telephone-lines and the central-station apparatus for connecting the same for conversation. Fig. 2 is a diagram showing the talking-circuit. Fig. 3 is a diagram showing the relay-circuit.

Like characters refer to like parts in the several figures.

The telephone-line A extends in two limbs a a' to the central station, where said limbs terminate, respectively, in the springs a^2 a^3 , the spring a^2 normally resting against back contact 1, which is connected to ground, the spring a^3 normally resting against back contact 2, which is connected through individual annunciator c to conductor 3. The springs a^2 and a^3 carry armatures resting opposite the poles of a relay-magnet b , and the spring a^2 when attracted is adapted to engage back contact 4, which is connected with the line-springs d' d' of the spring-jacks or switch-sockets d d . The spring a^3 is adapted when attracted to engage contact 5, which is connected with the sleeves d^2 d^2 of the spring-jacks. Moving with the spring a^2 , but insulated therefrom, is a spring a^4 , connected to ground through a resistance a^5 and adapted when the relay is energized to engage contact 6, which is connected with the test-rings d^3 d^3 . One end of the winding of relay b is connected with conductor 3, and the other end is connected with the contact-springs d^3 d^3 , which springs are mounted to move with but insulated from the line-springs d' d' , respectively. When the plug is inserted in the spring-jack, the line-spring d' is moved by the tip thereof to carry the spring d^3 into engagement with the grounded contact d^4 .

The subscriber is provided at the substation with the usual microphone f , receiver f' , and switch-hook f^2 , adapted when the line is not

in use to engage contact 7, which is connected through bell f^3 to ground. When the telephone is removed from the hook, the hook engages contact 8, which is connected with the telephone transmitter and receiver. The telephone-line B (shown at the right of the drawings) is like the telephone-line A and is provided with the same parts and mechanism, and like parts have been indicated by the same reference characters employed in connection with the line A.

The answering-plug p is provided with a tip p' and a sleeve p^2 , the tip p' being connected with strand t and the sleeve with strand s . The calling-plug o is provided with a tip o' and a sleeve o^2 , the tip being connected with strand t' and the sleeve with strand s' . The answering and calling plugs are united through a repeating-coil w , the windings w' and w^2 thereof being connected between strands t and s and the windings w^3 and w^4 being connected between strands t' and s' . The battery r is interposed between the windings w' and w^2 , and the battery r' is interposed between the windings w^3 and w^4 . The relay h is provided with a winding h' in series with the strand t and a winding h^2 in series with a strand s . Likewise the relay k is provided with a winding k' in series with the strand t' and a winding k^2 in series with the strand s' . The conductor 3 extending to a portion of the telephone-lines is connected with one pole of the battery r , and the conductor 3 extending to the remaining telephone-lines is connected with one pole of the battery r' . The other poles of these batteries are connected with ground. Opposite the pole of relay h is a spring m , carrying an armature, and this spring when the relay is energized is adapted to engage contact 13 to close the circuit of battery r through the lamp m' . Likewise spring v , situated opposite the pole of relay k , carries an armature adapted when attracted to carry said spring into contact with contact 15, to thereby close the circuit of battery r through the lamp v' . Instead of supplying current to both of these lamps from the battery r current to one or both of the lamps may be supplied from battery r' .

In the strand t' a key g' is provided, normally resting against contact 17 and adapted when depressed to engage contact 18 to send calling-currents from generator g over the line. The operator's telephone set i is bridged between the strands t' and s' , and a condenser l is connected in series with the telephone set.

I will now describe the method of connecting the subscribers for conversation. Supposing subscriber A desirous of conversing with subscriber B, he removes his receiver from the hook, thereupon closing together at the substation limbs a and a' and completing the circuit of battery r from ground over conductor 3, through annunciator c , contacts 2 and a^3 , limb a' , limb a , contacts a^2 and l , to ground, and back to the battery. The indi-

vidual annunciator c is thus actuated to convey to the operator the signal for connection. The operator thereupon inserts the answering-plug p in the spring-jack belonging to subscriber A. The engagement of the tip of the plug with spring d' moves said spring to carry the spring d^3 into engagement with contact d^4 . Circuit is thus closed through relay b , this circuit being traced from ground through battery r , conductor 3, relay b , spring d^3 , contact d^4 to ground. Relay b thereupon attracts springs a^2 and a^3 , separating the same, respectively, from contacts 1 and 2 and removing the annunciator c from circuit, and said springs a^2 and a^3 engage, respectively, contacts 4 and 5, thereby connecting the terminals of the spring-jack with the limbs of the telephone-line. The insertion of the answering-plug in the spring-jack also closes the circuit from battery r through windings w' and w^2 of the repeating-coil, through the windings h' and h^2 of the relay h , and through the strands t and s and the limbs a and a' of the line A. The windings h' and h^2 of the relay are thus both traversed by battery-current, and, as shown in Fig. 3, these windings are placed upon the core in opposition, so that the winding h' tends to polarize the core with one polarity, while the winding h^2 tends to polarize the core with the opposite polarity. The result is that during the flow of the current from battery r through both windings the core remains neutral and the armature upon spring m remains unattracted. After inserting the answering-plug the operator connects her telephone set i in circuit and having received the number of the called subscriber lifts the calling-plug o and touches the tip thereof to the test-ring d^5 belonging to the spring-jack of the called subscriber. If the line of the called subscriber is connected for conversation at another section of the switch-board, the relay b of the called subscriber will be energized. In this condition the touching of the tip of the calling-plug to the test-ring d^5 of the called subscriber will produce a click in the operator's telephone which will indicate that the line called for is busy. If the operator hears no click, she will know that the line is disengaged. The click in the telephone is due to the change of potential of the point of connection where the operator's telephone set is connected to strand t' . When the tip of the calling-plug is not in contact with the test-ring, the battery r' is on open circuit and the point of connection t^2 of the telephone set with the strand t' will be of the same potential as the battery. When, however, the tip of the calling-plug is touched to the test-ring, the circuit of battery r' will be closed from ground through said battery, winding w^3 , winding k' , strand t' , tip o' , test-ring d^5 , contacts 6 and a^4 to ground. The potential of the point t^2 will thus be lowered, due to the interposition of the resistance w^3 between said point and the

pole of the battery, and a momentary current will thus be caused to flow to the telephone-receiver, due to the change of potential at the point t^2 . If upon testing the operator finds
 5 that the line of the called subscriber is not busy, she inserts the calling-plug o into the spring-jack of the called subscriber B. The operator then depresses key g' and sends ringing-current from generator g over tip o' ,
 10 spring d' , contacts 4 and a^2 , limb a , through the subscriber's bell to ground. When the subscriber responds and lifts his receiver from the hook, the limbs a and a' are closed together at the substation and the circuit of bat-
 15 tery r' is completed through the windings $w^3 w^4 k' k^2$, strands $t' s'$, and limbs $a a'$, the windings $k' k^2$ being wound upon the core to neutralize each other. When the battery-current is flowing through both coils, the lamp v' will
 20 be extinguished.

The circuit arrangement during conversation is illustrated in Fig. 2. When subscriber A is talking, his microphone varies the resistance of the circuit containing battery r , and a vibratory current is thus produced through
 25 the windings $w' w^2$, which induces a corresponding current in the windings $w^3 w^4$ to alter current conditions through the receiver of subscriber B. Likewise when subscriber
 30 B is talking the vibratory current through windings $w^3 w^4$ induces a corresponding current in the windings $w' w^2$. Since the windings k' and k^2 are superimposed, of equal number of turns, and in opposition, the talking-current traverses the windings k' and k^2 without
 35 impedance. The self-induction in one of the windings neutralizes the self-induction in the other. Likewise the coils k' and k^2 offer no impedance to the passage of the talking-currents. When the subscribers have completed
 40 their conversation, they hang up their receivers, and the lamps m' and v' are thus lighted to convey to the operator the signal for disconnection. When, for instance, the
 45 subscriber A hangs up his receiver, the circuit of battery r is closed from ground through windings w' and k' , strand t , tip p' , line-spring d' , contacts 4 a^2 , limb a to ground at the substation. Current thus traverses windings k' ,
 50 while the winding k^2 remains deenergized, and the core of relay k is thus polarized to attract its armature and close spring m against contact 13, thereby closing the circuit of battery r through the lamp m' . Likewise the hang-
 55 ing up of the receiver of subscriber B energizes relay k to light the lamp v' . Noting the signal for disconnection, the operator withdraws the plugs p and o from the respective sockets, and the lamps m' and v' are thus
 60 extinguished, due to the opening of the battery-circuits at the terminals of the plugs. If either subscriber desires an immediate reconnection with another subscriber, he may in the usual manner vibrate his switch-hook
 65 up and down to thereby cause his lamp to be

alternately lighted and extinguished, thereby signaling the operator for a new connection.

Since the two windings of the relay are in opposition, the self-induced currents in the two windings due to the passage of talking-
 70 currents will neutralize each other. In consequence the relays may be mounted in position side by side in the usual manner without the employment of an inclosing sheath of iron or copper, as has been the usual practice with
 75 relays of the prior art, due to the fact that the talking-currents traversing the windings of relays as commonly employed heretofore induce corresponding currents in the windings of adjacent relays, thereby causing cross-talk.
 80 It has been the usual practice heretofore to surround the relay with a sheath of iron or copper to thereby prevent the formation of an external field and in this manner to prevent the cross-talk between the relays. By
 85 employing the relay of the present invention there will be no external field, since the relay-windings neutralize each other, and accordingly the relays may be held in position without inclosing sheaths, and the cost of installation may thus be materially reduced without
 90 affecting the operation of the system.

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

1. The combination with a telephone-line, of a connection-terminal therefor normally operatively disconnected from the line, a line-signaling device for the line, a cord-circuit, a
 100 source of current to send current over the metallic line for talking, a supervisory-signal-controlling electromagnet having differential windings disposed in the path of current from said source over the line-circuit, said magnet
 105 being rendered neutral by the current over the metallic circuit during conversation and energized by the excess of the magnetic effect in one of the differential coils at the termination of the conversation, a cut-off relay for the
 110 line to connect said terminal with the line when operated and to render said signal inoperative, and means to energize said relay by the act of connecting the cord-circuit with the line without unbalancing the said signal-controlling electromagnet.

2. The combination with a telephone-line, of a connection-terminal therefor normally operatively disconnected from the line, a line-signaling device for the line, a cord-circuit, a
 120 source of current for sending current over the metallic line for talking, a supervisory-signal-controlling electromagnet having differential windings disposed in the path of current from said source over the line-circuit, said magnet
 125 being rendered neutral by said current over the metallic circuit during conversation and energized by the excess of magnetic effect in one differential coil at the termination of the conversation, a cut-off relay for the line to
 130 connect said terminal with the line when op-

erated and to render said signal inoperative, and means to energize said relay from said source by the act of connecting the cord-circuit with the line without operating said signal by current over its circuit.

3. The combination with a telephone-line, of a connection-terminal therefor normally operatively disconnected from the line, a line-signaling device for the line, a cord-circuit, a source of current associated with the cord-circuit and adapted to send current over the metallic line for talking, a supervisory-signal-controlling electromagnet having differential windings disposed in the opposite sides of the cord-circuit, said magnet being rendered neutral by said current over the metallic circuit during conversation and energized by the excess of magnetic effect in one differential coil at the termination of the conversation, a cut-off relay for the line to connect said terminal with the line when operated and to render said signal inoperative, and means to energize said relay from said source by the act of connecting the cord-circuit with the line without permitting a flow of current over the circuit of said signal whereby said signal is not first operated.

4. The combination with a telephone-line, of a connection-terminal therefor normally operatively disconnected from the line, a line-signaling device for the line, a cord-circuit, a source of current associated with the cord-circuit, and adapted to send current over the metallic line for talking, a supervisory-signal-controlling electromagnet having differential windings disposed in the path of current from said source over the line-circuit, said magnet being rendered neutral by the current over the metallic circuit during conversation and energized by the excess of the magnetic effect in one of the differential coils at the termination of the conversation, a cut-off relay for the line to connect said terminal with the line when operated and to render said signal inoperative, and means to energize said relay from said source by the act of connecting the cord-circuit with the line without unbalancing the said signal-controlling electromagnet.

5. The combination with a telephone-line, of a connection-terminal therefor normally operatively disconnected from the line, a line-signaling device for the line, a cord-circuit, a source of current associated with the cord-circuit and adapted to send current over the metallic line for talking, a supervisory-signal-controlling electromagnet having differential windings disposed in the opposite sides of the cord-circuit, said magnet being rendered neutral by said current over the metallic circuit during conversation and energized by the excess of the magnetic effect in one differential coil at the termination of the conversation, a cut-off relay for the line to connect said terminal with the line when operated and to ren-

der said signal inoperative, and means to energize said relay from said source by the act of connecting the cord-circuit with the line without unbalancing the said signal-controlling electromagnet.

6. The combination with a telephone-line, of a connection-terminal therefor normally operatively disconnected from the line, a line-signaling device for the line, a cord-circuit, a source of current associated with the cord-circuit and adapted to send current over the metallic line for talking, a supervisory-signal-controlling electromagnet having differential windings disposed in the opposite sides of the cord-circuit, said magnet being rendered neutral by said current over the metallic circuit during conversation and energized by the excess of the magnetic effect in one differential coil at the termination of the conversation, a cut-off relay for the line to connect said terminal with the line when operated and to render said signal inoperative, and means to energize said relay by the act of connecting the cord-circuit with the line without unbalancing the said signal-controlling electromagnet.

7. The combination with a telephone-line, of a connection-terminal therefor normally operatively disconnected from the line, a line-signaling device for the line, a cord-circuit, a source of current associated with the cord-circuit and adapted to send current over the metallic line for talking, a supervisory-signal-controlling electromagnet having differential windings disposed in the path of current from said source over the line-circuit, said magnet being rendered neutral by said current over the metallic circuit during conversation and energized by the excess of magnetic effect in one differential coil at the termination of the conversation, a cut-off relay for the line to connect said terminal with the line when operated and to render said signal inoperative, and means to energize said relay in the act of connecting the cord-circuit with the line without operating said signal by current over its circuit.

8. The combination with a telephone-line, of a connection-terminal therefor normally operatively disconnected from the line, a line-signaling device for the line, a cord-circuit, a source of current associated with the cord-circuit and adapted to send current over the metallic line for talking, a supervisory-signal-controlling electromagnet having differential windings disposed in the opposite sides of the cord-circuit, said magnet being rendered neutral by said current over the metallic circuit during conversation and energized by the excess of magnetic effect in one differential coil at the termination of the conversation, a cut-off relay for the line to connect said terminal with the line when operated and to render said signal inoperative, and means to energize said relay in the act of connecting the cord-circuit

with the line without permitting a flow of current over the circuit of said signal whereby said signal is not first operated.

9. The combination with a telephone-line, of a connection-terminal therefor normally operatively disconnected from the line, a line signaling device for the line, a cord-circuit, a source of current associated with the line-circuit and adapted to send current over the metallic line for talking, a supervisory-signal-controlling electromagnet having differential windings disposed in the path of current from said source over the line-circuit, said magnet being rendered neutral by said current over the metallic circuit during conversation and energized by the excess of magnetic effect in one differential coil at the termination of the conversation, a cut-off relay for the line to connect said terminal with the line when operated and to render said signal inoperative, and means to energize said relay in the act of connecting the cord-circuit with the line without operating said line-signal or unbalancing said signal-controlling electromagnet.

10. The combination with a telephone-line, of a connection-terminal therefor normally operatively disconnected from the line, a line signaling device for the line, a cord-circuit, a source of current associated with the cord-circuit and adapted to send current over the metallic line for talking, said magnet being rendered neutral by said current over the metallic circuit during conversation and energized by the excess of magnetic effect in one differential coil at the termination of the conversation, a supervisory-signal-controlling electromagnet having differential windings disposed in the opposite sides of the cord-circuit, a cut-off relay for the line to connect said terminal with the line when operated and to render said signal inoperative, and means to energize said relay in the act of connecting the cord-circuit with the line without unbalancing the said magnet or actuating said signal.

11. The combination with a telephone-line, of a connection-terminal therefor normally operatively disconnected from the line, a line signaling device for the line, a cord-circuit, a source of current associated with cord-circuit and adapted to send current over the metallic line for talking, a supervisory-signal-controlling electromagnet having differential windings disposed in the path of current from said source over the line-circuit and rendered neutral thereby during conversation but adapted to be energized by an excessive magnetic effect in one coil at the termination of the conversation, a cut-off relay for the line adapted also to be energized from said source, to connect said terminal with the line and to render the device inoperative, and means for operating said cut-off relay by connecting the cord-circuit with the connection-terminal

without operating said signaling device or electromagnet.

12. The combination with a metallic telephone-line, of a line-signal therefor, a cord-circuit at the central office to establish conversational circuits with the line and consisting of two strands only, a third conductor, a supervisory-signal-controlling electromagnet associated with the cord-circuit and having two differential windings, a source of electricity at the central office adapted to send current through both of said windings over the metallic circuit or through one of said windings with return over said conductor, a cut-off relay for the line adapted when operated to render the line-signal inoperative, and means for actuating said cut-off relay from said source by connecting the cord-circuit with the line without unbalancing said electromagnet, substantially as described.

13. The combination with a pair of telephone-lines, of a pair of plugs and cords and an inductive means joining the cords for uniting the lines for conversation, a differential signal-controlling electromagnet for each cord, each of said electromagnets having two windings, one winding in series in the path of current over each strand of the corresponding cord, a separate source of grounded charging-current bridged across the strands of each cord, and a switch-hook at the substation of each of said lines, whereby the said source is allowed to send current over the metallic circuit of the corresponding line without energizing said electromagnet and over one limb only of said line and ground return to energize said electromagnet, substantially as described.

14. The combination with a pair of telephone-lines, of a pair of plugs and cords and an inductive means joining the cords for uniting the lines for conversation, a differential signal-controlling electromagnet for each cord, each of said electromagnets having two windings, one winding in series in each strand of the corresponding cord, a separate source of charging-current bridged across the strands of each cord, and a switch-hook in each of said lines, whereby each said source is allowed to send current over the metallic circuit of the corresponding line without energizing said electromagnet and over one limb only of said line to energize said electromagnet, substantially as described.

15. The combination with telephone-lines, a cord-circuit consisting of a pair of plugs and cords and an inductive means joining the cords, of a signal-controlling electromagnet for each cord having two differential windings, a separate charging source of electricity permanently connected with and between said windings, and means within the control of the subscribers alone for causing current to flow from said source serially

through said windings without energizing said electromagnet.

16. The combination with telephone-lines, of a cord-circuit consisting of a pair of plugs
5 and cords and an inductive means joining said cords, a separate battery bridged across each line as long as the line is switched for use, and having one pole grounded, a differential supervisory-signal-controlling electromagnet hav-
10 ing a winding in each of the strands of each cord, a suitable signal controlled by each said electromagnet, a hook-switch and a grounded signaling-bell at each substation, said switches being each adapted to close circuit from said
15 battery over one line-wire and one winding of the electromagnet and through the grounded bell when the receiver is operated, and to close circuit over the metallic line when the receiver is displaced to render the electromag-
20 net inoperative.

17. The combination with telephone-lines, of a cord-circuit consisting of a pair of plugs and cords and an inductive means joining them, of a differential signal-controlling elec-
25 tromagnet having two windings associated with each said cord-circuit, a separate talking-battery permanently connected with the windings of each signal and adapted to send current through them in a direction to cause the
30 same to neutralize each other, and means for sending current from said battery through one of said windings alone to energize the said electromagnet.

18. In a telephone system, the combination
35 with a multiple-switchboard telephone-line having a plurality of connection-terminals, of a line-signal therefor, a cord-circuit to establish connections with the line for conversa-
40 tion, a central source of current associated with the cord-circuit to furnish current for talking, said cord-circuit having only two strands and said strands forming portions of the two sides of the talking-circuit when in
45 use for conversation, test-contacts for the said connection-terminals of the line, means for determining the idle or busy condition of the line by touching the tip of a cord-circuit plug
50 to one of said test-contacts, a supervisory signaling device associated with the cord-circuit and having two differential windings, one in either side of the path of current over the cord-circuit from said central source, said device being neutral to current over the metallic line and responsive to an excess cur-
55 rent through one winding, substantially as described.

19. In a telephone system, the combination with a multiple-switchboard telephone-line having a plurality of connection-terminals, of
60 a line-signal therefor, a cord-circuit to establish connections with the line for conversation, a central source of current associated with the cord-circuit to furnish current for talking, said cord-circuit having only two
65 strands and said strands forming portions of

the two sides of the talking-circuit when in use for conversation, test-contacts for the said connecting-terminals of the line, means for determining the idle or busy condition of the line by touching the tip of a cord-plug to one
70 of said contacts, a cord signaling device associated with the cord-circuit and having two differential windings one in either side of the cord-circuit in the path of current over the cord-circuit from said central source, said de-
75 vice being neutral to current over the metallic line and responsive to an excess current through one winding, substantially as described.

20. The combination with a telephone-line
80 having its switchboard-section normally disconnected from the external line-circuit, of a calling-signal normally connected with said external line-circuit and separate from said switchboard-section of the line, a cord-circuit
85 to establish conversational circuits with the line, a source of current associated with the cord-circuit and adapted to be included in the metallic line to furnish current for talking, a supervisory-signal-controlling electromagnet
90 having differential windings disposed one in each side of the path of current from said source over the cord-circuit, said magnet being actuated when the magnetic effects in its coils are unbalanced, and a cut-off relay for
95 the line energized in connecting the cord-circuit with the line to render said line-signal inoperative and to connect said switchboard-section with the external line-circuit.

21. The combination with a telephone-line
100 having its switchboard-section normally disconnected from the external line-circuit, of a calling-signal normally connected with said external line-circuit and separate from said switchboard-section of the line, a cord-circuit
105 to establish conversational circuits with the line, a source of current associated with the cord-circuit and adapted to be included in the metallic line to furnish current for talking, a supervisory-signal-controlling electromagnet
110 having differential windings disposed in each side of the cord-circuit and in the path of current from said source, said magnet being actuated when the magnetic effects in its coils are unbalanced, and a cut-off relay for the
115 line energized in connecting the cord-circuit with the line to render said line-signal inoperative and to connect said switchboard-section with the external line-circuit.

22. The combination with a telephone-line,
120 of spring-jacks for the line normally disconnected from the external line-circuit but connected in multiple with the switchboard-section of the line, a calling-signal normally connected with the external line-circuit and dis-
125 connected from the said switchboard-section, a cord-circuit to establish conversational circuits with the line, said cord-circuit having only two strands, the said strands forming portions of the opposite sides of the talking-
130

circuit when in use, a source of current associated with the cord-circuit and arranged to be included in the metallic line to furnish current for talking, a supervisory-signal-controlling electromagnet, having differential windings disposed one in each side of the cord-circuit and in the path of current from said source, said magnet being actuated when the magnetic effects in its coils are unbalanced, a busy-testing circuit completed from said test-contacts over the tip-strand of the cord-circuit, and a cut-off relay for the line energized when a connection is established therewith by the cord-circuit to render said line-signal inoperative and to connect the switch-board-section of the line with the external line-circuit, substantially as described.

23. In a telephone-exchange system, the combination with a telephone-line, of a multiple-switchboard telephone-line extending from the substation to an exchange and having a plurality of connection-terminals at the exchange, each provided with a testing-contact and a cord-circuit at the exchange for connecting the said telephone-line with another, said cord-circuit having two strands only, the said strands being included in the opposite sides of the talking-circuit when in use, the busy-testing circuit being completed over one strand of the said cord-circuit, a signal in the cord-circuit provided with a controlling-magnet having differentially-wound coils, and a telephone switch-hook at the subscriber's station serving to close circuit through one of said coils when depressed through the agency of the receiver supported thereby and serving to close circuit through both of said coils when elevated, substantially as described.

24. In a telephone-exchange system, the combination with a telephone-line having its switchboard-section normally disconnected from the external line-circuit, of a calling-signal for the line normally connected with said external line-circuit, a cut-off relay for the line to render said signal inoperative and to connect the switchboard-section of the line with the external line-circuit, of a cord-circuit for connecting the said line with another, an indicator at the exchange provided with a controlling-electromagnet having differentially-wound coils, each strand of the cord-circuit including a coil thereof, and means for including one or both coils in circuit with the source of current, substantially as described.

25. In a telephone system, the combination with a telephone-line, of a plurality of connection-terminals therefor having each a main-line contact normally disconnected from the line but adapted to be connected therewith during conversation, a cord-circuit having two strands only to establish connections with the said lines for conversation, a differential relay associated with the line, a charging source of electricity also associated therewith

and means for sending current over the metallic line from said source and through said windings in a direction to cause them to neutralize each other, substantially as described.

26. In a telephone system, the combination with a telephone-line, of a plurality of connection-terminals therefor having each a main-line contact normally disconnected from the line but adapted to be connected therewith during conversation, a cord-circuit having two strands only to establish connections with the said lines for conversation, a differential relay associated with the line, a charging source of electricity also associated therewith and means for sending current from said source over the metallic line and in series through said windings to cause the windings to neutralize each other or for sending an excess current from said source through one only of said windings to cause the relay to be actuated, substantially as described.

27. The combination with a telephone-line and a connection-terminal therefor normally not in operative relation with the line, of a connecting-plug and cord-circuit to cooperate with said line, a supervisory-signal-controlling magnet and a battery associated with said cord-circuit, a telephone-transmitter and a switch at the subscriber's station, and means controlled by the insertion of the plug into the jack for placing the jack in operative relation with the line, whereby talking-current is furnished to said transmitter and said magnet is placed under the control of the subscriber.

28. The combination with a telephone-line, and a connection-terminal in the form of a spring-jack normally not in operative relation with the line, of a cord-circuit and a connecting-plug, a central source of current associated with said line and circuit to furnish talking-current to the substations, and means including said source of current actuated by the insertion of said plug in the jack for placing said jack in operative relation with said line.

29. The combination with a telephone-line and a connection-terminal in the form of a spring-jack, of a connecting-plug and a cord-circuit, a central source of current associated with said line and circuit to furnish current to the line for talking purposes, supervisory signal apparatus associated with the cord-circuit and operated from said source of current, and a relay actuated from said source by the insertion of said plug into and its withdrawal from said jack for controlling the operative relation of said jack with said line.

30. In a telephone system, a metallic-circuit line, a connection-terminal in the form of a spring-jack normally not in operative relation with said line, a connecting-plug and a cord-circuit, a signaling device normally in operative relation with said line, a central source of current and supervisory signaling appa-

ratus associated with said line and cord-circuit, said source being adapted to furnish current for the operation of said apparatus and to the line for talking purposes, and a relay actuated from said source when said plug is inserted in said jack to place said signaling device in inoperative relation with said line and said jack in operative relation with said line.

31. The combination with a telephone-line having a limb extending to the central station, of a line-contact for said limb normally disconnected therefrom, a cord-circuit and connecting-plug, supervisory signaling apparatus connected with said circuit, a central source of current associated with said line and circuit to furnish current to the line for talking purposes and for the operation of said supervisory apparatus, and means for automatically connecting said line-contact with said limb when the line is in use and for disconnecting the same therefrom when the line is not in use.

32. The combination with a telephone-line having a limb extending to the central station, of a signaling device normally connected with said limb, a line-contact for said line normally disconnected therefrom, a cord-circuit and connecting-plug, supervisory signaling apparatus associated with said cord-circuit, a central battery to furnish current to the line for

talking purposes and for the operation of said apparatus, and a relay energized from said battery adapted to disconnect said limb from said signaling device and to connect the same with the line-contact when a connection is established with the line.

33. The combination with a telephone-line having a limb extending to the central station, of a spring or moving part with which said limb connects at the central office, a signaling device connected with said spring or part in its normal position, a line-contact for said limb, a cord-circuit and connecting-plug, a central battery associated with the said line-circuit, supervisory signals also associated with the circuit, said battery being adapted to furnish current to the substations for talking purposes and for operating said supervisory signals, and a relay also energized from said battery adapted to disconnect said spring or part from the signaling device and to connect it with the line-contact when a connection is established with the line.

In witness whereof I have hereunto subscribed my name in the presence of two witnesses.

KEMPSTER B. MILLER.

Witnesses:

W. CLYDE JONES,
M. R. HYMAN.