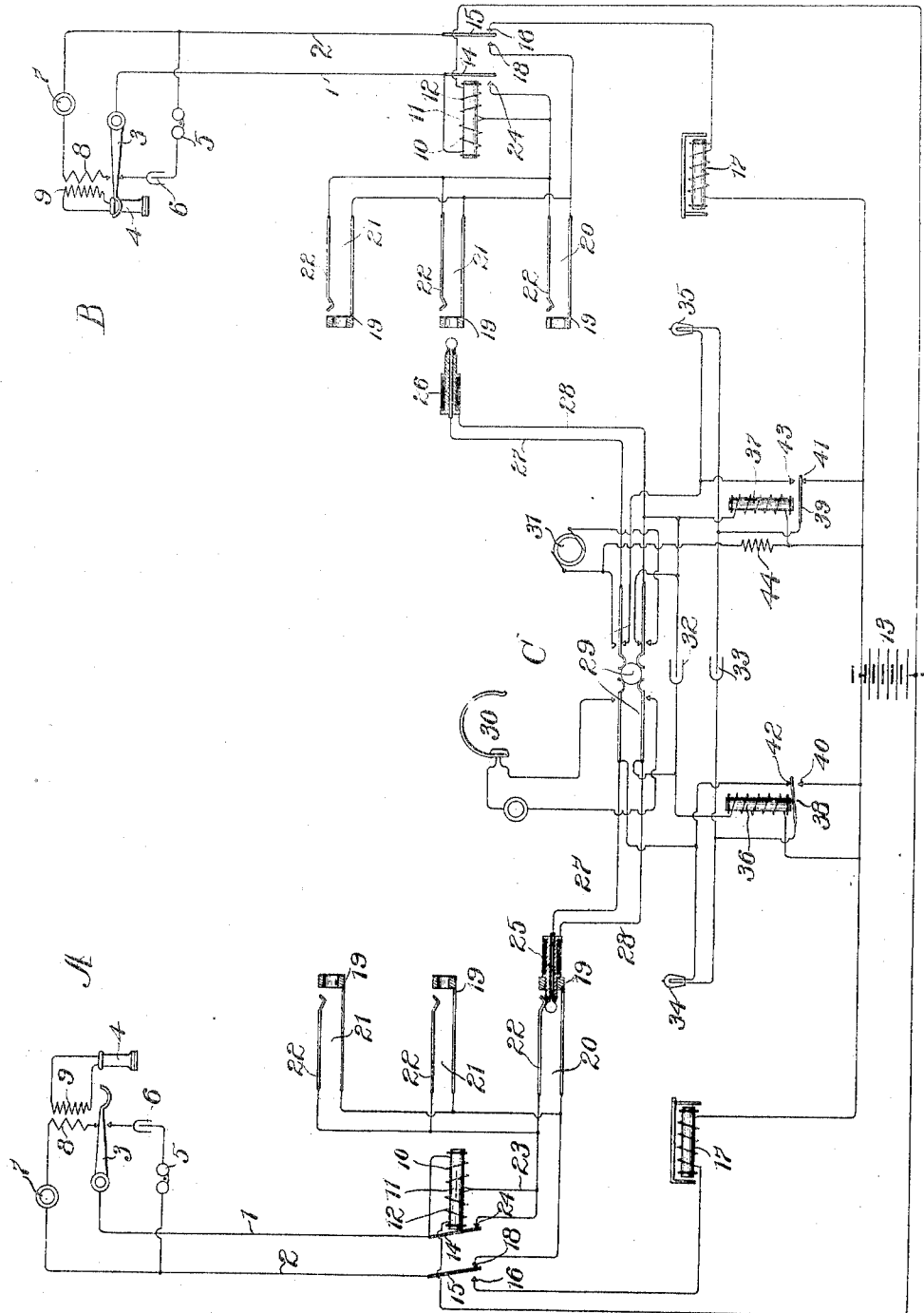


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E. LAND.
TELEPHONE EXCHANGE SYSTEM.

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TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 793,941, dated July 4, 1905.

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To all whom it may concern:

Be it known that I, EDMUND LAND, a citizen of the United States, residing at Grand Rapids, in the county of Kent and State of Michigan, have invented a certain new and useful Improvement 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 telephone-exchange systems, and particularly to systems in which a common source of current located at the central exchange is employed for the purpose of providing signaling-currents and currents for the operation of the substation telephone apparatus.

The objects of my invention are to provide an improved telephone system in which the complicated cut-off mechanism heretofore employed may be dispensed with and to provide an improved means for testing the condition of a subscriber's line to see whether or not it is in use.

While my invention provides a system of great mechanical and electrical simplicity, still the apparatus is not readily subject to defective operation due to defective line insulation or leakage or other conditions giving rise to electrical unbalancing of a telephone-line.

In accordance with my invention I provide a common form of line-signal, such as a drop normally serially included in circuit with a subscriber's telephone-line. There is also normally serially included in this line-circuit a differentially-wound cut-off relay. The two differentially-wound coils of this relay are directly connected in series with each other and with one limb of the telephone-line. An armature controlled by the energization of the differential relay serves to control the circuit through the line-signal, this circuit being broken upon the attraction of the relay-armature. On account of the differential winding of the cut-off relay its core is not energized upon the closure of the telephone line-circuit at the substation. The insertion of a plug of the operator's cord-circuit within a

line-jack causes the closure of a circuit of decreased resistance through one of the coils of the differential relay, the energization due to this coil thereby unbalancing that due to the other coil, and consequently causing an energization of the relay-core adapted to attract the relay-armature. The attraction of the relay-armature opens the circuit through the line-signal, thereby causing the restoration thereof. One of the two contacts of the line-spring-jack is normally disconnected from the line, the attraction of the relay-armature, however, serving to connect this contact, or in a multiple board the corresponding contacts in a series of sections, with one limb of the telephone-line. The set of spring-jack contacts thus connected with a limb of the telephone-line are used for the purpose of testing the operative condition of the line. The remaining spring-jack contacts are normally connected with the other limb of the telephone-line through a coil of the differential relay. The actuation of the relay-armature, however, serves to provide a short-circuit shunt-path around this coil of the relay, thereby providing a telephone-line for conversational purposes between the spring-jack contacts and the subscriber's substation which is entirely free from serially-included impedance.

The cord-circuit employed in connection with my invention is normally and continuously associated with the common source of current in such a way as to permit the closure of the hereinbefore-mentioned low-resistance circuit through a relay-coil upon the insertion of the cord connecting-plug within the corresponding line-jack.

Talking-current is supplied to the substation through a supervisory relay associated with the cord-circuit, whereby the closure of the substation-circuit causes the energization of the supervisory relay to control the operation of a suitable supervisory signal associated therewith. This supervisory signal may desirably be in the form of an incandescent lamp adapted to be illuminated by a current derived from the common source of current at the cen-

tral station. The attraction of the supervisory relay-armature breaks a previously-closed circuit through the supervisory signal-lamp, and as the supervisory lamp is normally
 5 serially included in one strand of the cord-circuit the attraction of the supervisory relay-armature also serves to short-circuit the supervisory lamp, thereby decreasing the resistance of the talking-circuit through the cord
 10 connecting apparatus.

My invention will be more fully understood by reference to the accompanying drawing, in which I have illustrated two substations, A and B, each connected with the central ex-
 15 change C by means of the telephone-limbs 1 and 2.

The substation apparatus consists of a switch-hook 3, the depression of which, due to the weight of the receiver 4, normally closes
 20 a circuit for alternating currents between the limbs 1 and 2 through a signal-bell 5 and a condenser 6. Upon the removal of the receiver from the switch-hook an alternative circuit for continuous currents is provided
 25 through the transmitter 7 and the primary 8 of an induction-coil whose secondary 9 is serially included in circuit with the receiver 4. The limb 1 leads to the coil 10 of a differentially-wound relay 11, whose oppositely-
 30 wound and serially-connected coil 12 is connected with one pole—for instance, the positive pole—of the common battery 13. The differential relay 11 is shown as provided with two armatures, the armature 14 serving when
 35 in its alternative condition to close a low-resistance shunt-circuit about the differential relay-coil 10. The other relay-armature 15 is permanently connected with the limb 2 of the telephone-line. When in its normal un-
 40 attracted condition, this armature closes a connection through the contact 16 and a line drop or signal 17 with the negative pole of the common battery 13. The front contact 18 for the armature 15 is connected with the
 45 sleeve-springs 19 of the answering-jack 20 and the multiple calling-jacks 21. It will be seen that these sleeve-springs are normally disconnected from every part of the telephone-circuit and from ground. The tip-springs 22
 50 of the line-jacks are permanently connected by conductor 23 with the connection of the differential relay-coils 10 and 12. The contact 24, which acts in conjunction with the armature 14 to short-circuit the coil 10, is also
 55 permanently connected with the tip-springs 22, whereby the attraction of the armature 14 causes the closure of a non-inductive connection between the tip-springs 22 and the limb 1 of the telephone-line.

60 The cord-circuit adapted for use with my invention comprises the answering-plug 25 and the calling-plug 26, both connected by the tip-strands 27 and the sleeve-strands 28 with contact-springs of the ringing and listen-
 65 ing key 29, which when actuated in one di-

rection serves to connect the operator's telephone set 30 in bridge between the strands of the cord-circuit and when actuated in the other direction serves to break the connection between the answering and calling plugs and
 70 to connect the terminals of the ringing-generator 31 with the conductors leading to the calling-plug 26. The condenser 32 is serially included in the sleeve-strand of the cord-circuit, while the condenser 33 is serially in-
 75 cluded in the tip-strand thereof. The tip-strand circuit also normally serially includes the supervisory signal-lamps 34 and 35. It will be seen that the condensers 32 and 33, while serving to inductively connect and relate the
 80 two sides of the cord-circuit, serve to conductively insulate the same. With either side of the sleeve-strand 28 is normally connected a terminal of the supervisory relays 36 and 37, the other terminals of these relays
 85 being connected with the negative pole of the battery 13. The supervisory relay-armatures 38 and 39 when in connection with back contacts 40 and 41 serve to connect the negative pole of the battery 13 with the supervisory
 90 signal-lamps 34 and 35. When in their attracted positions, the supervisory relay-armatures make connection with front contacts 42 and 43, thereby closing short circuits in shunt of the supervisory signal-lamps 34 and 35,
 95 respectively.

The operation of my improved system will now be apparent. Upon the removal of the receiver at substation A from its switch-hook
 100 a circuit for continuous currents is closed through the transmitter 7, which circuit may be traced from the positive pole of the battery 13 through the differentially-wound coils 12 and 10 of the cut-off relay 11, through the
 105 limbs 1 and 2 of the telephone-line to the relay-armature 15, to the back contact 16, through the line-relay 17, to the negative pole of the battery 13. On account of the differential winding of the relay-coils 10 and 12 there is no effective energization of the relay-
 110 coil 11. The current flowing through the line-drop, however, causes an energization thereof to give the central operator a line-signal. She thereupon inserts the plug 25 of
 115 her cord connecting apparatus within the answering-jack 20, as shown in the drawing. A circuit of decreased resistance may thereupon be traced through the cut-off-relay coil, as follows: from the positive pole of battery 13 to
 120 the coil 12, through conductor 23, tip-spring 22, the tip of the answering-plug 25, the tip-strand 27, through the lamp 34 to the armature 38, to the contact 40, to the negative pole of battery 13. This circuit of decreased resistance causes an unbalancing of the magnetiza-
 125 tion due to the two coils of the differential relay, whereupon the relay is energized to cause the attraction of the armatures 14 and 15. The attraction of the armature 14 causes the closure of a short circuit in shunt of the dif-
 130

ferential relay-coil 10 and connects the tip-springs 22 with the limb 1 of the telephone-line through a circuit including no inductive resistance or impedance. The attraction of the cut-off relay-armature 15 causes a break in the circuit through the line-drop between the armature and the contact 16. At the same time the connection between the armature 15 and its front contact 18 closes a direct non-inductive circuit between the limb 2 of the telephone-line and the sleeve-contacts 19 of the spring-jacks 20 and 21. The receiver at substation A being removed from its switch-hook permits the flow of current through a circuit, which may be traced as follows: from the positive pole of the battery 13, through the coil 12 of the differential relay to the conductor 23, to contact 24, to armature 14, to limb 1 of the telephone-line, through the transmitter at substation A to limb 2 of the telephone-line, to armature 15 of the differential relay, to contact 18, to sleeve-spring 19 of the answering-jack 20, to the sleeve-contact of the answering-plug 25, to sleeve-strands 28, and through the supervisory relay 36 to the negative pole of the battery 13. The consequent energization of the supervisory relay 36 causes the attraction of its armatures 38, whereupon the supply of battery-current to the supervisory signal-lamp 34 is cut off at the same time the connection between the supervisory relay-armature 38 and its front contact 42 closes a low-resistance shunt-circuit around the lamp 34. The necessary energization of the coil 12 is maintained by the flow of current through the circuit-supplying talking-current to the substation A, this circuit including the battery 13, the coil 12, the limbs 1 and 2 of the telephone-line, the armature 15 and contact 18, the sleeve-strands 28, and the relay 36. The operator upon ascertaining in the usual way that the subscriber at substation A desires communication with the subscriber at substation B inserts her calling-plug 26 within a line-jack 21 corresponding to the desired substation.

A circuit similar to that previously traced for the apparatus associated with the substation A may be traced through the coil 12 of the called-subscriber's cut-off relay, whereupon the cut-off relay is actuated to immediately break the connection with the corresponding line-drop 17. A circuit is established through the supervisory relay 37 upon the removal of the receiver at substation B, whereupon the relay-armature 39 is attracted to extinguish the lamp 35 and provide a short circuit for voice-currents through the cord-strand 27.

The condensers 32 and 33, as above pointed out, serve to conductively insulate the two sides of the cord-circuit, whereby each of the supervisory relays 36 and 37 is positively and absolutely controlled by the corresponding substation apparatus connected therewith.

The operator's busy-test for ascertaining whether or not a desired subscriber's line is in operation is attained by the use of my improved system as follows: The tip of a calling-plug 26 is charged with negative current from the battery 13 through the back contact 41, the armature 39, and the supervisory signal-lamp 35. When a called-subscriber's line is in use, the corresponding cut-off relay will have attracted its armatures 14 and 15 to their alternate position, thereby connecting the line-limb 2 directly with the thimbles 19 of the corresponding spring-jacks. Thus all the thimbles in the switchboard-sections corresponding with the substation B, for instance, are connected to the circuit through which current is supplied to the substation-transmitters. Since a supervisory relay-coil is included in circuit between the negative side of the battery and the test-thimbles, when a plug has been inserted within such a thimble there will be a difference in potential between the test-thimbles of the busy line and the tip of the calling-plug. The contact of the tip of the plug 26 with a busy thimble causes a partial discharge of a condenser 32, thereby producing a click in the operator's telephone set.

The resistance 44 is connected between the negative side of the battery 13 and the generator-terminal associated with the tip-strand of the cord-circuit. This is to prevent the release of the cut-off relay-armatures 14 and 15 upon the interruption of the circuit through the coil 12 upon the manipulation of the ringing-key.

It will be seen that in accordance with my invention the coils of the differential relays are connected in but one of the limbs from the common-battery to the substation apparatus, whereby an unbalancing of the system due to defective insulation or leakage of any kind does not injuriously affect the proper operation of the cut-off relay.

Talking-current is supplied to the transmitters at the substations from the battery 13 through a circuit each limb of which includes an inductive resistance, whereby the short-circuit of voice-currents through the common battery is prevented. At the same time the talking-circuit between connected substations is entirely free from inductive resistances except those of the supervisory relays 36 and 37, serially connected between the sides of the cord-strand 28. These serially-connected relays 36 and 37, however, are connected in parallel with the condenser 33, whereby the transmission of voice-currents is perfected.

While I have herein shown and described one particular embodiment of my invention, it will be apparent to those skilled in the art that many modifications and changes therein may be employed without departing from the spirit thereof. I do not, therefore, wish to limit myself to the precise disclosure herein set forth; but,

Having described my invention, I claim as new and desire to secure by Letters Patent—

1. In a telephone-exchange system, the combination with a telephone-line extending by its
5 limbs from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential windings normally serially included in a single
10 limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of the cord connecting apparatus with said line causes an actuation of said relay to destroy the substation control of said line-signal.

2. In a telephone-exchange system, the combination with a telephone-line extending by its
20 limbs from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential windings serially included in a single limb of said line, a line-signal controlled by switching
25 apparatus at the substation, and means whereby the connection of the cord connecting apparatus with said line causes an actuation of said relay to destroy the substation control of said line-signal.

3. In a telephone-exchange system, the combination with a telephone-line extending by its
30 limbs from a substation to an exchange, of a source of current at the exchange for supplying current to the substation-transmitters, cord connecting apparatus at the exchange for
35 connecting said line with another for conversation, a cut-off relay having two differential windings serially included in a single limb of said line, a line-signal controlled by switching
40 apparatus at the substation, and means whereby the connection of the cord connecting apparatus with said line causes an actuation of said relay to destroy the substation control of said line-signal.

4. In a telephone-exchange system, the combination with a telephone-line extending by its
45 limbs from a substation to an exchange, of a source of current at the exchange for supplying current to the substation-transmitters, cord connecting apparatus for connecting said
50 line with another for conversation, a cut-off relay having two differential windings normally serially included in an electrical path between one terminal of the source of current and the substation apparatus, a line-signal
55 controlled by switching apparatus at the substation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said relay.

5. In a telephone-exchange system, the combination with a telephone-line extending by its
60 limbs from a substation to an exchange, of a source of current at the exchange for supplying current to the substation-transmitters, cord connecting apparatus for connecting said
65 line with another for conversation, a cut-off

relay having two differential windings normally serially included in an electrical path between one terminal of the source of current and the substation apparatus, a line-signal normally serially included in circuit with
70 the telephone-line, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said relay to disconnect said line-signal from the telephone-line.

6. In a telephone-exchange system, the combination with a telephone-line extending by its
limbs from a substation to an exchange, of cord connecting apparatus at the exchange for
80 connecting said line with another for conversation, a cut-off relay having two differential windings normally serially included in a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord
85 connecting apparatus with said line causes the closure of a circuit through a winding of said relay thereby causing an actuation of said relay to disconnect said line-signal from the telephone-line.

7. In a telephone-exchange system, the combination with a telephone-line extending by its
limbs from a substation to an exchange, of cord connecting apparatus at the exchange for
90 connecting said line with another for conversation, a cut-off relay having two differential windings serially included in a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord connect-
95 ing apparatus with said line causes the closure of a circuit of decreased resistance through a winding of said relay, thereby causing an actuation thereof to destroy the substation control of said line-signal.

8. In a telephone-exchange system, the combination with a telephone-line extending by its
limbs from a substation to an exchange, of a source of current at the exchange for supply-
100 ing current to the substation-transmitters, cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential windings normally serially included in a single
105 limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord connecting apparatus with said line causes the closure of a circuit of decreased resistance through a winding of said relay, thereby causing
110 an actuation thereof to destroy the substation control of said line-signal.

9. In a telephone-exchange system, the combination with a telephone-line extending by its
limbs from a substation to an exchange, of a source of current at the exchange for supply-
115 ing current to the substation-transmitters, cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential

windings serially included in a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord connecting apparatus with said line causes the closure of a circuit through a winding of said relay, thereby causing an actuation of said relay to disconnect said line-signal from the telephone-line.

10. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential windings normally included in circuit with a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said relay to destroy the substation control of said line-signal, and to cause the establishment of a circuit of low resistance in shunt of one winding of said relay.

11. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of cord connecting apparatus for connecting said line with another for conversation, a cut-off relay having two differential windings normally serially included in circuit with a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said relay to destroy the substation control of said line-signal, and to cause the establishment of a circuit of low resistance in shunt of the winding of said relay.

12. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange for supplying current to the substation-transmitters, cord connecting apparatus for connecting said line with another for conversation a cut-off relay having two differential windings normally included in circuit with a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord connecting apparatus with said line causes an actuation of said relay to disconnect said line-signal from the telephone-line and to cause the closure of a circuit of low resistance in shunt of one winding of said relay.

13. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange for supplying current to the substation-transmitters, cord connecting apparatus for connecting said line with another for conversation, a cut-off relay having two differential windings nor-

mally serially included in circuit with a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of the cord connecting apparatus with said line causes an actuation of said relay to destroy the substation control of said line-signal and to cause the closure of a low-resistance circuit in shunt of one winding of said relay.

14. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential windings included in circuit with a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of the cord connecting apparatus with said line causes an actuation of said line-relay to destroy the substation control of said line-signal and to close a low-resistance circuit in shunt of one winding of said relay.

15. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential windings normally included in circuit with a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connecting of said cord connecting apparatus with said line causes the closure of a circuit of decreased resistance through a winding of said relay, thereby causing an actuation thereof to destroy the substation control of said line-signal and to cause the closure of a low-resistance circuit in shunt of the other winding of said relay.

16. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of cord connecting apparatus for connecting said line with another for conversation, a cut-off relay having two differential windings normally serially included in circuit with a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord connecting apparatus with said line causes the closure of a circuit through a winding of said relay, thereby causing an actuation of said relay to disconnect said line-signal from the telephone-line and to cause the closure of a low-resistance circuit in shunt of the other winding of said relay.

17. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange for supplying current to the substation-transmitters, cord connecting apparatus for connecting said

line with another for conversation, a cut-off relay having two differential windings normally included in circuit with a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord connecting apparatus with said line causes the closure of a circuit of decreased resistance through a winding of said relay, thereby causing an actuation thereof to destroy the substation control of said line-signal and to cause the closure of a low-resistance circuit in shunt of the other winding of said relay.

18. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange for supplying current to the substation-transmitters, cord connecting apparatus for connecting said line with another for conversation, a cut-off relay having two differential windings normally serially included in circuit with a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord connecting apparatus with said line causes the closure of a circuit through a winding of said relay, thereby causing an actuation of said relay to disconnect said line-signal from the telephone-line and to cause the closure of a low-resistance circuit in shunt of the other winding of said relay.

19. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential windings included in circuit with a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord connecting apparatus with said line causes the closure of a circuit of decreased resistance through a winding of said relay, thereby causing an actuation thereof to destroy the substation control of said line-signal and to cause the closure of a low-resistance circuit in shunt of the other winding of said relay.

20. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential windings normally serially included in a single limb of said line, a line signal controlled by switching apparatus at the substation, means whereby the connection of said cord connecting apparatus with said line causes the closure of a circuit through a winding of said relay thereby causing an actuation of said relay to disconnect said line-signal from the telephone-line, and means upon actuation of said relay for causing the closure

of a low-resistance circuit in shunt of the other winding of said relay.

21. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential windings serially included in a single limb of said line, a line-signal controlled by switching apparatus at the substation, means whereby the connection of said cord connecting apparatus with said line causes the closure of a circuit of decreased resistance through a winding of said relay, thereby causing an actuation thereof to destroy the substation control of said line-signal and means upon actuation of said relay for causing the closure of a low-resistance circuit in shunt of the other winding of said relay.

22. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange for supplying current to the substation-transmitters, cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential windings included in circuit with a single limb of said line, a line-signal controlled by switching apparatus at the substation, and means whereby the connection of said cord connecting apparatus with said line causes the closure of a circuit through a winding of said relay, thereby causing an actuation of said relay to disconnect said line-signal from the telephone-line and to cause the closure of a low-resistance circuit in shunt of the other winding of said relay.

23. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange for supplying current to the substation-transmitters, cord connecting apparatus at the exchange for connecting said line with another for conversation, a cut-off relay having two differential windings normally serially included in a single limb of said line, a line-signal controlled by switching apparatus at the substation, means whereby the connection of said cord connecting apparatus with said line causes the closure of a circuit of decreased resistance through a winding of said relay, thereby causing an actuation thereof to destroy the substation control of said line-signal, and means upon actuation of said relay for causing the closure of a low-resistance circuit in shunt of the other winding of said relay.

24. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange for supplying current to the substation-transmitters, cord connecting apparatus at the exchange

for connecting said line with another for conversation, a cut-off relay having two differential windings serially included in a single limb of said line, a line-signal controlled by switching apparatus at the substation, means whereby the connection of said cord connecting apparatus with said line causes the closure of a circuit through a winding of said relay, thereby causing an actuation of said relay to disconnect said line-signal from the telephone-line, and means upon actuation of said relay for causing the closure of a low-resistance circuit in shunt of the other winding of said relay.

25. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a line-signal normally serially included in circuit with said line, a source of current at the central station adapted to supply current to the substation-transmitters, a cut-off relay having two differential windings normally serially included in circuit with said line, and means whereby the connection of said cord connecting apparatus with said line may cause an actuation of said relay to close a circuit of low resistance in shunt of one of the windings of said relay.

26. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a source of current at the central station adapted to supply current to the substation-transmitters, a line-signal normally serially included in circuit with said line, a cut-off relay having two windings normally serially included in circuit with said line, and means whereby the connection of said cord connecting apparatus with said line may cause an actuation of said relay to close a low-resistance circuit in shunt of one of the windings of said relay.

27. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a line-signal normally serially included in circuit with said line, a cut-off relay normally serially included in circuit with said line, and means whereby the connection of said cord connecting apparatus with said line causes the establishment of a substantially short circuit about a winding of said relay.

28. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a source of current at the central station adapted to supply current to the substation-transmit-

ters, a line-signal normally serially included in circuit with said line, a cut-off relay normally serially included in circuit with said line, and means whereby the connection of said cord connecting apparatus with said line may cause the establishment of a substantially short circuit about a winding of said cut-off relay.

29. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a source of current at the central station adapted to supply current to the substation-transmitters, a line-signal normally serially included in circuit with said line, a cut-off relay having two windings normally serially included in circuit with said line, and means whereby the connection of said cord connecting apparatus with said line may cause the establishment of a substantially short circuit about one of the windings of said relay.

30. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a source of current at the central station adapted to supply current to the substation-transmitters, a line-signal normally serially included in circuit with said line, a cut-off relay having two differentially-wound coils normally serially included in circuit with said line, and means whereby the connection of said cord connecting apparatus with said line may cause the establishment of a substantially short circuit about one winding of said relay.

31. In a telephone-exchange system, the combination with a central exchange, of a telephone-line leading therefrom to a substation, a cord-circuit at the exchange having one strand normally continuous through a supervisory signal-lamp, a condenser serially included in circuit with said lamp, a source of current at the central exchange having one of its terminals normally connected to said cord-strand through said lamp and an armature and adapted to supply current to said lamp upon connection of said cord-circuit with said line, and a supervisory relay controlling said armature and adapted when energized upon actuation of substation apparatus to disconnect said cord-strand and lamp from said source of current and to close a low resistance in shunt of said lamp.

32. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of cord connecting apparatus at the exchange for connecting said line with another for conversation, a source of current at the central station adapted to supply current to the substation-transmitters, a line-signal normally serially included in circuit with said line, a cut-off relay having

two windings normally serially included in circuit with said line, and means whereby the connection of said cord connecting apparatus with said line establishes a circuit of decreased resistance through one of said windings, whereby said relay is actuated, the actuation of said relay serving to close a low-resistance circuit in shunt of the other of said windings.

33. In a telephone-exchange system, the combination with a central exchange, of a telephone-line leading therefrom to a substation, a cord-circuit and a source of current at the central exchange, one strand of said cord-circuit being telephonically continuous through a condenser, the other strand being normally continuous serially through two supervisory signal-lamps and a condenser disposed between said lamps, a supervisory relay for each lamp connected between one terminal of said source of current and the first strand, a circuit connecting said terminal with the other strand through the corresponding relay-armature and supervisory lamp, energization of said relays upon actuation of substation apparatus when said cord-circuit is connected with a line causing attraction of the relay-armatures to disconnect said lamps from said source of current and to establish a short circuit about the corresponding lamps.

34. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange for supplying current to the substation-transmitters, a cut-off relay having two differential windings normally serially included in one of said limbs between one terminal of said source of current and substation apparatus, a line-signal normally serially included in the other of said limbs between the other terminal of said source of current and the substation apparatus, a spring-jack at the exchange having a tip-contact primarily connected to the common terminal of said differential relay-windings and a sleeve-contact normally disconnected from said line, cord connecting apparatus associated with said source of current for connecting said line with another for conversation, means whereby the insertion of a plug of said cord connecting apparatus within said jack closes a circuit of decreased resistance through one winding of said differential cut-off relay to cause an actuation thereof, switching means controlled by the actuation of said cut-off relay to open the circuit from a terminal of said source of current through said line-signal to one limb of the line and to connect said limb with the sleeve-contact of the spring-jack and other switching means controlled by the actuation of said cut-off relay to close a low-resistance circuit in shunt of that winding of said relay connected between the tip-contact of the spring-jack and a limb of the line.

35. In a telephone-exchange system, the

combination with a cord-circuit having a strand normally telephonically continuous through a supervisory signal-lamp, of a supervisory relay adapted upon energization to close a low-resistance circuit in shunt of said lamp.

36. In a telephone-exchange system, the combination with a cord-circuit having one of its strands normally telephonically continuous through a supervisory signal-lamp, of a source of current having one of its terminals normally connected to said cord-strand through said lamp, and a supervisory relay adapted upon energization to disconnect said cord-strand and lamp from said source of current and to close a low-resistance circuit in shunt of said lamp.

37. In a telephone-exchange system, the combination with a cord-circuit having a strand normally telephonically continuous through a supervisory signal-lamp, of a condenser serially included in circuit with said lamp, a source of current having one of its terminals normally connected to said cord-strand and adapted to supply current to said supervisory signal-lamp, and a supervisory relay adapted upon energization to disconnect said cord-strand and lamp from said source of current and to close a low-resistance circuit in shunt of said lamp.

38. In a telephone-exchange system, the combination with a cord-circuit having a strand normally telephonically continuous through a supervisory signal-lamp, of a supervisory relay adapted upon energization to close a short circuit about said lamp.

39. In a telephone-exchange system, the combination with a cord connecting apparatus, of a calling and answering plug therefor, a supervisory lamp for each plug, one strand of said cord-circuit being normally telephonically continuous through said lamps, and a supervisory relay for each lamp, energization of said relays causing a short circuit to be established about the corresponding supervisory lamp whereby said lamps are removed from the telephone-circuit.

40. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange normally connected in bridge of the limbs of the line, cord connecting apparatus at the exchange, a cut-off relay included in one of the limbs of the line, armatures for said relay, a line-signal normally serially included in the other limb with one of said armatures, and means upon connection of the cord connecting apparatus in said line for disconnecting said line-signal from the line and for establishing a short circuit about part of the cut-off-relay winding.

41. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange,

of a source of current at the exchange normally connected in bridge of the limbs of the line, cord connecting apparatus at the central exchange, a cut-off relay having two windings normally included in one limb of the line, armatures for said relay, and a line-signal serially included in the other limb with one of said armatures, connection of said cord connecting apparatus with said line causing attraction of said armatures to disconnect the line-signal from circuit and to establish a short circuit about one of the cut-off-relay windings.

42. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange normally connected in bridge of a telephone-line, cord connecting apparatus at the exchange, a cut-off relay having two differential windings normally serially included in one limb of the telephone-line, an armature for said relay, and a spring-jack for said line, one member of said spring-jack being normally connected with one limb of a telephone-line through one of said differential windings, connection of said cord connecting apparatus with said spring-jack causing attraction of said armature by said cut-off relay to connect said jack member directly with said limb through a short circuit about said relay-winding.

43. In a telephone-exchange system, the combination with a telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange normally connected in bridge of the telephone-line, a cut-off relay having two differential windings normally serially included in one limb of said line, armatures for said relay, a line-signal normally serially included in the other limb with one of said armatures, a cord connecting apparatus at the central exchange, and switch-springs associated with said telephone-line, one of said springs being normally connected with one limb of the line through one of said differential windings, the other spring being normally disconnected from the other limb of the line, connection of the cord connecting apparatus with said springs causing energization of said cut-off relay to attract its armature, whereby said switch-spring is directly connected with the line-limb through a short circuit about said winding, and whereby the line-signal is disconnected from circuit and the other switch-spring connected with the other limb of the line.

In witness whereof I hereunto subscribe my name this 14th day of January, A. D. 1903.

EDMUND LAND.

Witnesses:

LYNN A. WILLIAMS,
HARVEY L. HANSON.