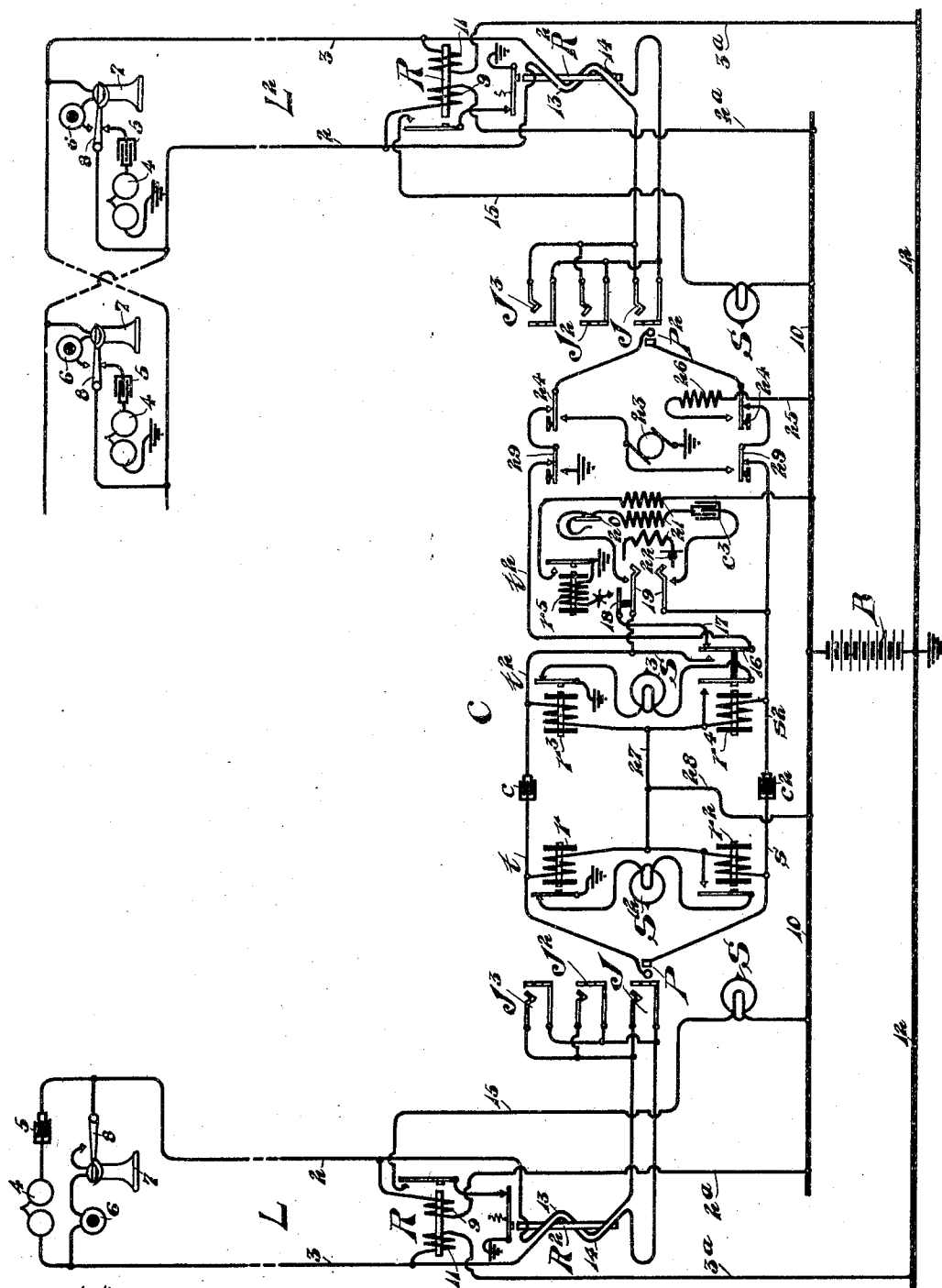


No. 794,349.

PATENTED JULY 11, 1905.

W. W. DEAN.
TELEPHONE SYSTEM.
APPLICATION FILED SEPT. 14, 1903.



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TELEPHONE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 794,849, dated July 11, 1905.

Application filed September 14, 1903. Serial No. 173,023.

To all whom it may concern:

Be it known that I, WILLIAM W. DEAN, a citizen of the United States of America, and a resident of Chicago, county of Cook, and State of Illinois, have invented a new and useful Improvement in Telephone Systems, of which the following is a specification.

My invention relates to improvements in telephone systems, and more particularly to the type known as "two-wire" telephone systems.

Among the objects of the invention are to produce a system of the type described in which no cut-off-relay contacts are present in the talking-circuit of the line, in which the cut-off relays for the telephone-lines are not in the path of current when the subscriber is calling the central office, and which may be extremely simple in construction, and in which the lines are practically "clickless," since the normal connections of the battery with the lines are not required to be severed in the operation of establishing connections for conversations.

Further objects are to provide a system in which the ringing-current may be readily sent out over either side of the lines and the cut-off relays maintained actuated without the use of complicated or unusual apparatus, and also to provide a relay in the line-circuit that does not impede the currents flowing in the metallic line, and still other objects are to provide a system that is extremely simple and inexpensive to install and to maintain in working condition.

To the accomplishment of these and such other objects as may hereinafter appear, I arrange a cut-off relay that is provided with two differential windings, so that said windings are included in the opposite line conductors of the telephone-line and locate said cut-off relay between the connection of the line-relay and the connection-terminals of the telephone-line. The line-relay is preferably permanently connected between the battery and the telephone-line conductors and provided with two balancing-windings placed one upon each side of the battery.

With this arrangement no relay-contacts are present in the talking-circuit, the cut-off relay is not in the path of current in the telephone-line when the subscriber is calling the central office, and said cut-off relay, although included in the talking-circuit, does not present impedance to the rapidly-varying voice-currents or to the ringing-currents.

My invention is illustrated in the accompanying drawing, in which the figure represents a diagram of a telephone system embodying the said improvements.

In the figure, L and L² indicate subscribers' lines extending in two limbs 2 and 3 from their respective substations to the central office. In case of a single party upon the line, as in the case of line L, there is provided an ordinary polarized signaling-bell 4 and a condenser 5 in a bridge of the line conductors, and a transmitter 6 and receiver 7 in a second bridge which is normally open at the switch-hook 8, but is adapted to be closed thereby when the receiver is lifted from the hook. In the case of a party-line, such as line L², the substations may have the bells legged to ground, as shown from the opposite sides of the line.

At the central office each line is provided with an answering-jack J and a plurality of multiple jacks J² and J³ in any desired number and also with a line-signal S. A line-relay R is provided for each line and has a winding 9 included in the preferably permanent conductor 2^a, extending from the line conductor 2 to the common battery-lead 10, connected with the live pole of the central common battery B, and with a winding 11 in permanent conductor 3^a, extending from the line conductor 3 to the common ground-wire 12, connected with the opposite and grounded pole of said battery. A cut-off relay R² is also provided for each line preferably between the line-relay and the connection-terminals or spring-jacks, said relay having differential windings 13 and 14 included in the line conductors 2 and 3, respectively, and said windings being superimposed or otherwise closely associated, so as to be neutral to the rapidly-

varying voice-currents or other currents flowing in the metallic line. The line-signal is connected upon one side with the conductor 10 and upon the other by a conductor 15, leading to the front contact of the line-relay R. The movable contact of this relay is joined by a conductor with the normal contact of the spring of the cut-off relay R², which is grounded. Thus the local circuit of the line-signal S is controlled at one point through normally open contacts of the line-relay and at another through normally closed contacts of the cut-off relay R².

The operator's outfit comprises a plurality of cord-circuits, one only being shown in the drawing and which is provided with an answering-plug P and a calling-plug P², each having tip and sleeve contacts adapted to register with the corresponding contact-surfaces of the spring-jacks of the line, the tip-contacts of said plugs being joined by the flexible strands *t* and *t*² and the interposed condenser *c*, while their sleeve-contacts are similarly united by the strands *s* and *s*² and the condenser *c*². The supervisory relays *r* and *r*² are bridged across the answering end of the cord-circuit and control the former through its normally closed contacts and the latter through its normally open contacts the local circuit of the supervisory signal S², preferably in the form of a small incandescent lamp, that is associated with the answering-plug P. A similar pair of supervisory relays *r*³ and *r*⁴ are bridged across the calling end of the cord-circuit and likewise control the local circuit of the supervisory signal S³, associated with the calling-plug P². An intermediate point of each of these bridges is connected with the live pole of said battery B by conductors 27 and 28. An extra contact 16 is provided for the supervisory relay *r*⁴, which serves when the relay is energized to complete the strand *t*² for conversation; but when the relay is deenergized to connect the forward portion of said strand with the conductor 17, leading to an extra contact 18, provided upon the listening-key, said contact when the listening-key is operated being adapted to connect said conductor 17 with the high-resistance and high-impedance test-relay *r*⁵, that is preferably common to all of the cord-circuits of the operator's position. The listening-key, which is diagrammatically represented by the springs 19, is adapted when operated to connect the operator's head telephone 20, the secondary of her induction-coil 21, and a suitable condenser *c*³ in a bridge of the calling end of the cord-circuit 7. The operator's transmitter 22 and the primary of her induction-coil are energized from any suitable source which may be the battery B. The ringing-generator 23 is adapted to be connected by the tip-ringing key-spring 24 to the tip side of the line, while at the same time the sleeve-ringing key-spring 24 is

adapted to complete connection with said conductor 10 by means of the intermediate conductor 25, containing a suitable resistance 26. An additional set of ringing-springs 29 is provided for ringing out on the other side of the line, the generator being connected during ringing with the sleeve side, while the tip-ringing spring is simultaneously grounded.

The resistance of the windings 9 and 11 of the line-relays may be three hundred ohms, while the resistances of the supervisory relays may be five hundred ohms each.

In the operation of the system the subscriber on line L, desiring a connection, takes up his receiver, thereby completing the metallic line at his substation and permitting current from the battery B to flow over conductors 10 and 2^a, through the winding 9 of the line-relay, line conductor 2, through the substation devices, and thence back to the central office over line conductor 3, through winding 11 of said line-relay R, and thence over conductors 3^a and 12 to the opposite pole of the battery. The current in this path, which is exclusive of the cut-off relay, energizes the line-relay which closes the local circuit of the line-signal S, thus lighting the same to attract the attention of the operator. Upon observing the signal the operator inserts the answering-plug P in the answering-jack J of the telephone-line, and connects her telephone with the cord-circuit by means of the listening-key. The insertion of the plug P completes a path for current from battery B over conductors 28 and 27, through the sleeve supervisory relay *r*², over the sleeve-strand *s* of the cord-circuit and that portion of the sleeve side 3 of the telephone-line which includes the winding 14 of the cut-off relay R², and thence through the winding 11 of the line-relay R to the reverse side of the battery. The current in the coil 14 of relay R² is such that said relay is energized and serves to open the local circuit of the line-signal S to retire the same. The actuation also of the supervisory relay *r*² at this time closes the local circuit of the supervisory signal S², but owing to the fact that the subscriber has his telephone off the hook the cooperating supervisory relay *r* is now also energized by current flowing over the strand *t* and through the winding 13 of the cut-off relay and serves to open the circuit of the said signal S² to prevent its operation. Upon learning the number of the party wanted that line is tested in the usual manner by touching the tip of the calling-plug to the test-ring of the multiple jack of the wanted line that is upon the operator's section of the switchboard. It will be observed that the test-rings of the lines are normally connected with ground through winding 11 of the line-relay, and since the tip of the plug is now likewise grounded through the

test-relay r^5 owing to the actuation of the listening-key 19 and the non-actuation of supervisory relay r^4 the application of the tip of the testing-plug to said test-ring when the line is idle results in no current-flow and the operator knows that the line is unemployed. If the line is connected for conversation, however, the potential of said test-rings is altered, since the sleeve-contact of the inserted plug is connected with the live pole of the battery B, and hence the touching of the tip of the testing-plug to one of said test-rings results in a current-flow through the test-relay, which is actuated to close the local circuit including the tertiary winding of the operator's induction-coil, thus causing a click in the operator's receiver to inform the operator that the line is busy. Assuming that the line is found idle and that the first party is wanted, the calling-plug is inserted in the multiple jack and the ringing-key 24 is operated. The insertion of this plug actuates the cut-off relay of line L^2 , as before explained with reference to line L, by connecting its winding 14 in a local circuit with the battery B, thus preventing the operation of the line-signal S. The fact that the line-relay may also operate at this time is of no importance, since the line-signal circuit is open at the cut-off relay.

In the operation of the ringing-key the cut-off relay R^2 is maintained actuated by current from the battery B over conductors 10 and 25, the remainder of the path being the same as under normal conditions. The ringing-current is sent out over the tip side of the line and through the signaling device at the substation and back to the central office through ground or common return. If the other party is wanted, the other set of springs 29 is operated and ringing-current is sent out over the sleeve side of the line to operate the bell that is grounded from said side. The cut-off relay is now operated by current over conductors 10 and 2^a and thence through winding 13 of said relay and the grounded tip-ringing spring 29. Thus no special pulsating or other ringing current is required for one or the other side of the line. In the case of metallic ringing, such as is required on line L, the ringing-springs 24 are used, the return-path for the ringing-current being over line conductor 3, the sleeve-contacts of the jack and plug, sleeve-spring 24, conductor 25, including resistance 26, conductor 10, and through the battery B to ground. After the subscriber has been called, but before his response, the sleeve supervisory relay r^4 is actuated and closes the circuit of the supervisory signal S^3 , which is therefore lighted to indicate to the operator the fact that the subscriber has not yet responded. The conductor 17 is also disconnected by the contact 16, and the strand t^2 of the cord-circuit is completed for conversation. At any time thereafter during the con-

nection the operator may connect her instrument with the cord-circuit without severing the strands thereof and without connecting the test-relay thereto. When the subscriber responds, current flows over the metallic line, a portion going through the supervisory relay r^3 , which is energized to retire the supervisory signal S^3 . During conversation the signals remain in exposed and the battery B is feeding current out to the substations mainly through the windings of the line-relay R, though, as stated, some current flows through relays r and r^3 . The cut-off relay R^2 presents no impedance to current in the metallic line, since the effects thereof are neutralized in the equal and opposite windings thereof. Thus the voice-currents are unimpeded by the presence of the said differential windings.

There are no relay-contacts in the talking-circuit of the lines, and it is thoroughly balanced. The cut-off relay is not in the path of current in the line when the subscriber calls the central office. Hence no marginal or differential adjustment is required.

At the termination of the conversation the return of the receivers to the hooks opens the line-circuits and permits the deenergization of the supervisory relays r and r^3 , which close the local circuits of the supervisory signals S^2 and S^3 , thus lighting the same and indicating to the operator the fact of the termination of the conversation. She then withdraws the cord-circuit plugs and restores all parts to normal condition.

Although separate line and cut-off relays are shown, it is obvious that they may be combined in any way without departing from the broad scope and principle of my invention. It is also apparent that various other changes and modifications may be made in the details of the construction and arrangement of the invention without avoiding the scope and principle thereof; but

Having thus described the principles of the invention and one practical method of carrying the same into effect, I claim and desire to secure by Letters Patent—

1. In a telephone system, the combination with a telephone-line, of connection-terminals therefor, a line-signal-controlling magnet and a source of current connected with the line at the central office, operators' connective means at the central office to establish connections with the lines of the system for conversational purposes through the medium of said connection-terminals, means under the control of the subscriber to permit a flow of current over the line from said source to operate said magnet and thereby the line-signal, and a differential cut-off magnet for the line located between said line-signal-controlling magnet and said connection-terminals, said cut-off magnet being operated when a connection is established with the

line by said connective means to render the line-signal inoperative, substantially as described.

2. In a telephone system, the combination
5 with a telephone-line, of connection-terminals therefor, a line-signal-controlling magnet and a source of current connected with the line at the central office, operators' connective means at the central office to establish
10 connections with the lines of the system for conversational purposes through the medium of said connection-terminals, means under the control of the subscriber to permit a flow of current over the line from said
15 source to operate said magnet and thereby the line-signal, and a differential cut-off magnet for the line located between said line-signal-controlling magnet and said connection-terminals, and having its differential
20 windings in the opposite sides of the line, said cut-off magnet being operated when a connection is established with the line by said connective means to render the line-signal inoperative, substantially as described.

25 3. In a telephone system, the combination with a telephone-line, of connection-terminals therefor permanently connected with the line conductors, a line-signal-controlling magnet and a common source of current connected with the line at the central office, operators' connective means at the central
30 office to establish connections with the lines of the system through the medium of said connection-terminals for conversational purposes, means under the control of the subscriber to permit a flow of current over the line from said source to operate said magnet and thereby the line-signal, and a differential cut-off magnet for the line located between
40 said line-signal-controlling magnet and said connection-terminals and having its differential windings in opposite sides of the line, said cut-off magnet being operated when a connection is established with the line by
45 said connective means to render the line-signal inoperative, substantially as described.

4. In a telephone system, the combination with a telephone-line, of connection-terminals therefor, operators' connective means at
50 the central office to establish connections with the line through the medium of said terminals for conversational purposes, a line-signal-controlling magnet and a central common source of current permanently connected
55 with the telephone-line, a line-signal controlled by said magnet, means under the control of the subscriber to permit a flow of current from said source over the telephone-line to operate said magnet and thereby the
60 line-signal, and a differential cut-off magnet located between the said line-signal-controlling magnet and the connection-terminals and having its differential windings disposed in the opposite sides of the line, said cut-off
65 magnet being operated when a connection is

established with the line by said connective means to render the line-signal inoperative, substantially as described.

5. In a telephone system, the combination with a telephone-line, of connection-terminals therefor permanently connected there-
70 with, operators' connective means at the central office to establish connections with the line for conversation through the medium of said terminals, a line-signal-controlling magnet and a central common source of current permanently connected with the telephone-
75 line, a line-signal controlled by said magnet, means controlled by the subscriber to permit a flow of current from said source over the
80 telephone-line to operate said magnet and thereby the line-signal, and a differential cut-off magnet located between said line-signal-controlling magnet and the connection-terminals and having its differential windings dis-
85 posed in the opposite sides of the line, said cut-off magnet being operated when a connection is established with the line by said connective means to render the line-signal inoperative, substantially as described.

6. In a telephone system, the combination with a telephone-line, of connection-terminals therefor, a line-signal-controlling magnet and a source of current connected with
95 the line at the central office, operators' connective means at the central office to establish connections with the lines of the system for conversational purposes through the medium of said connection-terminals, means under the control of the subscriber to permit a
100 flow of current over the line from said source to operate said magnet and thereby the line-signal, a differential cut-off magnet for the line located between said line-signal-controlling magnet and connection-terminals, and
105 means for including one winding of said cut-off magnet in a local circuit when a connection is established with the line by said connective means to thereby operate said cut-off magnet to render the line-signal inoperative, substantially as described.

7. In a telephone system, the combination with a telephone-line, of connection-terminals therefor, a line-signal-controlling magnet and a source of current connected with
115 the line at the central office, operators' connective means at the central office to establish connections with the lines of the system for conversational purposes through the medium of said connection-terminals, means under
120 the control of the subscriber to permit a flow of current over the line from said source to operate said magnet and thereby the line-signal, a differential cut-off magnet for the line located between said line-signal-controlling magnet and said connection-terminals
125 and having its differential windings in the opposite sides of the line whereby the voice-currents are unimpeded thereby, and means for including one winding of said cut-off magnet
130

in a local circuit with said source when a connection is established with the line by said connective means to thereby operate said cut-off magnet to render the line-signal inoperative, substantially as described.

8. In a telephone system, the combination with a telephone-line, of connection-terminals therefor, a line-signal-controlling magnet and a source of current connected with the line at the central office, operators' connective means at the central office to establish connections with the lines of the system for conversational purposes through the medium of said connection-terminals, means under the control of the subscriber to permit a flow of current over the line from said source to operate said magnet and thereby the line-signal, a differential cut-off magnet for the line located between said line-signal-controlling magnet and connection-terminals and having its differential windings in the opposite sides of the line, and means to include one winding of said cut-off magnet in a local circuit when a connection is established with the line by said connective means, a supervisory signal associated with the connective means, said signal being placed in position to operate by current in said local circuit, and means operated by the flow of current from said source over the telephone-line for preventing the operation of said supervisory signal, substantially as described.

9. In a telephone system, the combination with a telephone-line, of connection-terminals therefor permanently connected with the line conductors, a line-signal-controlling magnet and a common source of current connected with the line at the central office, operators' connective means at the central office to establish connections with the lines of the system through the medium of said connection-terminals for conversational purposes, means under the control of the subscriber to permit a flow of current over the line from said source to operate said magnet and thereby the line-signal, a differential cut-off magnet for the line located between said line-signal-controlling magnet and said connection-terminals and having its differential windings in the opposite sides of the line, and means to include one winding of said cut-off magnet in a local circuit when a connection is established with the line by said connective means to thereby operate the cut-off magnet to render the line-signal inoperative, substantially as described.

10. In a telephone system, the combination with a telephone-line, of connection-terminals therefor, operators' connective means at the central office to establish connections with the line through the medium of said terminals for conversational purposes, a line-signal-controlling magnet and a central common source of current permanently connected with the telephone-line, a line-signal, con-

trolled by said magnet, means under the control of the subscriber to permit a flow of current from said source over the telephone-line to operate said magnet and thereby the line-signal, a differential cut-off magnet located between the said line-signal-controlling magnet and the connection-terminals and having its differential windings disposed in the opposite sides of the line, and means for including one winding of said cut-off magnet in a local circuit with said source when a connection is established with the line by said connective means to thereby operate said cut-off magnet to render the line-signal inoperative, substantially as described.

11. In a telephone system, the combination with a telephone-line, of connection-terminals therefor permanently connected therewith, operators' connective means at the central office to establish connections with the line for conversation through the medium of said terminals, a line-signal-controlling magnet and a central common source of current permanently connected with the telephone-line, a line-signal controlled by said magnet, means controlled by the subscriber to permit a flow of current from said source over the telephone-line to operate said magnet and thereby the line-signal, a differential cut-off magnet located between the said line-signal-controlling magnet and the connection-terminals and having its differential windings disposed in the opposite sides of the line, and means for including one winding of said cut-off magnet in a local circuit with said source when a connection is established with the line by said connective means to thereby operate said cut-off magnet to render the line-signal inoperative, substantially as described.

12. In a telephone system, the combination with a telephone-line, of connection-terminals therefor, a line-signal-controlling magnet and a source of current connected with the line at the central office, operators' connective means at the central office to establish connections with the lines of the system for conversational purposes through the medium of said connection-terminals, means under the control of the subscriber to permit a flow of current over the line from said source to operate said magnet and thereby the line-signal, and a differential cut-off magnet for the line conductively associated therewith but out of the path of current when the subscriber is calling the central office, said cut-off magnet being operated when a connection is established with the line by said connective means to render the line-signal inoperative, substantially as described.

13. In a telephone system, the combination with a telephone-line, of connection-terminals for the line conductively associated therewith during conversation, a line-signal-controlling magnet and a source of current connected with the line at the central

office, operators' connective means at the central office to establish connections with the lines of the system for conversational purposes through the medium of said connection-terminals, means under the control of the subscriber to permit a flow of current over the line from said source to operate said magnet and thereby the line-signal, and a differential cut-off magnet for the line located between said line-signal-controlling magnet and said connection-terminals, said cut-off magnet being operated when a connection is established with the line by said connective means to render the line-signal inoperative, substantially as described.

14. In a telephone system, the combination with a telephone-line, of connection-terminals therefor, a line-signal-controlling magnet and a source of current connected with the line at the central office, a cord-circuit at the central office to establish connections with the lines for conversational purposes through the medium of said connection-terminals, means under the control of the subscriber to permit a flow of current over the line to operate said magnet and thereby the line-signal, an electromagnetic cut-off mechanism for the line to prevent the operation of said signal during connections, an alternating-current ringing-generator, and means for sending alternating ringing-current from said generator out over either side of the telephone-line and at the same time maintaining said cut-off mechanism operated by steady current over the other side of the line to prevent the operation of said signal during ringing, substantially as described.

15. In a telephone system, the combination with a telephone-line, of connection-terminals therefor, a line-signal-controlling magnet and a source of current connected with the line at the central office, a cord-circuit at the central office to establish connections with the lines for conversational purposes through the medium of said connection-terminals, means under the control of the subscriber to permit a flow of current to operate said magnet and thereby the line-signal, a

cut-off mechanism for the line adapted when operated to render the line-signal inoperative and having an electromagnet-winding in each side of the telephone-line, an alternating-current ringing-generator associated with the cord-circuit, and means for connecting said generator with the cord-circuit to send alternating ringing-current out over either side of the telephone-line and to simultaneously complete a path for steady current from said source of current through the winding of said cut-off mechanism in the other side of the line to maintain said signal operated during ringing, substantially as described.

16. In a telephone system, the combination with a telephone-line, of connection-terminals therefor, a line-signal-controlling magnet and a source of current connected with the line at the central office, a cord-circuit at the central office to establish connections with the line for conversational purposes through the medium of said connection-terminals, means under the control of the subscriber to permit a flow of current to operate said magnet and thereby the line-signal, a differential electromagnetic cut-off mechanism for the line adapted when operated to render the line-signal inoperative and having a winding in each side of the telephone-line, an alternating-current ringing-generator associated with the cord-circuit, and means for connecting said generator with the cord-circuit to send alternating ringing-current out over either side of the telephone-line and to simultaneously complete a path for steady current from said source of current through the winding of said cut-off mechanism in the other side of the line to maintain said signal operated during ringing, substantially as described.

Signed by me at Chicago, county of Cook, State of Illinois, this 12th day of September, 1903.

WILLIAM W. DEAN

Witnesses:

GAZELLE BEDER,
ROBERT LEWIS AMES.