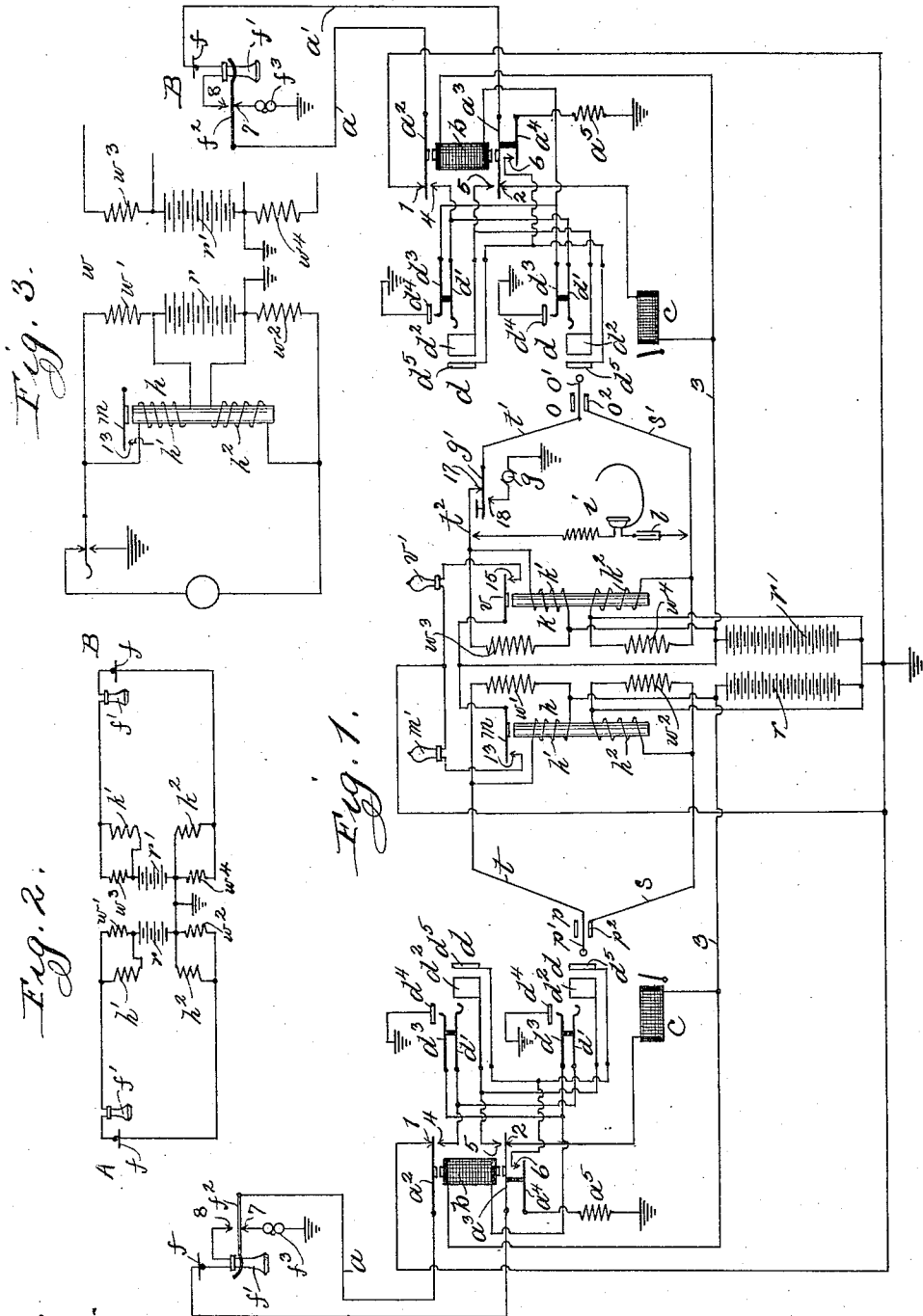


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F. W. DUNBAR.
CENTRAL ENERGY TELEPHONE SYSTEM.
APPLICATION FILED DEC. 19, 1900.



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UNITED STATES PATENT OFFICE.

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CENTRAL-ENERGY TELEPHONE SYSTEM.

No. 870,551.

Specification of Letters Patent.

Patented Nov. 12, 1907.

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To all whom it may concern:

Be it known that I, FRANCIS W. DUNBAR, 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 drawing, forming a part of this specification.

My invention relates to a central energy telephone system, my object being to provide an improved form of signal apparatus at the central station.

My invention relates more particularly to a telephone system employing so-called supervisory signals in which a relay is associated with the telephone circuit in such a manner that the same may be controlled by the subscriber to thereby close circuit through the supervisory signal which is usually in the form of a lamp adapted to be lighted and extinguished to give the desired signal.

It has been proposed to provide a telephone system in which the relay is provided with a pair of windings one included in series with each of the strands of the cord connector at the central station. The windings are placed in opposition so that during the passage of the charging currents through both windings the relay remains inert, the relay being actuated by unbalancing the windings, as for instance, by sending current through one of the windings alone.

It is the object of the present invention to provide a relay of this general type adapted to be connected in parallel with the talking circuit instead of in series therewith.

In order to place the windings in series in the talking circuit it is necessary to so relate the windings that the same will offer no impedance to the passage of the talking current, and accordingly, the two windings must be superimposed so that the core is subjected throughout its length to the conjoint action of the two windings.

When, however, the windings are bridged across the talking circuit it is necessary to provide impedance in the windings to oppose the passage of talking currents, while permitting at the same time the windings to neutralize the core when both are traversed by the charging current. To accomplish this effect I place the windings upon opposite ends with the same core, the windings being wound in opposition. Accordingly, when continuous current from the charging source traverses both windings the windings neutralize each other and the core is thus maintained inert and the relay is unactuated. When, however, current traverses one of the windings alone or when the current traversing one winding is in excess of that traversing the other winding the core is polarized and the relay is actuated. Since the windings are upon opposite ends of the core, each

winding will have a separate magnetic field when traversed by talking currents, and, accordingly, the talking currents will meet impedance in passing through the windings and the relay may thus be bridged across the talking circuit without materially shunting the talking currents.

I have illustrated my invention in the accompanying drawing in which:—

Figure 1 is a diagram illustrating two telephone lines and the central station apparatus for uniting the same for conversation. Fig. 2 is a diagram showing the talking circuits of two connected subscribers' lines. Fig. 3 is a diagram illustrating the relay windings and the circuit therethrough.

Like letters 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 front 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^3 of the spring jacks. Moving with spring a^3 , 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^4 . 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^4 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 drawing 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 letters employed in connection with line A.

The answering plug p is provided with a tip p' , and a sleeve p^2 , the former being connected with a strand t and the latter with strand s . The calling plug o is

provided with a tip o' and a sleeve o^2 , the former being connected with strand t' and the latter with strand s' . The strands t and t' are united through the windings of a repeating coil w . The windings w' and w^2 being connected between the strands t and s , the windings w^3 and w^4 being connected between the 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 . In parallel with the winding w' is the winding h' of relay h , and in parallel with the winding w^2 is the winding h^2 of said relay. Likewise, the winding k' of relay k is in parallel with winding w^3 and the winding k^2 of relay k is in parallel with the winding w^4 . The conductors 3 extending to the telephone lines are connected with the batteries r and r' , and the other poles of said batteries are grounded. Opposite the pole of relay h is an armature carried upon a spring m adapted when the relay is energized to engage contact 13. Contact 13 is connected through the lamp m' with one pole of the battery r' , and the spring m is connected with the opposite pole of said battery. Likewise, the spring n of relay k is connected with one pole of battery r' and the contact 15 is connected through the lamp n' to the opposite pole of the said battery. The windings h' and h^2 of the relay h are wound upon the core in such a manner that when the battery current r flows through one of said windings h' out over the telephone line back through the winding h^2 , the current will be in such a direction as to neutralize the core. Therefore, while the battery current flows through both windings, the relay h remains unenergized. When, however, current is passed through one of the windings alone, the core will be polarized to attract its armature. Since the windings h' and h^2 are wound upon opposite ends of the core and are not superimposed, the talking currents will meet impedance which will prevent the same passing through the windings h' and h^2 to short circuit the windings of the repeating coil. The relay thus opposes the passage of the talking current, is neutralized during the passage of the battery current through both windings, and is energized by the passage of the battery current through one of the windings. The relay k is wound and constructed in the same manner as relay h .

In the strand t' a ringing key g' is provided normally resting against contact 17 and adapted when depressed to engage contact 18, which is connected to ground through generator g . The operator's telephone set i is adapted to be connected between the strands t' and s' and a condenser l is interposed in the circuit of the telephone set.

Assuming now that subscriber A desirous of conversing with subscriber B he lifts his receiver from the telephone hook, thereby closing together the limbs a and a' at the substation. The circuit of battery r is thus closed over conductor 3, annunciator c , contacts 2 and a^2 , limb a' , limb a , contacts a^2 , 1, thence to the opposite pole of battery r . The individual annunciator c is thus actuated to convey to the operator the signal for connection, who thereupon lifts the answering plug p and inserts the same in the spring jack belonging to subscriber A. The insertion of the plug moves spring d^3 against contact d^4 thereby energizing the relay b , the circuit through said relay being traced from battery r

through conductor 3 relay b , spring d^3 contact d^4 to ground and back to the battery. The relay being thus energized attracts the armatures and moves springs a^2 and a^3 out of engagement, respectively with contacts 1 and 2, thus disconnecting the annunciator c from circuit and moves said springs into engagement, respectively, with contacts 4 and 5, thus connecting the terminals of the spring jacks with the limbs of the telephone line. The insertion of the answering plug also connects battery r in circuit through the windings h' and h^2 of relay h and through the strands t and s of the cord circuit and the limbs a and a' of the line. Current also traverses the windings w' and w^2 in parallel with the windings h' and h^2 , respectively. Since the battery current traverses both of the windings h' and h^2 the core of the relay remains neutral and the relay remains unactuated. The operator then connects her telephone set i in circuit and receives the number of the called subscriber. Learning that connection is desired with subscriber B she lifts the answering plug o and touches the tip o' thereof to the test ring d^5 belonging to the spring jack of subscriber B. If subscriber B is busy his relay b will be energized and test ring d^5 will be connected to ground through contact 6 and spring a^4 . If the line be thus busy the operator upon touching the tip of plug o to the test ring will hear a click in her telephone receiver, but on the other hand if the line be idle, she will hear no click and will know that the line is not busy. The click in the telephone is due to the fact that by touching the tip of the plug to the test ring d^5 of a busy line the potential at the point t^2 of strand t' is lowered thereby permitting a current to flow through the operator's receiver. When the tip o is not in contact with the test ring the battery r' is on open circuit, and the point t^2 is therefore of the same potential as the pole of the battery. When, however, the tip of the plug is touched to the test ring, of a busy line the circuit of battery r' is closed from ground through k' and w^3 , strand t' , tip o' , test ring d^5 , contacts 6 and a^4 , to ground. The resistance interposed between the pole of the battery and the point t^2 by the windings k' and w^3 lowers the potential of the point t^2 on closed circuit, and this change of potential of the point t^2 with which the operator's telephone set is connected, causes a momentary current to flow through the receiver, thereby causing a click therein.

Assuming that the operator finds the line of the called subscriber idle, she inserts the plug o therein and then depresses ringing key g' thereby sending current from generator g over strand t' , tip o' , spring d' , contacts 4 and a^2 , limb a , through bell f^3 to ground. When the subscriber responds, he lifts his receiver from the hook, thus closing together the limbs a and a' at the substation. The circuit of battery r' is thus closed through windings k' and k^2 , strands t' and s' , and limbs a and a' . Since the current flows through both of the windings of relay the relay remains unactuated. The circuits during conversation are shown in Fig. 2. When subscriber A is talking a vibratory current traverses windings w' and w^2 of the repeating coil thereby inducing corresponding currents in the windings w^3 and w^4 which traverse the receiver of subscriber B. Likewise, when subscriber B is talking a vibratory current traverses windings w^3 and w^4 thereby inducing similar currents in windings w' and w^2 which pass through the receiver of subscriber A. The windings h' and h^2 of the relay h being

in parallel with the windings of the repeating coil possessing impedance are not traversed by the talking currents. Likewise the impedance of windings k' k^2 prevents the passage of the talking current there-
5 through.

When the subscribers have completed their conversation and desire disconnection they hang up their telephone receivers, thereby separating limbs a a' at the substation and connecting limb a with ground. Lamps
10 m' and v' are thus lighted to convey to the operator the signal for disconnection. Thus, when subscriber A hangs up his telephone receiver, the circuit of battery r is closed from ground through winding k' , strand t , limb a , to ground at the substation. But one of the
15 windings of the relay h being thus energized, the core thereof is polarized to attract its armature and close together contacts m and 13 , thereby lighting lamp m' . Similarly the lamp v' is lighted by subscriber B in hanging up his telephone. The operator thereupon
20 removes the plugs p and o from the respective sockets and the circuits of the batteries are opened at the plug terminals, and the relays are deenergized to extinguish the lamps. If one of the subscribers should desire an
25 immediate re-connection with another subscriber he may, by vibrating his switch hook in the usual manner, cause the lamp to be alternately lighted and extinguished to thus convey the signal to the operator for re-connection.

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

1. The combination with a pair of telephone lines adapted to be united through an inductive device, of a signal controlling electro-magnet bridged between the two limbs of the talking circuit of one of said lines, said electro-magnet having two windings and possessing impedance to the passage of talking currents, and a charging source of electricity adapted to send current over the two limbs of the line in series and through said windings in a direction to cause the same to neutralize each other, said current source serving also to send an excess current through one of said windings to operate the magnet, substantially as described.

2. The combination with a pair of telephone lines adapted to be united through an inductive device, of a signal controlling electromagnet bridged between the two limbs of the talking circuit of one of said lines and having two windings and possessing impedance to the passage of talking currents, a charging source of electricity included in series between said windings to send current through said windings in a direction to cause the same to neutralize each other, and means for unbalancing said windings to energize said electromagnet, substantially as described.

3. The combination with a pair of telephone lines adapted to be united through an inductive device, of a signal controlling electro-magnet bridged between the two limbs of the talking circuit of one of said lines and having two windings and possessing impedance to the passage of talking currents, a charging source of electricity adapted to send current through said windings and over the telephone line to the substation in series to cause the said windings to neutralize each other, and means for sending current through one of said windings alone to energize said electro-magnet, substantially as described.

4. The combination with a pair of telephone lines adapted to be united through an inductive device, of a signal controlling electro-magnet bridged between the two limbs of the talking circuit of one of said lines and having two windings and possessing impedance to the passage of talking currents, a charging source of electricity adapted to send current through said windings in a direction to cause the same to neutralize each other and over the telephone line to the substation for talking purposes, and means for sending current from said source over one limb through

one of said windings alone with suitable return to energize said electro-magnet, substantially as described.

5. The combination with a pair of telephone lines adapted to be united through an inductive device, of a supervisory signal controlling electromagnet bridged between the two limbs of the talking circuit of one of said lines and having two windings and possessing impedance to the passage of talking currents, a charging source of electricity adapted to send current over the telephone line for talking purposes and through said windings in a direction to cause the same to neutralize each other, and means for closing circuit from said charging source through one of said windings alone over one limb of the telephone line with return through a third conductor, substantially as described.

6. The combination with a telephone line, of an electro-magnet bridged thereacross with a single core and two windings mounted upon opposite ends thereof, of a source of electricity adapted to send current through said windings in series to cause the same to normally neutralize each other and over the telephone line for talking purposes, whereby the passage of charging current neutralizes said core while the said windings offer impedance to the passage of non-continuous currents, means to unbalance the magnetism of said core by current from said source whereby the said electro-magnet is operated, and parts operated by said electro-magnet, substantially as described.

7. The combination with a telephone line, of a charging source of electricity bridged between the limbs thereof, a pair of electromagnetic windings included in said bridge, one on each side of said source of electricity, and a signaling device rendered inert by the passage of current through both of said windings and adapted to be actuated by the passage of current through one of said windings, substantially as described.

8. The combination with a telephone line, of a charging source of electricity for sending current therethrough, a repeating coil through which said line is adapted to be connected with another line for conversation, said repeating coil having its windings divided into two parts or coils, one situated upon each side of said charging source of electricity and a signal controlling electromagnet having two windings one in parallel with each of the parts or coils of said repeating coil, substantially as described.

9. The combination with a telephone line, of a repeating coil through which the same is adapted to be united with another line, said repeating coil having each winding thereof divided into two parts, a source of electricity connected between the two parts of each winding, a signal controlling electromagnet associated with said telephone line, and having two windings, one winding being in parallel with each part of the winding of said repeating coil connected with said line, and a switch at the substation for closing the circuit of said battery at will through both of the windings of said electromagnet or through one of the windings thereof, substantially as described.

10. The combination with a telephone line, of a repeating coil through which the same is adapted to be united with another telephone line, said repeating coil having each winding divided into two parts, a source of electricity connected between the two parts of each of said windings and connected upon one side with a third conductor, a signal controlling electromagnet having two windings, one winding being included in parallel with each of the parts of the winding of the repeating coil connected with said telephone line, and a switch at the substation for closing the circuit of said source of electricity through both of the windings of said electromagnet over the two limbs of the telephone line, or for closing the circuit of said source through one of the windings of said electromagnet over one limb of said telephone line with return through said third conductor, substantially as described.

11. The combination with a pair of telephone lines, of a repeating coil through which the same are adapted to be inductively united for conversation, each winding of said repeating coil being formed in two parts, a source of electricity connected between the two parts of each of said windings, a signal controlling electromagnet for each of said telephone lines, each electromagnet having two windings, one winding being connected in parallel with each of

the parts of the winding of the repeating coil connected with said line, and a switch at each substation for closing the current at will through one or both of the windings of the electromagnet belonging to said line, substantially as described.

12. The combination with telephone lines, of an operator's cord circuit to establish connections with the lines for conversation, an electro-magnet having two differential windings bridged across the cord circuit and possessing impedance to the passage of voice currents, a central source of current adapted to send current through said windings in a direction to cause the same to neutralize each other and over the telephone line for conversational purposes, and means for sending an excess current from said source through one of said windings to unbalance the same and energize said electro-magnet, substantially as described.

13. The combination with a metallic circuit telephone line and a third conductor, of a charging source of electricity adapted to send current in series over the two sides of said metallic circuit, a signal controlling electro-magnet bridged between the limbs of said metallic circuit and having differential windings, said windings being included in series in the path of said current over the line and adapted to neutralize each other when so traversed by current from said source, and means for closing the circuit of said charging source of electricity over one limb of said circuit and through one winding of said electro-magnet with return through the third conductor to operate said electro-magnet, substantially as described.

14. The combination with a plurality of telephone lines, each having connection terminals upon the different sections of a multiple switchboard, of means at each section of the switchboard including a repeating coil for uniting the lines in pairs for conversation, a signal controlling electro-magnet bridged across the talking circuit of each united pair upon each side of said repeating coil and possessing impedance to the passage of voice currents, each of said electro-magnets having two differential windings, means for sending a charging current over said lines to the substations and through said windings in series to neutralize said electro-magnets, and a switch at each substation for permitting an excess current to flow through one winding of the corresponding electro-magnet to energize the same, substantially as described.

15. The combination with a telephone line, of a cord circuit, a battery bridged across the cord circuit as long as the line is switched for use and having one pole grounded, a differential supervisory signal controlling electro-magnet bridged across the cord circuit and possessing impedance to the passage of voice currents, the windings of said electro-magnet being in the path of current from said source over the metallic line, a suitable signal controlled by said electro-magnet, a hook switch, and a grounded signaling bell at the substation, said switch being adapted to close circuit from said battery through one winding of said electro-magnet and one line wire, and thence through the grounded bell when the receiver is upon the switch-hook, whereby the electro-magnet is operated, and to close circuit over the metallic line when the receiver is displaced to render the electro-magnet inoperative, substantially as described.

16. The combination with a pair of telephone lines, of a pair of plugs and cords and an inductive means for joining the cords for uniting the lines for conversation, a signal controlling electro-magnet bridged across each cord and possessing impedance to the voice currents, each of said electro-magnets having two differential windings, a source of charging current bridged across the strands of each cord and adapted to send current through said windings, and a switch at the substation of each of said lines to permit current to flow from said source over the metallic circuit of the corresponding line without energizing said electro-magnet, and over one limb only of said line and ground return to energize said electro-magnet, substantially as described.

17. In a telephone exchange system, the combination with a telephone line extending from a substation to an exchange, of a cord circuit at the exchange for connecting said telephone line with another, a signal for the

cord circuit provided with a controlling magnet having differentially wound coils bridged across the cord circuit, a source of current at the central office connected between said windings and adapted to send current over the metallic line for conversation, and a telephone hook switch at the subscriber's station serving to close circuit through one of said coils when depressed through the agency of the receiver, and serving to close circuit through both of said coils when elevated, substantially as described.

18. In a telephone exchange system, the combination with a telephone line extending from a subscriber's station to an exchange, of an indicator at the exchange provided with a controlling electro-magnet having differentially wound coils bridged between the conductors of the talking circuit, a source of current at the central office connected between said coils and adapted to send current over the telephone line for conversation, a switch-hook at the subscriber's station, and means whereby when the switch-hook is depressed through the agency of the receiver supported thereby one of said coils is included in a circuit, and whereby when the said switch-hook is elevated circuit is completed through both of said coils, substantially as described.

19. 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 signal controlling electro-magnet for each cord bridged thereacross and possessing impedance to the passage of voice currents, each of said electro-magnets having two differential windings and connected with the opposite sides of the cords, a separate source of charging current between the windings of each electro-magnet, and a switch hook at each of the substations of the lines, whereby each source is allowed to send current in series over the two sides of the metallic circuit of the corresponding lines without energizing the electro-magnet associated therewith, or over one limb only of said line to energize said electro-magnet, substantially as described.

20. The combination with a pair of telephone lines adapted to be united through an inductive device, of a signal controlling electro-magnet bridged between the two limbs of the talking circuit of each of said lines and having two windings, said electro-magnet possessing impedance to the passage of the talking currents, a separate charging source of electricity adapted to send current through the windings of each electro-magnet and over the two sides of the telephone line in series to cause the same to neutralize each other, and means controlled by the subscriber for unbalancing said windings to energize said electro-magnet, substantially as described.

21. The combination with a pair of telephone lines, of a cord circuit including an inductive means joining its two ends to unite the lines for conversation, a signal controlling electro-magnet bridged between the two limbs of one end of the cord circuit and having two windings and possessing impedance to the passage of talking currents, a charging source of electricity adapted to send current through said windings in a direction to cause the same to neutralize each other, and means for sending current through one of said windings to energize said electro-magnet, substantially as described.

22. The combination with a pair of telephone lines adapted to be united through a cord circuit including an inductive device, of a signal controlling electro-magnet bridged between the two limbs of the cord circuit at one side of said device and having two windings and possessing impedance to the passage of talking currents, a charging source of electricity adapted to send current over the metallic telephone line for talking and through said windings in a direction to cause the same to neutralize each other, and means for sending current from said source over one limb through one of said windings with suitable return, substantially as described.

23. The combination with a pair of telephone lines adapted to be united through a cord circuit including an inductive device, of a supervisory signal controlling electro-magnet bridged between the two limbs of the talking circuit of one of said lines and having two windings and possessing impedance to the passage of talking currents, 160

a charging source of electricity adapted to send current over the two sides of the line in series for talking purposes and through said windings in a direction to cause the same to neutralize each other, and means for closing circuit from said charging source through one of said windings over one limb of the telephone line with return through a third conductor, substantially as described.

24. The combination with a telephone line and a connection terminal therefor normally in inoperative relation with said line, of a connecting plug and cord circuit adapted to cooperate with said line, a supervisory signal controlling electro-magnet having two differential windings bridged across the cord circuit, a battery connected between said windings and adapted to send current over the metallic line for conversation, a switch at the subscriber's station, and means controlled by the insertion of the plug into the connection terminal for placing said connection terminal in operative relation with the line whereby said signal controlling magnet is placed under the control of the subscriber, substantially as described.

25. The combination with a telephone line and a connection terminal in the form of a spring jack, of a central source of current associated with said line circuit to furnish current for talking purposes, a cord circuit a supervisory signal controlling electro-magnet having differential coils bridged across the cord circuit and possessing impedance to the passage of voice currents, the windings of said electro-magnets being connected in the path of current from said source over the metallic line, and a relay actuated from said source by the insertion of the plug into and its withdrawal from said jack for controlling the operative relation of said jack with the line, substantially as described.

26. 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 line signaling device normally in operative relation with said line, a central source of current and a supervisory signal controlling electro-magnet associated with said line and cord circuit, said magnet having two differential windings bridged across the cord circuit and possessing impedance to the passage of voice currents, the said source being connected between said windings and adapted to furnish current for talking purposes, and a relay actuated from said source when the plug is inserted in said jack to place said device in inoperative relation with said line and said jack in operative relation with said line, substantially as described.

27. The combination with a telephone line, of a line signal therefor, a cord circuit 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 electro-magnet bridged across the cord circuit and having differential windings disposed one in each side of the path of current from said source over the metallic line, said magnet being actuated when the magnetic effects in its coils are unbalanced, and a cut-off device for the line energized from said source when a connection is established by the cord circuit with the line to render said line signal inoperative and at the same time without unbalancing said supervisory signal controlling electro-magnet or operating said line signal by the act of making the connection, substantially as described.

28. 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 to send current over the metallic line for talking, a supervisory signal controlling electro-magnet bridged across the cord circuit and having differential windings disposed in the path of current from said source over the line circuit, said magnet being rendered neutral by current over the metallic circuit during conversation and energized by current over one side of the line at the termination of the conversation, a cut-off relay for the line to connect said terminal with the line 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 or unbalancing said electro-magnet, substantially as described.

29. The combination with a telephone line having a switchboard section normally operatively disconnected from the external line circuit, of a line signal normally connected with the external line circuit and separate from the switchboard section of the line, a cord circuit to establish conversational circuits with the line, a source of current adapted to be included in the metallic line to furnish current for talking, a supervisory signal controlling electro-magnet bridged across the cord circuit and 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 inoperative when the magnetic effects in its coils are neutral, and a cut-off relay for 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, all without unbalancing and operating said supervisory signal controlling electro-magnet, substantially as described.

30. The combination with a plurality of telephone lines, of a cord circuit to loop said lines together in pairs for conversation, means to inductively unite the ends of the cord circuit, a magnet bridged across each end of the cord circuit and having two differential windings, a source of current connected between said windings and adapted to send current over the corresponding metallic line during conversation, the magnet being neutral to such current, one pole of said source being grounded or connected to a common return, means controlled by the subscriber to cause current to flow from said source through one winding of the said magnet with return through the ground or common return to operate the magnet, a supervisory signal for each end of the cord circuit in a local circuit closed by the corresponding magnet when operated and opened thereby when deenergized, whereby the signals are normally inoperative but when a connection is established and the subscribers' telephones are not in use said signals are operated and are again inoperative during conversation, substantially as described.

31. In a telephone system, the combination with subscribers' lines having connection terminals and line signaling devices at the central office, of a cord circuit to establish connections between the lines for conversation, said cord circuit having a strand in each side of the talking circuit, means for inductively connecting and conductively separating the two ends of the cord circuit, means at the central office for supplying current to the lines for conversation, supervisory relay windings connected in series with said means for supplying current and between said cord strands and upon each side of the said inductive means, a normally inoperative supervisory signal for each end of the cord circuit controlled respectively by the said windings on the same side of the inductive means, the excitation of one of the said windings on each side of the inductive means causing the operation of the corresponding signal and the simultaneous excitation of the associated winding causing the said signal to become inoperative, substantially as described.

32. In a telephone system, the combination with subscribers' lines having connection terminals and line signaling devices at the central office, of a cord circuit to establish connections between the lines for conversation, said cord circuit having a strand in each side of the talking circuit, means for inductively connecting and conductively separating the two ends of the cord circuit, double supervisory signals associated with the cord circuit, a source of direct current at the central office, a relay for each of said signals associated, one with each end of the cord circuit, two windings for each of said relays connecting between the branches of the cord circuit and opposite poles of said source, said windings being adapted, one to neutralize the magnetizing effect of the other when equal currents flow through each, but to energize the relay when unequal currents flow therethrough, the actuation of each of said relays serving to display the signal associated therewith, substantially as described.

33. In a telephone system, the combination with a tele-

phone line, of a source of current and a pair of relay windings bridged between the two limbs of the talking circuit thereof, a switch at the substation and a switch at the central station for controlling the circuits through said relay windings, and a signal controlled by the conjoint energization of said relay windings, substantially as described.

34. In a telephone system, the combination with a telephone line, of a source of current and an electro-magnetic winding bridged between the two limbs of the talking circuit thereof, a second electro-magnetic winding connected in a circuit including a portion of one side of the talking circuit, and means for energizing it, a switch at the substation and a switch at the central station for controlling the circuits through said electromagnetic windings, and a supervisory signal controlled by the joint action of said electromagnetic windings, substantially as described.

35. The combination with a metallic telephone line free from permanent grounds outside the central office, of a cord circuit a charging current source, a third conductor, a

pair of relay windings associated with the cord circuit, one of said windings being energized over the telephone line, and the other over a portion of the talking circuit and the third conductor and a signal controlled by the conjoint action of said relay windings, substantially as described.

36. The combination with a telephone line, of a source of electricity and a pair of relay windings adapted to be bridged between the limbs of the talking circuit thereof, a switch at the central station for controlling the circuit through said relay windings, and a signal adapted to be controlled by the conjoint action of said windings, substantially as described.

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

FRANCIS W. DUNBAR.

Witnesses:

KEMPSTER B. MILLER,
MARY DOOLEY.