

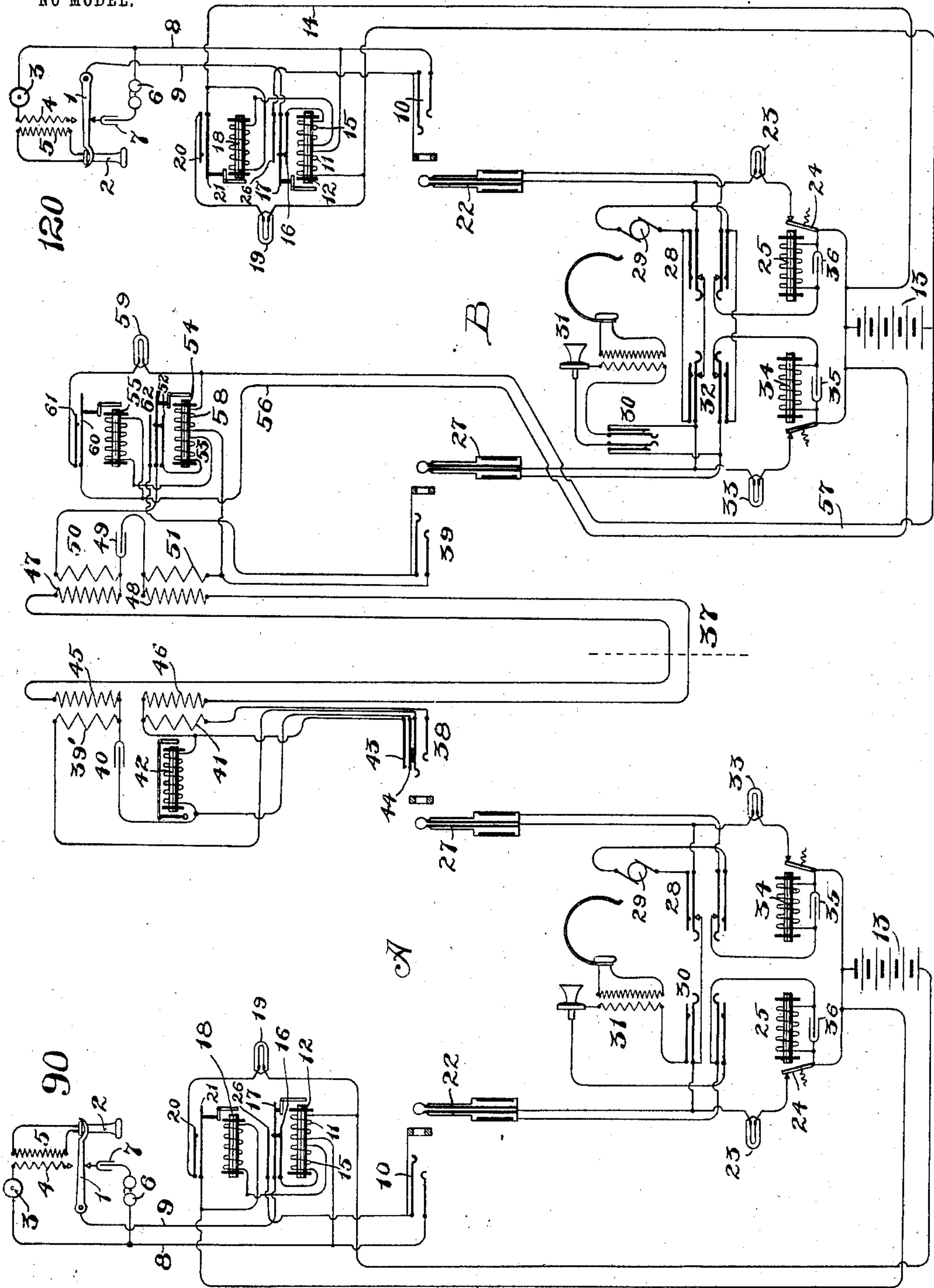
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W. M. DAVIS.  
TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED DEC. 2, 1901.

NO MODEL.



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# UNITED STATES PATENT OFFICE.

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## TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 737,590, dated September 1, 1903.

Application filed December 2, 1901. Serial No. 84,375. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM M. DAVIS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, 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 drawing, forming a part of this specification.

My invention relates to telephone-exchange systems, and has for its object the provision of improved means whereby subscribers whose lines extend to different telephone-exchanges may be connected through the agency of trunk-lines.

My invention has for its specific objects—first, the provision of improved means whereby the operators of different exchanges may signal each other over those conductors employed in effecting a complete connection between subscribers connected with the exchange, thereby dispensing with special conductors that have been generally employed hitherto for the purpose of establishing signal connection between the operators, and, second, the provision of means whereby repeating-coils may be employed in the trunk-line for the purpose of propagating voice-currents from one substation to another, in combination with means whereby the common battery employed in the system may not be short-circuited by reason of inductively-related closed circuits forming links in the telephonic circuit. While this latter feature of my invention is particularly adaptable for use in connection with repeating-coils contained in trunk-lines, I do not wish to be limited in all embodiments of the invention to this adaptation thereof.

I will explain my invention more fully by reference to the accompanying drawing, in which are illustrated two telephone-exchanges adapted for union by a trunk-line.

I have illustrated a subscriber's station No. 90 connected with the telephone-exchange A and a subscriber's station 120 connected to a telephone-exchange B. At each of the telephone-substations I have illustrated a gravity switch-hook 1, a receiver 2, that may be sup-

ported thereby, a transmitter 3, an induction-coil having the primary 4 adapted for inclusion in circuit with the telephone-line upon the elevation of the switch-hook, a secondary 5 included in closed circuit with the telephone-receiver, a signal-receiver 6, and a condenser 7 included in the signaling branch. When the switch-hook occupies its depressed position, the signal-receiver is cut into circuit and the telephonic apparatus is rendered inoperative. When the receiver is removed from the switch-hook, the switch-hook is elevated to open the signaling branch containing bell 6 and condenser 7 and to close circuit through the telephonic apparatus.

The substations are connected with the exchange by telephone-lines, the limbs 8 and 9 of each being connected with the short and long line springs of the spring-jacks 10 at the exchanges. The limb 8 of each telephone-line is continued through the helix 11 of a relay 12 and is connected with one pole of a common battery 13, the remaining pole of this common battery having connection by way of the conductor 14 with one terminal of the second helix 15 of the relay 12. The remaining terminal of the helix 15 is in the form of a contact-spring 16, normally engaging a contact carried by the spring 17, which spring constitutes the normal terminal of the limb 9. When the limbs 8 and 9 are conductively united at a substation 90 or 120, circuit from the battery 13 finds passage through both of the helices 11 and 15, which by being differentially wound do not cause the operation of the relay 12 when thus both included in circuit.

There is also included in circuit with the conductor 14 and the helix 15 the winding of a line-indicator 18, having a single helix which energizes its core when circuit through the battery 13 is completed upon the elevation of a corresponding telephone switch-hook. The line-signaling magnet 18 preferably presents a signal through the agency of a small incandescent lamp 19, whose circuit is completed as terminals 20 and 21 are engaged upon the energization of magnet 18. The operator in response to the signal conveyed by the lamp 19 inserts a plug 22 into the call-



ing-subscriber's jack, thereby including the helix 11 in a momentary closed circuit that contains the tip of the inserted plug, the clearing-out indicating-lamp or other signal 23 corresponding to the subscriber whose jack is engaged by the plug 22, the armature 24 of the signal-controlling magnet 25 corresponding to the signal 23, the battery 13, the helix 11, and the short-line spring of the spring-jack 10 engaging the tip of the inserted plug. The spring 17 is thereupon moved from its normal contact to its alternate contact 26, thereby opening the circuit, including the helix 15, and permanently connecting the short-line spring to the battery through the helix 11. It is understood, of course, that the short circuit momentarily maintained through the lamp 23 causes the coil 11 to exert a greater magnetizing effect upon the core than the differential coil 15, whereby the said relay may be operated. The helix of magnet 18 and the coil 15 of the relay are at the same time cut out of circuit, as the continuity of its circuit depends upon the engagement of the parts 16 and 17.

The cord-connecting apparatus at the exchange is similar to that devised by me hitherto and which is now well known to those skilled in the art. In addition to the plugs 22 there are also provided the plugs 27, united by tip and sleeve strands. There is provided at the board A a ringing-key 28 for including the calling-generator 29 in bridge of the telephone-lines and a listening-key 30 for including the operator's telephone appliance 31 in the telephonic circuit. Similar keys 28 and 30 are also provided at board B, there being also illustrated at this board a second ringing-key 32, so that the generator 29 at this board may be included in circuit with one or the other of the plugs 22 and 27. There is also preferably provided in connection with each cord-circuit an added supervisory signal 33, provided with a controlling-electromagnet 34. The magnets 25 and 34 are included in series in the cord-circuits, being shunted by condensers 35 36, included serially in the same cord-strands.

Having generally described a particular telephone-exchange system with which my invention is particularly adapted, I will now describe more particularly the salient features of my improved trunking system.

The exchanges A and B may have telephone-lines connected therewith united through the agency of said trunk-lines, as the trunk-line 37 illustrates. This trunk-line terminates in the long and short line springs of the spring-jack 38, that are adapted for engagement with the terminal of a plug, and in similar contact-springs of a spring-jack 39 at the board or exchange B.

The trunk-line is made up of three inductively-related sections. The first section includes the short and long line springs of the spring-jack 38, the primary helix 39', condenser 40, and the primary helix 41. When

the trunk-line jack 38 is not engaged with the plug, this first section of the trunk-line includes the drop or indicating magnet 42, which is thus normally in condition to be operated from the board B. When the jack 38, however, is engaged by a plug, the helix of its magnet is short-circuited by the engagement of terminals 43 44 of its helix, by which adjustment it is rendered unresponsive to alternating current, while its impedance is removed from the trunk-line circuit.

The second or middle section of the trunk-line is in the form of a local circuit that is closed telephonically. This telephonically-closed second or middle section of the trunk-line includes secondary coils 45 46 in inductive relation with the primaries 39' and 41 and secondary coils 47 and 48. This middle section also includes the condenser 40, that is common to the first and second sections of the trunk-line, and the condenser 49, that is common to the second and third sections of the trunk-line, said condensers serving to telephonically close said sections. This third section of the trunk-circuit also includes the primary coils 50 and 51 in inductive relation with the secondaries 47 and 48. There is included normally in this third section of the trunk-line a circuit-changing spring 52, the helix 53 of a relay 54, the helix of a signal-controlling magnet 55, the conductor 56, the battery 13 at the exchange B, the conductor 57, and the helix 58, that is differentially wound with respect to the helix 53, which arrangement is preserved as long as jack 39 is not engaged by a plug.

This association of the signal-controlling relay 54 and the signal-presenting magnet 55 constitutes one feature of my invention. By this arrangement, assuming that subscriber No. 90 is calling the subscriber No. 120, a signal is transmitted to the B operator upon a simple insertion of the A operator's calling-plug in the trunking-jack through the agency of the cord-circuit instrumentalities at the exchange A, which result I am enabled to secure because the sides of the circuit extending from the calling-operator's exchange to the board B are metallically continuous, as will be apparent by the metallic connections between the coils 39' and 45, coils 41 and 46, coils 47 and 50, and coils 48 and 51, which arrangement enables the passage of battery-current through the helices 55, 53, and 58 when the plug is inserted at the A exchange. The circuit may be traced as follows: from the long jack-spring of spring-jack 38 to the primary coil 39', the secondary coil 45 to the secondary coil 47, primary coil 50 to the middle spring of the relay 54, to the lower spring of the relay 54, through the winding 53 of relay 54, through the winding of relay 55, through conductor 56, through battery 13 at station B, through conductor 57, through winding 58 of relay 54, through the primary coil 51, through the secondary coil 48, secondary coil 46, primary coil 41, the short spring



of spring-jack 38 to the tip of plug 27, to the operator's key, through subscriber's substation 90, (if plug 22 is inserted in spring-jack 10,) back to the operator's key, through the winding of relay 25, winding of relay 34, through the sleeve-strand of the cord, and back to the long relay-spring of spring-jack 38. If the plug 22 is not inserted in spring-jack 10, the circuit at station A may be closed by the closure of the operator's listening-key, the circuit then including the operator's talking set instead of the apparatus at substation 90. This signal thus automatically transferred through the agency of apparatus at the board A is manifested in the signal 59, it being assumed that the relay 54 is not operated, owing to the differential arrangement of its windings. This signal 59 is preferably in the form of a small incandescent lamp and is included in a local circuit that is established by the armature of the magnet 55, which effects the closure of the switch parts 60 and 61, constituting terminals of the circuit, including the lamp 59.

The operator at the board B in response to the signal presented by the device 59 inserts a plug 27 into the jack 39, thereby momentarily establishing a local circuit that includes the tip of the inserted plug, the supervisory signal 33, the armature of the magnet 34, the battery 13, the helix 58, and the short-line spring of the jack 39 in engagement with the said tip. The momentary closure of this circuit causes an increase in the strength of the magnetism due to the winding 58 over that produced by the winding 53, whereupon the armature of the relay 54 is attracted, moving the contact-spring 62 from its normal contact-anvil, thereby opening the circuit including the helix 53. By the disconnection between the spring 62 and its normal contact-anvil the magnet 55 is thrown out of circuit, restoring the signal 59. The spring 62 when elevated engages its alternate contact-anvil, thereby effecting a direct connection between the primary 50 and the long-line spring of the spring-jack 39, thus placing the third section of the trunk-line in condition to afford telephonic communication between the calling and called subscribers. The condensers 40 and 49 prevent the short-circuiting of the batteries 13 13, which would otherwise take place if the second section of the trunk-line were placed in a metallicallly-closed circuit. The condenser 49 by furnishing sufficient impedance to the low-frequency calling-current serves to permit the passage of sufficient current from the calling-generator 29 at the board B (assuming now that subscriber No. 120 is the calling subscriber and that the operator at the A board is to be signaled) to effect the operation of the drop 42. This signaling-current may be traced from one terminal of the generator 29 to the tip of the plug 27, inserted within the jack 39, the short-line spring of this jack, the primary 51, the secondary 48, the secondary 46, the said magnet 42, the condenser 40, the sec-

ondary 45, the secondary 47, the primary 50, the long-line spring of the spring-jack 39, the sleeve of the inserted plug 27 to the remaining terminal of the generator. The condenser 49, taking the place of a metallic continuation of the second section of the trunk-line, prevents the current from the generator 29 at the exchange B from being short-circuited, forcing the same through magnet 42.

It is obvious that the condensers 49 and 40 may be so relatively constituted as to prevent and permit the passage of signaling-current in the generator 29. If it is not desired to relatively constitute the condensers in this way, the signal 42 may be operated by divided current received from the generator 29.

It is obvious that many changes may be made from the embodiment of my invention herein shown and particularly described, and I do not, therefore, wish to be limited to the precise arrangement herein shown; but,

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

1. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different switchboards, of a trunk-line between these boards, cord-connecting apparatus at each of the boards for connecting the trunk-line with subscribers' lines, a signal at one of the boards, an electromagnet associated with said signal for controlling the operation thereof, a relay for controlling the energization of said electromagnet, switching mechanism adapted to be actuated by said relay, differentially-wound coils on said relay normally included serially in the trunk-circuit with the winding of said electromagnet and said switching apparatus, a source of current, means associated with the cord apparatus at a second board for causing the current from said source to flow through said differential windings and the winding of said electromagnet, said relay remaining de-energized during such flow of current, and means at said first board for including one of said differential coils in an additional circuit with said source, whereby said switching mechanism is actuated to open the circuit through said electromagnet, whereby said signal is restored, substantially as described.

2. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different switchboards, of a trunk-line between these boards, repeating-coils interposed in said trunk-line between the two boards, cord-connecting apparatus at each of the boards for connecting the trunk-line with subscribers' lines, a signal at one of the boards, an electromagnet associated with said signal for controlling the operations thereof, a relay for controlling the energization of said electromagnet, switching mechanism adapted to be actuated by said relay, differentially-wound coils on said relay normally included serially in the trunk-circuit with the winding of said electromagnet



and said switching apparatus, a source of current, means associated with the cord apparatus at a second board for causing the current from said source to flow through said differential windings and the winding of said electromagnet, said relay remaining deenergized during such flow of current, and means at said first board for including one of said differential coils in an additional circuit with said source, whereby said switching mechanism is actuated to open the circuit through said electromagnet, whereby said signal is restored, substantially as described.

3. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different switchboards, of a trunk-line between these boards, the said trunk-line being divided into three inductively-related sections, cord-connecting apparatus at each of the boards for connecting the trunk-line with subscribers' lines, a signal at one of the boards, an electromagnet associated with said signal for controlling the operation thereof, a relay for controlling the energization of said electromagnet, switching mechanism adapted to be actuated by said relay, differentially-wound coils on said relay normally included serially in the trunk-circuit with the winding of said electromagnet and said switching apparatus, a source of current, means associated with the cord apparatus at a second board for causing the current from said source to flow through said differential windings and the winding of said electromagnet, said relay remaining deenergized during such flow of current, and means at said first board for including one of said differential coils in an additional circuit with said source, whereby said switching mechanism is actuated to open the circuit through said electromagnet, whereby said signal is restored, substantially as described.

4. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different switchboards, of a trunk-line between the boards, cord-connecting apparatus at each of the boards for connecting the trunk-line with subscribers' lines, a relay provided with differentially-wound coils connected with the trunk-line, an indicator at one of the boards, means controlled by the said relay for governing the operation of the said indicator, means for directing current through the differentially-wound coils of the relay, said means being controlled by instrumentalities associated with the cord-circuit at the board where the call is initiated through the agency of the trunk-line, switching apparatus for directing current through the said relay to change the operative condition of the indicator, the said trunk-line having metallic-continuous sides, repeating-coils included in these sides, condensing apparatus located across the sides to divide the trunk-line into telephonically-closed sections, and a source of electricity that is caused to pass its current over the me-

tallic sides of the trunk-circuit to the said relay, substantially as described.

5. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different switchboards, of a trunk-line between the boards, cord-connecting apparatus at each of the boards for connecting the trunk-line with subscribers' lines, a relay provided with differentially-wound coils connected with the trunk-line, a signal at one of the boards, means controlled by the said relay for governing the operation of the said signal, means for directing current through the differentially-wound coils of the relay, said means being controlled by instrumentalities associated with the cord-circuit at the board where the call is initiated through the agency of the trunk-line, and means operating in conjunction with the cord-connecting apparatus at said first board for causing additional current to flow through one of the coils of the relay whereby the magnetization of said relay is increased, substantially as described.

6. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different switchboards, of a trunk-line between the boards, repeating-coils interposed in said trunk-line, cord-connecting apparatus at each of the boards for connecting the trunk-line with the subscribers' lines, a relay provided with differentially-wound coils connected with the trunk-line, a signal at one of the boards, means controlled by the said relay for governing the operation of the said signal, means for directing current through the differentially-wound coils of the relay, said means being controlled by instrumentalities associated with the cord-circuit at the board where the call is initiated through the agency of the trunk-line, and means operating in conjunction with the cord-connecting apparatus at said first board for causing additional current to flow through one of the coils of the relay whereby the magnetization of said relay is increased, substantially as described.

7. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different switchboards, of a trunk-line between the boards, the said trunk-line being divided into three inductively-related sections, cord-connecting apparatus at each of the boards for connecting the trunk-line with subscribers' lines, a relay provided with differentially-wound coils connected with the trunk-line, a signal at one of the boards, means controlled by the said relay for governing the operation of the said signal, means for directing current through the differentially-wound coils of the relay, said means being controlled by instrumentalities associated with the cord-circuit at the board where the call is initiated through the agency of the trunk-line, and means operating in conjunction with the cord-connecting apparatus at said first board for causing ad-



ditional current to flow through one of the coils of the relay whereby the magnetization of said relay is increased, substantially as described.

5 8. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different switch-boards, of a trunk-line between the boards, cord-connecting apparatus at each of the  
10 boards for connecting the trunk-line with subscribers' lines, a relay provided with differentially-wound coils connected with the trunk-line, an indicator at one of the boards, means controlled by the said relay for gov-  
15 erning the operation of the said indicator, means operating in conjunction with the said cord-connecting apparatus for rendering the magnetization due to one of the helices of the differentially-wound relay or magnet stronger  
20 than that due to the other, the said trunk-line having metallic-continuous sides, repeating-coils included in these sides, condensing apparatus located across the sides to divide the trunk-line into telephonically-  
25 closed sections inductively related to each other, and a source of electricity that is caused to pass its current over the metallic sides of the trunk-circuit to the said relay by reason of the said condensing apparatus, substan-  
30 tially as described.

9. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different switch-boards, of a trunk-line between these boards,  
35 cord-connecting apparatus at each of the boards for connecting the trunk-line with subscribers' lines, a signal at one of the boards, an electromagnet associated with said signal for controlling the operation thereof, a relay  
40 for controlling the energization of said electromagnet, switching mechanism adapted to be actuated by said relay, differentially-wound coils on said relay normally included serially in the trunk-circuit with the winding of said  
45 electromagnet and said switching apparatus, a source of current, means associated with the cord apparatus at a second board for causing the current from said source to flow through said differential windings and the  
50 winding of said electromagnet, said relay remaining deenergized during such flow of current, and a local circuit at said first board including one of the windings of said relay and said source, said local circuit becoming closed  
55 upon insertion of the plug into the spring-jack at said board whereby additional current flows about said relay to cause magnetization thereof whereby said switching mechanism is actuated to open the circuit through  
60 said electromagnet whereby said signal is restored, substantially as described.

10. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different switch-boards, of a trunk-line between these boards,  
65 cord-connecting apparatus at each of the boards for connecting the trunk-line with sub-

scribers' lines, a signal at one of the boards, an electromagnet associated with said signal for controlling the operation thereof, a relay  
70 for controlling the energization of said electromagnet, switching mechanism adapted to be actuated by said relay, differentially-wound coils on said relay normally included serially in the trunk-circuit with the winding of said  
75 electromagnet and said switching apparatus, a source of current, means associated with the cord apparatus at a second board for causing the current from said source to flow through said differential windings and the winding of  
80 said electromagnet, said relay remaining deenergized during such flow of current, and means associated with the cord-circuit at said first board whereby said relay, said electromagnet, and said signal are excluded from the  
85 talking-circuit, substantially as described.

11. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different switch-boards, of a trunk-line between these boards,  
90 cord-connecting apparatus at each of the boards for connecting the trunk-line with subscribers' lines, a signal at one of the boards, an electromagnet associated with said signal for controlling the operation thereof, a relay  
95 for controlling the energization of said electromagnet, switching mechanism adapted to be actuated by said relay, differentially-wound coils on said relay normally included serially in the trunk-circuit with the winding of said  
100 electromagnet and said switching apparatus, a source of current, means associated with the cord apparatus at a second board for causing the current from said source to flow through said differential windings and the winding of  
105 said electromagnet, said relay remaining deenergized during such flow of current, and means whereby upon insertion of a plug into a spring-jack at said first board an additional circuit is closed through one of the coils of  
110 said relay and said source whereby said relay is energized to actuate said switching mechanism, said switching mechanism upon such actuation closing a short circuit about a portion of the trunk-circuit whereby said relay,  
115 said electromagnet, and said signal are excluded from the talking-circuit, substantially as described.

12. In a telephone-exchange system, the combination with telephone-lines extending  
120 from subscribers' stations to different switch-boards, of a trunk-line between the boards, cord-connecting apparatus at each of the boards for connecting the trunk-line with subscribers' lines, a relay provided with dif-  
125 ferentially-wound coils connected with the trunk-line, an indicator at one of the boards, means controlled by the said relay for governing the operation of the said indicator, means operating in conjunction with the said  
130 cord-connecting apparatus for rendering the magnetization due to one of the helices of the differentially-wound relay or magnet stronger than that due to the other, the said trunk-line



having metallicallly-continuous sides, repeating-coils included in these sides, condensing apparatus located across the sides to divide the trunk-line into inductively-related sections, a source of electricity that is caused to pass its current over the metallic sides of the trunk-circuit to the said relay by reason of the said condensing apparatus, the magnet directly controlling the said indicator being included in the trunk-line circuit to operate its signal upon the passage of current through the trunk-line, and a switch controlled by the differentially-wound relay and operated thereby upon the effective energization of the relay to restore the signal, substantially as described.

13. The combination with telephone-lines extending from subscribers' stations to different switchboards, of a trunk-line extending between the boards, repeating-coils in the trunk-line at each board for dividing said trunk-line into three inductively-related telephonic sections, a condenser between the repeating-coils at each board for uniting the sides of the trunk-line, a signal-controlling electromagnet at one of said boards whose winding is included in circuit with the condenser at said board, and a source of signaling-current at the other board for sending current over said trunk-line for actuating said signal-controlling electromagnet, substantially as described.

14. The combination with telephone-lines extending from subscribers' stations to different switchboards, of a trunk-line extending between the boards, repeating-coils in the trunk-line for dividing the same into inductively-related telephonic sections, condensing apparatus uniting the sides of the trunk-line at these repeating-coils, a source of calling-current at one board, a signal-controlling electromagnet whose winding is included in the trunk-line at the other board, responsive to current from the said source of signaling-current, contact-springs constituting terminals of the signal-controlling electromagnet-winding, and means whereby these contacts are engaged upon the establishment of a complete connection between subscribers connected with the boards, substantially as described.

15. The combination with telephone-lines extending from substations to different switchboards, of a trunk-line extending between the boards, a repeating-coil at each end of said trunk-line having its primary and secondary windings divided into sections for the purpose of affording an inductive transmission of telephonic current between the two switchboards, a metallic connection between the primary and secondary of said repeating-coils for the purpose of affording a metallic conducting-circuit for signaling-current, and an indicator associated with each end of said trunk-line, substantially as described.

16. The combination with telephone-lines extending from substations to different switchboards, of a trunk-line extending between the

boards, a repeating-coil at each end of said trunk-line having its primary and secondary windings divided into sections for the purpose of affording an inductive transmission of telephonic current between the two switchboards, a metallic connection between the primary and secondary of said repeating-coils for the purpose of affording a metallic conducting-circuit for signaling-current, an indicator associated with each end of said trunk-line, and condensers connected between the two sections of the primary and secondary windings, substantially as described.

17. In a telephone-exchange system, the combination of telephone-lines extending from substations to different exchange-stations, a trunk-circuit connecting the exchange-stations, metallicallly-connected repeating-coils included in the trunk-circuit and dividing said trunk-circuit into inductively-related sections, a source of current at one exchange-station adapted for connection with said trunk-circuit, and a signal-controlling device at a second station adapted to be operated by current from said source by virtue of the metallicallly-connected repeating-coils, substantially as described.

18. In a telephone-exchange system, the combination of telephone-lines extending from substations to different exchange-stations, a trunk-circuit connecting the exchange-stations, metallicallly-connected repeating-coils included in the trunk-circuit and dividing said trunk-circuit into inductively-related sections, a source of current at one exchange-station adapted for connection with said trunk-circuit, a signal-controlling device at a second station adapted to be operated by current from said source by virtue of the metallicallly-connected repeating-coils, and means associated with the trunk-circuit at said repeating-coils for telephonically closing said inductively-related stations, substantially as described.

19. In a telephone-exchange system, the combination of telephone-lines extending from substations to different exchange-stations, a trunk-circuit connecting the exchange-stations, metallicallly-connected repeating-coils included in the trunk-circuit and dividing said trunk-circuit into inductively-related sections, a source of current at one exchange-station adapted for connection with said trunk-circuit, a signal-controlling device at a second station adapted to be operated by current from said source by virtue of the metallicallly-connected repeating-coils, and condensing apparatus associated with the trunk-circuit at said repeating-coils for telephonically closing said inductively-related sections, substantially as described.

20. In a telephone-exchange system, the combination of telephone-lines extending from substations to different exchange-stations, a trunk-circuit connecting the exchange-stations, metallicallly-connected repeating-coils included in the trunk-circuit



and dividing said trunk-circuit into inductively-related sections, a source of current at one exchange-station adapted for connection with said trunk-circuit, a signal-controlling device at a second station adapted to be operated by current from said source by virtue of the metallicly-connected repeating-coils, and condensing apparatus connected across the trunk-circuit at said repeating-coils for telephonically closing said inductively-related sections, substantially as described.

21. In a telephone-exchange system, the combination of telephone-lines extending from substations to different exchange-boards, a trunk-line circuit intervening between the boards metallicly-connected repeating-coils dividing a telephone-circuit, which connects the substations and includes the trunk-line, into inductively-related telephonic sections, a source of current at one board adapted for connection with said telephone-circuit, and a signal-controlling device at a second board adapted to be operated by current from said source by virtue of the metallicly-connected repeating-coils, substantially as described.

22. In a telephone-exchange system, the combination of telephone-lines extending from substations to different exchange-boards, a trunk-line circuit intervening between the boards, metallicly-connected repeating-coils dividing a telephonic circuit, which connects the substation and includes the trunk-line, into inductively-related telephonic sections, a source of current at one board adapted for connection with said telephone-circuit, a signal-controlling device at a second board adapted to be operated by current from said source by virtue of the metallicly-connected repeating-coils, and condensers connected across the sides of the circuit of said repeating-coils for telephonically closing said inductively-related sections, substantially as described.

23. In a telephone-exchange system, the combination with telephone-lines extending from substations to different exchange-stations, of connecting apparatus intervening between the stations for uniting the lines for conversation, repeating-coils dividing the connecting apparatus into inductively-related sections, a signal at one exchange-station, a source of current at said station, an electromagnet at said station operated from a second station for causing the said source to be included in circuit with said signal, and a differentially-wound relay at said first station included in circuit with the aforesaid electromagnet for controlling the operation thereof, substantially as described.

24. In a telephone-exchange system, the combination with telephone-lines extending from substations to different exchange stations or boards, of connecting apparatus intervening between these stations or boards for uniting the lines for conversation, metallicly-connected repeating-coils dividing the

connecting apparatus into inductively-related sections, a signal at one exchange-station, a source of current at said station, and means at said station operated from a second station for causing the said source to be included in circuit with said signal, substantially as described.

25. In a telephone-exchange system, the combination with telephone-lines extending from substations to different exchange stations or boards, of connecting apparatus intervening between these stations or boards for uniting the lines for conversation, metallicly-connected repeating-coils dividing the connecting apparatus into inductively-related sections, a signal at one exchange-station, a source of current at said station, means at said station operated from a second station for causing the said source to be included in circuit with said signal, and condensing apparatus associated with said repeating-coils for telephonically closing said inductively-related sections, substantially as described.

26. In a telephone-exchange system, the combination with telephone-lines extending from substations to different exchange stations or boards, of connecting apparatus intervening between these stations or boards for uniting the lines for conversation, metallicly-connected repeating-coils dividing the connecting apparatus into inductively-related sections, a signal at one exchange-station, a source of current at said station, means at said station operated from a second station for causing the said source to be included in circuit with said signal, and a condenser at each exchange-station associated with said repeating-coils for telephonically closing said inductively-related sections, substantially as described.

27. In a telephone-exchange system, the combination of telephone-lines extending from substations to different exchange-stations, a trunk-circuit connecting the exchange-stations, metallicly-connected repeating-coils included in the limbs of the trunk-circuit and dividing said trunk-circuit into inductively-related sections, a source of current at one exchange-station adapted for connection with said trunk-circuit, a signal-controlling device at a second station adapted to be operated by current from said source by virtue of the metallicly-connected repeating-coils, an indicating device at said first exchange-station and a source of current at said second station for operating said indicating device, substantially as described.

28. In a telephone-exchange system, the combination of telephone-lines extending from substations to different exchange-stations, a trunk-circuit connecting the exchange-stations, metallicly-connected repeating-coils included in the limbs of the trunk-circuit and dividing said trunk-circuit into inductively-related sections, a source of current at one exchange-station adapted for connection with said trunk-circuit, a signal-control-



ling device at a second station adapted to be operated by current from said source by virtue of the metallicly-connected repeating-coils, an indicating device at said first  
5 exchange-station, a source of current at said second station for operating said indicating device, and a condenser at each of said exchange-stations connected across the limbs of the trunk-circuit at said repeating-coils, sub-  
10 stantially as described.

29. In a telephone-exchange system, the combination of telephone-lines extending from substations to different exchange-stations, a trunk-circuit connecting the exchange-  
15 stations, metallicly-connected repeating-coils included in the limbs of the trunk-circuit and dividing said trunk-circuit into inductively-related sections, a source of current at one exchange-station adapted for connec-

tion with said trunk-circuit, a signal-control- 20  
ling device at a second station adapted to be operated by current from said source by virtue of the metallicly-connected repeating-coils, a condenser at each exchange-station  
25 bridged between the repeating-coils included in opposite limbs of said trunk-circuit, an indicating device at said first exchange-station in series with the condenser at said station and a generator at said second station for operating said indicating device, substantially 30  
as described.

In witness whereof I hereunto subscribe my name this 27th day of November, A. D. 1901.

WILLIAM M. DAVIS.

Witnesses:

MAX W. ZABEL,  
HARVEY L. HANSON.