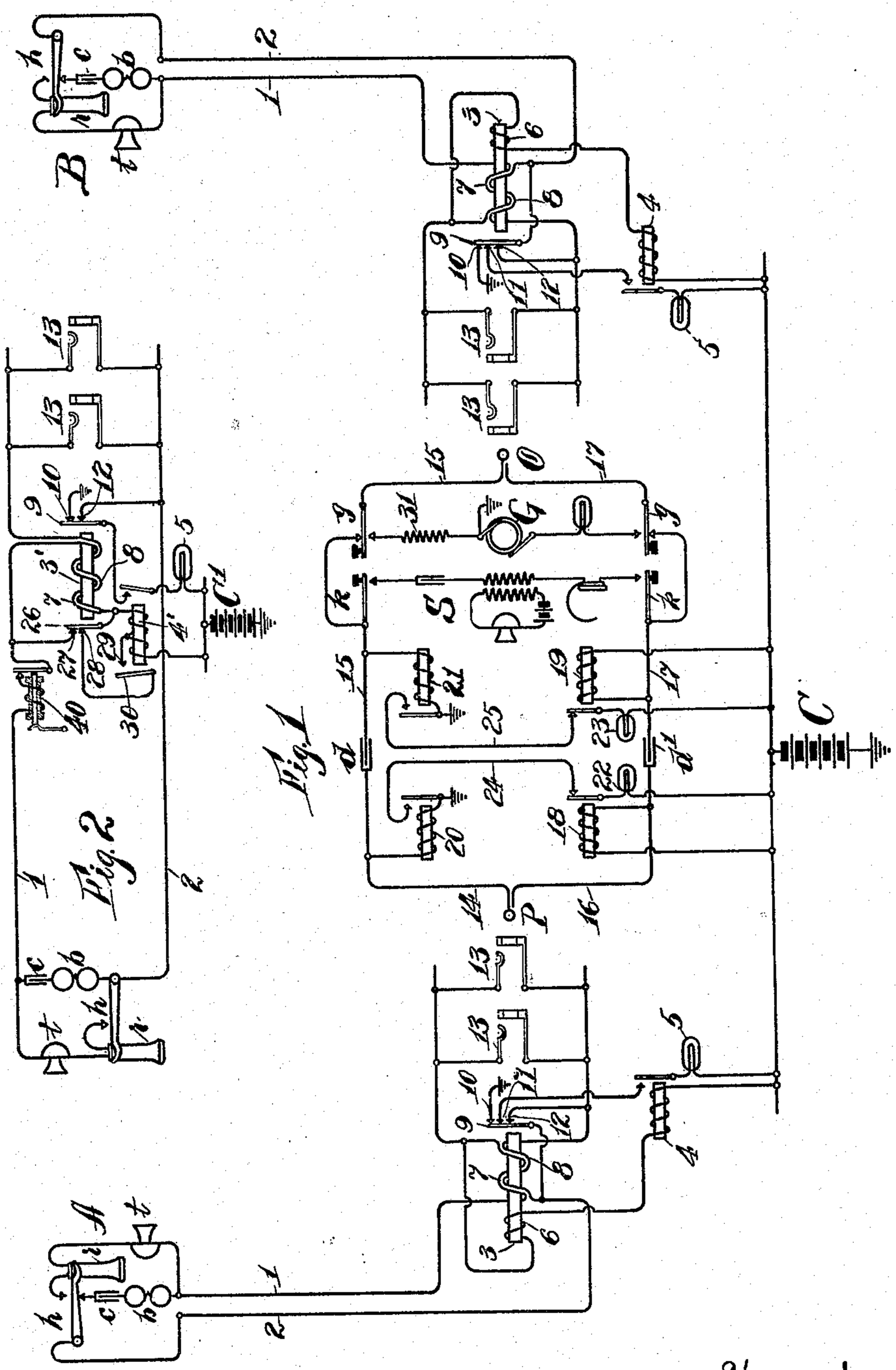
H. G. WEBSTER.

TELEPHONE SYSTEM.

APPLICATION FILED MAY 4, 1906.

930,520. Patented Aug. 10, 1909.



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TELEPHONE SYSTEM.

No. 930,520. Specification of Letters Patent. Patented Aug. 10, 1909.

Application filed May 4, 1906. Serial No. 315,161.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, residing at Chicago, county of Cook, and State of Illinois, have invented a new and useful Improvement in Telephone Systems, of which the following is a specification.

The present invention relates to telephone exchange systems generally and more particularly to that type in which current for transmission and signaling is furnished from a central source, and in which the spring jacks or switching terminals have but two contact pieces, the two contact pieces being permanently connected to the two line limbs respectively.

The object of my invention is to provide a system of this type with an improved organization of circuits and apparatus for maintaining or destroying the subscribers' control of the calling signal.

Another object of the invention is to provide means whereby a line signal or relay of relatively high resistance may be connected in permanent bridge of the line, its winding being partially short circuited during the display of the calling signal.

In accordance with my invention, I provide for the line circuit a cut-off magnet or relay having differential windings and associated switching mechanism adapted to alter the substation control of the calling signal and to control the battery connections of the line limbs. One winding of this relay is associated with that portion of a line limb extending to the substation, but it is normally so connected that any current flowing therethrough, due to the initiation of a calling signal by the subscriber, does not serve to energize the relay magnet. In association with this first mentioned winding, I provide a second winding, preferably wound as a "twin" winding or in parallel therewith, which may be called a neutralizing winding. This neutralizing winding is not normally included in the battery circuit of the line limbs, but the structure is such that upon the establishment of a connection by the operator, this neutralizing winding is serially included in one portion of the talking circuit thus established, and serves to neutralize the impedance effect to voice currents of the first mentioned winding which is at this time serially included in another portion of the talking circuit.

In one form of my invention, the first mentioned winding is rendered normally inert to the calling current by the provision of a third winding upon the relay magnet, having equal but opposed energizing capacity; and in this structure an excess of current through the third winding results from the establishment of a connection at the central office, thus energizing the relay magnet.

In a modification of the invention, the first mentioned winding is rendered normally inert by the provision of a path of low resistance in shunt thereof; and in this structure, an excess of current through the neutralizing winding, upon the establishment of a connection, serves to cause and maintain the energization of the cut-off relay magnet.

In accordance with another feature of my invention, I provide a line relay or signal controlling electromagnet normally under the control of the subscriber, having a winding of relatively high resistance. This magnet is provided with switching mechanism which serves, upon its energization, to short circuit the greater portion of its windings, the remaining portion serving to maintain the energization of the magnet and thus the display of the calling signal. Upon the operation of the cut-off relay previously described, the short circuit is broken and the full impedance of the line relay winding may thus be utilized to prevent short circuiting of voice currents. By this arrangement, I am enabled to use a heat coil or protective device for the line which normally would not be operated by extraneous current of high voltage, on account of the high resistance of the magnet windings, although the windings of said magnet might be injured by the presence of such a current. The short circuiting of the greater portion of the windings allows the accidental or extraneous current to increase instantly to a value which will operate the protective device before the remaining portion of the relay winding is damaged; and if desired, this remaining portion may be of comparatively heavy wire and of only sufficient turns to maintain the attraction of the relay armature when once drawn up.

The invention will be more fully understood from the following description taken in connection with its accompanying drawing, illustrating in Figure 1 two line circuits embodying the preferred form of my inven-

tion and a link conductor adapted for association therewith, and in Fig. 2 a modification of the line circuit arrangement of Fig. 1.

Referring to Fig. 1 of said drawing, A and B designate two subscribers' stations, which are connected to a central office battery C by suitable telephone lines. The equipment at substations A and B, which may be of any preferred type, is here shown as comprising a call-bell *b*, in series with a condenser *c* normally included in bridge of the telephone line by the engagement of the switch-hook *h* with its lower contact. A normally open bridge, including transmitter *t* and receiver *r*, is closed at the upper contact of the switch-hook whenever the receiver is removed therefrom. Assuming that subscriber A wishes to communicate with subscriber B, he removes his receiver from its switch-hook, thus closing circuit through limbs 1 and 2 and energizing relay 4 by current flowing from the upper terminal of battery C through the winding of relay 4, the windings 6 and 7 of relay 3, limbs 1 and 2 of the line and to the ground return side of the battery by armature 9 and contact 10. This energizes the relay 4, but as winding 6 is connected differentially or in opposition to winding 7, and the windings have an equal number of turns, relay 3 is not energized. The energization of relay 4 attracts its armature, closing the circuit of lamp 5 from the upper terminal of the battery, through contact 11, armature 9 and contact 10; thus indicating to the operator that subscriber A desires connection. Upon the insertion of an answering plug P, current will flow from the active terminal of battery C, through relay 4, winding 6, the tip contact pieces of the spring jack and plug, strand 14 and to the return side of the battery through the winding of relay 20. The resulting excess of current in winding 6 over that in winding 7 serves to energize the relay 3 and the attraction of its armature opens the local circuit of lamp 5 at contact 11, removes the normal earth connection from the line limb 2 at contact 10 and removes the normal short circuit of winding 8 at contact 12. Current will now flow from the active terminal of battery C, through relay 18, strand 16, sleeve contacts of the plug and spring jack, winding 8 of relay 3, limb 2, the subscriber's receiver and transmitter, limb 1, winding 7 of relay 3, and thence through the plug and jack contact to the return side of the battery, through strand 14 and relay 20. This current serves to energize the relay 18, preventing the display of supervisory lamp 22, and to energize the substation transmitter; and is of equal value in the opposing "twin" windings 7 and 8 of relay 3. The attraction of the armature of relay 3 is maintained by current flowing through winding 6 which is, as illustrated, wound upon a different portion of the core from winding 7 and 8, and therefore does not interfere with the inductive neutrality of windings 7 and 8 to voice currents. Were the subscriber to replace his receiver at this time, the current flow through windings 7 and 8 would be interrupted, thus deënergizing relay 18 and allowing the associate lamp 22 to become illuminated.

Learning that subscriber A wishes to communicate with subscriber B, the operator tests in the usual way by touching the tip of her calling plug O to the sleeve contact of a multiple jack 13 associated with the line of subscriber B. This sleeve contact is normally connected to the return side of the battery, as is also relay 21 of the cord circuit, and no "click" will result unless the line be connected at some other jack. Should such a connection exist, the potential of this jack would be raised above that of the return side of the battery by the removal of the normal earth connection of the line limb at contact 10, and the battery connection completed through relay 19 and strand 17 of the busy cord. The charge and discharge of the condenser in the operator's set S, resulting from the application of the tip to this busy contact, would give her the customary "click." The line being idle, the operator inserts the calling plug O and actuates her ringing key *g*. Current then flows from the active side of battery C, through relay 4, winding 6 of relay 3, through the plug and jack contacts, strand 15, and the resistance 31 to the return side of the battery, energizing relay 3; thus removing the direct earth connection from limb 2 and opening the circuit of lamp 5 to prevent a false signal. Ringing current then flows from generator G, through strand 17, plug and jack contacts, winding 8, limb 2, the substation bell and condenser, limb 1, winding 7, strand 15, and resistance 31 to the return side of the generator. While a certain percentage of this current will tend to flow through the impedance of winding 6 and through the winding of relay 4, this will be insufficient in value to cause armature 9 to be released or vibrated. Upon the restoration of the ringing key, current will flow through winding 6 and relay 21, maintaining the energization of relay 3 and energizing relay 21; and thus completing the circuit of lamp 23, through conductor 25 and causing its illumination. When the subscriber answers, current will flow from the upper terminal of battery C, through relay 19, strand 17, winding 8, limbs 2 and 1, winding 7, strand 15, and relay 21 to the return side of the battery. The current over this circuit energizes the substation transmitter as well as relay 19, and the consequent attraction of the armature of relay 19 extinguishes supervisory lamp 23. The subscribers are now inductively united for conversation by means

of the condensers *d* and *d'* included in the cord strands. When either subscriber hangs up, the consequent deënergization of relay 18 or 19 will cause the illumination of lamp 22 or 23. When both lamps are lighted, the operator understands that conversation is finished and removes the plugs, and the apparatus returns to its normal position.

Fig. 2 differs from the structure of Fig. 1 in that the opposing windings of the relay 3′ are both included in the same line limb, and in that the winding associated with that portion of the line limb extending to the substation is normally short circuited. A further difference consists in the provision of a circuit in shunt of a portion of the winding of relay 4′, one function of this shunt being to increase the current through limb 1 prior to the insertion of the connecting plug, whereby a heat coil or protective device may be operated, which would not respond to the current from excessive voltage, were the entire resistance of the winding of the relay 4′ to remain in circuit. In this figure, when the subscriber removes his receiver, current will flow from the upper terminal of battery C′, through relay 4′, armature 26, contact 27, heat coil 40, limbs 1 and 2, and to the return side of the battery through contact 12, armature 9 and contact 10; the engagement of armature 26 and contact 27 serving to short circuit winding 7 of relay 3′ at this time, preventing its operation. The consequent energization of relay 4′ closes the circuit of lamp 5 through armature 9 and contact 10, lighting the lamp; and the engagement of armature 30 with contact 29 completes a low resistance shunt around the right hand portion of the winding of relay 4′ through contact 28 and armature 26. Upon the insertion of a connecting plug, as P, current will flow through relay 4′, winding 8, the tip contact pieces of the spring jack and plug to the return side of the battery, through strand 14 and relay 20, energizing relay 3′. The attraction of armature 26 of relay 3′ removes the short circuit from winding 7, as well as the shunt circuit of relay 4′, and the attraction of armature 9 interrupts the local circuit of lamp 5 and removes the normal earth connection of limb 2 at contact 10. Additional current will now flow from battery C of the cord circuit, through relay 18, strand 16, plug and jack contacts, limb 2, limb 1, winding 7, winding 8, plug and jack contacts, strand 14 and relay 20. This additional current is of equal value in the opposed windings 7 and 8, and therefore does not alter the energization of relay 3′; the excess of current in winding 8, due to the battery connection through relay 4′, serves to maintain the energization of relay 3′. The further operations of calling a subscriber, securing a busy test, and disconnecting, are similar to those described in connection with Fig. 1 and will therefore be understood without further description. Should limb 1 of the structure of Fig. 2 become connected with a source of excessive potential exterior to the exchange, current from this excessive source would flow through the winding of the low resistance protective device 40 and to ground through contact 27, armature 26, winding of relay 4′ and battery C′. On account of the high resistance of the winding of relay 4′, this current might not operate the protective device within sufficient time to prevent damage to the winding of relay 4′ were it not for the shunt circuit about a portion of this winding, previously referred to. The attraction of armature 30 of the relay 4′, due to this excessive voltage, cuts out the major portion of the resistance of relay 4′, thus allowing the current from the outside source to at once reach a value sufficient to immediately operate the protective device 40. It is to be understood that when the shunt circuit is applied in the regular process of initiating a call, the unshunted turns of relay 4′ are sufficient in number to maintain the attraction of the relay armature when once attracted, and that the insertion of a connecting plug causes the breaking of the shunt circuit at contact 28, thus allowing the full impedance effect of the winding of relay 4′ to be utilized in preventing the shunting of voice currents.

Attention is called to the fact that in Fig. 2 the winding 8 causes the energization of relay 3′, thus serving the function of winding 6 of Fig. 1; and that in Fig. 2, the relay 3′ is rendered inert during the initiation of a calling signal by the short circuiting of the winding included in the circuit to the substation, whereas in Fig. 1, this inert condition is secured by the opposing action of windings 6 and 7. In both figures, the windings 7 and 8 of relays 3 and 3′ are directly included in the talking circuit during conversation, and may be of relatively low resistance; being differentially connected and being "twin" windings, no undue interference with transmission results from such inclusion.

While I have illustrated the calling signal as a lamp controlled by a relay, it will be understood that a mechanical signal, having a locking or restoring winding or other means for causing its effacement, could be equally well employed. The several grounds illustrated will be understood as connections to the return side of the central battery or the office return.

Obviously in carrying out my invention, various modifications may be made in the structures of the drawing and my invention may be embodied in various other structures; I therefore do not wish to be limited to the specific disclosure.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. A telephone exchange system compris-

ing a telephone line extending from a substation to a source of current at the exchange, a branch conductor, a line signal, a line relay included in said branch conductor and normally responsive to calling current in said line, a switching terminal for the line, a cut-off relay, a winding for said relay associated with that portion of the line extending to the substation from the point of connection of said branch conductor, means for rendering said winding inert to calling current, a neutralizing winding associated with said winding, a link-conductor, means whereby the connection of said link-conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to serially include said windings in differential relation in the talking circuit of said line, whereby the impedance of said windings is neutralized.

2. A telephone exchange system comprising a telephone line extending from a substation to a source of current at the exchange, a branch conductor, a line signal, a line relay included in said branch conductor and normally responsive to calling current in said line, a switching terminal for the line, a cut-off relay, a winding for said relay included in that portion of the line extending to the substation from the point of connection of said branch conductor, means for rendering said winding inert to calling current, a neutralizing winding associated with said winding, a link conductor, means whereby the connection of said link conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to serially include said windings in differential relation in the talking circuit of said line, whereby the impedance of said windings is neutralized.

3. A telephone exchange system comprising a telephone line extending from a substation to a source of current at the exchange, a branch conductor, a line signal, a line relay included in said branch conductor and normally responsive to calling current in said line, a switching terminal for the line, a cut-off relay, a winding for said relay serially included in that portion of the line extending to the substation from the point of connection of said branch conductor, means for rendering said winding inert to calling current, a neutralizing winding associated with said winding, a link conductor, means whereby the connection of said link conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to serially include said windings in differential relation in the talking circuit of said line, whereby the impedance of said windings is neutralized.

4. A telephone exchange system comprising a telephone line extending from a substation to a source of current at the exchange, a line signal, a line relay normally responsive to calling current in said line to display said signal, a switching terminal for the line, a cut-off relay, a winding for said cut-off relay included in series with said line relay, means for preventing the energization of said cut-off relay at the time of energizing said line relay, a neutralizing winding associated with said winding, a link conductor, means whereby the connection of said link conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to serially include said windings in differential relation in the talking circuit of said line, whereby the impedance of said windings is neutralized.

5. A telephone exchange system comprising a telephone line extending from a substation to a source of current at the exchange, a line signal, a line relay normally responsive to calling current in said line to display said signal, a switching terminal for the line, a cut-off relay, a winding for said cut-off relay included in series with said line relay, means for normally preventing the energization of said cut-off relay at the time of energizing said line relay, a neutralizing winding associated with said winding, a link conductor, means whereby the connection of said link conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to serially include said windings in differential relation in the talking circuit of said line, whereby the impedance of said windings is neutralized.

6. A telephone exchange system comprising a telephone line extending from a substation to a source of current at the exchange, a line signal, a line relay normally responsive to calling current in said line to display said signal, a switching terminal for the line, a cut-off relay, a winding for said cut-off relay included in series with said line relay, means for preventing the energization of said cut-off relay at the time of energizing said line relay, a neutralizing winding associated with said winding, a link conductor, means whereby the connection of said link-conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to serially include said windings in differential relation in the talking circuit of said line, whereby the impedance of said windings is neutralized.

7. A telephone exchange system comprising a telephone line extending from a substation to a source of current at the exchange, a line signal, a line relay normally responsive to calling current in said line to

display said signal, a switching terminal for the line, a cut-off relay, a winding for said cut-off relay included in series with said line relay, means for preventing the energization of said cut-off relay at the time of energizing said line relay, a differential winding associated with said winding, a link conductor, means whereby the connection of said link conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to serially include said windings in differential relation in the talking circuit of said line, whereby the impedance of said windings is neutralized.

8. A telephone exchange system comprising a telephone line extending from a substation to a source of current at the exchange, a line signal, a line relay normally responsive to calling current in said line to display said signal, a switching terminal for the line, a cut-off relay, a winding for said cut-off relay included in series with said line relay, means for preventing the energization of said cut-off relay at the time of energizing said line relay, a parallel winding associated with said winding, a link conductor, means whereby the connection of said link conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to serially include said windings in differential relation in the talking circuit of said line, whereby the impedance of said windings is neutralized.

9. A telephone exchange system comprising a telephone line connecting a substation with the exchange, a line signal normally under the control of the substation, a central source of current, a switching terminal, a relay for destroying said substation control having differential windings permanently serially included in said line, one winding being included at a point intermediate of the substation and the connection of said source to the line limbs and the other intermediate of said connection and said terminal, means for preventing the energization of said relay by current flowing over the line limbs to cause the display of the line signal, and means for energizing said relay when connection is established with the line to destroy said substation control.

10. A telephone exchange system comprising a telephone line connecting a substation with the exchange, a line signal normally under the control of the substation, a central source of current, a switching terminal, a relay for destroying said substation control having differential windings permanently serially included in said line, one winding being included at a point intermediate of the substation and the connection of said source to the line limbs and a second winding intermediate of said terminal and said connection, means for rendering said relay inert during the display of the line signal, and means for energizing said relay when connection is established with the line to destroy said substation control.

11. A telephone exchange system comprising a telephone line connecting a substation with the exchange, a branch conductor, a line signal, a line relay included in said branch conductor and normally under the control of the substation, a relay for destroying the substation control, a winding for said relay in series with said line relay and the substation a winding for said relay in a normally open circuit, a normally short circuited winding for said relay, means under the control of an operator for closing circuit through said first mentioned winding to destroy said substation control, and to bring said short circuited winding into differential relation with said first mentioned winding, and means for maintaining an unequal flow of current in the two windings.

12. A telephone exchange system comprising a telephone line connecting a substation with the exchange, a source of current, a line signal normally under the control of the substation, a relay for destroying said substation control having a normally short circuited winding included in a line limb intermediate of the substation and said source, a second winding for said relay, means for closing circuit through said second winding only upon the establishment of a connection with the line, means for including the first mentioned winding in differential relation with the second winding, whereby the inductive effect of both windings is neutralized, and means for maintaining an unequal flow of current from said source in the two windings whereby the substation control of the line signal is prevented.

13. A telephone exchange system comprising a telephone line extending by its limbs from a substation to an exchange, a source of current at the exchange, a line signal, a controlling electromagnet therefor permanently included in circuit with one of said line limbs, a differential cut-off relay having a normally inert winding permanently included in a limb of said line intermediate of said source and said substation, and a second winding in a normally open circuit, cord connecting apparatus for connecting said line with another for conversation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said cut-off relay to destroy the substation control of said signal.

14. A telephone exchange system comprising a telephone line extending from a substation to the exchange, a high resistance signal controlling electromagnet for the line, means controlled by said magnet to increase the current flow through its energizing circuit by

short-circuiting a portion of its winding, thereby producing a relatively low resistance circuit for said magnet, a cut-off relay, switching terminals for the line, a link conductor, means whereby the connection of said link conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to interrupt said relatively low resistance circuit.

15. A telephone exchange system comprising a telephone line extending from a substation to the exchange, a high resistance signal controlling electromagnet for the line, switching mechanism controlled by said magnet whereby the energization of said magnet completes a short circuit of a portion of its windings, a cut-off relay, switching terminals for the line, a link conductor, means whereby the connection of said conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to interrupt said short circuit.

16. A telephone exchange system comprising a telephone line extending from a substation to the exchange, a high resistance signal controlling electromagnet for the line, switching mechanism actuated by said magnet when energized, whereby a portion of the resistance of its windings is excluded from circuit with the line, a cut-off relay, switching terminals for the line, a link conductor, means whereby the connection of said link conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to prevent the said exclusion of resistance.

17. A telephone exchange system comprising a telephone line extending from a substation to the exchange, a high resistance signal controlling electromagnet permanently connected with the line, means controlled by said magnet to increase the current flow through its energizing circuit by short-circuiting a portion of its windings, thereby producing a relatively low resistance circuit for said magnet, a cut-off relay, switching terminals for the line, a link conductor, means whereby the connection of said link conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to interrupt said relatively low resistance circuit.

18. A telephone exchange system comprising a telephone line extending from a substation to the exchange, a high resistance signal controlling electromagnet permanently connected with the line, switching mechanism controlled by said magnet whereby the energization of said magnet completes a short circuit of a portion of its windings, a cut-off relay, switching terminals for the line, a link-conductor, means whereby the connection of said link-conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to interrupt said short circuit.

19. A telephone exchange system comprising a telephone line extending from a substation to the exchange, a high resistance signal controlling electromagnet permanently connected with the line, switching mechanism actuated by said magnet when energized, whereby a portion of the resistance of its windings is excluded from circuit with the line, a cut-off relay, switching terminals for the line, a link conductor, means whereby the connection of said link conductor with said switching terminal completes an energizing circuit for said relay, and switching mechanism actuated by said relay when energized to prevent the said exclusion of resistance.

20. A telephone exchange system comprising a telephone line extending from a substation to the exchange, a high resistance signal controlling electromagnet for the line, switching mechanism actuated by said magnet when energized, whereby a portion of the resistance of its windings is excluded from circuit with the line, and a protective device responsive to heavy currents when such resistance is excluded.

21. A telephone exchange system comprising a telephone line circuit extending from a substation to the exchange, a thermal protective device normally included in said circuit, electromagnetic means responsive to an increased current over said circuit to reduce its normal resistance to thereby facilitate the operation of said protective device, and a signal controlled by said electromagnetic means.

22. A telephone exchange system comprising a telephone line circuit extending from a substation to the exchange, a thermal protective device and a line relay normally included in said circuit, and means actuated by said relay in response to an increased current over said circuit to reduce its normal resistance to thereby facilitate the operation by said protective device.

In witness whereof, I hereunto subscribe my name this 30th day of April, 1906.

HARRY G. WEBSTER.

Witnesses:

CAROLYN WEBER,

L. D. KELLOGG.