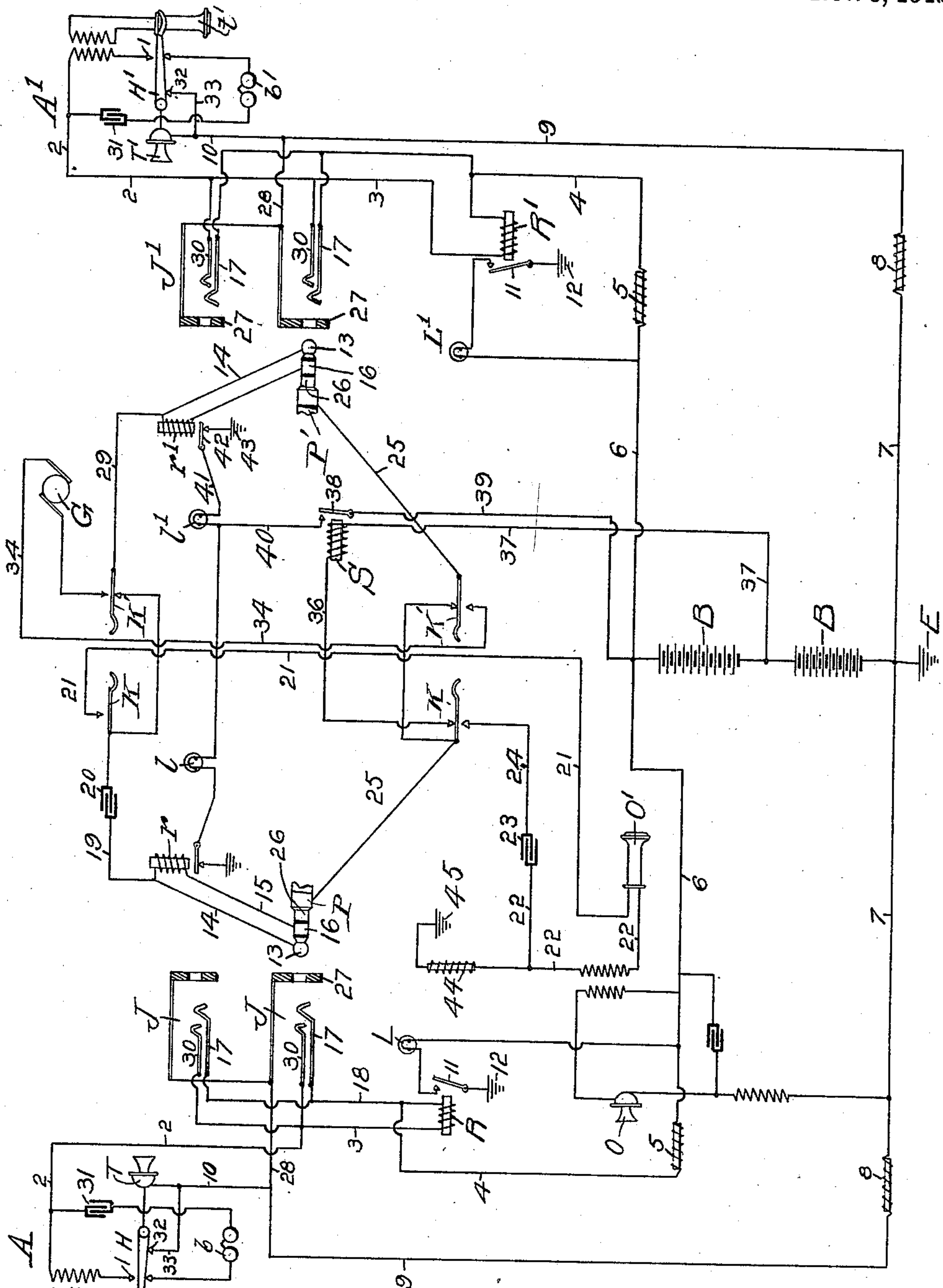


H. P. CLAUSEN.
TELEPHONE SYSTEM.
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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

1,043,299.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, HENRY P. CLAUSEN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems in general, but more particularly to systems of the complete metallic circuit and central energy type. In telephone systems of this character, complete metallic line connection is employed between each substation and the central exchange. Each line is preferably connected with a spring jack located on the switchboard at the central exchange. A line signal, preferably in the nature of a small incandescent lamp, is associated with each line terminal at the central station. The operator at the exchange is provided with a flexible cord having a plug at each end adapted for insertion in the jacks. In this way, the operator can connect up the jack of one subscriber's line with the jack of any other subscriber's line. A call sent in from one of the substations operates the line signal, so as to attract the attention of the operator, and the latter, upon receiving the order for connection, then inserts the calling plug of the cord-circuit in the jack of the called subscriber. Furthermore, in a system of this character, supervisory or clearing out signals are provided and arranged in connection with the operator's cord-circuit. These supervisory or clearing-out signals indicate when the subscribers have finished their conversation. The current, both for talking and signaling purposes, is supplied from a common battery located at the central exchange. In this way, local batteries at the substations are dispensed with, and all of the current necessary for the operation of the system is supplied from the central station. In a system of this type it is also the practice to employ suitable circuit arrangements whereby the line lamp is automatically extinguished or restored when the operator inserts the answering plug in the jack for the purpose of answering a call. Again, and in case the system is of the multiple switchboard type—that is to say, of that type in which each subscriber is connected with a plurality of switchboards or with a plurality of switch-board sections, the

circuit arrangement is such that the various operators can make what is known as the "busy" test, so as to ascertain whether or not the line called for is busy. This test is usually made by touching the tip of the calling plug to the testing ring of one of the multiple jacks, so as to cause, in case the line is busy, a sudden flow of current through the receiver of the operator's talking set. This sudden flow of current produces a click in the operator's receiver, indicating that the called-for line is busy.

Generally stated, it is the object of my invention to provide a simple and highly efficient telephone system of the foregoing character.

A special object is to provide an improved circuit arrangement for operating and controlling the line and supervisory signals.

Another object is to provide an improved circuit arrangement which will obviate the necessity of supplying current through the cord-strands to the lines.

A further object is to provide an improved arrangement whereby line current may be employed for shunting out the line relays.

It is also an object to provide an improved circuit arrangement which will enable an operator at the central exchange to make the usual busy test.

In addition, it is a further object to provide certain details and features of improvement tending to increase the general efficiency and to render a system of this character efficient and reliable in use.

To the foregoing and other useful ends, the line signals preferably consist of small incandescent lamps, and the local circuits of these lamps are controlled by line relays. When a call is sent in, one of these line relays is energized, and the relay armature, when attracted, causes battery current to flow through the local circuit of the line lamp. The arrangement is such that the central operator in answering a call extinguishes or restores the line lamp to its normal condition. Preferably, this automatic restoration of the line signal is obtained by shunting the current around the line relay, so as to allow the latter to release its armature. This shunt is of such character that the shunting action is obtained with line current, and without the

necessity of supplying current to the line through the cord-circuit. In other words, both terminals of the shunt are in the line, and the current, regardless of the polarity of the battery, must first pass through the line before passing through the conductor forming the shunt. In this way, as stated, the line signals are extinguished or restored by shunting out the line relays, but without the necessity of any direct connection between the cord-circuit and the battery. With this arrangement and method of operation, the signaling apparatus is controlled and operated in a convenient and efficient manner, and at the same time there is practically no liability of any of the cords being injured or burned out as a result of the passage of heavy battery current. Preferably, the test circuit includes a line relay and a substation when the subscriber's receiver is off the hook-switch and no plug is in one of the jacks. When a plug is in one of the jacks, however, then the test circuit preferably includes one of the supervisory relays. The nature and advantages of my improved circuit arrangement will, however, hereinafter more fully appear.

The accompanying drawing is a diagram illustrating a telephone system embodying the principles of my invention. In this diagram, only two of the substations are indicated, together with line connections and the jacks and cord-circuit of the central exchange. It will be understood that only such instruments and devices are illustrated as are necessary to a full understanding of the invention.

In said drawing, T, t, and b designate respectively the transmitter, receiver, and bell of any one subscriber's station A; T¹, t¹, and b¹, the corresponding parts of any other subscriber's station A¹; and O and O¹ the transmitter and receiver of the operator's cord circuit.

K K and K¹ K¹ represent the switches of the operator's ringing and listening key, G the calling generator, and P and P¹ the plugs by which to make connections with the jacks J and J¹ corresponding to the two subscribers' stations, a pair of jacks connected in multiple being herein shown for such subscriber to indicate that a multiple board is contemplated.

R and R¹ are high resistance relays connected in each subscriber's circuit and controlling calling signal lamps L and L¹, respectively, and r and r¹ are low resistance relays partially controlling supervisory signal lamps Z and Z¹, respectively, these supervisory signals being further controlled by a relay S.

B B are the common batteries or sources of operating energy of the exchange.

The method of connecting the pieces of apparatus thus referred to with themselves

and to other pieces of apparatus necessary to a complete telephone exchange will be readily understood by tracing the circuits existing in the system from time to time as the several different possible connections of the system are made. If the subscriber at station A wishes a connection he calls the operator at the central station by lifting his receiver from the hook H. This immediately completes a circuit from the hook and contact 1 through the line 2 and connection 3 to the coil of the high resistance relay R, and from this coil by connections 4 through an impedance coil 5 and connections 6 to the batteries B. Thence from the batteries through connections 7, impedance coil 8, connections 9, and line 10, back to the transmitter T and receiver hook H. The flow of current through this circuit will cause the magnet of the relay R to attract its armature 11 and thus close a local circuit from the battery through the signal lamp L to a ground 12, and from this ground back to the battery ground connection E, thus lighting the lamp and indicating to the operator that subscriber A is signaling. The operator then responds by placing the plug in subscriber A's jack J which completes a circuit from the line 2 to the tip 13 of the plug through the tip spring 30 of the jack, through a connection 14 to the coil of the low resistance relay r, thence back through a connection 15 and through the intermediate ring 16 of the plug to the intermediate jack spring and thence through connection 18, connection 4, impedance coil 5, and connection 6 to the battery, and thence through connection 7, impedance coil 8, connection 9, and line 10 back to the transmitter T and hook H as before. This obviously throws the coils of the two relays R and r into parallel and owing to the difference in resistance between them practically cuts out the relay R, thus releasing its armature 11 and opening the local circuit through the signal lamp L so as to restore the latter. The operator then closes her listening key K and completes a parallel circuit from the hook through the tip 13 and connection 14 and through a connection 19 and condenser 20 to the listening key K, thence through a connection 21 and 22, condenser 23 and connection 24 to the other side of the closed listening key K, and through the sleeve 27 of the jack, connection 28, and line 10 to the transmitter and the hook. Being now in talking communication with the subscriber, the operator learns the number of the subscriber to be called, and immediately proceeds to place the plug P¹ in the jack J¹ of such subscriber whose station is herein designated as A¹. Then she shifts her ringing and listening key so as to open the listening side K and close the ringing side K¹. This cuts off the operator's

telephone from subscriber A, but completes a circuit from the calling generator G through the ringing key K^1 and through connections 29 and 14 to the tip 13 of the plug, thence through the tip spring 30 of the jack and line 2, and through a condenser 31 to the bell b^1 , thence through the switch hook H^1 , contact 32, connection 33, line 10, and connection 28, to the sleeve 27 of the jack, and thence from the sleeve 26 of the plug by connection 25, to and through the closed ringing key K^1 , and through a connection 34, back to the generator. Having thus rung up station A^1 , the operator releases her ringing and listening key and permits it to resume its normal position as illustrated. Then when the called subscriber at station A^1 lifts his receiver from the hook, a circuit will be completed through contact 1 and line 2, tip spring and plug tip of the jack J^1 , connections 14 and 29, ringing and listening key, condenser 20, connections 19 and 14, plug tip and tip spring of jack J, line 2 and contact 1, to the hook H and transmitter T of station A. And thence back through line 10, connection 28, sleeve 27 and plug sleeve of jack J, connection 25, the ringing and listening key, connection 25, plug sleeve 26 and sleeve 27 of jack J^1 , connection 28, and line 10 back to the transmitter T^1 and hook H^1 of station A^1 , thus putting subscribers A and A^1 into talking communication. On the releasing of the ringing key by the operator, circuits will also be completed on each side from the jack sleeve 27, through the plug sleeve 26, connection 25 and through the ringing and listening key and connection 36 to the coil of the relay S and thence through connection 37 to the battery, thence from the battery through connection 7, impedance coil 8, and connections 9 and 28 to the sleeve of the jack. The resulting flow of current in this circuit will cause the magnet of the relay S to attract its armature 38 and close a line from the battery through circuit connections 39 and 40 to the supervisory lamp L^1 , thence through connections 41 and the armature 42 of the low resistance relay r^1 , to a ground 43 and thence back through the earth to the battery ground E. This flow of current will light the supervisory lamp and keep it lighted as long as the receiver at station A^1 remains on its hook and the plug P^1 remains in the jack j^1 . When, however, the subscriber at station A^1 lifts his receiver from the hook, as before described, still another circuit will be completed through the contact 1 and line 2, tip spring and plug tip of jack J^1 , and connection 14 to the coil of the relay r^1 and from this coil back through the intermediate sleeve 16 of the plug and intermediate spring 17 of the jack j^1 and through connection 4 to the batteries and thence back through connection 7, impedance coil 8, con-

nection 9 and line 10 to the transmitter T^1 and hook H^1 . And the flow of current through this circuit will in turn cause the relay r^1 to attract its armature 42, and open the circuit through the supervisory lamp L^1 . This lamp will then remain extinguished until the subscriber at station A^1 hangs up his receiver again, whereupon the circuit through the relay r^1 will be broken and its armature 42 will drop back and re-light the lamp, thus notifying the operator that the conversation is completed. In the meantime the supervisory lamp L for subscriber's station A will have remained dark owing to the closing of the circuit through the relay r due to the removal of the receiver R from the hook H and to the subsequent retraction of the armature 42 of the relay r which opens the circuit through the lamp to another ground 43. Just as with subscriber's station A^1 , however, when subscriber A hangs up his receiver the circuit through the relay r will be broken and the armature 42 will fall back, thus closing the circuit through the lamp L and causing it to light up and additionally notify the operator that the conversation has been terminated. The lighting up of the two lamps L and L^1 will ordinarily occur simultaneously, as the two subscribers will naturally hang up their receivers practically at the same moment, and thereupon the operator will withdraw the plugs leaving the apparatus free for a new connection, this connection being indicated by the going out of both supervisory lamps.

The operator's busy test for ascertaining whether or not the line wanted is already in use, will consist merely in moving the key K into listening position and touching the tip of the plug to the sleeve of the jack J^1 of the station called for before inserting the plug therein. Then if one of the multiple jacks of that line already contains a plug, a flow of current will result from the sleeve of the jack through the tip 13 of the plug, connections 14 and 29, keys K^1 and K, and connection 21, to the operator's receiver O^1 , and from the receiver through connection 22, impedance coil 44, into the ground at 45, thence to ground connection E and through battery B, and from the battery back to the sleeve through connection 37, relay S, connection 36, keys K and K^1 , connection 25, and sleeve 26 of the plug already inserted. This flow of current will cause a perceptible click in the operator's receiver, which click will indicate to the operator that the line is already in use. Or if it should happen that the jacks J^1 were free from plugs but that the subscriber at station A^1 had lifted his receiver from the hook for the purpose of himself asking for a connection, a flow of current would result in the same manner from the sleeve of the jack

through the operator's receiver to ground, thence back from the ground through batteries and connection 6, resistance 5, connection 4, relay R^1 , connection 3, line 2, contact 1, to the hook, and thence through the transmitter T^1 , line 10, and connection 28, back to the sleeve, this flow of current also producing a click in the operator's receiver indicative of the fact that the line is busy. In the first case—that is to say, when a plug is in one of the jacks, the test circuit includes the coil of the third supervisory relay S which is connected to the middle point of the battery B . It will be understood that by this is meant that the circuit includes the supervisory relay of the cord-circuit already in use. In the second case, however, the test circuit merely includes the line relay of the substation with respect to which the test is made.

Thus it will be seen that my improved telephone system is operated on the principle of retardation coil transmission, and that consequently the current required by the subscribers' telephones is distributed to the lines through retardation coils permanently connected to the subscribers' lines. As will be observed, these retardation or impedance coils are connected one to each side of the battery, one of the coils being connected to the sleeve side of the circuit and the remaining coil to the tip side of the circuit, the latter through an ordinary line-signal relay movement. With this arrangement, the central operator in answering a call shunts the line relay out of circuit, leaving the current supply upon the line from the battery directly through the impedance coils. Thus it will be seen that the cord-circuit is not employed for supplying current to the lines for talking purposes. The current passing through the shunt must, regardless of the polarity or arrangement of the battery, first pass through the line. In other words, both terminals of the shunt when in use are in the line or in the direct connection between the line and battery. With this method of operation, no objectionable sounds are produced in the subscriber's receiver when the operator answers the call. The cord-strands, as will be understood, are usually composed of fibrous material involving fine strands of tinsel. A slight break in any of these tinsel strands would ordinarily permit the battery current to arc across the break, and in this way burn out the cord. With my improved arrangement, however, it will be seen that there is practically no liability of any trouble of this kind, inasmuch as the only battery current passing through the cord-strands is that which flows through the supervisory relays. This current, it will be seen, is not taken directly from the batteries, as explained, but from the lines. In other words, with my improved arrangement, the insertion of a plug

in a jack does not create or establish a double source of current to one side of the line.

From the foregoing it will be seen that the substations are free from operating grounds, as both the talking and the signaling is conducted entirely over metallic line circuits. Therefore, it can be said that the telephone lines of my improved system are normally non-grounded at the substations thereof. Furthermore, it will be seen that the relay r and the relay S are, during conversation, connected with opposite poles of the battery or source of current. And also it will be seen that the telephone lines of my improved system are permanently connected with the source of talking current, which is also the source of signaling current. Thus each telephone line has at least one side thereof normally and permanently connected with one pole of the common battery.

I claim as my invention:—

1. In a telephone system, the combination of a central source of current, a plurality of subscribers' lines connected with said source of current, subscribers' switches for opening and closing the line circuits, an electro-magnet in each line circuit, an operator's cord circuit, and suitable connections and contacts normally disconnected from said source and adapted for shunting said electro-magnets when the cord circuit is connected with the lines.

2. In a telephone system, the combination of a central source of current, a plurality of subscribers' lines connected with said source of current, subscribers' switches for opening and closing the line circuits, an electro-magnet and an impedance coil connected in series in each line circuit, an operator's cord circuit, and suitable connections and contacts normally disconnected from said source and adapted for shunting the said electro-magnets and leaving the impedance coils in the circuits when the said cord circuit is connected with the lines.

3. In a telephone system, the combination of a central source of current, subscribers' lines connected with said source of current, a line signal and a line relay for each line, an operator's cord circuit, and suitable contacts and connections normally disconnected from said source and adapted for shunting said line relays when the cord circuit is connected with the lines.

4. The combination with a telephone line and line relay, of a source of current with which the line is connected, an operator's cord circuit, and means for shunting the line relay to render it inoperative when the cord circuit is connected with the line, said means comprising four switch contacts to close the shunt.

5. The combination with a telephone line, a line relay, and a signal controlled thereby, of a source of current connected with the

line, a jack having two terminals connected with the line, and an auxiliary terminal with which the line relay is connected, a cord circuit having a plug provided with two line contacts and an auxiliary contact adapted to connect with the auxiliary terminal of the jack, and a supervisory relay connected between one of the line contacts and the auxiliary contact of the plug so as to be connected in parallel with the line relay to short circuit the latter when the plug is inserted in the jack.

6. In a telephone system, the combination of a subscriber's line, a line relay in the line, a line lamp signal having a local-circuit controlled by said line relay, a shunt having its two ends or terminals adapted to be placed in the line to shunt said relay, so as to extinguish or restore said lamp, and central source of current from which said shunt is normally totally disconnected.

7. In a telephone system, the combination of a subscriber's line, a battery permanently connected with the line, impedance coils between the battery and line, a line relay between the substation and the said impedance coils, and a shunt adapted to be connected in the line between the substation and the impedance coils, so as to short-circuit said relay.

8. In a telephone system, the combination of a subscriber's line, a jack connected with the line and provided with tip and ring contact springs, a line relay connected with both of said springs, a source of current connected with the line, an operator's cord-circuit provided with a plug adapted for insertion in said jack, and a shunt connecting the tip and ring contacts of said plug, whereby the line relay is shunted out or deenergized when the plug is inserted in the jack.

9. In a telephone system, the combination of a subscriber's line, a jack connected with the line, a line relay, an operator's cord-circuit provided with a plug adapted for insertion in said jack, a source of current permanently connected with the line, and a shunt for short-circuiting the line relay when the plug is inserted in the jack, said shunt including a plurality of the contacts of said plug.

10. In a telephone system, the combination of a subscriber's line, a line relay, a line lamp signal having a local circuit controlled by said line relay, a source of current connected with the line, an operator's cord-circuit comprising a shunt connection adapted to be placed in the line circuit to short-circuit said line relay, a supervisory relay located in said shunt connection, but excluded from the talking circuit, and a supervisory lamp having a local-circuit controlled by said supervisory relay.

11. In a telephone system, the combination of a subscriber's line, a source of current

connected with the line, an inductive resistance and a line relay in the same side of the line, and a shunt adapted to be connected with the line for the purpose of shunting or short-circuiting said line relay, the said shunt including the said resistance.

12. In a telephone system, the combination of a subscriber's line, a line relay for operating a line signal, a shunt adapted to be placed in the line to short-circuit said line relay, a source of current permanently connected with the line, a plurality of jacks connected with the line, operators' cord-circuits provided with plugs adapted for insertion in said jacks, and a test circuit which, when the subscriber's receiver is off the hook-switch and no plugs are in the jacks, includes the said line relay.

13. In a telephone system, the combination of a subscriber's line, a plurality of jacks connected with the line, operators' cord-circuits provided with plugs adapted for insertion in said jacks, a line relay for operating a line signal, a shunt adapted to be placed in the line to short-circuit said line relay, and a test circuit which, when a plug is in one of said jacks, includes the said shunt.

14. In a telephone system, the combination of a subscriber's line, a plurality of jacks connected with the line, operators' cord-circuits provided with plugs adapted for insertion in said jacks, a source of current permanently connected with the line, a line relay for operating a line signal, suitable circuit connections for short-circuiting the line relay, so as to restore the line signal, and a test circuit which, when the subscriber's receiver is off the hook and no plugs are in the jacks, includes the substation and the said line relay.

15. In a telephone system, the combination of subscribers' lines, line relays for operating line signals, shunts adapted to be placed in the lines to short-circuit said line relays, so as to extinguish or restore the said line signals, a supervisory relay located in each shunt, supervisory lamps having normally closed switch-points in their circuits controlled by said supervisory relays, and a third or supplemental supervisory relay for controlling a normally open switch-point in the circuits of said supervisory lamps.

16. In a telephone system, the combination of subscribers' lines, line relays for operating line signals, relatively low resistance supervisory relays adapted to be placed in the lines to short-circuit said line relays, and supervisory lamps having normally closed switch-points in their local circuits controlled by said supervisory relays.

17. In a telephone system, the combination of a subscriber's line, a source of current permanently connected with the line, a spring jack permanently connected with the

line, a signal controlling electro-magnet having its coil permanently connected with a plurality of the spring contacts of said jack, and a signal controlling electro-magnet having its coil connected and arranged to be placed in the line to short-circuit said first-mentioned electro-magnet.

18. In a telephone system, the combination of a subscriber's line, a plurality of spring jacks having their testing rings permanently connected with one side of the line, each jack having two spring contacts permanently connected with the other side of the line, a line relay located in the line between the said spring contacts, a source of current permanently connected with the line, impedance coils in the connections between the line and source of current, an operator's cord-circuit provided with a plug adapted for insertion in said jacks, the contacts of the plug registering with those of the jacks, and a signal-controlling electro-magnet associated with the cord-circuit and having its coil connected with a plurality of the contacts of said plug.

19. In a telephone system, the combination of a line signal, and a cord circuit shunt having its ends or terminals adapted to be placed in the line for the purpose of restoring said signal.

20. In a telephone system, a supervisory relay, and a cord-plug having two contacts of the same side of the talking circuit connected with the opposite terminals of the coil of said relay.

21. In a telephone system, the combination of subscribers' lines, subscribers' hook-switches for opening and closing the lines, an operator's cord-circuit adapted for establishing connection between the lines, two supervisory relays associated with the cord-circuit and arranged to be energized while the lines are connected and the circuits closed by said hook-switches, supervisory lamps having local circuits provided with normally closed switch-points controlled by said supervisory relays, the latter being de-energized as soon as the line circuits are opened by said hook-switches, and a third or supplemental supervisory relay arranged to control a normally open switch-point in the local circuits of said supervisory lamps, said supplemental supervisory relay continuing to be energized until the lines are disconnected from the cord-circuit.

22. In a telephone system, the combination of subscribers' lines, subscribers' hook-switches for opening and closing the line circuits, an operator's cord-circuit for establishing connection between the lines, two supervisory relays associated with the cord-circuit and arranged to be controlled by said hook-switches, supervisory lamps having switch-points controlled by said supervisory relays, and a third or supplemental super-

visory relay for controlling another switch-point in the circuits of said lamps.

23. In a telephone system, the combination of subscribers' lines, a central source of current connected with the line and adapted to supply current for both talking and signaling purposes, an operator's cord-circuit for establishing connection between the lines, two supervisory lamps associated with the cord-circuit, and three supervisory relays for controlling the circuits of said lamps, adapted to extend in bridge of the talking circuit.

24. In a telephone system, the combination of subscribers' lines, a central source of current connected with the line and adapted to supply current for both talking and signaling purposes, jacks connected with the lines, each jack having three contacts, a cord-circuit provided with plugs adapted for insertion in said jacks, each plug being provided with three contacts, supervisory lamps associated with the cord-circuit, and three supervisory relays connected and arranged to control the circuits of said lamps, adapted to extend in bridge of the talking circuit.

25. In a telephone system, the combination of subscribers' lines, an operator's cord-circuit for establishing connection between the lines, line relays, supervisory relays associated with the cord-circuit and adapted to be placed in the lines to serve as shunts for short-circuiting said line relays, a source of current permanently connected with the lines, supervisory lamps having local circuits provided with normally closed switch-points controlled by said supervisory relays, and a third or supplemental supervisory relay connected and arranged to control a normally open switch-point in the circuits of said lamps.

26. In a telephone system, the combination of a central source of current, subscribers' lines connected with said source of current, a pair of impedance coils in each line at opposite sides of said source of current, an electro-magnet in each line circuit, visual signals controlled by said magnets, an operator's cord circuit, and suitable contacts and connections whereby the said electromagnets are shunted when the cord circuit is connected with the lines, the shunts being located between the lines and the impedance coils.

27. In a telephone system, the combination of a central source of current, subscribers' lines connected with said source of current, an electromagnet in each line, an impedance coil in each line circuit, a plurality of spring jacks connected with each line, each jack having a pair of contacts connected with the terminals of the electro-magnet allotted to the line, an operator's cord circuit provided with plugs adapted for insertion in said jacks, each plug being

equipped with means for shunting one of said electromagnets when inserted in one of said jacks.

28. In a telephone system, the combination of a central source of current, subscribers' lines connected with said source of current, an electro-magnet and impedance coil connected in series in each line circuit, a plurality of jacks connected in each line, each jack having three contacts two of which are connected with the terminals of the electro-magnet allotted to the line in which the jack is connected, an operator's cord circuit provided with three-way plugs adapted for insertion in said jacks, and means whereby each plug is operative to shunt one of said electro-magnets when inserted in a jack.

29. In a telephone system, the combination of a central source of current, subscribers' lines connected with said source and adapted to receive current from the latter for both talking and signaling purposes, an electro-magnet and an impedance coil connected in series in the same side of each line circuit, an operator's cord circuit, and suitable contacts and connections for short circuiting the electro-magnets and leaving the impedance coils unshunted in the line circuits when the cord circuit is connected with the lines.

30. In a telephone system, the combination of a central source of current, subscribers' lines connected with said source of current and adapted to receive current therefrom for both talking and signaling purposes, a pair of impedance coils in each line circuit at opposite sides of said source of current, a line relay in each line circuit, line signals controlled by said relays, an operator's cord circuit, and suitable contacts and connections for shunting the said relays and leaving the impedance coils in the line circuits when the cord circuit is connected with the lines.

31. In a telephone system, the combination of a central source of current, subscribers' lines connected with said source of current and adapted to receive current therefrom for both talking and signaling purposes, a line relay in each line circuit, subscribers' switches for opening and closing the line circuits, an operator's cord circuit, supervisory relays associated with said cord circuit and normally disconnected from the source of current, and suitable contacts and connections whereby the supervisory relays are placed in parallel with the line relays when the cord-circuit is connected with the lines, the supervisory relays being of less resistance than the line relays.

32. In a telephone system, the combination of a central source of current, subscribers' lines connected with the said source of current and adapted to receive

current therefrom for both talking and signaling purposes, an impedance coil in each line circuit, an electro-magnet in each line circuit, subscribers' switches for opening and closing the line circuits, an operator's cord circuit, supervisory relays associated with said cord circuit and normally disconnected from the source of current, and suitable contacts and connections whereby the supervisory relays are placed in parallel with the said electro-magnets when the cord circuit is connected with the lines, leaving the impedance coils in the line circuits, the said supervisory relays being of less resistance than the said electro-magnets.

33. In a telephone system, the combination of a central source of current, subscribers' lines connected with the said source of current and adapted to receive current therefrom for both talking and signaling purposes, suitable line signal apparatus, a plurality of three-way jacks connected with each line, three-way plugs adapted for insertion in said jacks, and supervisory relays each having its two end or opposite terminals connected with two separated contacts in the same side of the talking circuit of one of said plugs.

34. In a telephone system, the combination of a central source of current, subscribers' lines connected with said source and adapted to receive current therefor for both talking and signaling purposes, a pair of impedance coils in each line circuit at opposite sides of the said source of current, an electro-magnet in each line circuit, visual line signals controlled by said electro-magnets, an operator's cord circuit, and suitable contacts and connections whereby the said electro-magnets only are shunted when the cord circuit is connected with the lines.

35. In a telephone system, the combination of a central source of current, subscribers' lines connected with said source of current and adapted to receive current therefrom for both signaling and talking purposes, a pair of impedance coils in each line circuit at opposite sides of said source of current, a line relay in each line circuit, line lamp signals controlled by said line relays, an operator's cord circuit, supervisory relays and supervisory lamps associated with said cord circuit, and suitable contacts and connections for placing the said supervisory relays in parallel with the said line relays when the cord circuit is connected with the lines, leaving the impedance coils in the line circuits, the said supervisory relays being of less resistance than the line relays.

36. In a multiple switchboard system, a metallic circuit, a battery permanently bridged thereon, a plurality of spring-jacks each having a test-thimble and a contact spring permanently connected to opposite sides of the metallic circuit and battery, a

test circuit connected to the same side of the battery as the jack thimbles, and thence through an operator's telephone to a plug tip, and means at the subscriber's station to
 5 close the two sides of the metallic circuit together through his telephone in calling or answering a call, whereby the potential difference between the jack thimble and the test plug may be raised from zero to an appreciable quantity by the subscriber in the
 10 use of his apparatus.

37. In a multiple switchboard system, a line and a bridged battery, a plurality of spring-jacks for said line each having a test-ring or thimble normally connected to line
 15 and to one side of battery, plugs and cord circuits for interconnecting lines, each plug having a sleeve contact adapted to cooperate with the test-ring of a jack when inserted, and connected to the main battery at a point
 20 having a potential difference from that of the test-rings, a tip contact for each plug adapted to be brought into connection when testing, with the same side of battery to
 25 which the test thimbles of the jacks are normally connected, and means at the subscriber's station to cross the two sides of the line together in the use of his telephone set, whereby a difference of potential is created
 30 between the tip of a testing plug and the thimble of a spring-jack when a subscriber is calling or being called, as well as during a connection.

38. The combination with a multiple
 35 switchboard telephone line, a battery permanently connected between one line conductor and a third conductor, the other line conductor being also connected with said third conductor, and a plurality of busy testing
 40 terminals connected with the latter line conductor, the portion of said conductor between the testing terminals and the third conductor possessing an appreciable resistance, whereby when a subscriber calls and
 45 connects the two line conductors together the testing terminals are raised to a potential above that of the third conductor and the line is in condition to test busy, and an operator's testing terminal to cooperate with
 50 any of the said busy testing terminals.

39. The combination with a multiple switchboard telephone line, of a grounded battery permanently connected between the line conductors, a plurality of busy testing
 55 terminals connected with the grounded line conductor, and an artificial resistance in said conductor on the battery side of the testing terminals whereby when a subscriber calls and connects the two line conductors together the line is in condition to test busy,
 60 and an operator's testing terminal to cooperate with any of said busy testing terminals.

40. In a telephone busy testing system,
 65 the combination with a multiple switchboard

telephone line having tip and sleeve conductors, of a battery permanently connected between the said conductors of the line and grounded at its sleeve pole, a plurality of busy testing terminals for the line connected
 70 with its sleeve conductor, and a resistance coil between said terminals and battery, whereby as soon as a subscriber calls central and connects the line conductors together the line is in condition to test busy, and an operator's testing terminal to cooperate with
 75 any of said busy testing terminals.

41. In a telephone system, the combination of substations and a central station and suitable line connection between the same,
 80 jacks and a cord-circuit having plugs adapted for insertion in said jacks, a central source of current supply connected with the lines, line relays connected with the lines, local circuits including said source of current supply and having normally open
 85 switch-points controlled by said line relays, line lamp signals located in said local circuits, circuit-changing devices at the substations for closing the line circuits and thereby energizing said line relays, so as to light
 90 the line signal lamps, supervisory relays connected with the cord circuit, supervisory signals controlled by said supervisory relays, suitable connections whereby each supervisory relay, together with a portion of
 95 the cord-circuit and registering contacts of a plug and jack, combine to form a shunt around one of said line relays, the supervisory relays being of lower resistance than the line relays, whereby the line relays are shunted out and deenergized when the plugs are inserted in the jacks, and a third supervisory relay connected between the cord-circuit and said source of current supply and
 100 arranged to control the said supervisory signals.

42. In a telephone system, the combination of substations and a central station and suitable line connections between the same, a
 110 central source of current supply connected with the lines, jacks and an operator's cord-circuit for establishing connection between the lines, line relays controlling line signals, circuit-changing devices at the substations for operating said line relays, supervisory lamps associated with the cord-circuit, the local circuit of each supervisory lamp having two switch-points, one normally closed and the other normally open, relays for controlling said switch-points, suitable connections between said relays and said source of current supply, the relays which control the said normally closed switch-points being of lower resistance than the line relays, whereby when the plugs are inserted in the jacks the current is shunted through the said low resistance supervisory relays, so as to cut out or deenergize the line relays and restore
 120 the line signals.

43. In a telephone system, the combination of line lamps, line relays for closing the circuit of said line lamps, supervisory lamps provided with circuits having normally
5 closed and normally open switch-points, supervisory relays of lower resistance than the line relays for controlling normally closed switch-points in the circuits of said supervisory lamps, circuit connections
10 whereby each relatively low resistance supervisory relay forms part of a shunt for shunting out and deenergizing the line relay, another relay for controlling the normally open switch-point in the circuit of each
15 supervisory lamp, and a source of current suitably connected for energizing said relays and lighting said lamps.

44. The combination with a telephone line, of a line signaling device and a battery con-
20 nected with the line, a supervisory relay of low resistance as compared with the line signaling device adapted to be connected in parallel relation therewith when a connection is established for conversational pur-
25 poses, whereby the line signaling device is rendered unresponsive and the supervisory relay responsive to current in the line, a supervisory signal controlled by said relay, and means for rendering the said super-
30 visory signal responsive only when connection is established and the line circuit is opened at the substation.

45. The combination with a telephone line, of a line signaling device and a bat-
35 tery in series in the line, of a supervisory relay of low resistance as compared with the signaling device adapted to be connected in parallel therewith when a connection is established with the line for conver-
40 sational purposes, whereby the line signaling device is rendered inoperative and the supervisory relay is rendered operative, a supervisory signal controlled during the connection by said relay and adapted to be
45 inoperative during conversation, and means operated in making and unmaking connection with the line to close and open the circuit of said signal.

46. The combination with a telephone line,
50 of a line signaling electro-magnet and a battery both permanently connected in series in the line, a supervisory relay of lower resistance than the said electro-magnet adapted to be connected in parallel therewith
55 when a connection is established with the line, a supervisory signal having its circuit normally closed through said relay, and a switch in the said circuit closed when the connection is established and opened when
60 the connection is taken down, whereby the signal is inert before connection is made with the line and active when connection is made and the subscriber replaces his telephone upon the hook.

65 47. The combination with a telephone line,

of a line relay, a battery and a resistance in series in the line; a supervisory relay of comparatively low resistance adapted to be connected in parallel relation with said line
70 relay when a conversational circuit is established with the line, whereby the substation transmitter is charged by current from the said battery flowing through the resistance coil and the supervisory relay, the said coil
75 and supervisory relay possessing sufficient impedance to prevent the passage of voice currents, a supervisory signal having its circuit controlled by said relay when the line is switched for use so as to render the signal
80 inert during conversation, and means for normally rendering said signal inert.

48. The combination of a pair of metallic telephone lines; of a line signaling device of high resistance, a battery and a resistance in series in each line in the order named; a cord
85 circuit having a pair of strands adapted to connect with the lines beyond the said device and resistance, a condenser interposed in the strand connecting the signaling device limbs together, a supervisory relay of low resist-
90 ance associated with each end of the cord circuit and connected with the strand containing the condenser, upon the opposite sides thereof, and with the same pole of the battery as the limb containing the signaling
95 device, a supervisory signal for each end of the cord circuit the current through which is controlled by the corresponding relay when the lines are united for conversation so as to render the signal inert during con-
100 versation, said lamp circuits being normally open, and means for automatically closing the same in establishing the connection.

49. The combination with a telephone line,
105 of a battery having both its poles permanently connected with a line and serving when desired to send current over the telephone line for the operation of its apparatus, a relay adapted to be included in a branch circuit always completed when a con-
110 nection is established with the line, and a supervisory signaling device having the continuity of its circuit controlled at one point by said relay.

50. The combination with a telephone line,
115 of a battery permanently connected with the line, a relay adapted to be included in a local circuit at the central office, always completed when a connection is established with the line, said circuit including a portion of
120 one line conductor and being charged by current from said battery, and a supervisory signal having its circuit controlled at one point by said relay.

51. The combination with a telephone line,
125 of a battery permanently connected with the line, a cord circuit, a relay connected with a strand of the cord circuit and the battery, whereby when a connection is made with the line a local circuit is always completed for
130

said relay including the relay conductor, the cord strand and a portion of one line conductor, and receiving current from said battery, and a supervisory signal placed in operative condition by the actuation of said relay.

52. The combination with a telephone line, of a line relay in one conductor of the line, a battery between said conductor and the other conductor, a cord circuit, a relay connected therewith and with the battery, and means for including said relay in a local branch circuit comprising its conductor, the cord circuit, and a portion of said other line conductor, said circuit being charged by current from said battery.

53. The combination with a telephone line, of a battery permanently connected with the line, a cord circuit and a pair of supervisory relays bridged across the line when connection is established by the cord circuit with the line, one of said relays being in a path for current supplied for charging the transmitter at the substation of the line and the other relay being in a branch circuit closed when connection is made with the line, and a supervisory signal jointly controlled by said relays.

54. In a telephone system, the combination with a telephone line, of a source of current and a relay bridged between the two limbs of the talking circuit thereof, a second relay at the central office 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 relays, a line signal adapted to be retired by the closure of the circuit through said switch at the central station, and a supervisory signal controlled by the conjoint action of said relays.

55. In a telephone system, the combination with a telephone line, of a source of electricity at the central office, a permanent connection between said line and one pole of said source, an operator's plug and a pair of relays associated therewith, one of said relays being energized from the said source of electricity as long as the said operator's plug is connected with the said line and over a path having a part coincident with the talking circuit, and the other relay being energized as long as the said operator's plug is connected with the said line and when the subscriber's telephone is in use, and a signal associated with said pair of relays, the circuit of said signal being established by the operation of the first of said relays, and said signal being rendered inoperative by the operation of the second of said relays.

56. In a telephone system, the combination with a metallic telephone line, of a source of current and a relay bridged between the two

limbs of the talking circuit thereof, a second relay and means for energizing it, a switch at the substation and a switch at the central station for controlling the circuit through said relays, a signal controlled by the conjoint action of said relays, and a permanent inductive connection from both sides of the line to the source of current.

57. In a telephone system, the combination with a telephone line, of a source of current and a relay bridged between the two limbs of the talking circuit thereof, a second relay and means for energizing it, a switch at the substation for controlling said bridged relay and a switch at the central office for controlling said other relay, a signal controlled by the conjoint action of said relays, and a permanent inductive connection from both sides of the line to the source of current.

58. In a telephone system, the combination with a telephone line, of a source of current and an electro-magnet bridged between the two limbs of the talking circuit thereof, a second electro-magnet and means for energizing it, a switch at the substation and a switch at the central station for controlling the circuit through said electro-magnets, a supervisory signal controlled by the joint action of said electro-magnets, and a permanent inductive connection from both sides of the line to the source of current.

59. The combination with a telephone line, of a source of electricity and a pair of relays adapted to be bridged between the limbs of the talking circuit thereof, a switch at the substation and a switch at the central station for controlling the circuit through said relays, a signal adapted to be controlled by the conjoint action of said relays, and a permanent connection from the line to the source of current.

60. The combination with a metallic telephone line, of an operator's plug and a cord circuit, a source of current and a pair of relays bridged across said circuit, a third conductor connected with the said source, one of said relays being adapted to be operated over the metallic line when the subscriber's telephone is in use, the other to be operated over a part of the line and said third conductor when the subscriber's telephone is not in use and the operator's plug is connected with the line, and a permanent connection from the line to the source of current.

61. In a telephone system, the combination with a telephone line, of a source of current and a relay bridged between the two limbs of the talking circuit thereof, a second relay at the central office and connected with 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 circuit through said relays, a signal controlled by the conjoint action of said relays,

and a permanent inductive connection from both sides of the line to the source of current.

62. In a telephone system, the combination with a telephone line, of a source of electricity at the central office, an operator's plug and a pair of relays associated therewith, one of said relays being energized from the said source of electricity as long as the said operator's plug is connected with the said line and over a path having a part coincident with the talking circuit, and the other relay being energized as long as the said operator's plug is connected with the said line and when the subscriber's telephone is in use, a signal associated with said pair of relays, the circuit of said signal being established by the operation of the first of said relays and said signal being rendered inoperative by the operation of the second of said relays, and a permanent connection from the line to the source of current.

63. The combination with a metallic telephone line free from permanent grounds outside the central office, of a charging current source, a third conductor, a pair of relays at the central office, one of said relays being energized over the telephone line and the other over a portion of the talking circuit and the third conductor, and a permanent connection from the line to the source of current.

64. The combination with a metallic telephone line, of a pair of relays and a charging current source bridged across the line at the central station, a third conductor to which the current source is connected, both of said relays being adapted to be operated over the metallic telephone line, one of said relays being adapted to be operated over a portion of said line and the third conductor, and a permanent connection from the line to the source of current.

65. The combination with a telephone line, of a source of electricity and a pair of relays adapted to be bridged between the limbs of the talking circuit thereof, a switch at the substation and a switch at the central station for controlling the circuit through said relays, and a signal adapted to be controlled by the conjoint action of said relays, the circuit of said signal being open during conversation, and one of said relays being adapted to deenergize and thereby close said signal circuit when the subscriber restores his telephone to normal.

66. In a telephone system, the combination with a telephone line, of a source of current and a relay bridged between the two limbs of the talking circuit thereof, a second relay at the central office 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 cir-

uits through said relays, and a signal controlled by the conjoint action of said relays, the circuit of said signal being open during conversation, and one of said relays being adapted to deenergize and thereby close said signal circuit when the subscriber restores his telephone to normal.

67. The combination with a telephone line, of a source of electricity and a pair of relays adapted to be bridged between the limbs of the talking circuit thereof, a switch at the substation and a switch at the central station for controlling the circuit through said relays, and a signal adapted to be controlled by the conjoint action of said relays, the energizing circuit of one relay including a portion of the talking circuit and excluding the substation switch.

68. In a telephone system, the combination with a telephone line, of a source of current and a relay bridged between the two limbs of the talking circuit thereof, a second relay at the central office 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 relays, and a signal controlled by the conjoint action of said relays, the energizing circuit of one relay including a portion of the talking circuit and excluding the substation switch.

69. In a telephone system, the combination with a telephone line, of a source of current and a pair of relay windings bridged between the two limbs of the talking circuit thereof, a permanent connection between said line and one side of said source, 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.

70. 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 permanent connection between said line and one side of said source, 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 electro-magnetic windings, and a supervisory signal controlled by the joint action of said electro-magnetic windings.

71. 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 permanent connection between said line and one side of said source, 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.

72. In a telephone system, the combination with subscribers' lines extending from substations to jacks at an exchange, of a cord circuit at the exchange for interconnecting subscribers' lines, a relay associated with said cord circuit, means including a jack and a cord circuit plug inserted in the jack for establishing a closed circuit through said relay which is independent of the operative position of sub-station apparatus, a second relay also associated with said cord circuit, means whereby the latter relay is responsive to changes in the operative position of sub-station apparatus, said relays being serially included in a bridge across the talking circuit, a source of current for energizing said relays, and a supervisory signaling lamp in a local circuit serially including contacts controlled by said relays, substantially as described.

73. In a telephone system, the combination with subscribers' lines extending from sub-stations to jacks at an exchange, of a cord circuit at the exchange for interconnecting subscribers' lines, a relay associated with said cord circuit, means including a jack and a cord circuit plug inserted in the jack for establishing a closed circuit through said relay which is independent of the substation apparatus, a second relay also associated with said cord circuit, means whereby the latter relay is responsive to changes in the operative position of sub-station apparatus, a source of current for energizing said relays, said relays being serially included in a bridge across said cord circuit, an armature for each of said relays, and a supervisory signaling lamp in a local circuit adapted to be closed when the armature of said first relay is in its attracted position and when the armature of said second relay is in its unattracted position, substantially as described.

74. The combination with a telephone line, of a source of electricity and a pair of relays adapted to be bridged between the limbs of the talking circuit thereof, a switch at the substation and a switch at the central station for controlling line and local circuits for said relays, and a signal adapted to be controlled by the conjoint action of said relays, said relays being connected during conversation with said source of electrical current.

75. In a telephone system, the combination with a telephone line, of a source of current and a relay bridged between the two limbs of the talking circuit thereof, a second relay at the central office 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 line and local circuits for said relays, and a signal controlled by the conjoint action of said relays, said relays being connected during conversation with said source of electrical current.

76. In a telephone system, the combination with a telephone line closed at the substation, of a source of electricity at the central office, an operator's plug and a pair of relays associated therewith, one of said relays being energized from the said source of electricity as long as the said operator's plug is connected with the said line and over a path having a part coincident with the talking circuit, and the other relay being energized over a local circuit including a part of the talking circuit as long as the said operator's plug is connected with the said line, and a signal associated with said pairs of relays, the circuit of said signal being established by the operation of the second of said relays, and said signal being rendered inoperative by the operation of the first of said relays, said relays being connected during conversation with said source of electrical current.

77. The combination with a telephone line, of a source of electricity and a pair of relays adapted to be bridged between the limbs of the talking circuit thereof, a switch at the substation and a switch at the central station for controlling the circuit through said relays, and a signal adapted to be controlled by the conjoint action of said relays, said telephone line being normally non-grounded at the substation thereof.

78. In a telephone system, the combination with a telephone line, of a source of current and a relay bridged between the two limbs of the talking circuit thereof, a second relay at the central office 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 relays, and a signal controlled by the conjoint action of said relays, said telephone line being normally non-grounded at the substation thereof.

79. In a telephone system, the combination with a telephone line, of a source of electricity at the central office, an operator's plug and a pair of relays associated therewith, one of said relays being energized from the said source of electricity as long as the said operator's plug is connected with the said line and over a path having a part coincident with the talking circuit, and the other relay being energized as long as the said operator's plug is connected with the said line and when the subscriber's telephone is in use, and a signal associated with said pairs of relays, the circuit of said signal being established by the operation of the

first of said relays, and said signal being rendered inoperative by the operation of the second of said relays, said telephone line being normally non-grounded at the substation thereof.

80. The combination with a telephone line, of a source of electricity and a pair of relays adapted to be bridged between the limbs of the talking circuit thereof, a switch at the substation and a switch at the central station for controlling the circuit through said relays, and a signal adapted to be controlled by the conjoint action of said relays, the circuit of said signal having a normally open switch point controlled by one relay and a normally closed switch point controlled by the other relay.

81. In a telephone system, the combination with a telephone line, of a source of current and a relay bridged between the two limbs of the talking circuit thereof, a second relay at the central office 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 relays, and a signal controlled by the conjoint action of said relays, the circuit of said signal having a normally open switch point controlled by one relay and a normally closed switch point controlled by the other relay.

82. In a telephone system, the combination with a telephone line, of a source of electricity at the central office, an operator's plug and a pair of relays associated therewith, one of said relays being energized from the said source of electricity as long as the said operator's plug is connected with the said line and over a path having a part coincident with the talking circuit, and the other relay being energized as long as the said operator's plug is connected with the said line and when the subscriber's telephone is in use, and a signal associated with said pairs of relays, the circuit of said signal being established by the operation of the first of said relays, and said signal being rendered inoperative by the operation of the second of said relays, the circuit of said signal having a normally open switch point controlled by one relay and a normally closed switch point controlled by the other relay.

83. The combination with a telephone line, of a source of electricity and a pair of relays adapted to be bridged between the limbs of the talking circuit thereof, a switch at the substation and a switch at the central station for controlling the circuit through said relays, a signal adapted to be controlled by the conjoint action of said relays, and a line signal adapted to be retired as a result of the passage of current over the energizing circuit of one of said relays.

84. In a telephone system, the combination with a telephone line, of a source of current and a relay bridged between the two limbs of the talking circuit thereof, a second relay at the central office 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 relays, a signal controlled by the conjoint action of said relays, and a line signal adapted to be retired as a result of the passage of current over the energizing circuit of one of said relays.

85. In a telephone system, the combination with a telephone line, of a source of electricity at the central office, an operator's plug and a pair of relays associated therewith, one of said relays being energized from the said source of electricity as long as the said operator's plug is connected with the said line and over a path having a part coincident with the talking circuit, and the other relay being energized as long as the said operator's plug is connected with the said line and when the subscriber's telephone is in use, a signal associated with said pairs of relays, the circuit of said signal being established by the operation of the first of said relays, and said signal being rendered inoperative by the operation of the second of said relays, and a line signal adapted to be retired as a result of the passage of current over the energizing circuit of one of said relays.

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

87. In a telephone system, the combination with a telephone line, of a source of current and a relay bridged between the two limbs of the talking circuit thereof, a second relay at the central office 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 circuit through said relays, and a signal controlled by the conjoint action of said relays.

88. In a telephone system, the combination with a telephone line, of a source of electricity at the central office, an operator's plug and a pair of relays associated therewith, one of said relays being energized from the said source of electricity as long as the said operator's plug is connected with the said line and over a path having a part coincident with the talking circuit, and the

other relay being energized as long as the said operator's plug is connected with the said line and when the subscriber's telephone is in use, and a signal associated with said pair of relays, the circuit of said signal being established by the operation of the first of said relays and said signal being rendered inoperative by the operation of the second of said relays.

89. In a telephone system, the combination with a pair of conductors comprising the strands of a talking circuit extending from a central office to a substation, a charging source of current and a pair of impedances, one on each side of said source, connected in a bridge between said conductors, and a relay adapted to be connected between one conductor of the line and the opposite pole of said source from which said line conductor is connected through its associated impedance.

90. In a telephone system, the combination with subscribers' lines extending from substations to an exchange, of cord-connecting apparatus for interconnecting subscribers' lines, two relays connected in branch of the cord circuit, a supervisory signal jointly controlled by said relays, a source of current for energizing said relays, means at the substation for effecting operation of said signal through the agency of one of said relays, and means whereby the operative condition of the other relay is independent of the operative condition of substation apparatus, substantially as described.

91. In a telephone system, the combination with subscribers' lines extending from substations to jacks at an exchange, of a cord circuit at the exchange for interconnecting subscribers' lines, a relay associated with said cord circuit, means including a jack and a cord circuit plug inserted in the jack, for establishing a closed circuit through said relay which is independent of the operative position of substation apparatus, a second relay also associated with said cord circuit, said relays being included in branch of the cord circuit, means whereby the latter relay is responsive to changes in operative position of substation apparatus, a source of current for energizing said relays, and a supervisory signal jointly controlled by said relays, substantially as described.

92. In a telephone system, the combination with subscribers' lines extending from substations to jacks at an exchange, of a cord circuit at the exchange having two talking strands for interconnecting subscribers' lines, a relay associated with said cord circuit, means including a jack and a cord circuit plug inserted in the jack for establishing a closed circuit through said relay, which is independent of the operative

position of substation apparatus, a second relay also associated with said cord circuit, said relays being included in branch of the talking strands of the cord circuit, means whereby the latter relay is responsive to changes in operative position of substation apparatus, a source of current for energizing said relays, and a supervisory signal jointly controlled by said relays, substantially as described.

93. In a telephone system, the combination with subscribers' lines extending from substations to jacks at an exchange, of a cord circuit at the exchange for interconnecting subscribers' lines, a relay associated with said cord circuit, means including a jack and a cord circuit plug inserted in the jack for establishing a closed circuit through said relay, which is independent of the operative position of substation apparatus, a second relay also associated with said cord circuit, means whereby the latter relay is responsive to changes in operative position of substation apparatus, said relays being serially included in a bridge across the said cord circuit, a source of current for energizing said relays, and a supervisory signal jointly controlled by said relays, substantially as described.

94. The combination with a telephone substation provided with a receiver, a transmitter and a switch hook, of a cord circuit, a magnet adapted for inclusion in the circuit, a source of current adapted for inclusion in circuit with the magnet winding through the agency of the switch hook, a branch conductor connected with the cord circuit including the said magnet, a supplemental electromagnet also adapted for inclusion in circuit with its source of current independently of the operative position of said switch hook, a branch conductor connected with the cord circuit including the supplemental electromagnet, and a signal jointly controlled by said magnets, substantially as described.

95. The combination with a telephone substation provided with a receiver, a transmitter and a switch hook, of a cord circuit, a magnet adapted for inclusion in the circuit, a source of current adapted for inclusion in circuit with the magnet winding through the agency of the switch hook, a supplemental electromagnet also adapted for inclusion in circuit with its source of current independently of the operative position of said switch hook, a branch conductor connected with the cord circuit including the supplemental electromagnet, and a signal jointly controlled by said magnets, substantially as described.

96. The combination with a telephone substation provided with a receiver, a transmitter and a switch hook, of a cord circuit, a magnet adapted for inclusion in the cir-

5 cuit, a branch conductor connected with the
 cord circuit including the said magnet, a
 source of current adapted for inclusion in
 circuit with the magnet winding through
 the agency of the switch hook, the arma-
 10 ture of the said magnet being provided with
 a contact and engaged thereby upon a
 change in the operative condition of the
 said magnet, a supplemental electromagnet,
 a branch conductor connected with the cord
 15 circuit including the supplemental electro-
 magnet, means for effecting the inclusion of
 the supplemental magnet in circuit with its
 source of current independently of the
 aforesaid electromagnet, and a signal coop-
 20 eratively associated with said magnets, its
 circuit including the aforesaid armature
 and its contact, substantially as described.

25 97. The combination with a telephone sub-
 station provided with a receiver, a trans-
 mitter and a switch hook, of a cord circuit,
 a magnet adapted for inclusion in the cir-
 cuit, a source of current adapted for inclu-
 sion in circuit with the magnet winding
 30 through the agency of the switch hook, the
 armature of the said magnet being provided
 with a contact and engaged thereby upon a
 change in the operative condition of the said
 magnet, a supplemental electromagnet, a
 branch conductor connected with the cord
 circuit including the supplemental electro-

magnet, means for effecting the inclusion of
 the supplemental magnet in circuit with its
 source of current independently of the
 aforesaid electromagnet, and a signal co- 35
 operatively associated with said magnets, its
 circuit including the aforesaid armature and
 its contact, substantially as described.

98. In a telephone system, an operator's
 cord circuit, a pair of relays each operated 40
 over circuits including portions of the talk-
 ing circuit and a supervisory signal having
 its circuit controlled by the contacts of both
 said relays, one of said relays being adapted
 to normally close the circuit and to be en- 45
 ergized over the telephone line when the
 line is in use, whereby the signal is at that
 time rendered inert, and the other relay be-
 ing adapted to normally open the circuit,
 whereby when the cord circuit is not con- 50
 nected with the line, the signal is inert, and
 when connected with a line not in use the
 signal is displayed, substantially as de-
 scribed.

In testimony, that I claim the foregoing 55
 as my invention, I affix my signature in
 presence of two subscribing witnesses, this
 13th day of September, A. D. 1901.

HENRY P. CLAUSEN.

Witnesses:

D. C. GURNEE,
 A. J. SINCLAIR.