

H. G. WEBSTER.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED AUG. 4, 1904.

930,513.

Patented Aug. 10, 1909.

2 SHEETS—SHEET 1.

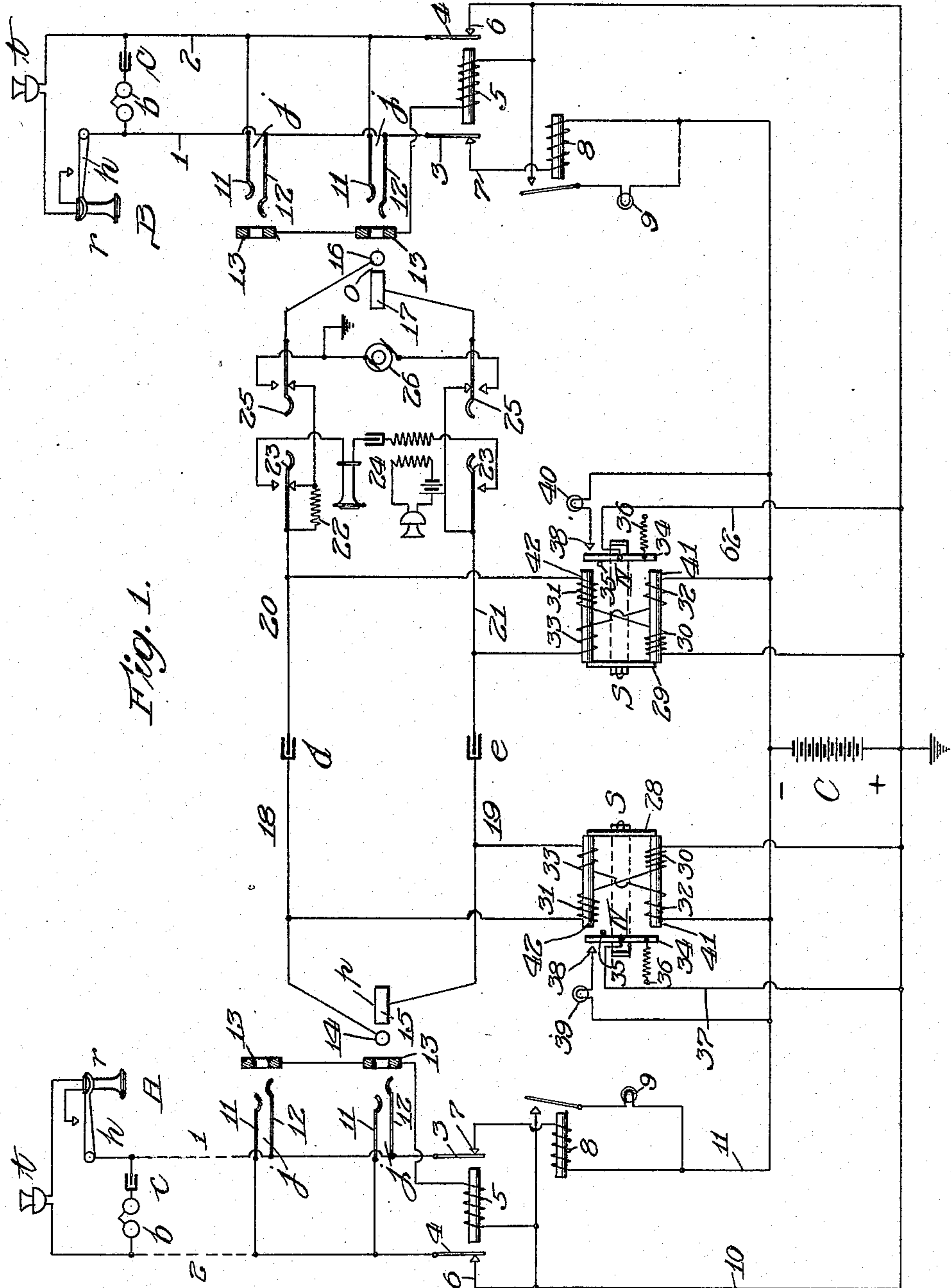


Fig. 1.

Witnesses:
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J. B. Weir

Inventor:
Harry G. Webster

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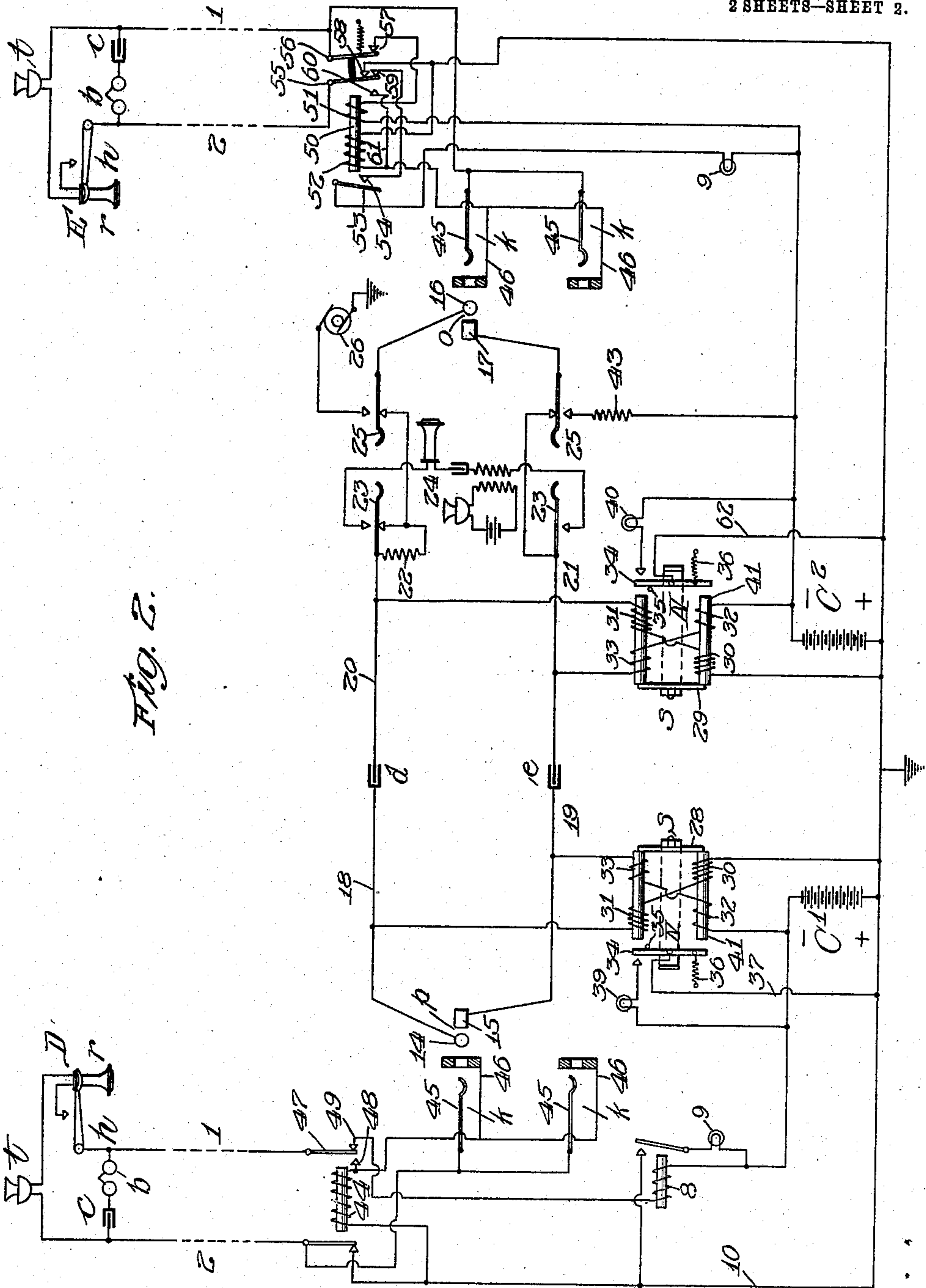


FIG. 2.

Witnesses:
Robert A. Weir
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UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR TO MILO G. KELLOGG, OF CHICAGO, ILLINOIS.

TELEPHONE-EXCHANGE SYSTEM.

No. 930,513.

Specification of Letters Patent.

Patented Aug. 10, 1909.

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To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, and a resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to central battery telephone exchange systems in which subscribers' lines extend from substations to an exchange, and are there associated with cord connecting apparatus; the said cord connecting apparatus including a supervisory signal or signals, which are controlled jointly by the manipulations of the operator, and the actuation of the subscriber's hook switch. Systems of this character have been devised in which the supervisory signal is a small incandescent lamp, its circuit being controlled by a differentially wound relay having its two windings included in the two talking strands of the cord circuit. In such systems it is necessary that a line wire leading from one side of the central battery be normally connected to ground through a contact associated with the subscriber's hook switch, the ground connection being automatically broken when the telephone is taken for conversation. In other systems which have gone into use, the use of a ground at the subscriber's station is avoided by using two relays, one for each of the talking strands of the cord circuit; and in such systems the supervisory signal is in a local circuit controlled by the joint action of the two relays.

The object of my invention is to provide means by which the ground at the subscriber's station is rendered unnecessary; and also to simplify the switching apparatus at the central office.

In accordance with my invention I associate with the connecting cord at the central office, a polarized electromagnet having differential windings and controlling by its armature the display or non-display of a supervisory signal. The arrangement of circuits is such that when the connecting plug is inserted into the jack of an idle line a circuit will be completed through one of the relay windings through which current will flow in a direction tending to weaken

the magnetization in one pole of the magnet causing the armature to move to a position which will cause the display of the supervisory signal, which may be an indicator directly connected to the armature, or a lamp or mechanical signal in a local circuit controlled by the armature. When the line circuit is closed at the subscriber's station a second circuit will be completed through the other winding of the polarized electromagnet, and while this circuit will also include the first mentioned winding, the windings are so proportioned that the effect of the current through the second winding is equal to or greater than that through the first winding, and the two windings being connected differentially to each other, the effect of the first winding will be neutralized or overcome and the armature will return to its normal position effacing the supervisory signal.

The arrangement which I have outlined may be embodied in a number of different constructions and will be more fully explained in the following description.

In the accompanying drawings illustrating a preferred form of my invention I have shown diagrammatically in Fig. 1, two complete line circuits of the three wire type in association with cord connecting apparatus including such a polarized electromagnet as I have described. In Fig. 2 I have indicated similar cord connecting apparatus associated with two different line circuits of the two wire type, one line circuit being that employing a cut-off relay and a separate signal controlling magnet, and the other line circuit that in which a single relay associated with the line causes the display of the line signal when energized to a limited extent and causes its effacement when energized to a greater extent.

Referring to Fig. 1, subscribers' stations A and B are provided with the usual apparatus adapted for use with a central source of current supply, comprising a receiver *r* and a transmitter *t*, in a circuit which stands normally opened at the contact of the hook switch *h*; the bell *b* and condenser *c* being in permanent bridge of the line limbs. Under normal conditions limbs 1 and 2 of the line extend to the central office and are there connected to the jacks *j j*, limb 1 being also carried through the winding of the line relay 8 to the negative side of the central battery

C; and limb 2 is carried through the contacts 4—6 of the cut-off relay to the positive or grounded side of the central battery C. The winding of the cut-off relay 5 is of comparatively high resistance, and is interposed between the test pieces or thimbles 13 of the jacks and the positive side of the battery C. The jacks are provided with tip contact pieces 11 and sleeve contact pieces 12 and are so arranged that when a connection plug is inserted an electrical connection is established between the sleeve springs 12 and the thimbles 13, through the sleeve contact piece of the plug. The cord connecting apparatus includes an answering plug *p* and a calling plug *o*, the plug tips 14—16 being united by strands 18—20 and condenser *d*, and the plug sleeves 15—17 being united by strands 19—21 and condenser *e*. The usual listening-key 23, operator's set 24, ringing key 25 and generator 26 are provided, and the listening key is so arranged that the non-inductive resistance 22 is brought into circuit of strand 20 when the key is moved to the listening position. A supervisory relay 28 is associated with the answering plug, having a permanent magnet whose poles N—S serve normally to give a corresponding polarity to the armature 34, and pole pieces 41—42 respectively, of the relay. A spring 36 and stop 35 are so arranged that the armature is held normally in the position shown in the drawing, but when actuated during the course of a connection it engages contact 38, completing the circuit of supervisory lamp 39. The relay cores are provided with a winding 30—31 associated with the tip strand of the cord and a second winding 32—33 associated with the sleeve strand, and these windings are so connected that when connected with the battery C as shown, they will be in opposition or "differentially connected," and the winding 30—31 is so proportioned as to produce a preponderating effect over winding 32—33 when in circuit. A second supervisory relay 29 of similar construction is associated with the calling plug *o*, and controls the circuit of supervisory lamp 40.

Subscriber A in calling completes the circuit of relay 8 and battery C, lighting the line lamp 9 in the usual manner. Upon the insertion of the answering plug *p* a circuit of battery C is completed through winding 32—33 of relay 28 through strand 19 and plug sleeve 15 of the cord circuit thimble 13 of the jack and the winding of relay 5, causing the actuation of the latter relay to break the normal connections of the line to relay 8 and battery C. The plug sleeve 15 being also in contact with sleeve spring 12 of the jack, another circuit is completed from this point through the line limbs and instrument to spring 11 of the jack, tip 14 and strand 18 of the cord and winding

30—31 of relay 28. It will be seen that at this time the current flow through winding 32—33 of the relay is greater than that through its opposing winding, but as previously stated, the winding 30—31 is so proportioned that the magnetic effect of the current traversing it is sufficient to neutralize or overcome the effect of the current in winding 32—33; and the armature 34 thus remaining in its normal position, lamp 39 remains unlighted. After learning from subscriber A with which line connection is desired (in this case that of subscriber B) the operator tests in the usual manner, her key being in the listening position. In case the line is idle the tip 16 and thimble 13 will have the same potential and no effect will be produced when they are brought in contact. If, however, the line were busy, current would flow from the positive side of battery C through relay 29, strand 20, resistance 22, plug tip 16, thimble 13 and thence through the plug sleeve and circuit of the cord at the point where the busy connection existed. This would produce a click in the operator's receiver in the well-known manner, but on account of resistance 22, which at this time is in circuit with strand 20, and is of relatively high resistance, the disturbance in the circuit of the tested line would be reduced to a minimum, the resistance 22 being provided for this purpose. Upon finding that the line is idle the operator inserts her calling plug *o* and rings in the usual manner. Upon the insertion of the plug a circuit of battery C is completed through winding 32—33 of relay 29, strand 21, plug sleeve 17, thimble 13, and relay 5 of line B, the latter relay being thus energized to break the normal connections of the line to relay 8 and battery C. While ringing, the current from generator 26 serves to maintain relay 5 energized and thereby prevents the display of the signal lamp 9, as will be understood. The adjustment of relay 29 is such that the current which at this time flows through winding 32—33, strengthens the normal magnetism of pole 41 and weakens that of pole 42 to an extent sufficient to attract the armature 34 to pole 41 and close the circuit of supervisory lamp 40 from battery C, through wire 62, armature 34 and contact 38, thus lighting the lamp. When subscriber B responds, completing the circuit of limbs 1 and 2, additional current will flow through winding 32—33 of relay 29, and circuit will be completed through line limbs 1 and 2, springs 11 and 12 of the jack, tip 16 and strand 20 of the cord circuit and winding 30—31 of the relay. On account of the relative proportions of the two windings the magnetic effect of the current through winding 30—31 equals or overcomes that of the current through winding 32—33, thus restoring or increasing the po-

larity of pole 42 and restoring or decreasing that of pole 41; the armature 34 now returns to its normal position, extinguishing lamp 40, which indicates that subscriber B has answered. When either subscriber hangs up, the circuit through winding 30—31 being broken, the current through winding 32—33 will again cause the actuation of armature 34 lighting lamp 39 or 40. When both lamps are lighted, constituting the usual disconnect signal, the operator removes the plugs, and the various parts return to the normal position shown in the drawing.

Fig. 2 shows substantially the same cord connecting apparatus as that of Fig. 1, but is indicated in association with line circuits of different characters. The line circuit of subscriber D differs from that of A in Fig. 1, in that the cut-off relay 44 is directly connected to one side of the talking circuit, but the thimbles 46 of the jacks $\frac{1}{2}$ are not brought into direct connection with line limb 1 until after the operation of the cut-off relay. In this case the subscriber D calls in the usual manner completing the circuit of relay 8 and lighting the signal lamp 9, both by means of current from battery C'. When the operator plugs in to answer, circuit is completed through winding 32—33 of the relay 28 and through contact 46 of the jack and the winding of the cut-off relay 44, causing the operation of the latter. Upon the operation of this relay the normal battery connections of the line limbs are broken, and contacts 47—48 of the relay are brought into engagement; thus completing a second circuit through relay 28, which includes the two line limbs and the windings 30—31 of the relay, causing lamp 39 to remain unlighted, as was described with regard to Fig. 1. The busy test is secured in the same manner as previously described and when the operator "plugs in" to call on a line similar to that of subscriber D, the cut-off relay 44 is energized during ringing by current from battery C² flowing through resistance 43 instead of by current from the ringing generator 26. After the restoration of the ringing-key, the cut-off relay 44 is energized by current through winding 32—33 of relay 29 as in the previous case and the armature of relay 29 is attracted to cause the illumination of supervisory lamp 40; which is extinguished as soon as the subscriber by answering completes the circuit through winding 30—31 of the relay. As soon as the circuit through winding 30—31 of either supervisory relay is broken by the replacement of the subscriber's receiver, the relay armatures assume their normal position, lighting their corresponding supervisory lamps. It is thus seen that the operation of the signals is the same as that in the first figure.

Referring to the line circuit of subscriber E of Fig. 2, the relay 50 associated with the

line is one which when energized to a limited extent will control one pair of contacts and when energized to a greater extent will also control additional contacts. Relays of this character are now known and the present drawing is only a diagrammatic illustration of such a structure. Subscriber E in calling, completes a circuit of battery C² through winding 51 of the relay 50, thence through contacts 57—56, through limbs 1 and 2 of the line and contacts 55—58, to the positive or grounded side of the battery. The winding 51 has a relatively weak magnetic effect and can only actuate armature contact 53 which, engaging contact 54, completes the circuit of lamp 9 through contact pieces 59—55— and 58, causing the illumination of the lamp. When the operator "plugs in" to answer, a circuit is completed, which may be traced as follows:—from the negative side of the battery through winding 32—33 of the relay 28 associated with the plug $\frac{1}{2}$, through contact 46 of the jack, thence through winding 52 of relay 50, and back to the positive or grounded side of the battery. This winding 52 having relatively great magnetic effect, causes the actuation of the additional contacts of the relay; contacts 56—57 are separated, disconnecting winding 51 from the line; contacts 55—58 and 59 are separated, disconnecting the line from its direct connection with the positive side of the battery, and opening the circuit of lamp 9 extinguishing the same; and contacts 55—60 are brought into engagement thus connecting thimble 46 directly to limb 2 of the line. The circuit of the line limbs 1 and 2 being closed at E a circuit is now completed from thimble 46 of the jack through the line limbs and cord strands which includes both windings of the supervisory relay, and as previously described the armature remains in its normal position, leaving the supervisory lamp unlighted. The busy test is secured in the same manner as previously described; and when the ringing key is actuated, a circuit of battery C² being thus completed through resistance 43, thimble 46 and winding 52, the relay 50 is energized to its greater extent and all of its contacts are actuated as previously described. The circuit of the calling generator is completed from ground through the ringing key, contact 45 of the jack, the two limbs of the line, contacts 55—60 of the relay and through wire 61 to the circuits of the battery C² and the ground or common return as in the previous cases. Upon the restoration of the ringing key winding 32—33 only of the relay 29 is in circuit, the armature of the relay is consequently actuated and lamp 40 lighted. When the subscriber answers, circuit being then completed through both relay windings the armature assumes its normal position extinguishing the lamp. When a

subscriber hangs up winding 30—31 is again cut out of circuit and the lamp relighted by the actuation of the relay armature. When the connection is taken down all parts assume their normal position. While in Fig. 2 I have indicated that the calling plug and answering plug are associated with separate batteries it will be understood that these may be one and the same.

Wherever in the following claims I have referred to "the non-use" of a line, it is to be understood that I am referring to that condition in which the telephone of the associated line is not in use, rather than to the existence of a connection with said line at the central office.

Wherever in the following claims I refer to "the use" of a line, it is to be understood that I am referring to the conversational circuit being established.

While I have illustrated the polarized supervisory relays as having two split windings and indicated a certain arrangement of permanent magnet, cores and armature it is obvious that relays of this character may be arranged in other ways and I therefore do not wish to limit myself to any particular construction. It will be also evident to those skilled in the art that a cord circuit such as I have indicated may be associated with other line circuits without departing from the spirit of my invention, and I therefore do not wish to be limited to the precise arrangement of apparatus and circuits shown, but claim:—

1. The combination in a telephone exchange system of a cord circuit adapted to make connection with a telephone line, a signal controlling electromagnet associated therewith responsive to current in a circuit established by the connection of said cord circuit to the line, means including a winding for securing a greater energization of one pole of said electromagnet over the other during the non-use of the line to cause the display of a signal, and a second winding for securing a decreased energization of said first pole and an increased energization of said second pole when the line is in use whereby the said signal is effaced.

2. The combination in a telephone exchange system of a cord circuit adapted to make connection with a telephone line, a polarized signal controlling magnet associated therewith responsive to current in a circuit established by the connection of said cord circuit to the line, a winding for securing a greater energization of one pole of said electromagnet over the other during the non-use of the line to cause the display of a signal, and a second winding for securing a decreased energization of said first pole and an increased energization of said second pole when the line is in use whereby the said signal is effaced.

3. The combination in a telephone exchange system of a signal controlling electromagnet having two windings associated with a cord circuit and responsive to current therein when said cord circuit is united to a telephone line, and a normally effaced signal associated with said electromagnet, adapted to be displayed by the greater energization of one pole of the electromagnet over the second pole by current through one only of said windings, and to be again effaced by a substantially equal or greater energization of the said second pole as a result of current through said second winding.

4. The combination in a telephone exchange system of a signal controlling electromagnet associated with a cord circuit and responsive to current therein when said cord circuit is united to a telephone line, a normally effaced signal associated with said electromagnet, adapted to be displayed by the greater energization of one pole of the electromagnet over the second pole, and to be again effaced by a substantially equal or greater energization of the said second pole, means including one energizing winding only for securing the said energization only of the first pole of the electromagnet when the cord circuit is united to an idle line, and a second winding for securing said equal or greater energization of the second pole of the electromagnet when the line is in use.

5. The combination in a telephone exchange system of a cord circuit adapted to make connection with a telephone line, a signal controlling electromagnet associated therewith adapted to display a signal in response to the greater energization of one pole of the electro-magnet over the second pole, and to efface said signal in response to a substantially equal or greater energization of the said second pole, means including one energizing winding only for securing the said energization of said first pole when the line is not in use and the cord circuit connected thereto, and a second winding for securing the equal or greater energization of said second pole during the use of the line.

6. The combination in a telephone exchange system of a cord circuit adapted to make connection with a telephone line, a signal controlling electromagnet having two windings associated therewith adapted to display a signal in response to the greater energization of one pole of the electromagnet over the second pole, and to efface said signal in response to a substantially equal or greater energization of the said second pole, a circuit including one of said windings only controlled by the operator for securing said energization of said first pole, and means for securing the equal or greater energization of said second pole during the use of the line by current through said second winding.

7. The combination in a telephone exchange system of a cord circuit adapted to make connection with a telephone line, a signal controlling electromagnet associated therewith adapted to display a signal in response to the greater energization of one pole of the electromagnet over the second pole and to efface said signal in response to a substantially equal or greater energization of the second pole, a circuit including one winding only of said signal controlling electromagnet controlled by the operator for securing said energization of said first pole, and a circuit including a second winding controlled from a sub-station for securing said equal or greater energization of said second pole.

8. The combination in a telephone exchange system of a cord circuit adapted to make connection with a telephone line, a polarized signal controlling electromagnet associated therewith adapted to display a signal when one pole is energized to a greater extent than the other and to efface said signal when said second pole is energized to an equal or greater extent than said first pole, a single energizing winding for securing the said energization of said first pole when the line is not in use and the cord circuit is connected thereto, and a second winding for securing the equal or greater energization of said second pole during the use of the line.

9. The combination in a telephone exchange system of a cord circuit adapted to make connection with a telephone line, a polarized signal controlling electromagnet associated therewith adapted to display a signal when one pole is energized to a greater extent than the other and to efface said signal when said second pole is energized to an equal or greater extent than said first pole, a circuit including one winding only of said polarized signal controlling electromagnet, controlled by the operator for securing said energization of said first pole, and a second winding for securing the equal or greater energization of said second pole during the use of the line.

10. The combination in a telephone exchange system of a cord circuit adapted to make connection with a telephone line, a polarized signal controlling electromagnet, having two windings associated therewith adapted to display a signal when one pole is energized to a greater extent than the other and to efface said signal when said second pole is energized to an equal or greater extent than said first pole, a circuit including one of said windings only controlled by the operator for securing said energization of said first pole, and a circuit including said second winding controlled from a sub-station for securing the equal or greater energization of said second pole.

11. The combination in a telephone exchange system of a telephone line uniting a sub-station with the central office, a switch at the sub-station for controlling the flow of current over said line through the sub-station, a cord circuit and an associated signal controlling electromagnet, said cord circuit being adapted to make connection with said line and to complete a circuit through one energizing winding only of said associated signal controlling electromagnet, means including said winding only for securing an increased energization of one pole only of said electromagnet over a circuit controlled by the operator whereby the said magnet is caused to display its signal, and a second winding included in a circuit controlled by the sub-station switch for securing an equal or greater energization of the other pole of said magnet over the first mentioned pole whereby the said signal is effaced.

12. The combination in a telephone exchange system of a telephone line uniting a sub-station with a central office, a cord circuit adapted to make connection with said line, a polarized signal controlling electromagnet associated therewith having two windings and responsive to current in one winding only to cause the display of a signal, but not responsive to current in both windings, a circuit for the said one winding only, local to the exchange and under the control of the operator for causing the actuation of the electromagnet and means under the control of the subscriber for controlling an increased flow of current through both windings when the line is switched for conversation.

13. The combination in a telephone exchange system of a telephone line uniting a sub-station with a central office, a cord circuit adapted to make connection with said line, a polarized signal controlling magnet associated therewith having two windings and responsive to current in one winding only to cause the display of a signal, but not responsive to current in both windings, a circuit for the said one winding local to the exchange and under the control of the operator for causing the actuation of the electromagnet, and means under control of the subscriber for controlling a circuit of both windings when the line is switched for conversation.

14. The combination in a telephone exchange system of a telephone line uniting a sub-station with a central office, a cord circuit adapted to make connection with said line, a polarized signal controlling magnet having two opposing windings and responsive to current in one winding only to cause the display of a signal but not responsive to current in both windings, a circuit for the said one winding only local to the exchange and under the control of the operator for

causing the actuation of the electromagnet, and means under control of the subscriber for controlling an increased flow of current through both windings when the line is switched for conversation.

15. The combination in a telephone exchange system of a telephone line uniting a sub-station with a central office, a cord circuit adapted to make connection with said line, a polarized signal controlling magnet having two opposing windings and responsive to current in one winding only to cause the display of a signal but not responsive to current in both windings, a circuit for the said one winding local to the exchange and under the control of the operator for causing the actuation of the electromagnet, and means under control of the subscriber for controlling a circuit of both windings when the line is switched for conversation.

16. The combination in a telephone exchange system of a telephone line uniting a sub-station with a central office, a cord circuit adapted to make connection with said line, a polarized signal controlling magnet having two opposing windings and responsive to current in one winding only to cause the display of a signal but not responsive to current in both windings, means under control of the operator for completing a circuit through the said winding only, and means under control of the subscriber for controlling a circuit of both windings when the line is switched for conversation.

17. The combination in a telephone exchange system of a telephone line uniting a sub-station with a central office, a cord circuit adapted to make connection with said line, a polarized signal controlling magnet associated therewith having two opposing windings, one of lesser magnetic effect than the other, an armature for said magnet normally engaging a stop and adapted to be only actuated from its normal position to cause the display of a signal by current in the said lesser winding, means under the control of the operator for completing a circuit through the winding of lesser effect, and means under control of the subscriber for completing a circuit through the other winding to cause the effacement of said signal.

18. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a connection including resistance extending between one of said line conductors of a connected telephone line and a return con-

ductor maintained at a potential different from that pole of the source of current then connected to said line conductor, a polarized signal controlling electromagnet associated with said link circuit, having a winding included in circuit with said source of current and with said resistance when said line is connected with said link circuit, whereby a difference in the relative polarization of the poles of said electromagnet in a certain direction is secured to cause the display of its signal, and a second winding for said electromagnet in a circuit under the control of the sub-station switch for destroying said relative difference in polarization whereby said signal is effaced.

19. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a connection including resistance extending between one of said line conductors of a connected telephone line and a return conductor maintained at a potential different from that pole of the source of current then connected to said line conductor and a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being adapted, when energized alone, to cause a difference in the relative polarization of the poles of said electromagnet in a certain direction to cause the display of its signal, and the other of said windings being adapted, when energized, to destroy said difference of polarization whereby said signal is effaced.

20. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a connection including resistance extending between one of said line conductors of a connected telephone line and a return conductor maintained at a potential different from that pole of the source of current then connected to said line conductor, and a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being included in circuit with said source of current and with said resistance when said line is connected with said link circuit, and included

also in circuit with said source of current and with the second winding when the circuit of the telephone line is closed at the substation, whereby a difference in the relative polarization of the poles of the said electromagnet in a certain direction is secured by current over the former path to cause the display of its signal, and whereby said difference in polarization is destroyed by current over said latter path to efface said signal.

21. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a connection including resistance extending between one of said line conductors of a connected telephone line and a return conductor maintained at a potential different from that pole of the source of current then connected to said line conductor, a polarized signal controlling electromagnet associated with said link circuit, having a winding included in circuit with said source of current and with said resistance when said line is connected with said link circuit, whereby a difference in the relative polarization of the poles of said electromagnet in a certain direction is secured to cause the display of its signal, a second winding for said electromagnet in a circuit under the control of the substation switch for destroying said relative difference in polarization whereby said signal is effaced, and a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with that contact piece of a spring jack connected with said resistance, a flow of current will result through said test circuit if another plug is inserted into another spring jack of the same line, and whereby, when no connection exists with the line, no test indication will result.

22. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a connection including resistance extending between one of said line conductors of a connected telephone line and a return conductor maintained at a potential different from that pole of the

source of current then connected to said line conductor, a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being adapted, when energized alone, to cause a difference in the relative polarization of the poles of said electromagnet in a certain direction to cause the display of its signal, and the other of said windings being adapted, when energized, to destroy said difference of polarization whereby said signal is effaced, and a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with that contact piece of a spring jack connected with said resistance, a flow of current will result through said test circuit if another plug is inserted into another spring jack of the same line, and whereby, when no connection exists with the line, no test indication will result.

23. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a connection including resistance extending between one of said line conductors of a connected telephone line and a return conductor maintained at a potential different from that pole of the source of current then connected to said line conductor, a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being included in circuit with said source of current and with said resistance when said line is connected with said link circuit, and included also in circuit with said source of current and with the line limbs of the telephone line and with the second winding when the circuit of the telephone line is closed at the substation, whereby a difference in the relative polarization of the poles of the said electromagnet in a certain direction is secured by current over the former path to cause the display of its signal, and whereby said difference in polarization is destroyed by current over said latter path to efface said signal, and a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with that contact piece of a spring jack connected with said resistance, a flow of current will result through said test circuit if another plug is inserted into another spring jack of the same line, and

whereby, when no connection exists with the line, no test indication will result.

24. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a relay winding included in circuit between one of said line conductors of a connected telephone line and a return conductor maintained at a potential different from that pole of the source of current then connected to said line conductor, adapted to be energized from said source of current over a portion of the link circuit then connected with said line conductor to destroy the substation control of its associated call signal, a polarized signal controlling electromagnet associated with said link circuit, having a winding included in circuit with said source of current and with said relay winding when said line is connected with said link circuit, whereby a difference in the relative polarization of the poles of said electromagnet in a certain direction is secured to cause the display of its signal and a second winding for said electromagnet in a circuit under the control of the substation switch for destroying said relative difference in polarization whereby said signal is effaced.

25. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a relay winding included in circuit between one of said line conductors of a connected telephone line and a return conductor maintained at a potential different from that pole of the source of current then connected to said line conductor, adapted to be energized from said source of current over a portion of the link circuit then connected with said line conductor to destroy the substation control of its associated call signal and a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being adapted, when energized, to cause a difference in the relative polarization of the poles of said

electromagnet in a certain direction to cause the display of its signal, and the other of said windings being adapted, when energized, to destroy said difference of polarization whereby said signal is effaced.

26. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a relay winding included in circuit between one of said line conductors of a connected telephone line and a return conductor maintained at a potential different from that pole of the source of current then connected to said line conductor, adapted to be energized from said source of current over a portion of the link circuit then connected with said line conductor to destroy the substation control of its associated call signal and a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being included in circuit with said source of current and with said relay winding when said line is connected with said link circuit, and included also in circuit with said source of current and with the line limbs of the telephone line and with the second winding when the circuit of the telephone line is closed at the substation, whereby a difference in the relative polarization of the poles of the said electromagnet in a certain direction is secured by current over the former path to cause the display of its signal, and whereby said difference in polarization is destroyed by current over said latter path to efface said signal.

27. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a relatively high resistance connection extending between one of said line conductors of a connected telephone line and a return conductor, said return conductor being maintained at a potential different from that pole of the source of current then connected to said line conductor, said relatively high re-

sistance connection including a relay magnet winding adapted to be energized from said source of current over a portion of the link circuit then connected with said line to destroy the substation control of its associated call signal, a polarized signal controlling electromagnet associated with said link circuit, having a winding included in circuit with said source of current and with said relatively high resistance connection when said line is connected with said link circuit, whereby a difference in the relative polarization of the poles of said electromagnet in a certain direction is secured to cause the display of its signal and a second winding for said electromagnet in a circuit under the control of the substation switch for destroying said relative difference in polarization whereby said signal is effaced.

28. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a relatively high resistance connection extending between one of said line conductors of a connected telephone line and a return conductor, said return conductor being maintained at a potential different from that pole of the source of current then connected to said line conductor, said relatively high resistance connection including a relay magnet winding adapted to be energized from said source of current over a portion of the link circuit then connected with said line to destroy the substation control of its associated call signal, and a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being adapted, when energized, to cause a difference in the relative polarization of the poles of said electromagnet in a certain direction to cause the display of its signal, and the other of said windings being adapted, when energized, to destroy said difference of polarization whereby said signal is effaced.

29. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits

and adapted to be bridged across the line circuits when connected for conversation, a relatively high resistance connection extending between one of said line conductors of a connected telephone line and a return conductor, said return conductor being maintained at a potential different from that pole of the source of current then connected to said line conductor, said relatively high resistance connection including a relay magnet winding adapted to be energized from said source of current over a portion of the link circuit then connected with said line to destroy the substation control of its associated call signal and a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being included in circuit with said source of current and with said relatively high resistance connection when said line is connected with said link circuit, and included also in circuit with said source of current and with the line limbs of the telephone line and with the second winding when the circuit of the telephone line is closed at the substation, whereby a difference in the relative polarization of the poles of the said electromagnet in a certain direction is secured by current over the former path to cause the display of its signal, and whereby said difference in polarization is destroyed by current over said latter path to efface said signal.

30. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a relay winding included in circuit between one of said line conductors of a connected telephone line and a return conductor maintained at a potential different from that pole of the source of current then connected to said line conductor, adapted to be energized from said source of current over a portion of the link circuit then connected with said line conductor to destroy the substation control of its associated call signal, a polarized signal controlling electromagnet associated with said link circuit, having a winding included in circuit with said source of current and with said relay winding when said line is connected with said link circuit, whereby a difference in the relative polarization of the poles of said electromagnet in a certain direction is secured to cause the display of its signal, a second

winding for said electromagnet in a circuit under the control of the substation switch for destroying said relative difference in polarization whereby said signal is effaced and a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with that contact piece of a spring jack connected with said relay winding, a flow of current will result through said test circuit if another plug is inserted into another spring jack of the same line, and whereby, when no connection exists with the line, no test indication will result.

31. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a relay winding included in circuit between one of said line conductors of a connected telephone line and a return conductor maintained at a potential different from that pole of the source of current then connected to said line conductor, adapted to be energized from said source of current over a portion of the link circuit then connected with said line conductor to destroy the substation control of its associated call signal, a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being adapted, when energized, to cause a difference in the relative polarization of the poles of said electromagnet in a certain direction to cause the display of its signal, and the other of said windings being adapted, when energized, to destroy said difference of polarization whereby said signal is effaced and a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with that contact piece of a spring jack connected with said relay winding, a flow of current will result through said test circuit if another plug is inserted into another spring jack of the same line, and whereby, when no connection exists with the line, no test indication will result.

32. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with

said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a relay winding included in circuit between one of said line conductors of a connected telephone line and a return conductor maintained at a potential different from that pole of the source of current then connected to said line conductor, adapted to be energized from said source of current over a portion of the link circuit then connected with said line conductor to destroy the substation control of its associated call signal, a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being included in circuit with said source of current and with said relay winding when said line is connected with said link circuit, and included also in circuit with said source of current and with the line limbs of the telephone line and with the second winding when the circuit of the telephone line is closed at the substation, whereby a difference in the relative polarization of the poles of the said electromagnet in a certain direction is secured by current over the former path to cause the display of its signal, and whereby said difference in polarization is destroyed by current over said latter path to efface said signal and a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with that contact piece of a spring jack connected with said relay winding, a flow of current will result through said test circuit if another plug is inserted into another spring jack of the same line, and whereby, when no connection exists with the line, no test indication will result.

33. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a relatively high resistance connection extending between one of said line conductors of a connected telephone line and a return conductor, said return conductor being maintained at a potential different from that pole of the source of current then connected to said line conductor, said relatively high re-

sistance connection including a relay magnet winding adapted to be energized from said source of current over a portion of the link circuit then connected with said line to destroy the substation control of its associated call signal, a polarized signal controlling electromagnet associated with said link circuit, having a winding included in circuit with said source of current and with said relatively high resistance connection when said line is connected with said link circuit, whereby a difference in the relative polarization of the poles of said electromagnet in a certain direction is secured to cause the display of its signal, a second winding for said electromagnet in a circuit under the control of the substation switch for destroying said relative difference in polarization whereby said signal is effaced and a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with that contact piece of a spring jack connected with said relatively high resistance connection, a flow of current will result through said test circuit if another plug is inserted into another spring jack of the same line, and whereby, when no connection exists with the line, no test indication will result.

34. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a relatively high resistance connection extending between one of said line conductors of a connected telephone line and a return conductor, said return conductor being maintained at a potential different from that pole of the source of current then connected to said line conductor, said relatively high resistance connection including a relay magnet winding adapted to be energized from said source of current over a portion of the link circuit then connected with said line to destroy the substation control of its associated call signal, a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being adapted, when energized, to cause a difference in the relative polarization of the poles of said electromagnet in a certain direction to cause the display of its signal, and the other of said windings being adapted, when energized, to destroy said

difference of polarization whereby said signal is effaced and a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with that contact piece of a spring jack connected with said relatively high resistance connection, a flow of current will result through said test circuit if another plug is inserted into another spring jack of the same line, and whereby, when no connection exists with the line, no test indication will result.

35. A telephone exchange system including telephone lines extending to a central office, line conductors for extending said telephone lines to the switchboard, spring jacks associated with said line conductors at the switchboard, calling signals associated with said lines and adapted to be operated by current over said lines, link circuits for uniting said lines for conversation, a source of current associated with said link circuits and adapted to be bridged across the line circuits when connected for conversation, a relatively high resistance connection extending between one of said line conductors of a connected telephone line and a return conductor, said return conductor being maintained at a potential different from that pole of the source of current then connected to said line conductor, said relatively high resistance connection including a relay magnet winding adapted to be energized from said source of current over a portion of the link circuit then connected with said line to destroy the substation control of its associated call signal, a polarized signal controlling electromagnet having two windings associated with said link circuit, one of said windings being included in circuit with said source of current and with said relatively high resistance connection when said line is connected with said link circuit, and included also in circuit with said source of current and with the line limbs of the telephone line and with the second winding when the circuit of the telephone line is closed at the substation, whereby a difference in the relative polarization of the poles of the said electromagnet in a certain direction is secured by current over the former path to cause the display of its signal, and whereby said difference in polarization is destroyed by current over said latter path to efface said signal and a test circuit extending from said return conductor through a signal producing device to the testing contact piece of a plug, whereby, when said testing contact piece of the plug is engaged with that contact piece of a spring jack connected with said relatively high resistance connection, a flow of current will result through said test circuit if another plug is inserted into an-

other spring jack of the same line, and whereby, when no connection exists with the line, no test indication will result.

36. The combination, in a telephone exchange system, of a telephone-line uniting a substation with the central office, a cord-circuit adapted to make connection with said line, a polarized signal-controlling electromagnet having two opposing windings and responsive to current in one winding only to cause the display of a signal, but not responsive to current in both windings, a circuit for one of said windings local to the exchange and under the control of the operator for causing the actuation of the electromagnet, and a switch at the substation included in the circuit of the other winding when the line is switched for conversation.

37. A telephone system comprising a telephone line extending from a substation to a central office, a link-circuit for making connection to said line, a polarized two-winding signal-controlling electromagnet associated with said link-circuit, means for displaying a signal in response to the one-winding energization of said electromagnet and for effacing said signal in response to the two-winding energization thereof, a source of current, a resistance associated with said telephone line, means under the control of the operator for completing a circuit through one of the windings of said signal-controlling electromagnet and said resistance, and means under the control of the subscriber, when the operator has completed said circuit, for completing a circuit including the other winding of said signal-controlling electromagnet in parallel with said resistance.

38. A telephone system comprising a telephone line extending from a substation to a central office, a link-circuit for making connection to said line, a polarized two-winding signal-controlling electromagnet associated with said link-circuit, means for displaying a signal in response to the one-winding energization of said electromagnet and for effacing said signal in response to the two-winding energization thereof, a source of current, a line-signal associated with said telephone line, a signal-effacing electromagnet for removing said line-signal from the control of the subscriber, means under the control of the operator for completing a circuit through one of the windings of said signal-controlling electromagnet and the winding of said signal-effacing electromagnet, and means under the control of the subscriber, when the operator has completed said circuit, for completing a circuit including the other winding of said signal-controlling electromagnet in parallel with the winding of said signal-effacing electromagnet.

39. A telephone system comprising tele-

phone lines extending from substations to a central office, springjacks in which said lines terminate, a link-circuit and terminal plugs for connecting said lines for conversation, a polarized two-winding signal-controlling electromagnet associated with said link-circuit, means for displaying a signal in response to the one-winding energization of said electromagnet and for effacing said signal in response to the two-winding energization thereof, a source of current, a resistance associated with each telephone line, means operative upon the connection of said link-circuit to a telephone line to close a circuit through one of the windings of said signal-controlling electromagnet and the said resistance associated with said telephone line, means under the control of the subscriber, when the operator has completed said circuit, for completing a circuit including the other winding of said signal-controlling electromagnet in parallel with said resistance, a test circuit connected to one terminal of said resistance and extending to the testing contact-piece of a terminal plug, and a signal-producing device associated with said test contact whereby, when said testing contact-piece of the plug is engaged with the testing contact-piece of a springjack associated with a disconnected line, no flow of current will result, and whereby, when said engagement is made with a springjack of a connected line, a flow of current will result to cause the operation of the said signal-producing device.

40. A telephone system comprising telephone lines extending from substations to a central office, springjacks in which said lines terminate, a link-circuit and terminal plugs for connecting said lines for conversation, a polarized two-winding signal-controlling electromagnet associated with said link-circuit, means for displaying a signal in response to the one-winding energization of said electromagnet and for effacing said signal in response to the two-winding energization thereof, a source of current, a line-signal associated with each telephone line, a signal-effacing electromagnet for removing said line-signal from the control of the subscriber, means operative upon the connection of said link-circuit to a telephone line to close a circuit through one of the windings of said signal-controlling electromagnet and the winding of the associated signal-effacing electromagnet, means under the control of the subscriber, when the operator has completed said circuit, for completing a circuit including the other winding of said signal-controlling electromagnet in parallel with the winding of said signal-effacing electromagnet, a test circuit connected to one terminal of said signal-effacing electromagnet

and extending to the testing contact-piece of a terminal plug, and a signal-producing device associated with said test contact, whereby when said testing contact-piece of the plug is engaged with the testing contact-piece of a springjack associated with a disconnected line, no flow of current will result, and whereby when said engagement is made with a springjack of a connected line,

a flow of current will result to cause the operation of the said signal-producing device.

In witness whereof, I hereunto subscribe my name this 28th day of July, A. D. 1904.

HARRY G. WEBSTER.

Witnesses:

KEMPSTER B. MILLER,
GRACE MITCHELL.

It is hereby certified that in Letters Patent No. 930,513, granted August 10, 1909, upon the application of Harry G. Webster, of Chicago, Illinois, for an improvement in "Telephone-Exchange Systems," an error appears in the printed specification requiring correction, as follows: Page 7, line 1, after the word "current" the words *and with the line limbs of the telephone line* should be inserted; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of October, A. D., 1909.

[SEAL.]

C. C. BILLINGS,
Acting Commissioner of Patents.