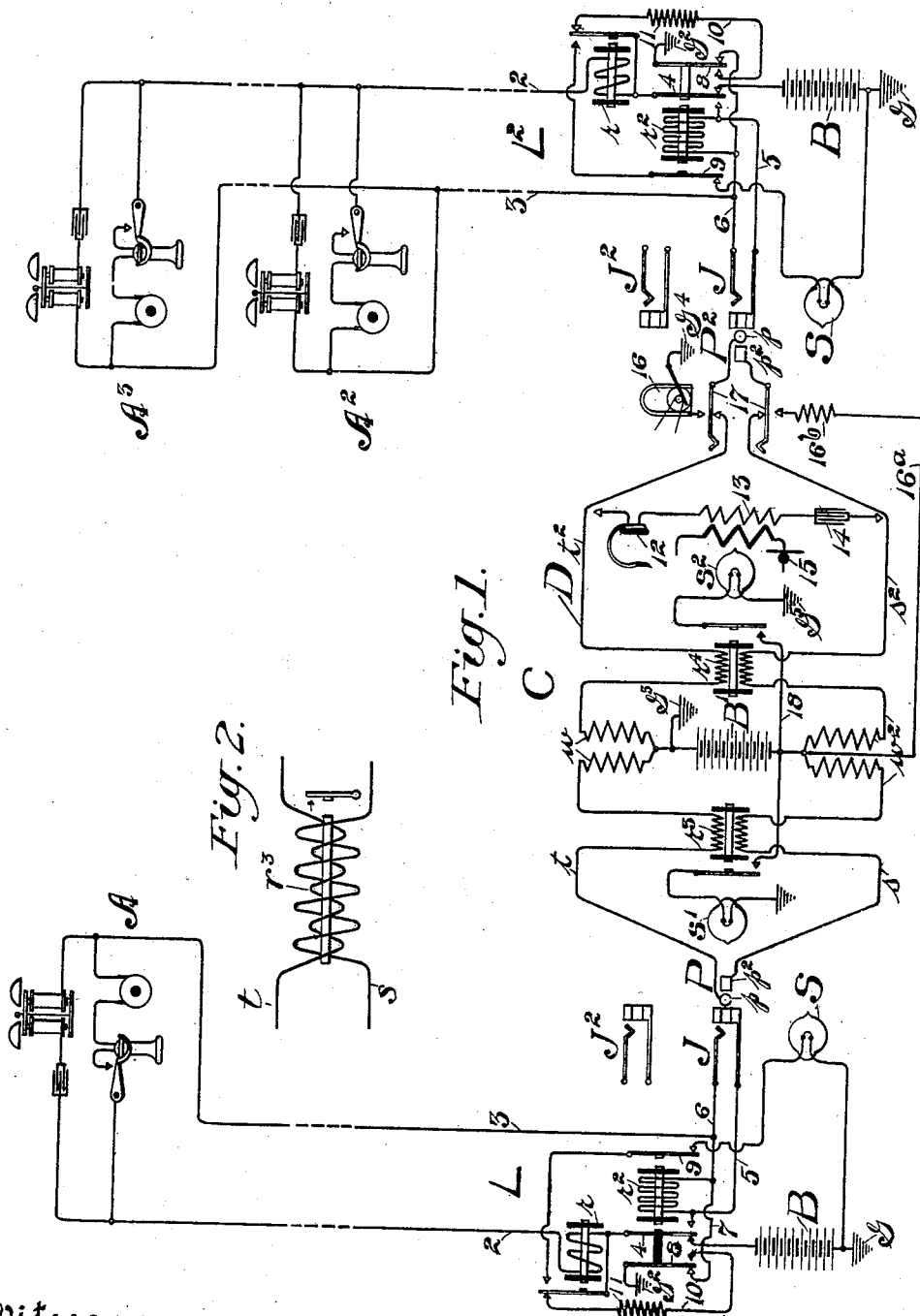


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W. W. DEAN.
TELEPHONE SYSTEM.
APPLICATION FILED SEPT. 3, 1901.



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TELEPHONE SYSTEM.

No. 862,616.

Specification of Letters Patent.

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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 certain new and useful Improvement in Telephone Systems, of which the following is a specification.

My invention relates to common battery telephone systems, and more particularly to that class in which the supervisory signals associated with the operator's connectors are operated by an excess of current over one side of a portion of the circuit.

In some systems of this class the excess flow of current is obtained by grounding the lines on one side at the substation by hanging up the receiver. But when it is desired to place several subscribers on such a line difficulty is encountered since the several grounds prevent the desired operation of the supervisory apparatus.

My invention has for its object the provision of a system wherein such a central office apparatus can be employed with any number of substations on the lines.

Other objects are the simplification of the circuits and apparatus and the provision of an efficient and highly satisfactory system.

In the drawings which accompany and illustrate this invention, Figure 1 is a diagrammatic view of two subscribers' lines and the central office apparatus, and Fig. 2 is a view showing the windings of the supervisory relays.

The same reference characters are used throughout the drawing to designate like parts.

L and L² designate subscribers' lines extending from their respective substations to the central office C, the latter line having two stations A² and A³ located thereon and the former having but one, A. The telephones at these stations are placed in a bridge of the main conductors 2 and 3, whose normal discontinuity is maintained by the usual hook switch, which is adapted to support the receiving telephone when not in use, but to close the bridge when the receiver is displaced. A standard call bell and condenser are placed in a parallel bridge between the line conductors. Of course it will be understood that any substation apparatus suitable for use with a common battery may be employed instead of that shown and described. At central the lines are each fitted with a line relay *r*, a cut-off relay *r*², connecting jacks J, J², a signal S and a connection to a battery B. The main conductor 2, includes the relay *r*, and has normal connection through the armature 4 of cut off relay *r*², with battery B and ground G, but is adapted to be connected with the conductor 5 leading to the jack J, when relay *r*² is energized. Main conductor 3 is permanently connected with the branch 6 leading to the tip line contact of the jack, and is normally con-

nected through conductor 7 and armature 8 of relay *r*², with ground G². The jack conductors 5 and 6 include between them the winding of relay *r*², whose armature 9, normally closes the circuit of signal lamp S. This circuit is normally open at line relay *r*, but is adapted to be closed thereby and when so closed includes the armatures 4 and 9 of relay *r*², and the battery B together with the intermediate conductors. A conductor 10 including a resistance 11, extends between the normal contact of relay *r*, and the forward contact of armature 8 of relay *r*².

A cord circuit D is adapted to unite any two lines for conversational purposes, and comprises two plugs P and P², having tip and sleeve contact surfaces *p* and *p*², adapted to register with like line contact surfaces when they are inserted in the jacks of the lines. The tip surfaces *p* of the plugs are united by strands *t* and *t*², which are inductively connected through the medium of the windings *w* of a repeating coil. The sleeves of the plugs are likewise connected by strands *s* and *s*², inductively united through windings *w*², of the repeating coil. The middle points of these windings are connected with the battery B', which has one pole grounded at G³. A differential relay *r*³, carries a coil included in each of the strands *t* and *s* and controls the circuit of supervisory lamp S', associated with plug P. A corresponding supervisory relay *r*⁴, has its windings interposed in the strands *t*², and *s*², and controls the circuit of lamp S², associated with the calling plug P². These relay windings are differential so that equal currents flowing in opposite directions through them do not operate the relay and are superimposed or otherwise arranged in proximity so as not to impede the voice currents. An operator's set is adapted to be bridged across the cord circuit by means of any suitable key, the bridge including a receiver 12, secondary winding 13 of her induction coil, and a condenser 14. The primary coil and the transmitter 15 are preferably charged from battery B'. A ringing generator 16, grounded at G⁴, is adapted to be connected by means of a key with the plug P². A branch 16^a containing a resistance 16^b extends between the battery B', and sleeve spring 17.

The operation is as follows:—Subscriber A lifts his receiver and causes current from the battery B to flow from ground G, through the battery over main conductor 2 to the substation and back over conductor 3, through conductors 6 and 7 and armature 8 to ground G². This operates line relay *r* and causes it to close the local circuit of lamp S from battery B, through the lamp, armature 9 of relay *r*², armature of relay *r*, and the resting contact and armature 4 of relay *r*², back to the battery. Upon seeing the signal the operator inserts the answering plug P into the jack J of the

line calling and connects her head telephone with the cord circuit. The insertion of the plug P operates relay r^2 , by current from battery B' over the tip and sleeve cord strands connected with plug P and the conductors 5 and 6 of the connection terminal of the line. The operation of relay r^2 , opens the lamp circuit through its armatures 4 and 9 thus extinguishing it and connects main conductor 2 with sleeve conductor 5 of the jack. Armature 8 is disconnected from main conductor 3 and is connected with conductor 10. Both line conductors are disconnected from ground, and the line relay r is now operated from battery B', and current from battery B' also flows through the coils of supervisory relay r^2 , in equal amounts so that the signal S' is unexposed. The presence of armature 9 of relay r^2 , in the lamp circuit prevents the line lamp S from operating when the plug is inserted as well as supervisory lamp S', by current from battery B' over the sleeve strand s.

Upon learning the number wanted, the calling plug P², is inserted and the generator 16 connected therewith to ring the subscriber's bell. The path for ringing current is from ground G⁴, at the generator, tip of plug P², line wire 3 to the station and back over main conductor 2, armature 4 of relay r^2 , conductor 5, conductor 16^a and through the battery B' to ground G³. Conductor 16^a serves to maintain the excitation of relay r^2 , from battery B' during this ringing operation, while resistance 16^b, can be adjusted as desired to cut down the battery current. The desired one of the subscribers will be selected by a prearranged system of signals. Upon the closing of the ringing key the battery B' sends current through the cord strands t², and s² to the cut-off relay r^2 , which energizes the same and causes it to attract all its armatures, the armatures 9 and 4 serving to open the circuit of lamp S to keep it dark. Armature 4 connects main conductor 2 with branch 5, and armature 8 connects with conductor 10, thus throwing a ground upon the sleeve side of the line and operating supervisory relay r^4 , by an excess of current in its sleeve winding. This circuit may be traced as follows:—from ground G³, through battery B' sleeve strand s², of the cord circuit containing a winding of relay r^4 , conductor 5, armature 4, line relay armature, which is not yet operated and its normal contact; conductor 10 containing resistance 11, armature 8, and its forward contact to ground G². Supervisory lamp S², is therefore lighted from battery B' over a circuit including ground G², battery B', conductor 18, armature and forward contact of relay r^4 , lamp S² to ground at G⁵, and the operator knows that the subscriber has not yet responded.

When the subscriber responds current from the battery B' flows over the line to charge the transmitter, and operates the line relay r to open the ground connection through branch 10, thus equalizing the flow through the windings of relay r and extinguishing lamp S², which indicates the response to the operator. The function of resistance 11 is to raise the potential of line conductor 2 at this point considerably above zero, as with a ground directly applied to the line, current would not flow to the substation and return, and relay r would not operate. The parties are now in communication and all lamps are dark. When either subscriber hangs up his receiver the correspond-

ing line relay is deenergized and establishes a ground connection through wire 10 with the sleeve side of the line and causes an excess of current in the sleeve winding of the proper supervisory relay to cause it to attract its armature and light the lamp. Either subscriber may signal for another connection by vibrating his hook, thus flashing the lamp. The lighting of both lamps will indicate the end of the conversation when the plugs may be withdrawn and all parts returned to normal position. It will be noticed that the connections are the same and the same operation takes place whether there are one or many subscribers on the line, and in the latter case the line relay as well as the supervisory signal are under the control of the talking subscriber.

The expression "excess of current", is meant to include even the case of where current in one coil is zero or any other equivalent arrangement. Good results have been obtained with cut off relays of 500 ohms resistance and resistance 11 of a like amount. The cut off relays of course have sufficient impedance to prevent short circuiting the voice currents.

It will be understood that the several batteries may be one and the same and that the several grounds may be the same or the common office return. The ground branches from the lines may be connected with any third conductor instead of ground and in practice they are preferably all connected with a main lead running throughout the exchange. The multiple board feature is generally indicated by the jacks J², J³, the connecting wires being omitted to avoid confusion.

I claim:

1. The combination with a telephone line, of a battery, a relay in the line permanently under the control of the subscriber, a line signal normally controlled by the relay, and means to open the circuit to the said battery when a connection is established with the line.
2. The combination with a telephone line, of a battery and a line relay in the line, a line signal normally controlled by said relay, means to maintain the actuation of said relay whenever the line is in condition for conversation and means to cut off said battery only, when a connection is established with the line.
3. The combination with a telephone line, of a line relay and a battery in series in the line, a line signal normally controlled by said relay, and a cut off relay actuated when a connection is established with the line to sever the line between the said line relay and battery and to re-establish the connection of said point and battery through the cord circuit, whereby said line relay will be actuated whenever the circuit is completed at the substation.
4. The combination with a telephone line, of a line relay permanently associated with the line, a battery temporarily associated with the line, a line signal normally controlled by said relay and adapted to be energized from said battery, and means to disconnect said battery and reconnect it at the same point through a different path when a connection is established with the line.
5. The combination with a telephone line, of a line relay permanently in the line, a signal controlled thereby, a battery normally connected with the line, a connection terminal for the line normally disconnected from the line, and means for severing the connection with the battery and completing a connection with the connection terminal when a conversational circuit is established.
6. The combination with a telephone line, of a line relay, a signal in a local circuit controlled thereby, a battery normally connected with the line, a cut off relay adapted to sever the connection of the line with the battery and to itself open the local circuit of the signal when a connection is established with the line.

7. The combination with a telephone line, of a line relay, a signal controlled thereby, a battery in the line, a jack for the line, and a cut off relay adapted to be connected in a bridge of the line between the line relay and the jack and to open said battery connection when a conversational circuit is established with the line.
8. The combination with a telephone line, of a relay therein under the control of the subscriber, a cut off relay adapted to be energized over a portion of the talking circuit, a ground branch adapted to be associated with said line by said cut off relay and controlled by said first named relay, and supervisory apparatus adapted to be controlled by said ground branch.
9. The combination with a telephone line, of a line relay and a battery in the line, a signal controlled by said relay, a cut off relay for the line to cut off the said battery, a ground branch adapted to be associated with the line by said cut off relay when a connection is established with the line and telephonic apparatus controlled by current over said ground branch.
10. The combination with a telephone line, of a line relay and a battery therein, a line signal normally controlled by said relay, a cut off relay also for the line adapted to sever the battery connection, a ground branch adapted to be associated with the line by said cut off relay when it is actuated, the continuity of said branch being controlled by said line relay during a connection, and supervisory apparatus controlled by said line relay and ground branch.
11. The combination with a telephone line, of a line relay and a battery in the line, a line signal normally controlled by said relay, a cut off relay, a ground branch associated with the line by said cut off relay when a connection is established with the line, the said battery connection being severed by said cut off relay at the same time, a cord circuit, and supervisory apparatus associated with the cord circuit and adapted to be operated to expose a signal by an excess of current over one side of the cord circuit and said ground branch, the said ground branch being controlled by the said line relay when the connection exists.
12. The combination with a telephone line, of a line relay and a battery in the line, a signal normally controlled by said relay, a cut off relay, a ground branch associated with the line by said cut off relay when a connection is established with the line, the said battery connection being severed by said cut off relay at the same time, a cord circuit, a differential supervisory relay and a battery in the said circuit, the said line relay being adapted to control the ground branch during the connection and thereby the supervisory relay.
13. The combination with a telephone line, of a line relay and a battery in the line, a line signal normally controlled by said relay, a cut off relay, a ground branch associated with the line by said cut off relay when a connection is established with the line, the said battery connection being severed by said cut off relay at the same time, a cord circuit, a differential supervisory relay and a battery in said cord circuit, the said line relay being adapted to close the ground branch when deenergized to permit an excess of current in one of the supervisory relay coils.
14. The combination with a telephone line, of a line relay and a battery in the line, a line signal normally controlled by said relay, a cut off relay, a ground branch associated with the line by said cut off relay when a connection is established with the line, the said battery connection being severed by said cut off relay at the same time, a cord circuit having two strands and a grounded battery between the strands a differential supervisory relay having a coil in each strand, the said line relay controlling the said ground branch, whereby the operation of the supervisory relay is under the control of any subscriber on the line.
15. The combination with a through conductive telephone line, of a line relay, a signal normally controlled by said relay, a branch conductor adapted to be connected with the line on the central office side of the said relay, the continuity of said branch being controlled by the said relay during a connection and telephonic apparatus controlled over said branch.
16. The combination with a telephone line, of a relay in the line, a branch conductor adapted to be connected with the line and controlled by said relay, a resistance in said branch, and supervisory telephonic apparatus controlled over said branch.
17. The combination with a telephone line, of a relay in the line, a third conductor adapted to be connected with one side of the line, the continuity of said conductor being controlled by said relay, a resistance in said conductor, and supervisory telephonic apparatus controlled over said branch.
18. In a telephone system, the combination with a telephone line, of a cord circuit to establish connections therewith for conversation, a source of current associated with the said cord circuit and adapted to send current over the said telephone line to the subscriber's station during conversation, a supervisory signaling apparatus associated with the said cord circuit, a ground connection associated with the said line during a connection and controlled by the subscriber, said apparatus being operated by current over said ground branch, substantially as described.
19. In a telephone system, the combination with a telephone line, of a cord circuit to establish connections therewith for conversation, a source of current associated with the cord circuit and adapted to send current over the telephone line during conversation, a supervisory signaling apparatus associated with the said cord circuit and depending upon the balanced condition of the circuit for its inoperation, a relay in the line controlled by the subscriber, and means controlled by said relay to throw said circuit out of balance to cause the operation of said apparatus, substantially as described.
20. In a telephone system, the combination with a telephone line, of a cord circuit to establish connections therewith for conversation, a source of current associated with the cord circuit and adapted to send current over the telephone line during conversation, a differential supervisory signal controlling magnet in the path of current over both sides of the cord circuit and depending upon the balanced condition of the circuit for its inoperation, a relay in the line controlled by the subscriber, and means controlled by said relay to throw said circuit out of balance to cause the operation of said magnet, substantially as described.
21. In a telephone system, the combination with a telephone line, of a cord circuit to establish connections therewith for conversation, a source of current associated with the cord circuit and adapted to send current over the telephone line during conversation, a differential supervisory signal controlling magnet having its windings in the opposite sides of the cord circuit and depending upon the balanced condition of the line for its inoperation, a relay in the line controlled by the subscriber, and means controlled by said relay to throw said circuit out of balance to cause the operation of said magnet, substantially as described.
22. In a telephone system, the combination with a telephone line, of a ground branch therefor containing a resistance, a cord circuit associated with the line, and a supervisory signal caused to operate by current over one side of the cord circuit and said ground branch when the cord circuit is connected with the line and the subscriber's telephone is not in use, substantially as described.
23. In a telephone system, the combination with a telephone line, of a relay connected with the line, a cord circuit connected with the line during conversation, a source of current bridged across the line, a non-inductive resistance connected between one side of said line and the opposite pole of said source from that with which the said side of the line is connected, telephone apparatus actuated by current in said non-inductive resistance, said relay serving when actuated to open the circuit through said non-inductive resistance, substantially as described.
24. In a telephone system, the combination with a telephone line, of a relay connected in the line, a cord circuit connected with the line during conversation, a source of current bridged across the line, a non-inductive resistance connected between one side of said line and the opposite pole of said source from that with which the said side of the line is connected, telephone apparatus actuated by current through said non-inductive resistance, said relay serving when actuated to open the circuit of the non-inductive

resistance, said resistance serving to permit the actuation of said relay, substantially as described.

25. In a telephone system, the combination with a telephone line, of a relay in the talking circuit of the line, a
5 source of current bridged across the line during conversation, a third conductor connected with one side of said line, and with the opposite pole of said source from that with which the said side of the line is connected, telephonic apparatus actuated by current in said third conductor,
10 ductor, said relay serving when actuated to open said

third conductor, and a resistance included in said third conductor to cause a sufficient flow of current over the talking circuit to operate said relay when the line is closed at the substation, substantially as described.

Signed by me at Chicago, county of Cook and State of Illinois, this 26th day of August 1901. 15

WILLIAM W. DEAN.

Witnesses:

C. J. DURHAM,

ROBERT LEWIS AMES.