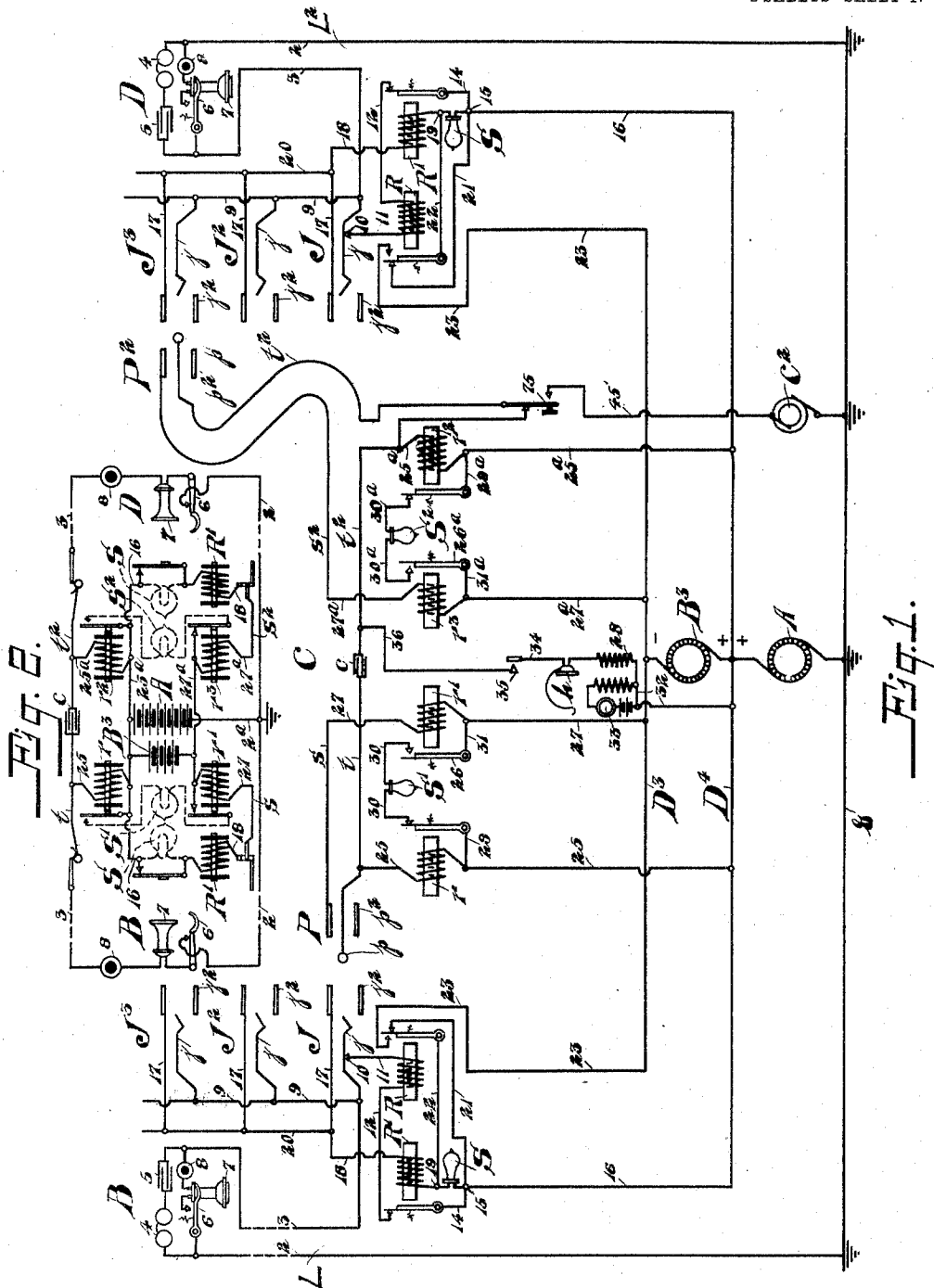


J. G. ROBERTS.
TELEPHONE SYSTEM.

APPLICATION FILED FEB. 24, 1902.

NO MODEL

2 SHEETS—SHEET 1.



Witnesses.
R. H. Burford
H. D. Dyer

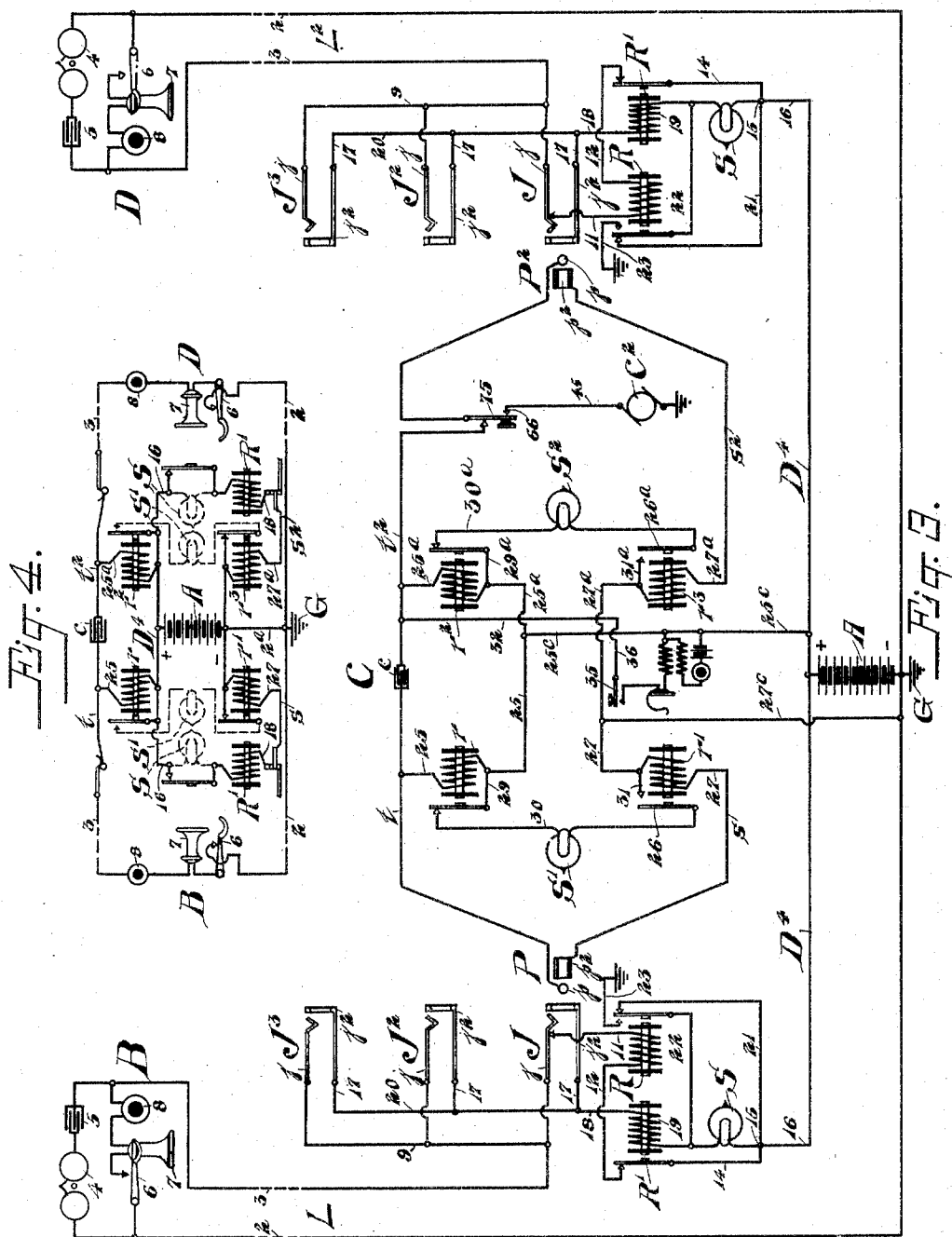
Inventor:-
John S. Roberts,
by Robert Lewis Ames,
Attorney.

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Witnesses.
R. H. Burdette
H. D. Miller

Inventor:-
John G. Roberts,
by *Robert Lewis Amis*,
Attorney.

UNITED STATES PATENT OFFICE.

JOHN G. ROBERTS, OF DETROIT, MICHIGAN, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 777,544, dated December 13, 1904.

Original application filed December 15, 1899, Serial No. 740,395. Divided and this application filed February 24, 1902. Serial No. 95,155. (No model.)

To all whom it may concern:

Be it known that I, JOHN G. ROBERTS, a citizen of the United States of America, and a resident of Detroit, county of Wayne, and State of Michigan, have invented a certain new and useful Improvement in Telephone Systems, of which the following is a specification.

This application is a division of my application filed December 15, 1899, Serial No. 740,395, renewed February 23, 1901, Serial No. 48,590.

The subject-matter of the present application relates more particularly to the supervisory features of a telephone system and the parts coöperating therewith, the object of the invention being to provide a supervisory system that is positive and efficient in operation, that is simple in construction and arrangement, and one that consists of but few and inexpensive parts.

In the accompanying drawings, forming a part of this specification, in which the preferred form of the invention is illustrated and in which the same reference characters designate like parts throughout the several views, Figure 1 is a diagram of the system embodying the subject-matter of this application. Fig. 2 is a simplified diagram of the talking-circuit of Fig. 1. Fig. 3 is a diagram in a simplified form of the system of Fig. 1, but with only one battery at the central office; and Fig. 4 is a simplified diagram of the talking-circuit of Fig. 3.

Referring to Fig. 1, two subscribers' lines L and L² are shown extending from their respective substations B and D to the central office C. The limbs 2 and 3 of the subscribers' lines are permanently connected together at the substations through the call-bell 4 and the condenser 5, the latter being adapted to permit the passage of alternating or ringing current and to prevent the passage of steady current. A bridge normally open through the telephone-hook 6 extends between the two limbs and includes the receiver 7 and transmitter 8. At the central office these lines center in a switchboard, where they are fitted

with switch-sockets, connection terminals or jacks J J² J³, the tip conductor 3 terminating in the tip-spring *j* of the answering-jack J and is multiplied through the several corresponding contact-terminals of the multiple jacks J² and J³, the conductor 9 serving to connect them to the limb 3. The other conductor or limb, 2, of the telephone-line, which corresponds to the "sleeve" side of the line, is connected at the central office with the ground G. The tip-spring *j* of the answering-jack normally engages a contact-anvil 10, which is connected, by means of a conductor 11, to one side of the winding of the line-relay R and thence to the normal or back contact of the cut-off relay R'. The armature of the said cut-off relay R' is connected, by means of conductor 14, to the point 15, from whence the conductor 16 extends to the common wire D¹, connected with one pole of the direct-current generator A. The opposite pole of the generator A is connected to the ground G. The sleeve contact or ring *j*² of the answering-jack J is connected, by means of conductors 17 and 18, through the winding of the cut-off relay R' to the point 19 upon one side of the line-signal S, which is preferably a small incandescent lamp. The corresponding contacts *j*² of the multiple jacks J² J³ are connected, by means of like branches 17 and a conductor 20, to the branch 17 of the answering-jack J and conductor 18.

From the points 15 and 19, respectively, conductors 21 and 22 extend to the back contact and armature of the line-relay R and comprise when closed together at the said armature and back contact a shunt of the signal S. The forward contact of the line-relay R is connected, by means of a conductor 23, with the common lead or conductor D² from one side of the direct-current generator B², the other pole of which is in connection with the like pole of the generator A.

The cord-circuit, which is adapted to form an operative union between any two circuits of the system, includes the answering-plug P and the connecting-plug P², each having tip

and sleeve contacts p and p^2 , adapted to engage, respectively, with corresponding contact-surfaces j and j^2 of the jacks when the plugs are inserted therein. The tip-contacts of the two plugs are joined by the strands t and t^2 and the interposed condenser c . From the tip-strand t of the answering-plug P a conductor 25 extends to the winding of a supervisory relay r and thence to the common wire D^4 and to one pole of the generator A. The corresponding sleeve-strand s is extended, by means of a conductor 27, through the winding of a supervisory relay r' and thence to the lead D^3 and to one pole of the generator B^3 . The armature of the supervisory relay is connected, by means of a conductor 29, with the conductor 25, and its back contact is connected to a conductor 30, which includes the supervisory signal or lamp S' , the circuit of said lamp being completed through the forward contact and armature 26 of supervisory relay r' and the conductor 31 to the conductor 27. Similar supervisory relays r^2 and r^3 are provided in connection with the tip and sleeve strands t^2 and s^2 of the connecting-plug P^2 , and a similar supervisory lamp S^2 has its circuit jointly controlled through the armatures and contacts of said relays. The operator's receiver h in conductor 34 is connected by any suitable listening-key 35 and conductor 36 with the strand t^2 of the cord-circuit on one side and through the secondary winding 28 and conductor 32 with the live pole of generator A. Her transmitter 33 is included in a local circuit with the primary winding of the induction-coil and a suitable current source. A ringing-generator C^2 of usual type is grounded at one pole and is adapted to be connected by conductor 45 and the ringing-key 75, of any usual or desired type, with the tip-strand t^2 of the said cord-circuit.

Referring to Fig. 1, the operation of the system will now be described. The subscriber B desiring a connection takes up his receiver and completes the bridge between the limbs 2 and 3 of the line and provides a circuit for current from the generator A over the following path: from the positive pole of the generator A, lead D^4 , conductor 16, point 15, conductor 14, armature and back contact of cut-off relay R' , conductor 12, the winding of the line-relay R, conductor 11, tip-contact j of the answering-jack J, line conductor 3, through the substation devices, to the sleeve conductor 2, and back to ground and the negative pole of generator at the central office. This causes the operation of the line-relay R, which attracts its armature and closes a local circuit including the line-lamp S to the generator B^3 , which may be traced from the positive pole of the said generator, over lead D^4 , to the conductor 16, lamp S, conductor 22, armature and forward contact of line-relay R, and back to the generator over the conductor 23 and lead D^3 . Upon noticing the signal the operator inserts

the answering-plug P of her cord-circuit in the jack J of the subscriber's line. In so doing the tip-spring of the jack is lifted from its normal contact, thus opening the circuit of the line-relay R and permitting its armature to close the shunt about the lamp S to extinguish said lamp and remove its resistance from the circuit. At the same time a local circuit through the sleeve-contacts of the plug and jack is established, said circuit including the sleeve-contacts, conductors 17 and 18, the winding of the cut-off relay R' , the shunt 22 about the lamp S, branch 16, and lead D^4 to one pole of the generator B^3 , the circuit being completed from the opposite pole of the generator through the lead D^3 , conductor 27, including supervisory relay r' , to the strand s of the cord-circuit. The closure of this local circuit causes the operation of the cut-off relay R' to maintain the circuit of the line-relay R open during the established connection. The insertion of the plug also serves to complete a circuit from the generator A, over lead D^4 , and through the wire 25, including relay r , to the tip-strand t of plug P, thence over the tip side 3 of the telephone-line, through the substation transmitter and receiver, and back to the generator A over the other line conductor, 2, and ground-wire G. The supervisory lamp S' has its circuit closed through the armature and front contact of the relay r' , but remains inert on account of the opening of its circuit through the armature and back contact of the supervisory relay r . The circuit of this lamp, it is evident, includes the generator B^3 , lead D^4 , conductors 25, 29, 30, 31, and 27, and lead D^3 . Immediately upon the insertion of the plug P, as stated, the operator depresses the listening-key 35 to connect her instrument with the cord-circuit to receive the order of the calling subscriber. Upon ascertaining the number of the subscriber wanted the operator proceeds to test the condition of the line wanted. This is effected by touching the tip of her calling-plug, such as P^2 , to the test-ring of the jack of the said line. If such line has just called the central office and an operator has not had time to connect therewith, it will be seen from the previously-described operation that the test-rings of the several jacks of the line are connected, by means of conductors 17 20 18 22, the armature and front contact of the line-relay R of that line, the conductor 23, and lead D^3 , with the negative pole of the generator B^3 . As the tip of the calling-plug P^2 used for testing is connected, through the conductor 36, key 35, and conductors 34 and 32, to the opposite pole of the generator B^3 , it is apparent that a circuit will be completed through the operator's telephone when the line is so tested and that she will receive a click to inform her of the busy condition of the line. In case a connection has been established with the wanted line by means of a

cord-circuit similar to that shown in the figure the test-rings of the jacks are connected with the negative pole of the generator B^3 through the sleeve-strand of the inserted cord-circuit and the conductor 27 or 27^a, and a testing-circuit is therefore again completed to the other pole of the said generator through the tip-strand of the testing-plug and the operator's instrument. Upon finding the wanted line idle the calling-plug P^2 is inserted in one of the multiple jacks in the usual manner. The insertion of this plug accomplishes several results: First, the local circuit through the cut-off relay R' is established from the positive pole of the generator B^3 , lead D^4 , conductor 16, the short circuit of the line-lamp S , including conductors 21 and 22, the winding of the cut-off relay R' , the conductors 18 and 20, and the branch 17 of the proper multiple jack to the sleeve-contact of the inserted plug, from whence a circuit is extended by the sleeve-cord s^2 and conductor 27^a through the relay-winding r^3 to the opposite pole of the generator B^3 . Actuating the relay R' prevents the operation of the line-relay R when the subscriber responds, and thus retains the line-signal S in inert condition. The energization of supervisory relay r^3 closes the circuit to the supervisory lamp S^2 . On account of the subscriber's telephone not being off its hook the line-circuit is open to steady currents at the substation, and the supervisory relay r^2 , which is under the control of the subscriber after the insertion of the plug, is not operated. The supervisory lamp S^2 therefore lights over a circuit from the positive pole of the generator B^3 , conductors 25^a and 29^a, armature and back contact of relay r^2 , through the lamp S^2 , the armature 26^a and front contact of relay r^3 , conductors 31^a and 27^a, to the opposite pole of the generator B^3 . This light remains active until the response of the called subscriber, when it is rendered inert, as will be hereinafter described. The operator now depresses the ringing-key to connect the ringing-generator C^2 with the cord-circuit to call the wanted subscriber. The said key opens the strand t^2 to prevent the ringing-current from passing back over the cord-circuit and making a noise in the waiting-subscriber's receiver. The ringing-current finds a path from the live pole of the generator over conductor 45, key 75, strand t^2 , tip-contacts of the plug and jack, conductor 9, limb 3, through the condenser 5 and bell 4 at the substation and operating the bell, and thence back over line-limb 2 to ground at the central office and the other pole of the ringing-generator. When the subscriber responds, the tip-supervisory relay r^2 is operated by current over the line-circuit and the supervisory lamp S^2 is extinguished. The subscribers are now in communication. During conversation the supervisory signals S' and S^2 are inert by reason of the actuation of the supervisory relays r and r^2 , associated with the

plugs. Current for talking purposes is fed out to the substations from the generator A , which is a direct-current generator and may be called the "charging-generator," through the supervisory relays r and r^2 , which are designed to present sufficient impedance to the passage of voice-currents to prevent short-circuiting the same, the said currents being repeated through the condenser c from one end of the strand of the cord-circuit to the other, and thereby from one line to the other. At the termination of the conversation the subscribers return their receivers to the hooks, and thereby open the line-circuits for steady current between the two line-wires. This causes the deenergization of the supervisory relays r and r^2 , which close the circuits of the supervisory signals S' and S^2 through their armatures and back contacts, the circuit for lamp S' including the generator B^3 , conductors D^4 , 25, 29, 30, 31, 27, and D^3 , while the circuit of lamp S^2 includes said generator, conductors D^4 , 25^a, 29^a, 30^a, 31^a, 27^a, and D^3 . The signals being exposed, the operator is notified that the conversation is terminated and the plugs are withdrawn, thus restoring all parts to normal position. In case a reconnection is desired by either subscriber or the attention of the operator is wanted while the plugs are still in the jacks the hooks at the substations may be vibrated to alternately energize and deenergize the corresponding relays r and r^2 to expose and efface the supervisory signals.

When a connection is established, the charging-generator A and the relays r or r^2 are in a bridge of the talking-circuit, and the said relays are under the control of the respective subscribers and are energized over the talking-circuit, including the telephone-lines. The cooperating relays r' and r^3 are under the control of the operator and in the specific arrangement shown are energized over local circuits. Both sets of relays, it may also be observed, are in the path of current from said generators to the contacts of the jack and may also be said to be connected between the cord-strands of the cord-circuit.

The generator B^3 may be of lower electromotive force than the generator A to save wire on the relays and make the resistance of the local circuits lower. It is not, however, necessary that it be a separate generator from A . It may, in fact, be entirely dispensed with, in which case the lead or common line D^3 from the negative pole of the said generator B^3 is connected with or forms a part of the ground-line or common ground G . Such an arrangement is shown in Fig. 3 of the drawings, in which the generator A only is used, the only change required being to extend the branches which formerly connected with the common wire D^3 to the ground-wire G or to ground them direct, for it will be understood that the line G is indicative of the

common ground connection of the central office, which is usually shown in drawings of this character by merely indicating an earth connection for each branch. Instead, therefore, of bringing all branches to a common ground-line, such as G, each branch may be grounded separately in the common and well-understood manner. In said figure, therefore, I have shown some one way and some the other. In this figure I have also sought to indicate the apparatus at central by a simpler and more usual type of diagram, the strands of the cord-circuit being spread apart to show between their coöperating relays. The same reference characters are used as in connection with Fig. 1. This figure, as stated, shows the system using simply the main generator A. The wires 23 are shown directly grounded, or they may be extended to the ground G or to the conductors 2, leading to ground G. In practice they are all connected to the common office-ground or common office-return. The line 27^c is carried to the grounded pole of the battery, although it might have been directly grounded, as in the case of lines 23. It will be clearly seen by tracing the operation with reference to this figure that the system is fully operative with only the single generator A. The subscriber in initiating a call operates the line-relay R from the main generator A in the same manner as in the previous figure. The line-signal, however, is operated from the main generator A instead of the auxiliary generator B³, the circuit of said signal being from ground at the generator, through the generator, over conductors D⁴ and 16, through the lamp S, over conductors 22 and 23, to ground or common office-return. The operator, seeing the signal, inserts the answering-plug P, as before, and in so doing closes a local circuit through the sleeve-contacts of the plug and jack containing the cut-off relay R' and the supervisory relay r', said circuit being traceable from the positive pole of the generator A, over conductors D⁴, 16, 21, and 22, through the winding of relay R', conductors 18 and 17, the sleeve-contacts of the jack and plug, sleeve-strand s, conductor 27, containing the winding of the relay r', and conductor 27^c, to the negative pole of the said generator. This causes the operation of the cut-off relay R' to open the circuit of the line-relay R, thus rendering the line-signal inoperative during the remainder of the connection.

The actuation of supervisory relay r' closes the local circuit of the supervisory lamp S'; but the said circuit is opened through the armature of the coöperating supervisory relay r, which is now in a bridge of the talking-circuit, together with the generator A, said bridge being extended from the tip-strand t of the cord-circuit, through the conductors 25 and 25^c, to the generator A and from the opposite pole of the generator to the line 2 or

ground. The listening-key 35 serves to connect the operator's telephone with the cord-circuit, as heretofore explained, whereby she is enabled to immediately talk with the subscriber B as soon as the answering-plug P is inserted.

Upon ascertaining the number of the party wanted, the subscriber-line is tested in the usual way, and if found idle the plug is inserted. The insertion of this plug operates the relay r³ over a local circuit similar to that specified in connection with the relay r', and as the subscriber's telephone is upon its hook the relay r² is not yet operated and the supervisory lamp S² is lighted. The circuit of this lamp S² may be traced from the positive pole of the generator A, over the conductors 25^c, 25^a, and 29^a, armature and back contact of relay r², conductor 30^a, containing the lamp S², armature 26^a and front contact of relay r³, conductors 31^a, 27^a, and 27^c, back to the opposite pole of the generator A. When the subscriber responds, the relay r² is actuated over a circuit from the generator A including the telephone-line, which relay opens the circuit of the signaling-lamp S² to indicate the subscriber's response to the operator.

In Fig. 2 I show in simple diagram two connected lines with special reference to the supervisory relays and their connections at such times, the two generators being employed as in Fig. 1 and all ringing and operator's-telephone apparatus being omitted. The local circuits established when the plugs are inserted in the jacks are here clearly shown. The one on the left includes the generator B³, conductor 16, cut-off relay R', conductor 18, sleeve-contacts of plug and jack, strand s, wire 27, and supervisory relay r' to the opposite pole of the generator B³. A similar local circuit is established for the other connected line. These circuits remain intact as long as the plugs are inserted and are therefore under the control of the operator. The relay r is in circuit with the generator A, said circuit including the telephone-line and adapted to be opened at the hook of the substation. This relay may therefore be said to be under the control of the subscriber. The relay r and generator A are connected in a bridge of the talking-circuit, said bridge starting from strand t and including conductor 25, containing the winding of relay r, the generator A, and the common connection from the negative pole of the generator to the line-wires 2. The relay r² is likewise in a bridge. The talking-circuit is shown in rectangular form and is apparent from the figure. The relays r and r', broadly considered, are in a path of current from their respective generators to contacts of the jack, and the former may be stated to be in the path of current from the charging-generator A to one line conductor.

Fig. 4 shows the same kind of a diagram

with but one generator. Here the local circuits, as well as the line-circuits, are supplied with current from the generator A. The local circuits include one the cut-off relay R' and supervisory relay r' and the other the cut-off relay R' and supervisory relay r'' . The relay r' or r'' is in a bridge of the talking-circuit with the generator A, as before described. The only difference in the connections of the two systems is to omit generator B³ and connect the wires 27 and 27^a to the grounded pole of the generator A. In this diagram it is apparent that of each pair of relays jointly controlling the signals one is under the control of the operator and the other is under the control of the subscriber. It is further apparent that said relays are in the path of current from said generator to the tip and sleeve contacts of the jack. They are also connected upon the opposite sides of the generator A between the cord-strands of each end of the cord-circuit, one relay being in addition in a bridge of the talking-circuit with generator A.

The lines are free from constant grounds at the substations and are thereby distinguished from some systems wherein party lines are provided with ground branches at the several stations some one of which branches is always completed to earth. It is apparent, however, that the invention is not to be so limited in all respects, since it is capable of use with many types of lines. The sleeve-relay and associated tip-relay serve to entirely control the exposure and non-exposure of the supervisory signal, though other arrangements may in some respects fall within the scope of the invention.

I claim—

1. 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 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, substantially as described.

2. 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 one of said relays and a switch at the central office for controlling the other of said relays, and a signal controlled by the conjoint action of said relays, substantially as described.

3. 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, and a signal controlled by the conjoint action of said relays, substantially as described.

4. 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 at the central office, a second relay in a local circuit at the central station, and a signal controlled by the conjoint action of said relays, substantially as described.

5. 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 in an auxiliary circuit closed in registering contacts of the plug and jack, and a signal controlled by the conjoint action of said relays, substantially as described.

6. 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 at the central station, a second relay in a local circuit closed in registering contacts of the plug and jack, and a signal controlled by the conjoint action of said relays, substantially as described.

7. 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 and a switch at the central station for controlling the circuit through said relays, and a signal in a local circuit completed through the contacts of said relays, substantially as described.

8. In a telephone system, the combination with a telephone-line free from constant grounds at the substation, of a charging source of electricity, a pair of relays at the central office, one of said relays being under the control of a subscriber and the other under the control of the operator, and a signal in the local circuit including the contacts of both said relays, substantially as described.

9. In a telephone system, the combination with a telephone-line free from constant grounds at the substation, of a charging source of electricity and a pair of relays at the central office, one of said relays being under the control of the subscriber and the other under the control of the operator, and a signal entirely controlled by said relays, substantially as described.

10. In a telephone system, the combination with a telephone-line free from constant grounds outside of the central office, of a charging source of electricity, an operator's plug, a pair of relays, one of said relays being in a bridge of the talking-circuit at the central office and energized as long as the subscriber's telephone is in use, and the other relay in an

auxiliary circuit and energized as long as the operator's plug is connected with the line, and a signal controlled by said relays, substantially as described.

5 11. In a telephone system, the combination with a telephone-line, of a relay and a source of current in a bridge at the central office, a second relay at the central office, and means for energizing it, said relay being in a local
10 circuit, and means for controlling a signal jointly by said relays, substantially as described.

12. In a telephone system, the combination with a telephone-line of a charging source of
15 electricity and a relay connected with the tip-strand of the cord-circuit whereby the same is adapted to be operated over the telephone-line, a second relay at the central office connected with the sleeve-strand of the cord-circuit and adapted to be closed in a local circuit
20 during conversation, whereby the same is operated as long as the plug is in the jack, and a signal in a local circuit including the contacts of both said relays, substantially as described.
25 scribed.

13. In a telephone system, the combination with a cord-circuit at the central office, of two relays associated therewith and adapted to control a supervisory signal, one of said relays
30 being arranged to open the circuit of said signal when energized and the other being adapted to close the circuit of said signal when energized, substantially as described.

14. In an operator's cord-circuit, a pair of
35 relays 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 energized over the telephone-line when the line is in use,
40 whereby the signal is at that time rendered inert, and the other relay being adapted to normally open the circuit, whereby when the cord-circuit is not connected with the line the signal is inert and when connected with a line
45 not in use the signal is displayed, substantially as described.

15. In a telephone system the combination with a telephone-line and a cord-circuit, of a pair of relays associated with each end of the
50 circuit and adapted jointly to control an associated supervisory signal, one of said relays being adapted to normally open the circuit of the signal and to be energized upon the insertion of a plug in the subscriber's jack, and the
55 other being adapted to close the signal-circuit when deenergized and to be actuated over the subscriber's line when the same is in use for talking, substantially as described.

16. In a telephone system, the combination
60 with a telephone-line free from constant grounds at the substation, of a charging source of electricity, a pair of relays adapted to be energized from said source, a switch at the substation and a switch at the central station
65 for controlling the circuit through said re-

lays, a local circuit controlled by contacts of both said relays, and a signal controlled by said circuit, substantially as described.

17. The combination with a telephone-line free from continual grounds at the substa-
70 tion, of a charging source of electricity, a pair of relays adapted to be energized from said source, an operator's plug, a switch at the substation for controlling one of said relays, means for controlling the other relay through
75 the agency of the operator's plug at the central station, and a signal-circuit including contacts of both said relays, substantially as described.

18. In a telephone system, the combination
80 with a telephone-line free from constant grounds at the substation, of a charging source of electricity, a pair of relays adapted to be simultaneously energized from said source, one of said relays being under the control of
85 the subscriber and the other under the control of the operator, and a signal adapted to be controlled by the conjoint action of said relays, substantially as described.

19. In a telephone system, the combination
90 with a telephone-line free from constant grounds at the substation, of a charging source of electricity, an operator's plug, a pair of relays adapted to be energized from said source, one of said relays being energized as long as
95 the subscriber's telephone is in use and the other relay being energized as long as the operator's plug is connected with the line and a signal controlled by said relays, substantially as described.
100

20. In a telephone system, the combination with a metallic telephone-line free from permanent grounds outside the central office, of a charging-current source, a third conductor
105 a pair of relays, one of said relays being energized over the telephone-line and the other over a circuit including the third conductor and a signal controlled by said relays substantially as described.

21. In a telephone system, the combination
110 with a metallic telephone-line insulated from ground away from the central office when used for talking, of a charging-current source, a third conductor, a pair of relays adapted to be energized from said source, a switch at the
115 substation controlling one of said relays over the telephone-line, and a switch at the central office controlling the other relay over a local circuit including the third conductor and a signal controlled by said relays, substantially
120 as described.

22. 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
125 relays being energized from the said source of electricity as long as the said operator's plug is connected with the said line, and the other relay being energized as long as the said operator's plug is connected with the said line and
130

the subscriber's telephone is in use, and a signal whose actuation is controlled solely by the said two relays, substantially as described.

23. 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 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, substantially as described.

24. 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 electromagnets associated therewith, a supervisory signal, one of said magnets being energized from the said source of electricity as long as the said operator's plug is connected with the said line to operate the said signal, and the other magnet 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 to prevent the operation of said signal, substantially as described.

25. In a telephone system, the combination with a telephone-line, of a cord-circuit and a source of electricity associated therewith at the central office, a pair of relays associated with the cord-circuit, one of said relays being connected with one strand of the cord-circuit whereby the same is operated over the telephone-line and the second relay being connected with the other strand of the cord-circuit and a local circuit in which the said second relay is adapted to be closed during a connection whereby the same is operated as long as the plug is in the jack, and a signal whose exposure depends upon the energization of one of said relays and whose non-exposure is controlled by the other of said relays, substantially as described.

26. In a telephone system, the combination with a telephone-line, of a source of current at the central office, an operator's plug and connecting-circuit, a supervisory signal, two supervisory electromagnet-windings associated with said plug and circuit, one of said windings being energized from said source of current as long as the operator's plug is connected with the line to operate said signal and the other winding being energized as long as the operator's plug is connected with the line and the subscriber's telephone is in use to prevent said signal operating, substantially as described.

27. In a telephone system, the combination

with a telephone-line, of a source of current at the central office, an operator's plug and connecting-circuit, a supervisory signal, two supervisory electromagnet-windings associated with said plug and circuit, one of said windings being energized from said source of current as long as the operator's plug is connected with the line and serving to place said signal in condition to operate and the other winding being energized as long as the operator's plug is connected with the line and the subscriber's telephone is in use to render the said signal inoperative, substantially as described.

28. 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 electromagnets associated therewith, a supervisory signal, one of said magnets being energized from the said source of electricity as long as the said operator's plug is connected with the said line and serving when energized alone to operate said signal, and the other magnet 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 serving when energized to render the signal inoperative, substantially as described.

29. In a telephone system, the combination with a telephone-line, of a source of current and an electromagnet bridged between the two limbs of the talking-circuit thereof, a second electromagnet and means for energizing it, a switch at the substation and a switch at the central station for controlling the circuit through said electromagnets, and a supervisory signal controlled by the joint action of said electromagnets, substantially as described.

30. In a telephone system, the combination with a telephone-line, a cut-off relay, a cord-circuit and source of current associated with the line, of a supervisory signal associated with said cord-circuit, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, and means for establishing a path for current over one strand of said cord-circuit to operate said cut-off relay and said supervisory signal, and a relay adapted to render the said signal inoperative and having its winding in a path for current over the other strand of said cord-circuit and telephone-line, said relay being controlled by the subscriber, substantially as described.

31. In a telephone system, the combination with a telephone-line and cord-circuit adapted to connect with said line, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, of a supervisory signal associated with said cord-circuit and adapted to be operated by current passed over one strand of said cord-circuit when connected with the line, and means controlled by the subscriber for rendering said signal inoperative by current passed over the line-circuit and other strand, substantially as described.

32. In a telephone system, the combination with a telephone-line and cord-circuit adapted to connect with said line, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, of a supervisory signal associated with said cord-circuit and adapted to be operated when a connection exists by current passed over one strand of said cord-circuit and over a suitable office-return and not under the control of the subscriber, and means under the control of the subscriber for rendering said signal inoperative by current passed over the line-circuit and other strand, substantially as described.

33. In a telephone system, the combination with a telephone-line and cord-circuit adapted to connect with said line, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, of a supervisory signal associated with said cord-circuit and adapted when a connection exists to be operated over a local circuit including one of said strands and not under the control of the subscriber, and means under the control of the subscriber for rendering the said signal inoperative by current passed over the line-circuit and other strand, substantially as described.

34. In a telephone system, the combination with a telephone-line, a cut-off relay for the line, and a cord-circuit adapted to connect with said line, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, of a supervisory signal associated with said cord-circuit and adapted when a connection exists to be operated over a local circuit not under the control of the subscriber, said local circuit including the actuating-winding of said cut-off relay and one of said strands, and means under the control of the subscriber for rendering the said supervisory signal inoperative by current passed over the line-circuit and other strand, substantially as described.

35. In a telephone system, the combination with a pair of telephone-lines, a cut-off relay and source of current for each line, a cord-circuit adapted to connect said lines together for conversation, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, a supervisory signal associated with each end of said cord-circuit, and means for establishing a path for current over one strand of one end of said cord-circuit to operate the cut-off relay and supervisory signal associated therewith, and a relay associated with each end of the cord-circuit and adapted to render the said signal inoperative and having its winding in a path of current over the other strand of said cord-circuit and corresponding telephone-line, said relays being controlled by the subscribers, substantially as described.

36. In a telephone system, the combination with a pair of telephone-lines, a cord-circuit

to connect said lines together for conversation, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, a supervisory signal associated with each end of the cord-circuit and adapted to be operated by current passing over one strand of the cord-circuit when connection is established with the line, and means controlled by the subscriber's response for rendering said signals inoperative by current passing over the line-circuits and other strands, substantially as described.

37. In a telephone system, the combination with a pair of telephone-lines and a cord-circuit to connect them together for conversation, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, a supervisory signal associated with each end of the cord-circuit and adapted to be operated when a connection exists with the line by current passing over one strand of said cord-circuit and over a suitable office-return and not under the control of the subscriber, and means under the control of the subscribers for rendering said signals inoperative by current passing over the line-circuits and other strands, substantially as described.

38. In a telephone system, the combination with a pair of telephone-lines and a cord-circuit adapted to connect the lines together for conversation, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, of a supervisory signal associated with each end of the cord-circuit and adapted when a connection exists to be operated over a local circuit not under the control of the subscriber, said local circuit including the actuating-winding of said cut-off relay and one of said strands, and means under the control of the subscribers for rendering the said supervisory signals inoperative by current passing over the line-circuit and other strand, substantially as described.

39. In a telephone system, the combination with a telephone-line and a cut-off relay therefor, of a cord-circuit adapted to be connected with said line, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, a supervisory signal associated with said cord-circuit and adapted to be operated by current passing over one strand of said cord-circuit when connected with the line, the actuating-winding of the cut-off relay being included in the path of said current whereby it is operated, and means controlled by the subscriber for rendering said signal inoperative by current passing over the line-circuit and other strand, substantially as described.

40. In a telephone system, the combination with a telephone-line and cut-off relay therefor, of a cord-circuit adapted to connect with said line, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, of a supervisory signal

associated with said line-circuit and adapted to be operated when a connection exists by current passing over one strand of said cord-circuit and over a suitable office-return and
 5 not under the control of the subscriber, the actuating-winding of said cut-off relay being also included in the path of said current, and means under the control of the subscriber for rendering said signal inoperative by current
 10 passing over the line-circuit and other strand, substantially as described.

41. In a telephone system, the combination with a telephone-line, and a cut-off relay therefor, of a cord-circuit adapted to connect with
 15 the said line, said cord-circuit having only two strands, one of which forms a part of the busy-testing circuit, a supervisory signal associated with said line-circuit and adapted when a connection exists to be controlled over
 20 a local circuit not under the control of the subscriber, the actuating-winding of said cut-off relay and one of said strands being included in said local circuit, and means under the control of the subscriber for rendering the signal
 25 inoperative by current passing over the line-circuit and other strand, substantially as described.

42. In a telephone system, the combination with a subscriber's telephone and line-circuit
 30 normally discontinuous or open to direct currents at the subscriber's station, of a main-line terminal consisting of two normally open contact-pieces at the central office, a cord-circuit consisting of two strands and with contact-terminals adapted to connect with the contact-terminals of the line when the line is connected for conversation, one of said strands
 35 being adapted to be included in the busy-testing circuit, a source of current associated with said cord-circuit and adapted to send current over the telephone-line to feed the subscriber's transmitter, a supervisory signal associated with said cord-circuit and adapted to be
 40 operated over one strand of said cord-circuit when connected with the line, the circuit for operating said signal being completed over a local circuit at the central office, and means under the control of the subscriber to render said
 45 signal inoperative by closing the line-circuit at the subscriber's station to form a path for current over the line-circuit and the other strand, substantially as described.

43. In a telephone system, the combination with a main line normally open or discontinuous at the subscriber's station, of a calling-signal normally associated with the line at the central office, a cut-off relay at the central office adapted to render the calling-signal inoperative when connection is made with the
 55 line, a line-terminal for the said line, a cord-circuit consisting of two conductors only and adapted to be placed in connection with the said line-terminals, one of said conductors forming a part of the busy testing-circuit, a
 60 source of current associated with said cord-

circuit and adapted to send current over the line-circuit for energizing the subscriber's transmitter during conversation, a supervisory signal associated with said cord-circuit and adapted to be operated when connection is
 70 made with said line by current flowing in a local circuit including one of said conductors and the cut-off relay or electromagnet, said circuit not including the subscriber's instrument, and means controlled by the subscriber
 75 for rendering the said supervisory signal inoperative by current from the said source located in the cord-circuit and sent over the line and other strand, substantially as described.

44. The combination with a telephone-line, 80 of a subscriber's station, a line-terminal at the central office associated with said line, a cord-circuit consisting of two conductors and adapted to be united to the said line-circuit by means of registering contacts in the line- 85 terminal and cord-terminal, a source of current and a supervisory signal associated with said cord-circuit, an electromagnet to operate said signal and operated over a circuit established by the connection of the cord-circuit 90 with the line-circuit, said circuit being local and including one of said conductors and not completed through the subscriber's instrument, and means under the control of the subscriber for rendering inoperative the said 95 signal by current passed over the line-circuit and other conductor, substantially as described.

45. In a telephone system, the combination with a telephone-line, a cut-off relay, a cord- 100 circuit and source of current associated with the line, of a supervisory signal associated with said cord-circuit, and means for establishing a path for current over one side of said cord-circuit to operate said cut-off relay 105 and to cause the operation of said supervisory signal, and a relay adapted to render the said signal inoperative and having its winding in a path for current over the other side of said cord-circuit and telephone-line, said relay being controlled by the subscriber, substantially 110 as described.

46. In a telephone system, the combination with a telephone-line and a cord-circuit adapted to connect with said line, of a supervisory 115 signal associated with said cord-circuit and having its operation caused by current passed over one side of said cord-circuit when the cord-circuit is connected with the line, and means controlled by the subscriber for rendering 120 said signal inoperative during conversation by current passed over the line-circuit, substantially as described.

47. In a telephone system, the combination with a telephone-line and a cord-circuit adapted 125 to connect with said line, of a supervisory signal associated with said cord-circuit and made operative when a connection exists by current passed over one side of said cord-circuit and over a suitable office-return and not 130

under the control of the subscriber, and means under the control of the subscriber for rendering said signal inoperative by current passed over the line-circuit, substantially as described.

48. In a telephone system, the combination with a telephone-line and a cord-circuit adapted to connect with said line, of a supervisory magnet associated with said cord-circuit and adapted when a connection exists to be operated over a local circuit not under the control of the subscriber, a supervisory signal caused to operate by said magnet when energized, and means under the control of the subscriber for rendering the said signal inoperative by current passed over the line-circuit, substantially as described.

49. In a telephone system, the combination with a telephone-line, a cut-off relay and cord-circuit adapted to connect with said line, of a supervisory magnet associated with said cord-circuit and adapted when a connection exists to be operated over a local circuit not under the control of the subscriber, said local circuit including the actuating-winding of said cut-off relay, a supervisory signal operated by said magnet when energized, and means under the control of the subscriber for rendering the said supervisory signal inoperative by current passed over the line-circuit, substantially as described.

50. In a telephone system, the combination with a pair of telephone-lines, a cut-off relay and source of current for each line, a cord-circuit adapted to connect said lines together for conversation, a supervisory signal associated with each end of said cord-circuit, and means for establishing a path for current over one side of one end of said cord-circuit to operate the cut-off relay and to cause the operation of the supervisory signal associated therewith, and a relay associated with each end of the cord-circuit and adapted to render the said signal inoperative and having its winding in a path of current over the other side of said cord-circuit and corresponding telephone-line, said relay being controlled by the subscriber, substantially as described.

51. In a telephone system, the combination with a pair of telephone-lines, of a cord-circuit to connect said lines together for conversation, a supervisory signal associated with each end of the cord-circuit and caused to operate by current passing over one side of the corresponding end of the cord-circuit when said end is connected with the line, and means controlled by each subscriber for rendering the supervisory signal associated with his line inoperative by current passing over his line-circuit, substantially as described.

52. In a telephone system, the combination with a pair of telephone-lines and a cord-circuit to connect them together for conversation, a supervisory signal associated with each end of the cord-circuit and caused to operate

when a connection exists with the line by current passing over one side of said cord-circuit and over a suitable office-return and not under the control of the subscribers, and means under the control of the subscribers for rendering said signals inoperative by current passing over the line-circuits, substantially as described.

53. In a telephone system, the combination with a pair of telephone-lines and a cord-circuit adapted to connect the lines together for conversation, a cut-off relay for the line, a supervisory magnet associated with each end of the cord-circuit and adapted when a connection exists to be operated over a local circuit not under the control of the subscriber, said local circuit including the actuating-winding of said cut-off relay, a supervisory signal operated by said magnet when energized, and means under the control of the subscribers for rendering the said supervisory signals inoperative by current passing over the line-circuit, substantially as described.

54. In a telephone system, the combination with a telephone-line and a cut-off relay therefor, of a cord-circuit adapted to be connected with said line, a supervisory signal associated with said cord-circuit and placed in condition to operate by current passing over one side of said cord-circuit when connected with the line, the actuating-winding of the cut-off relay being included in the path of said current whereby it is operated, and means controlled by the subscriber for rendering said signal inoperative by current passing over the line-circuit, substantially as described.

55. In a telephone system, the combination with a telephone-line and cut-off relay therefor, of a cord-circuit adapted to connect with said line, of a supervisory signal associated with said line-circuit and placed in condition to operate when a connection exists by current passing over one side of said cord-circuit and over a suitable office-return and not under the control of the subscriber, the actuating-winding of said cut-off relay being also included in the path of said current, and means under the control of the subscriber for rendering said signal inoperative by current passing over the line-circuit, substantially as described.

56. In a telephone system, the combination with a telephone-line and a cut-off relay therefor, of a cord-circuit adapted to connect with the said line, a supervisory relay associated with said line-circuit and adapted when a connection exists to be operated over a local circuit not under the control of the subscriber, the actuating-winding of said cut-off relay being included in said local circuit, a supervisory signal having its circuit closed by said supervisory relay, and means under the control of the subscriber for rendering the signal inoperative by current passing over the line-circuit, substantially as described.

57. In a telephone system, the combination with a main line normally open or discontinuous at the subscriber's station, of a telephone instrument at said subscriber's station, of a
5 calling-signal normally associated with the line at the central office, a cut-off relay at the central office adapted to render the calling-signal inoperative when connection is made with the line, a line-terminal for the said line,
10 a cord-circuit consisting of two conductors and adapted to be placed in connection with the said line-terminal, a source of current associated with said cord-circuit and adapted to send current over the line-circuit for energizing the subscriber's transmitter during
15 conversation, a supervisory signal associated with said cord-circuit, a magnet adapted to be operated when connection is made with said line over a local circuit including the cut-off relay, said circuit not including the subscriber's instrument, said magnet serving to operate said supervisory signal, and means controlled by the subscriber for rendering the said supervisory signal inoperative by current from the said source located in the cord-circuit and sent over the line, substantially as described.

58. In a telephone system, the combination with a line-circuit, of a subscriber's telephone, a line-terminal at the central office consisting of two contacts registering with two contacts in a cord-circuit when connection is made with the line, said cord-circuit including a source of current for energizing the subscriber's transmitter, a supervisory
30 signal associated with said cord-circuit and caused to operate by current passed over one side of the cord-circuit when connection is made with the line, said circuit being local and not under the control of the subscriber, 40 and means for rendering the said signal inoperative by current sent over the main line, said flow of current being under the control of the subscriber, substantially as described.

59. The combination with a telephone-line, 45 of a cord-circuit having two strands to establish connections with the line for conversational purposes, a source of current associated with the cord-circuit and adapted to send current over both sides thereof during 50 conversation, two electromagnets associated with the cord-circuit one in the path of current from said source over each said strand, a supervisory signal, one of said magnets serving when energized to operate the signal 55 and the other serving when energized to render the signal inert, substantially as described.

Signed by me at Chicago, county of Cook, State of Illinois, this 11th day of January, 1902.

JOHN G. ROBERTS.

Witnesses:

ROBERT LEWIS AMES,
M. R. ROCHFORD.