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A. STROMBERG.

TELEPHONE SYSTEM.

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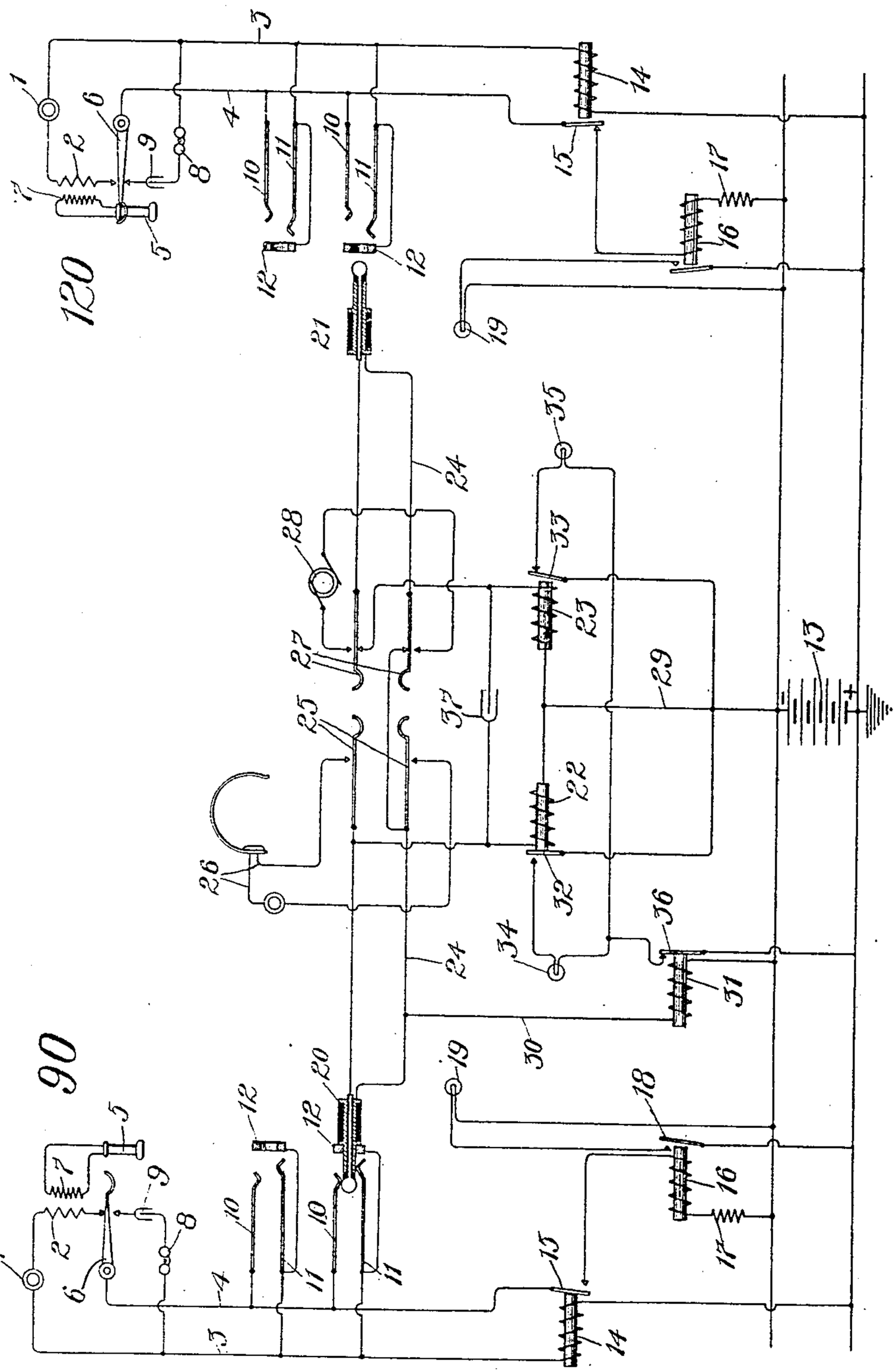

Witnesses:
Lenard W. Novander.
Harvey L. Hanson.

Inventor
Alfred Stromberg
By Charles A. Brown
Attorney

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UNITED STATES PATENT OFFICE.

ALFRED STROMBERG, OF CHICAGO, ILLINOIS, ASSIGNOR TO STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

TELEPHONE SYSTEM.

No. 835,046. Specification of Letters Patent. Patented Nov. 6, 1906

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To all whom it may concern:

Be it known that I, ALFRED STROMBERG, 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 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 systems, and more particularly to telephone systems in which a central exchange serves to interconnect any of the subscribers associated with the said exchange.

My invention is particularly well adapted for use in connection with a telephone-exchange system in which the source of the signaling and talking current is located at the central exchange. Such systems are commonly known as "common-battery" systems, and I shall describe an embodiment of my invention employing such a common battery located at the central exchange.

My invention provides for the normal inclusion at the central station, in series with a subscriber's line-circuit, of a pair of relays, one of which may be known as a "line-relay" and the other as a "cut-off relay." The line-relay is desirably so constructed as to be actuated to cause a line-signal upon the closure of the subscriber's line-circuit at his substation. The cut-off relay is so constructed that it will not be responsive to signaling-currents passing through the subscriber's line. Means are provided, however, whereby the connection of the operator's cord-circuit with a subscriber's line causes the actuation of the cut-off relay associated therewith to break the line-circuit through the line-relay, whereupon the line-signal is automatically restored.

A preferred embodiment of my invention contemplates the provision at the central station of a common battery, to one pole of which (for instance, the positive pole) one of each subscriber's two lines is permanently connected, each through a cut-off relay of comparatively low resistance. This line may also be permanently connected with one terminal or spring of a switchboard-spring-jack, or, in case a multiple switchboard is used, all of the sleeve-springs of a set of multiple jacks may be permanently connected with this line, as is well understood by those skilled in the art. The other of the two metallic lines leading to the subscriber's station may be permanently connected with the tip-springs of the same set of spring-jacks. This second line is desirably connected with the other pole of the battery through a line-relay, preferably of high resistance, there being included in this line between the tip-springs and the battery-terminal the armature of the cut-off relay. When this armature of the cut-off relay is attracted, due to the proper energization of its associated magnet, the line connection through the line-relay to the battery is broken. The line-relay may control a visual signal mechanically operated or may actuate an armature adapted to close a local circuit through a signaling-lamp, as is well understood by those skilled in the art. A two-strand cord-circuit is desirably employed, the sleeve-strand of which is preferably connected with the opposite (*e. g.*, negative) pole of the common battery from that to which the line through the cut-off relay is permanently connected. Upon the insertion of an operator's plug within a spring-jack contact is made between the sleeve of the plug and the sleeve-spring, whereby a circuit is established from the negative pole of the battery through the sleeve-strand of the cord-circuit to the line connected through the cut-off relay with the positive pole of the battery. Since one of the metallic lines running from a subscriber's station to the central station includes the low-resistance coil of the cut-off relay and the other the high-resistance coil of the line-relay, the closure of a circuit through these lines at the substation causes a current to flow which is sufficient to actuate the armature of the line-relay, but not sufficient to actuate the armature of the low-resistance cut-off relay. When, however, the sleeve-strand is brought into connection with the sleeve-spring of the jack, a low-resistance circuit is formed from the battery through the cut-off relay, allowing sufficient current to flow to cause the actuation of the cut-off relay, whereby the line-relay is cut out of the circuit. Battery-current is then supplied to the subscriber's transmitter through the permanent line connection, through the cut-off

relay to the common battery, and through the tip-strand of the cord-circuit, which is permanently connected to the other pole of the battery. The connection from the sleeve-strand of the cord-circuit with the negative pole of the battery may include a relay adapted to close the operator's supervisory circuit.

I will more fully explain my invention by reference to the accompanying drawing, diagrammatically representing a preferred embodiment thereof.

I have illustrated at 90 and 120 subscribers' substations, at each of which is located the customary battery-transmitter 1 in circuit with the primary 2 of an induction-coil. Circuit through the metallic lines 3 and 4 may be closed upon the removal of the receiver 5 from the receiver switch-hook 6. The receiver is connected with a secondary coil 7 in inductive relation with the primary 2. When the receiver is placed upon the switch-hook, the latter is depressed to make contact with the terminal adapted to connect the metallic lines with a signaling-bell 8 through the condenser 9.

I have shown multiple spring-jacks, the tip-springs 10 of which are permanently connected to the metallic line 4, while the sleeve-springs 11 and thimbles 12 are permanently connected with the metallic line 3.

At 13 I have illustrated a common battery to the positive pole of which the lines 3 are permanently connected through the magnet-coils of the cut-off relays 14. These cut-off-relay coils are preferably of comparatively low resistance—for instance, two hundred ohms. When in its normal unattracted condition, an armature 15 of a cut-off relay closes a circuit from the negative pole from the battery 13 through the coil of the line-relay 16 to the metallic limb 4 of the subscriber's line. The circuit from the negative pole of the battery through the coil of the line-relay to the armature 15 is desirably of high resistance—for example, two thousand five hundred ohms. This resistance may be provided by winding the line-relay coils with German silver or other high-resistance wire or by including in the circuit an extraneous resistance 17. The armatures 18, associated with the line-relays, are adapted to close circuit through the line signaling-lamps 19. A two-strand cord-circuit is employed, including the answering and calling plugs 20 and 21, the tip-contacts of which are permanently connected through the coils of the supervisory relays 22 and 23 and the sleeves of which are connected by the sleeve-strand 24. A condenser 37 is desirably shunted around the supervisory relays in order to improve the transmission of voice-currents through the cord-circuit.

An operator's listening-key 25 is provided whereby the operator's telephone set 26 may be connected across the cord-circuit and a ringing-key 27, whereby the ringing-generator 28 may be connected with the strands leading to the calling-plug, the remainder of the cord-circuit being disconnected for the time being. A conductor 29 affords a connection between the negative pole of the battery 13 and a point on the tip-strand between the supervisory relays 22 and 23. A conductor 30 affords a permanent connection between the sleeve-strand 24 of the cord-circuit and the negative pole of battery, this connection including in its circuit the coil of the supervisory controlling-relay 31. The coil of this supervisory controlling-relay should be of considerably less resistance than that of the line-relays 16. I have found that these coils when wound to a resistance of five hundred ohms give satisfactory results. Associated with the magnets of the supervisory relays 22 and 23 are armatures 32 and 33, adapted, respectively, to close circuits through the supervisory signaling-lamps 34 and 35. These lamps are provided with a local-battery circuit which is controlled by the armature 36, actuated by the controlling-relay 31.

The operation of my improved system will now become apparent. The subscriber at substation 90 desiring connection with subscriber 120 removes his receiver from the switch-hook, whereupon a circuit is closed between the metallic limbs 3 and 4, which circuit may be traced as follows: from the positive pole of the battery 13 through the low-resistance coil of the cut-off relay 14, through the line 3 to the transmitter 1, to the primary coil 2, to the receiver-hook 6, through the line 4, to the armature 15, to the coil of the line-relay 16, through the resistance 17 to the negative pole of the battery 13. It will be seen that this circuit includes in addition to the considerable resistance of the line and the subscribers' instruments the resistance of two hundred ohms in the cut-off relay and the resistance of two thousand five hundred ohms in the line-relay circuit. The relay 14 is so adjusted that this comparatively small amount of current will not actuate its armature 15; but the relay 16, being very much more sensitive, is actuated by the current which flows in series through both cut-off and line relays. The armature 18 being thus drawn up, the local circuit through the lamp 19 is closed, thereby affording the operator a visual line-signal. The operator thereupon plugs into the answering-jack associated with the lines to substation No. 90, as shown in the drawing. Circuit is thereupon established as follows: from the positive pole of the battery 13 through the coil of the relay 14, to the sleeve-spring 11, to the sleeve of the answering-plug 20, through the sleeve-strand 24, through the conductor 30, through the coil of the relay 31 to the negative pole of the battery 13. The coil of the relay 31 be-

ing of comparatively low resistance, (five hundred ohms,) a very much increased current is permitted to flow through the coil of the cut-off relay 14. This increased current is sufficient to cause the attraction of the armature 15, whereupon the connection of the line 4 through the high-resistance line-relay circuit to the negative pole of the battery is broken. Thus upon the insertion of the answering-plug within the jack the line-relay is cut out of circuit, thereby releasing the armature 18 and breaking the circuit through the line-signal 19. It will be seen that upon the insertion of the plug within the answering-jack circuit is closed through the relay 31, whereupon the armature 36 is attracted, thus connecting the positive pole of the battery with the lamps 34 and 35. The relay 22 will be energized by current flowing from the negative pole of the battery through the tip-strand and tip-spring to the line 4, the energization of this relay 22 thus causing the attraction of the armature 32, whereupon circuit through the lamp 34 is broken. The lamp 35, on the other hand, will be caused to glow, due to current passing through the unattracted armature 33. The operator upon ascertaining that the subscriber at substation 90 wishes to obtain connection with the subscriber at substation 120 plugs into the associated calling-jack and manipulates the ringing-key 27. Upon removal of the receiver at station 120 the coil of the relay 23 will be energized to attract the armature 33, thereby breaking the circuit through the associated supervisory lamp 35. The insertion of the plug 21 within the jack also closes a circuit through the associated cut-off relay 14 and the supervisory controlling-relay 31, which circuit being of comparatively low resistance the armature 15 is attracted, thereby immediately cutting off the associated line-relay 16. Upon the completion of the conversation either subscriber upon hanging up his receiver opens connection between the lines 3 and 4, thereby causing a deënergization of the corresponding supervisory relay 22 or 23, thus causing the associated supervisory signal-lamp 34 or 35 to glow. The operator upon removing the plugs from the jacks automatically causes the deënergization of the cut-off magnets, whereupon their armatures are restored to their normal condition. Upon the removal of the plugs from the jacks the circuit through the controlling-relay 31 is also broken, whereupon the armature 36 is released.

It will be seen that the actuation of the armature of the cut-off relay 14 is dependent upon a marginal difference in the magnetization of the relay-core. The cut-off relay is marginally adjusted, so as not to be actuated when energized by the small normal signaling-current serially passing through the cut-off and line relays. The adjustment of the relay is such, however, that the armature 15 will be attracted upon an increase in the magnetization thereof, due to an increased current passing through the relay-coil upon the closure of the shunt-circuit through the cord-circuit. This marginal adjustment of the cut-off relay is in contradistinction with certain cut-off relays of the prior art, commonly known as "differential" relays, in which the cut-off relay is provided with differentially-wound coils, so that the closure of the line-circuit through the cut-off relay causes no magnetization of the relay-core, the magnetization of the core being effected by unbalancing the number of ampere-turns in the two differential coils. In such systems the armature of the differential relay is adjusted to be actuated whenever the relay-core is magnetized.

I have found that with the resistances above mentioned for the cut-off relays, the line-relay circuits, and the supervisory controlling-relay a short circuit across the metallic limbs 3 and 4 will not cause an actuation of the armature of the cut-off relays, while the line-relays may be adjusted to be actuated through a resistance as high as five thousand ohms in the telephone line-circuit. It will thus be seen that my system does not depend upon marginal differences which are likely to be exceeded in practice.

Since the operation of my improved system depends upon the relative adjustment of the cut-off and line relays, so that the line-relay will be actuated upon the closure of circuit through the line-relay and the cut-off relay and so that the cut-off relay will not be actuated by the current flowing in the same circuit, it will be apparent that many means for securing this relative adjustment could be employed. I prefer, however, to insure the inoperativeness of the cut-off relay, due to current flowing through the line-circuit, by making the circuit through the line-relay of high resistance. It will be apparent, as above pointed out, that this circuit may be made of high resistance either by winding the entire resistance upon the line-relay itself or by including in the circuit an extraneous resistance. In the following claims, however, I shall refer to the line-relay and the local high-resistance circuit therethrough as a "line-relay of high resistance."

It will be seen that my invention provides a great improvement in common-battery-exchange systems, in that talking-current is supplied to the transmitters at the substations through circuits which do not include any switches or contacts controlled by electromagnetic means, or by switches of any kind which are not thoroughly positive and reliable in their operation. It will be seen that positive battery is supplied to the transmitters through a line which is perfectly continuous. Negative battery is supplied

to the transmitters through a line which is continuous except for the contact between the tip of the connecting-plug and the tip-spring of the spring-jack. It is well known that contacts thus made in a spring-jack offer none of the disadvantages associated with the use of connecting mechanism controlled by electromagnetic means. For all practical purposes a connection through a spring-jack is quite as continuous and reliable as though the circuit were through a continuous copper wire. In the same way the contact at the subscriber's switch-hook exchange is actuated by mechanical means made sufficiently positive and reliable in its action to give no difficulty whatever.

In the following claims I refer to a circuit which contains no electromagnetically-controlled switching means and no switching means which are actuated by unreliable mechanical means as a "continuous" circuit and to the lines forming such a circuit as "continuous" lines.

While I have herein shown and described but one embodiment of my invention, it will be apparent to those skilled in the art that many changes and modifications therein might profitably be employed, and 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 multiple-switchboard telephone-exchange system, the combination with a common source of current located at the central exchange, of a continuous line-circuit adapted to supply talking-current to a substation, two-strand-cord connecting apparatus for connecting said line-circuit with another for conversation, a marginally-adjusted cut-off relay serially included in said circuit, and a line-relay normally serially included in said circuit, the connection of said cord connecting apparatus serving to provide a circuit in shunt with said line-relay, said shunt-circuit serving to control the supply of current to the supervisory signaling apparatus, substantially as described.

2. In a telephone-exchange system, the combination with a common source of current located at the central exchange, of a continuous line-circuit adapted to supply talking-current to a substation, two-strand-cord connecting apparatus for connecting said line-circuit with another for conversation, a marginally-adjusted cut-off relay of low resistance serially included in said circuit, and a line-relay normally serially included in said circuit, the connection of said cord connecting apparatus with said line-circuit serving to provide a circuit in shunt of said line-relay, said shunt-circuit serving to control the supply of current to the supervisory signaling apparatus, substantially as described.

3. In a telephone-exchange system, the combination with a common source of current located at the central exchange, of a continuous line-circuit adapted to supply talking-current to a substation, two-strand-cord connecting apparatus for connecting said line-circuit with another for conversation, a marginally-adjusted cut-off relay serially included in said circuit, and a line-relay of high resistance normally serially included in said circuit, the connection of said cord connecting apparatus with said line-circuit serving to provide a circuit in shunt of said line-circuit, said shunt-circuit serving to control the supply of current to the supervisory signaling apparatus, substantially as described.

4. In a telephone-exchange system, the combination with a common source of current located at the central exchange, of a continuous line-circuit adapted to supply talking-current to a substation, two-strand-cord connecting apparatus for connecting said line-circuit with another for conversation, a marginally-adjusted cut-off relay serially included in said circuit, and a line-relay normally serially included in said circuit, the connection of said cord connecting apparatus with said line-circuit serving to provide a circuit of low resistance in shunt of said line-relay, said shunt-circuit serving to control the supply of current to the supervisory signaling apparatus, substantially as described.

5. In a telephone-exchange system, the combination with a common source of current located at the central exchange, of a continuous line-circuit adapted to supply talking-current to a substation, cord connecting apparatus at the central exchange for connecting said line-circuit with another for conversation, a marginally-adjusted cut-off relay of low resistance serially included in said circuit, and a line-relay of high resistance normally serially included in said circuit, the connection of said cord connecting apparatus with said line-circuit serving to provide a circuit of low resistance in shunt of said line-relay, said shunt-circuit serving to control the supply of current to the supervisory signaling apparatus, substantially as described.

In witness whereof I hereunto subscribe my name this 18th day of November, A. D. 1902.

ALFRED STROMBERG.

Witnesses:

CHARLES A. BROWN,

JOHN STAHR.