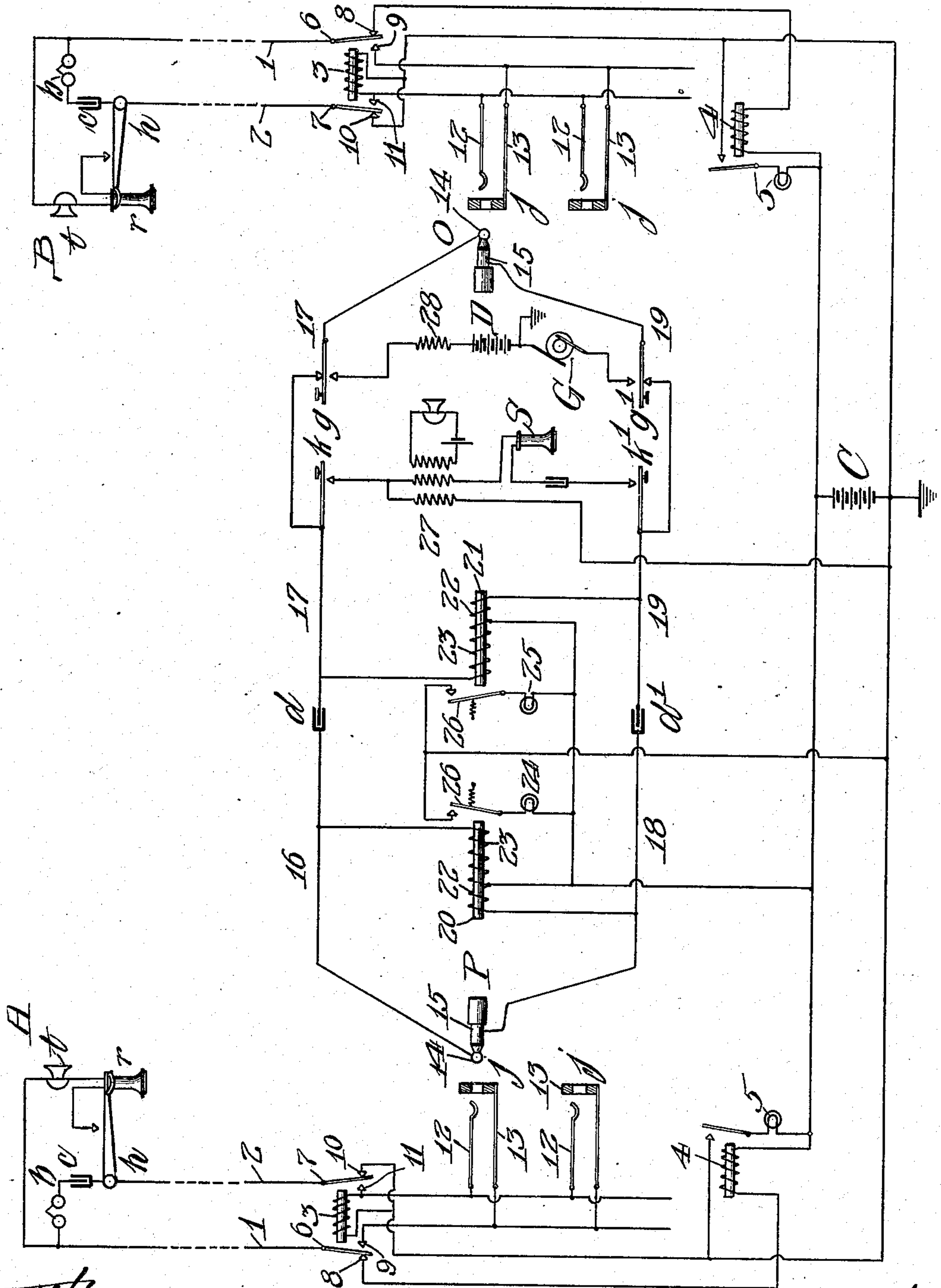


H. G. WEBSTER.  
TELEPHONE EXCHANGE SYSTEM.  
APPLICATION FILED DEC. 16, 1904.

930,514.

Patented Aug. 10, 1909.



Witnesses:  
Robert H. Weir  
Emil E. Wetmann

Inventor:  
Harry G. Webster



# UNITED STATES PATENT OFFICE.

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

## TELEPHONE-EXCHANGE SYSTEM.

No. 930,514.

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 drawing, 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 those 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, an electromagnet having two 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, circuit will be completed through one of the magnet windings and a portion of a talking limb of the line, and the current which then flows through the winding will energize the magnet sufficiently to cause the display of the associated super-

visory signal. This signal may be an indicator directly connected to the magnet 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, circuit will be completed through the other winding of the electromagnet and current will flow through this winding in the opposite direction and, therefore, tend to neutralize the magnetization due to the first winding. The adjustment or spring tension, which causes the retraction of the magnet armature, is such that the full magnetizing effect of the current through the first mentioned winding is necessary to secure and maintain the attraction of the armature, causing the display of a supervisory signal; and any substantial decrease in this magnetizing effect will allow the retraction of the armature and the consequent effacement of the signal.

In a preferred form of my invention, the two windings are arranged upon opposite ends of the magnet core and I complete the circuit of the first mentioned winding through an impedance associated with the line limb with which this winding is connected, and this impedance may be in the cut-off relay which controls the normal connections of the line circuit. In such an arrangement, this winding of the electromagnet would be of relatively high resistance as compared to its other winding and to the winding of the cut-off relay, and would have a substantially greater number of turns than its opposing winding. The current through this winding would then be confined to the circuit local to the exchange and would only flow over that portion of the line limb extending from the cord circuit to the point of connection of the cut-off relay. The second winding of the electromagnet in such an arrangement would have its circuit controlled solely by the subscriber after the insertion of the connecting plug, and the current through the circuit of this winding would include the two line limbs and the same winding of the cut-off relay which serves to complete the circuit of the first mentioned winding. The resistance and number of turns of this second winding are so proportioned that with a line of average resistance, the current flowing there-through would substantially neutralize the magnetizing effect of the current through the first winding and, having established these proportions, it will be seen that a consider-



able variation in line resistance will not prevent a sufficient neutralization between the current effect in the two windings to allow the retraction of the magnet armature when the circuit of both windings is complete. It is to be noted, therefore, that my system is one which does not depend upon the complete neutralization of the magnetic effect of the two windings for the effacement of the supervisory signal; but that this effacement is secured through a partial neutralization and consequent decrease in net energization over that due to one winding alone.

I have found in practice that in a system in which the central battery has a potential of twenty-four volts, the resistance of the first mentioned winding may be made approximately seven hundred ohms, that of the second winding one hundred ohms and that of the winding of the cut-off relay one hundred ohms with satisfactory results, but do not wish to be limited to these specific resistances or to the proportional relation between such resistances.

In the accompanying drawing illustrating a preferred form of my invention, I have shown diagrammatically two complete line circuits of the two wire type, in association with cord connecting apparatus including such a signal controlling electromagnet as I have described, all organized in accordance with a preferred form of my invention.

The subscriber's apparatus, indicated at A, is represented as consisting of a telephone hook switch *h*, a signal bell *b*, condenser *c*, receiver *r* and transmitter *t*; the bell and condenser being in permanent bridge of the two line limbs, and the circuit being closed through the receiver and transmitter upon the elevation of the hook switch. Although I have shown but one arrangement, it will be understood by those skilled in the art that various other arrangements of the subscriber's apparatus may be used, and I do not confine myself to the particular arrangement illustrated. Under normal conditions, the receiver hangs upon its hook switch maintaining its contact open, and the condenser *c* prevents a normal flow of current from battery C at the central office over the line limbs. When the subscriber removes his telephone from its hook, thus closing the contact of hook switch *h* and establishing a relatively low resistance path for the flow of current through the transmitter *t* and receiver *r*, relay 4 at the central office will be operated by the flow of current from said battery C through the winding of relay 4, anvil 8 and armature 6, the two limbs of the line and through armature 7 and anvil 10 to the return side of the battery. This flow of current through relay 4 causes its energization and the consequent illumination of calling lamp 5. Each subscriber's line is provided with one or more spring jacks *j*, each having

contact pieces 13 and 12 corresponding to limbs 1 and 2 of the line respectively, the circuit of contact piece 13, which also serves as a testing terminal, being normally open and contact piece 12 being connected through the winding of cut-off relay 3 to the return side of the battery C and normally disconnected from its associated line limb 2. The illumination of signal lamp 5 indicating to the operator that the subscriber has removed his receiver from its hook for the purpose of making a call, she inserts the answering plug P into a spring jack *j* corresponding to the calling signal, thus causing contact piece 15 of the plug to engage contact piece 13 of the jack and contact piece 14 of the plug to engage contact piece 12 of the spring jack. Current will now flow from battery C through winding 23 of supervisory relay 20, strand 16 of the cord circuit, contact 14—12 of the plug and spring jack and thence through the winding of relay 3 to the return side of battery C. This current causes the energization of relay 3, and the actuation of its armatures breaks the normal connections of the line limbs at anvils 8 and 10, and engaging anvils 9 and 11, completes the circuit of limbs 1 and 2 to contact pieces 13 and 12, respectively, of the spring jacks. Current will now flow from battery C through winding 22 of relay 20, strand 18, plug and jack contact 15—13, anvil 9 and armature 6, limbs 1 and 2, armature 7 and anvil 11 and thence through the winding of relay 3 to the return side of the battery. Under this condition, it will be seen that current is flowing through the two windings of relay 20 in opposite directions—that through the comparatively great number of turns of winding 23 being comparatively weak, and that through the comparatively few number of turns of winding 22 being comparatively strong; and it will be seen that these two currents unite at relay 3 the resultant current flowing through the winding of relay 3 to the return side of the battery. At this time, the net energizing effect of the current in the two windings will be substantially less than that of winding 23 alone, and armature 26 of the relay remains in its retracted position and the lamp 24 is consequently unilluminated. Being informed with what line connection is desired—in this case, that of subscriber B,—the operator tests in the usual manner by touching the tip of her calling plug O to the contact piece 13 of a jack associated with that line. The circuit of this contact piece being normally open, no effect will be produced unless there is a cord circuit connected with some jack of the line. If such a connection exists, current will flow at the time of making the test from battery C through winding 22 of a relay associated with the said cord circuit, strand 19 and plug and jack contact 15—13 and thence through contact piece



13 of the jack tested to tip contact piece 14 of the testing plug, thence through strand 17 and winding 27 of the operator's induction coil, producing the customary "click" which indicates that the line is busy.

While I have indicated one particular arrangement of busy test, it will be understood that other well known arrangements may be employed without departing from my invention. Upon the insertion of the plug O and the actuation of the ringing key levers  $g-g^1$ , relay 3 is energized by current from battery D flowing through resistance 28, strand 17, plug and jack contact 14—12 and thence through the winding of relay 3 to the return side of the battery; and the circuit of the calling generator G is at this time completed through strand 19, plug and jack contact 15—13, limbs 1 and 2 of the line, armature 7 and anvil 11 and thence to the office return. Upon the restoration of the ringing key, relay 3 is energized by current from battery C flowing through winding 23 of relay 21 over a circuit similar to that previously described for the line of subscriber A. On account of the absence of current at this time in winding 22 of relay 21, the current through winding 23 exercises its full energizing effect, causing the attraction of armature 26 of relay 21 and the consequent illumination of supervisory lamp 25. When subscriber B answers, he completes the circuit of winding 22 through the line limbs and, as explained, the current which then flows through winding 22 partially or completely neutralizes the effect of the current in winding 23 allowing armature 26 to be retracted, thus extinguishing the lamp 25. The two subscribers may now converse, their circuits being inductively united through strand 16—17 and condenser  $d$ , and strand 18—19 and condenser  $d^1$ . When either subscriber hangs up, he interrupts the circuit of his corresponding winding 22 and the associated winding 23 then exercises its full energizing capacity, causing the attraction of the armature associated with the relay and the consequent illumination of the associated supervisory lamp. When both subscribers have hung up, the consequent illumination of both lamps constitutes the customary disconnect signal and the connection is taken down, the consequent deenergization of relay 3 restoring the normal connections of the line.

It will be understood that the grounds indicated in association with battery C and with battery D and generator G represent the office return or grounded terminal of the central battery; and it will also be understood that the batteries C and D may be one and the same. It will also be understood that while I have shown but one embodiment of my invention, various modifications may be made by those skilled in the art

without departing from its spirit and I, therefore, do not limit myself to the precise arrangement illustrated and described, but claim:—

1. 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 source of current, a signal controlling magnet having two opposing windings connected to the live pole of said source 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 a switch at the substation included in the circuit of the other winding when the line is switched for conversation.

2. A telephone exchange system including telephone lines extending to a central office, call signals for said lines adapted to be operated by current over said lines, a single-winding signal effacing electromagnet for destroying the substation control of its call signal, a signal controlling electromagnet having two differential windings, means under the control of the operator for completing a circuit through one of the windings of said signal controlling electromagnet and through 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 through the subscriber's line, the other winding of said signal controlling electromagnet and through the winding of said signal effacing electromagnet.

3. A telephone exchange system including telephone lines extending to a central office, call signals for said lines adapted to be operated by current over said lines, a single-winding signal effacing electromagnet operative, when energized, to destroy the substation control of its said call signal, a signal controlling electromagnet having two differential windings, means for displaying a signal in response to the energization of one winding of said magnet and for effacing said signal in response to the energization of both windings of said magnet, means under the control of the operator for completing a circuit through the winding of said signal effacing electromagnet and through that winding of said signal controlling electromagnet necessary to display its signal, and means under the control of the subscriber, when the operator has completed said circuit, for completing a circuit through the subscriber's line, the winding of said signal effacing electromagnet and through the other winding of said signal controlling electromagnet, whereby the signal of said latter electromagnet is effaced.

4. A telephone exchange system including



a telephone line extending to a central office, a call signal for said line adapted to be operated by current over said line, a link-circuit adapted to be connected to said telephone line, a single-winding signal effacing electromagnet for destroying the substation control of said call signal, a signal controlling electromagnet having two differential windings associated with said link-circuit, means operative upon the connection of said link-circuit to said telephone line for completing a circuit through one of the windings of said signal controlling electromagnet and through the winding of said signal effacing electromagnet, and means under the control of the subscriber, when said circuit has been completed, for completing a circuit through the other winding of said signal controlling electromagnet, the subscriber's line and through the winding of said signal effacing electromagnet.

5. A telephone exchange system including a telephone line extending to a central office, a call signal for said line adapted to be operated by current over said line, a link-circuit adapted to be connected to said telephone line, a single-winding signal effacing electromagnet operative, when energized, to destroy the substation control of said call signal, a signal controlling electromagnet having two differential windings associated with said link-circuit, means for displaying a signal in response to the energization of one winding of the said magnet and for effacing said signal in response to the energization of both windings of said magnet, means operative upon the connection of said link-circuit to said telephone line for completing a circuit through the winding of said signal effacing electromagnet and through that winding of said signal controlling electromagnet necessary to display its signal, and means under the control of the subscriber, when said circuit has been completed, for completing a circuit through the winding of said signal effacing electromagnet, the subscriber's line and through the other winding of said signal controlling electromagnet whereby the signal of said latter electromagnet is effaced.

6. A telephone exchange system including telephone lines extending to a central office, call signals for said lines adapted to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, spring jacks for said lines connected with said line conductors, link-circuits provided with terminal plugs for connecting said telephone lines for conversation, a source of current adapted to furnish current to a telephone line when connected with a link-circuit, a single-winding signal effacing electromagnet for said line, adapted, when energized, to destroy the substation control of its call signal, a switch at the substation adapted to control the flow of current over

the telephone line, a signal controlling electromagnet having two differential windings associated with said source of current and said link-circuit, one of said windings being, when said link-circuit is connected to said telephone line, included in circuit with said source of current and with said signal effacing electromagnet, whereby said signal controlling electromagnet is energized to cause the display of its signal, and the other of said windings being included in a circuit normally open at the terminal plug and at the substation switch, but, when said link-circuit is connected with said telephone line and said substation switch is closed, included in circuit with said source of current and with said telephone line and said signal effacing electromagnet, whereby said signal is effaced.

7. A telephone exchange system including telephone lines extending to a central office, call signals for said lines adapted to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, spring jacks for said lines connected with said line conductors, link-circuits provided with terminal plugs for connecting said telephone lines for conversation, a source of current adapted to furnish current to a telephone line when connected with a link-circuit, a single-winding signal effacing electromagnet for said line, adapted, when energized, to destroy the substation control of its said call signal, a switch at the substation adapted to control the flow of current over the telephone line, a signal controlling electromagnet having two differential windings associated with said source of current and said link-circuit, one of said windings being, when said link-circuit is connected to said telephone line, included in circuit with said source of current and with said signal effacing electromagnet, whereby said signal controlling electromagnet is energized to cause the display of its signal, the other of said windings being included in a circuit normally open at the terminal plug and at the substation switch, but, when said link-circuit is connected with said telephone line and said substation switch is closed, included in circuit with said source of current and with said telephone line and said signal effacing electromagnet, whereby said signal is effaced, and 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 circuit, whereby when said testing contact piece of the plug is engaged with the testing contact piece of a spring jack associated with a disconnected line, no flow of current will result, and whereby when said engagement is made with a spring jack of a connected line, a flow of current will result to cause the operation of the said signal producing device.



8. A telephone exchange system including telephone lines extending to a central office, call signal magnets for said lines adapted to be operated by current over said lines, control switches for said lines at the substations, a link-circuit adapted to connect said lines for conversation, a signal controlling electromagnet associated with said link-circuit, means under the control of the operator for completing a circuit of definite resistance local to the central office and over a portion of the talking circuit through an energizing winding of said signal controlling electromagnet to produce a definite energization thereof, a signal displayed in response to said energization, means for obtaining a decreased energization of said signal controlling electromagnet to efface said signal, consisting of, when said circuit of definite resistance has been completed, a circuit in parallel with the said energizing winding of said signal controlling electromagnet through said telephone line open only at the substation control switch, and means operative also upon the completion of said circuit of definite resistance for preventing the energization of the associated call signal magnet whereby the substation control of said magnet is destroyed.

9. A telephone exchange system including telephone lines extending to a central office, call signal magnets for said lines adapted to be operated by current over said lines, control switches for said lines at the substations, a link-circuit adapted to be connected to any one of said telephone lines, a signal effacing electromagnet for said telephone line adapted, when energized, to destroy the substation control of said call signal, a signal controlling electromagnet associated with said link-circuit, means under the control of the operator for completing a circuit of definite resistance local to the central office and over a portion of the talking circuit through an energizing winding of said signal effacing electromagnet and through said signal controlling electromagnet to produce a definite energization of the latter, a signal displayed in response to said energization, means for obtaining a decreased energization of said signal controlling electromagnet to efface said signal consisting of, when said circuit of definite resistance has been completed, a circuit in parallel with the said energizing winding of said signal controlling electromagnet through said telephone line open only at the substation control switch, and means operative also upon the completion of said circuit of definite resistance for preventing the energization of the associated call signal magnet whereby the substation control of said magnet is destroyed.

10. A telephone exchange system including telephone lines extending to a central office, call signal magnets for said lines adapted

ed to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, spring jacks connected with said line conductors, link-circuits for uniting said lines for conversation, a source of current, a link-circuit adapted to connect said lines for conversation, a signal controlling electromagnet associated with said link-circuit, means under the control of the operator for completing a circuit of definite resistance local to the central office and over a portion of the talking circuit through an energizing winding of said signal controlling electromagnet to produce a definite energization thereof, a signal displayed in response to said energization, means for obtaining a decreased energization of said signal controlling electromagnet to efface said signal, consisting of, when said circuit of definite resistance has been completed, a circuit in parallel with the said energizing winding of said signal controlling electromagnet through said telephone line open only at the substation control switch, and means operative also upon the completion of said circuit of definite resistance for preventing the energization of the associated call signal magnet whereby the substation control of said magnet is destroyed.

11. A telephone exchange system including telephone lines extending to a central office, call signal magnets for said lines adapted to be operated by current over said lines, a link-circuit adapted to connect said lines for conversation, a signal controlling electromagnet associated with said link-circuit, means under the control of the operator for completing a circuit of definite resistance local to the central office through an energizing winding of said signal controlling electromagnet to produce a definite energization thereof, a signal displayed in response to said energization, means under the control of the subscriber, when said circuit of definite resistance has been completed, for completing a circuit in parallel with the said energizing winding of said signal controlling electromagnet through his telephone line and another energizing winding of said signal controlling electromagnet to secure a decreased energization of said signal controlling electromagnet whereby said signal is effaced, and means operative also upon the completion of said circuit of definite resistance for preventing the energization of the associated call signal magnet whereby the substation control of said magnet is destroyed.

12. A telephone exchange system including telephone lines extending to a central office, call signal magnets for said lines adapted to be operated by current over said lines, a link-circuit adapted to be connected to any one of said telephone lines, a signal effacing electromagnet for said telephone line adapted, when energized, to destroy the sub-



station control of its said call signal, a signal controlling electromagnet associated with said link-circuit, means under the control of the operator for completing a circuit of definite resistance local to the central office through an energizing winding of said signal effacing electromagnet and through said signal controlling electromagnet to produce a definite energization of the latter, a signal displayed in response to said energization, means under the control of the subscriber, when said circuit of definite resistance has been completed, for completing a circuit in parallel with the said energizing winding of said signal controlling electromagnet through his telephone line and another energizing winding of said signal controlling electromagnet to secure a decreased energization of said signal controlling electromagnet whereby said signal is effaced, and means operative also upon the completion of said circuit of definite resistance for preventing the energization of the associated call magnet, whereby the substation control of said magnet is destroyed.

13. A telephone exchange system including telephone lines extending to a central office, call signal magnets for said lines adapted to be operated by current over said lines, line conductors for extending said telephone lines to the switchboard, spring jacks connected with said line conductors, link-circuits for uniting said lines for conversation, a source of current, a signal controlling electromagnet associated with said link-circuit, means under the control of the operator for completing a circuit of definite resistance local to the central office through an energizing winding of said signal controlling electromagnet to produce a definite energization thereof, a signal displayed in response to said energization, means under the control of the subscriber, when said circuit of definite resistance has been completed, for completing a circuit in parallel with the said energizing winding of said signal controlling electromagnet through said subscriber's telephone line and another energizing winding of said signal controlling electromagnet to secure a decreased energization of said signal controlling electromagnet whereby said signal is effaced, and means operative also upon the completion of said circuit of definite resistance for preventing the energization of the associated call signal magnet whereby the substation control of said magnet is destroyed.

14. 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 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 over the subscriber's line and through the other winding of said signal-controlling electromagnet in series with said resistance.

15. 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 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 over the subscriber's line and through the other winding of said signal-controlling electromagnet in series with the winding of said signal-effacing electromagnet.

16. A telephone system comprising telephone lines extending from substations to a central office, spring-jacks in which said lines terminate, a link-circuit and terminal plugs for connecting said lines for conversation, a 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 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, and means under the control of the subscriber, when the operator has completed said circuit, for completing a circuit over the subscriber's line and through the other winding of said signal-controlling electromagnet in series with said resistance.

17. A telephone system comprising telephone lines extending from substations to a central office, spring-jacks in which said lines terminate, a link-circuit and terminal plugs



for connecting said lines for conversation, a two-winding signal-controlling electromagnet associated with said link-circuit, means for displaying a signal in response to the one-  
5 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  
10 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  
15 electromagnet and the said signal effacing

electromagnet associated with said telephone line, and means under the control of the subscriber, when the operator has completed said circuit, for completing a circuit over the subscriber's line and through the other winding of said signal-controlling electromagnet in series with the winding of said signal-effacing electromagnet.

In witness whereof, I hereunto subscribe my name this 10th day of December, A. D., 25 1904.

HARRY G. WEBSTER.

Witnesses:

L. D. KELLOGG,  
G. E. MUELLER.