

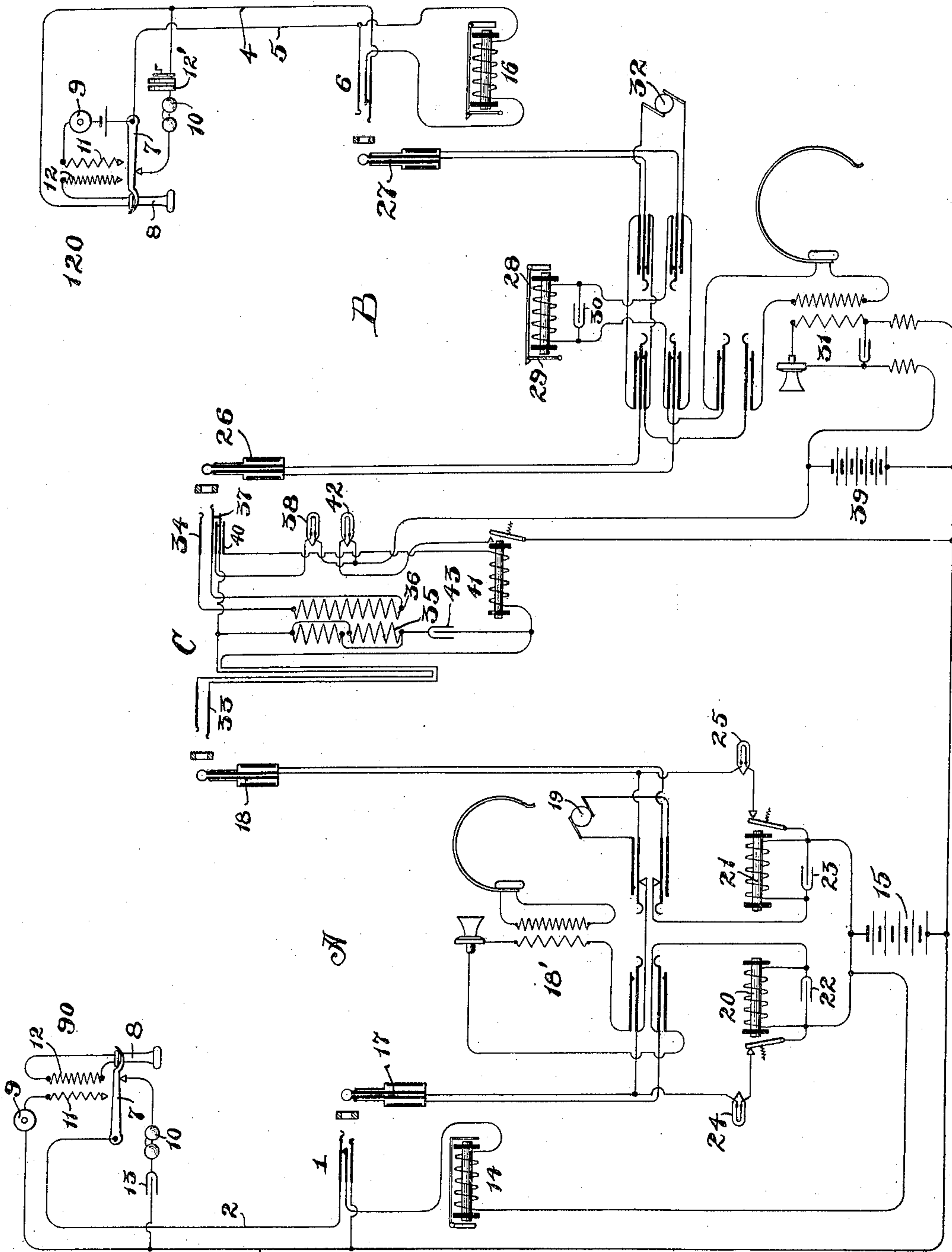
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W. M. DAVIS.  
TELEPHONE EXCHANGE SYSTEM.

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. 770,268, dated September 20, 1904.

Application filed December 2, 1901. Serial No. 84,376. (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 drawings, forming a part of this specification.

My invention relates to telephone-exchange systems, and has for its object the provision of improved signal-controlling means whereby a subscriber may readily indicate to an operator a disconnection.

My invention is more particularly applicable for use in connection with telephone-exchange systems that work in combination with toll-boards and enables the toll operator to effect supervision of all the connections that are established through a main board and a toll-board.

Generally speaking, my invention consists in the employment of a clearing-out or supervisory signal and an electromagnet which is rendered inoperative while the subscriber whose line enters the main board has his telephone off its switch-hook, but which becomes operative when the subscriber restores his telephone to its switch-hook, thereupon indicating to the toll operator that he has restored his receiver. The switchboards are also provided with means whereby the toll operator in effecting a disconnection between the main board and the toll subscriber will operate the clearing-out indicating apparatus at the main board, at which board the main operator finally completes the disconnection.

More specifically, a telephone-exchange system equipped in accordance with my invention may be described as comprising telephone-lines extending from subscribers' stations to a main switchboard, toll-lines extending from toll subscribers to a toll-switchboard, cord connecting apparatus at the main switchboard for connecting any line leading to the

main switchboard with the toll-switchboard, and in the provision of cord connecting apparatus at the toll-switchboard, whereby such connection may be continued through the toll-switchboard to a toll subscriber. The connections that exist between the main switchboard and the toll-switchboard are preferably in the form of trunk-lines, each terminating at both ends in trunk-line jacks, so that ordinary link or cord connecting apparatus may be employed in effecting connection between the main and toll lines. A complete connection thus comprises a main line, a cord-circuit at the main switchboard, a trunk-line between the main switchboard and the toll-switchboard, a cord-circuit at the toll-switchboard, and the toll-line that is connected with the said trunk-line by the cord-circuit at the toll-switchboard.

There is provided a signal appliance whereby the operator at the main switchboard may signify to the toll operator that a connection is desired with a toll-line, which signal is controlled by the toll operator, preferably through the agency of a switch that is added to the toll-line jack, which switch is actuated when the toll operator inserts a plug therein to restore the said signal. The clearing-out indicator that is controlled by the connected main subscriber has its controlling-electromagnet so associated with the composite telephone-circuit that it is deprived of sufficient current for its operation during the time that the main-line subscriber has his telephone removed from its switch-hook. As soon, however, as this telephone is restored this controlling-electromagnet receives sufficient current to effect its operation, and thereby an actuation of the clearing-out signal, which is preferably in the form of an incandescent lamp. If the toll operator has also received a signal to disconnect from the connected toll-line subscriber, the said operator withdraws the plugs from their engaging jacks, thereby effecting or completing the operation of the clearing-out apparatus at the main-line board,



where the operator finally effects a complete disconnection. This controlling-electromagnet is preferably in bridge of the united telephone-lines and in circuit with a common  
 5 battery and is of high resistance—say one thousand ohms—so that when the telephone is off its switch-hook at the calling-subscriber's station this electromagnet is deprived of sufficient current for its operation. When, how-  
 10 ever, the telephone at the main subscriber's station is restored, the branch of low resistance completed thereby is broken, thus removing the low-resistance shunt about the controlling-electromagnet, so that it may operate in the  
 15 manner heretofore specified.

There is another feature of my invention that may enter into the present embodiment thereof or which may be employed in connection with other telephone-exchange sys-  
 20 tems. This feature of the invention relates to clearing-out indicators whereby their connection in telephonic circuits may be greatly facilitated. In practicing this feature of my invention I am enabled to include the clear-  
 25 ing-out indicator serially in a conductor carrying telephonic current by shunting this conductor with a condenser. The winding of the indicator is preferably made of low impedance, so that the condenser and the in-  
 30 dicator are connected in parallel so far as the talking-current is concerned, whereby the condenser may be more effective in eliminating or sufficiently counteracting what impedance remains in the magnet-winding.  
 35 This series-multiple arrangement of the indicator and condenser in a cord-circuit is particularly useful in connection with telephone systems where magneto-generators are employed at the substations for sending clearing-  
 40 out current. The condenser while acting as a good conductor for high-frequency voice-currents presents high impedance to the low-frequency clearing-out current, so that prac-  
 45 tically all of the clearing-out current is selected by the clearing-out indicator, while the path containing the condenser selects a great portion of the high-frequency voice-currents.

I will explain my invention more fully by  
 50 reference to the accompanying drawing, illustrating a composite telephone-exchange system embodying the features of my invention.

In the diagram I have illustrated a single main line, connecting station No. 90 with the  
 55 main exchange A. This telephone-station is connected with the spring-jack 1 at the main exchange by means of a metallic-circuit telephone-line extending by its limbs 2 and 3 to the exchange, the limb 2 being connected with  
 60 the long or sleeve line-spring of the spring-jack, while the limb 3 is connected with the short or tip line-spring of this jack. I have also indicated a toll-subscriber's station No. 120, that extends by its limbs 4 and 5 to a toll-  
 65 switchboard B, constituting a subexchange.

The limb 4 of the telephone-line is shown as being connected with the long or sleeve line-spring of the spring-jack 6, while the limb 5 is shown as being connected with the short or  
 70 tip line-spring of this jack. Each of the telephone-stations 90 and 120 has a gravity switch-hook 7, a receiver 8, adapted to be supported thereby, a transmitter 9, a signal bell or re-  
 75 ceiver 10, and an induction-coil comprising the primary 11 and secondary 12. The switch-hook at either station is adapted to close the bell branch thereat when the telephone-re-  
 80 ceiver is upon its hook, in which position of the switch-hook the telephone appliances are out of service. When the receiver is re-  
 85 moved from its switch-hook, the telephone appliances are brought into circuit, the signal-receivers 10 being excluded from circuit. The substation 90, in this particular instance  
 90 forming a part of a common-battery telephone-exchange system, is not provided with any special signal-current generator at the subscriber's station, while the station 120, which  
 95 need not necessarily form a part of a common-battery system, is provided with a signal-current generator 12', preferably in the form of a magneto-generator. In order to prevent the  
 100 flow of battery over the telephone-line leading to the subscriber's station 90 when the said line is not in use, I connect a condenser 13 in cir-  
 105 cuit with the signal-receiver. The line-indicator of such telephone-lines as that connecting the subscriber's station 90 with the main exchange may be in the form of a visual in-  
 110 dicator 14, that is normally connected with common battery 15. One terminal of the helix of the magnet of this indicator terminates in the back contact to the longer line-  
 115 spring of the spring-jack 1 and is excluded from circuit upon the insertion of a plug that  
 120 separates this back contact from the said spring. The line-indicator 16, connected with the telephone-line extending from the toll-line subscriber, has one terminal in the form  
 125 of a back contact that engages the longer line-spring of the spring-jack 6, so that it may preferably be cut out of the circuit when a connection with this line is established, though  
 130 I do not wish to be limited to this disconnection of the line-indicators employed in connection with toll-lines. As the station 120, connected with the toll-line, is provided with a magneto-generator, the indicator 16 is preferably in the form of an ordinary magneto-  
 135 drop, wherein the shutter is released by the armature-catch when the said magnet is energized by the current emanating from the magneto-generator 12'.

The cord connecting apparatus at the main switchboard A may be of any suitable type.  
 140 That illustrated includes an answering-plug 17 and a connecting-plug 18, united by tip and sleeve strands. There is included in the cord-circuit-switching mechanism whereby  
 145 either the operator's telephone set 18' or the



signaling-generator 19 may be properly included in circuit. The cord-circuit at the main switchboard is in this instance provided with two supervisory relays 20 and 21, included serially in the sleeve-strand and shunted by condensers 22 23. A bridge conductor, including the battery 15, has one terminal connected between the relays 20 and 21, so that the said relays may be independently controlled by the connected substations, assuming that two main lines are connected at the main switchboard or by one substation and a toll operator, as in the present case. The supervisory signal controlled by the magnet 20 is preferably in the form of a small incandescent lamp 24, that is adapted for inclusion in a local circuit that may be traced from the armature of the magnet 20, the contact engaged thereby when the said magnet is de-energized during the presence of the telephone-receiver upon the switch-hook at the substation 90, the lamp 24, the tip-strand and tip of the answering-plug 17, the short line-spring of the spring-jack 1, the battery 15, to the armature of magnet 20. The supervisory signal controlled by the magnet 21 is also preferably in the form of a small incandescent lamp 25, that may similarly include the tip-strand and tip of plug 18, the battery 15, and a conductor connected with the said plug upon its insertion within the jack that completes the local circuit including the said battery. The local circuit that enters into the control of the supervisory signal 25 when connection is established between subscribers connected with main and toll switchboards will be hereinafter set forth. The cord connecting apparatus employed at the toll-switchboard may be of any well-known construction. That illustrated includes an answering-plug 26 and a connecting-plug 27, united by tip and sleeve strands.

My improved clearing-out signaling apparatus comprises an electromagnet 28, that is included serially in one of the cord-strands, in this particular instance the sleeve-strand. This electromagnet may mechanically or electrically control a clearing-out signal. In the present instance it mechanically engages a drop or shutter 29, which is released when said magnet is operated in response to clearing-out current. In order that this clearing-out electromagnet 28 will not render the sleeve-strand opaque to voice-currents, I connect the same in parallel with condenser 30, this condenser being also included in series in the same cord-strand with the winding of the magnet of the clearing-out indicator.

The clearing-out signaling apparatus that I have provided is of particular service in connection with telephone systems where magneto-generators are employed at the substations, as was stated in the preamble, the condenser acting, as heretofore stated, to present high impedance to the low-frequency current

emanating from the magneto-generators, forcing practically all of this current through the indicator, while at the same time affording a suitable shunt about the indicator for the high-frequency voice-currents.

To further improve the transmission of voice-currents, the winding of the magnet 28 is made of low impedance, so that the voice-currents pass through the same and the condenser in parallel. The cord connecting apparatus at the toll-exchange board may also be equipped in the ordinary way with operator's telephone appliance 31 and a calling-generator 32, having the usual keys for controlling their connections. Trunk-lines intervene between the switchboards A and B for connecting subscribers whose lines extend to these exchanges. I have illustrated but one of such trunk-lines at C. This trunk-line terminates at boards A and B in spring-jacks 33 and 34, adapted for connection, respectively, with the plugs 18 and 26. In order that the trunk-line may the better serve in conveying signals between the boards, the jacks 33 and 34 are metallically disconnected during conversation, repeating-coils 35 and 36 in inductive relation directly uniting the main line-springs of the jacks 33 and 34. The jack 34 is provided with a supplemental signal-controlling spring 37, that is connected with the shorter line-spring of the jack 33, and which in engaging its normal contact connects the said shorter line-spring with an indicator 38, it being understood that the spring 37 is in engagement with its normal contact when the plug 26 is not within the jack 34. Assuming that subscriber No. 90 desires communication with subscriber No. 120, the calling subscriber actuates the line-indicator 14 by removing his telephone from its switch-hook. The A-board operator thereupon inserts the answering-plug 17 within the jack of the calling subscriber and ascertaining that this subscriber desires communication with subscriber No. 120 inserts the connecting-plug within the jack 33. By this act the signal 38, which is preferably in the form of a small incandescent lamp, is operated, current being traced from the battery 39 through the said incandescent lamp 38, the spring 37 and its normal contact, the short or tip line-spring of the spring-jack 33, the tip of the plug 18, the tip-strand connecting the tips of plugs 18 and 17, the short line-spring of the spring-jack 1 engaging tip of the plug 17, thence back to the battery 39. The toll-board operator at B in response to the signal of the lamp 38 inserts the plug 26 within the jack 34, thereby separating the spring 37 from its normal contact and bringing it into engagement with its alternate contact 40. This alternate contact constitutes one terminal of a signaling magnet or relay 41, that is preferably of high resistance—say one thousand ohms. The other terminal of this magnet or



relay is preferably the long or sleeve line-spring of the spring-jack 33. Thus when the spring 37 is brought into engagement with its alternate contact 40 the winding of the signal-controlling magnet 41 is included in bridge between the sides of the composite telephone-circuit uniting the subscribers 90 and 120. The battery 15 is also included in bridge between the sides of the telephonic circuit.

When the calling subscriber 90 has his telephone off its switch-hook, the signal-controlling magnet 41 is deprived of the necessary current from the battery 15 by reason of the low-resistance parallel branch closed by the telephone-receiver and including the transmitter with its primary coil at the calling-subscriber's station. When, however, this low-resistance branch is opened upon the restoration of the receiver to its switch-hook, the signal-controlling magnet 41 may receive the necessary quota of current for its operation. The magnet 41 thereupon causes a signal, which is preferably manifested by means of an incandescent lamp 42, that is included in a circuit controlled by the armature of magnet 41, this circuit including the battery 39. I do not wish to be limited, however, to the peculiar nature of the signal controlled by the magnet or relay 41. The toll-board operator before effecting a disconnection in response to the signal conveyed by the lamp 42 awaits the operation of the clearing-out signal 29 by the called subscriber 120. Upon the actuation of both clearing-out signals 42 and 29 the operator at the toll-board withdraws the plugs 26 and 27. The plug 26 having been withdrawn from the jack 34, circuit including the clearing-out signal-controlling magnet 21 is broken, whereupon its armature closes circuit through the clearing-out indicating-lamp 25, which circuit may be traced from the battery 15, the said lamp 25, tip of the plug 18, the tip-line spring of spring-jack 33, the spring 37 at jack 34, the normal contact of the spring 37, the lamp 38, the battery 39, thence back to battery 15. The operator at board A thus has had both clearing-out signals presented to her, the lamp 24 having been previously actuated by the calling subscriber when he restored his switch-hook.

In order that current emanating from battery 15 will not be short-circuited by reason of the direct and closed circuited telephonic connection between the springs of the jack 33, I interpose a condenser 43 in the connection uniting the springs of the said jack.

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

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

1. In a telephone-exchange system, the com-

bination with telephone-lines extending from subscribers' stations to main and sub exchanges, of trunk-lines intervening between the exchanges, cord connecting apparatus at the exchanges for connection with the trunk-lines and with the subscribers' telephone-lines whereby main and sub exchange subscribers may be connected for conversation, an indicator at the subexchange, a switch controlled by the subexchange operator for connecting the magnet of the indicator in bridge between the sides of the composite telephone-circuit established between the main and sub exchange subscribers, and means whereby the magnet of the said indicator may be operated by the main-exchange subscriber, substantially as described.

2. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to main and sub exchanges, of trunk-lines intervening between the exchanges, cord connecting apparatus at the exchanges for connection with the trunk-lines and with the subscribers' telephone-lines, whereby main and sub exchange subscribers may be connected for conversation, an indicator at the subexchange, a switch forming a part of a trunk-line jack at the subexchange operated upon the insertion of the plug within the said jack to connect the magnet of the indicator in bridge between the sides of the composite telephone-circuit established between the main and sub exchange subscribers, and means whereby the magnet of the said indicator may be operated by the main-exchange subscriber, substantially as described.

3. In a telephone-exchange system, the combination with telephone-lines extending from substations to main and sub exchanges, of trunk-lines intervening between the exchanges, cord connecting apparatus at each of the exchanges for uniting the trunk-lines with main and sub exchange subscribers, an indicator at the subexchange whose magnet is connected in bridge of a composite telephone-line, a source of current at the main exchange also connected in bridge of the telephone-line, and means whereby a main subscriber may operate the said indicator, substantially as described.

4. In a telephone-exchange system, the combination with telephone-lines extending from substations to main and sub exchanges, of trunk-lines intervening between the exchanges, cord connecting apparatus at each of the exchanges for uniting the trunk-lines with main and sub exchange subscribers, an indicator at the subexchange whose magnet is of high resistance and is connected with a composite telephone-line, a switch-hook at the substation of the main-exchange subscriber closing the telephone branch thereat upon the removal of the receiver to establish a path of low resistance with respect to the said magnet, and a source of current bridged across the



line adapted for operation of the said magnet upon the replacement of the main-exchange subscriber's receiver upon its switch-hook, substantially as described.

5 5. In a telephone-exchange system, the combination with telephone-lines extending from substations to main and sub exchanges, of trunk-lines intervening between the ex-  
10 changes, cord connecting apparatus at each of the exchanges for uniting the trunk-lines with main and sub exchange subscribers, an indi-  
15 cator at the subexchange whose magnet is of high resistance and is connected in bridge of a composite telephone-line, a switch-hook at the substation of the main-exchange subscriber  
20 closing the telephone branch thereat upon the removal of the receiver to establish a path of low resistance with respect to the said magnet, and a source of current bridged across the  
25 line adapted for operation of the said magnet upon the replacement of the main-exchange subscriber's receiver upon its switch-hook, substantially as described.

6. In a telephone-exchange system, the com-  
25 bination with telephone-lines extending from substations to main and sub exchanges, of trunk-lines intervening between the ex-  
30 changes, cord connecting apparatus at each of the exchanges for uniting the trunk-lines with main and sub exchange subscribers, an indi-  
35 cator at the subexchange whose magnet is of high resistance and is connected in bridge of a composite telephone-line, a switch-hook at the substation of the main-exchange subscriber  
40 closing the telephone branch thereat upon the removal of the receiver to establish a path of low resistance with respect to the said magnet, and a source of current adapted for operation  
45 of the said magnet upon the replacement of the main-exchange subscriber's receiver upon its switch-hook, the said source of current being in parallel with the winding of the said indi-  
cating-magnet and the said telephone branch at the main-exchange subscriber's station, sub-  
stantially as described.

7. In a telephone-exchange system, the combination with a telephone-line extending from  
50 a substation to an exchange, of an indicator having a controlling-magnet of comparatively high resistance in bridge of the telephone-line, a battery in another bridge of the telephone-  
line, the substation branch of the telephone-  
55 line being of comparatively low resistance, and a switch-hook at the substation for closing the telephone branch of comparatively low  
60 resistance thereby to prevent the operation of the said indicating-magnet when the receiver is off its hook and to permit the operation of said magnet when the receiver is on its hook, substantially as described.

8. In a telephone-exchange system, the combination with telephone-lines extending to two  
65 different exchanges, of a trunk-line intervening between the exchanges, cord connecting apparatus at each exchange for connecting the

trunk-line with the telephone-lines, repeating-coils forming the telephonic connection be-  
70 tween the ends of the trunk-line, a source of current at one exchange connected with the sides of telephone-lines thereat, a signal at the second exchange, a jack-switch associated with  
75 the trunk-line at the second exchange serving to cut the said signal out of circuit upon the engagement of a plug therewith, a metallic connection between the said jack-switch and the terminal of the trunk-line at the first board,  
80 a circuit closed upon the establishment of connection between a line at the first board and the end of the trunk-line thereat, said circuit including the said metallic connection, source  
85 of current and the signal whereby the operator at the second exchange may be notified that a connection is desired with one of her subscribers, and a condenser included in circuit with the winding of the repeating-coil that  
unites the portions of the trunk-line extending to the first exchange, whereby short-circuiting of the source of current by the trunk-line is prevented, substantially as described.

9. In a telephone-exchange system, the combination with a telephone-line extending from  
90 a substation to an exchange, of an indicator having a controlling-magnet of comparatively high resistance in bridge of the telephone-line, a battery in another bridge of the telephone-  
95 line, the substation branch of the telephone-line being of comparatively low resistance, and means at the substation for closing said substation branch to prevent operation of said  
100 indicating-magnet, substantially as described.

10. In a telephone-exchange system, the combination with a bimetallic telephone-line  
105 extending from a substation to an exchange, of cord connecting apparatus at the exchange for connecting subscribers for conversation, a source of current bridged across the talking-  
circuit, and a high-resistance supervisory relay connected independently in bridge of said  
talking-circuit, substantially as described.

11. In a telephone-exchange system, the combination with bimetallic telephone-lines  
110 extending from a substation to an exchange, of cord connecting apparatus at the exchange for connecting subscribers for conversation, a source of current bridged across the talk-  
115 ing-circuit, and a high-resistance supervisory relay in an independent bridge connection with the cord-strands, substantially as described.

12. In a telephone-exchange system, the combination with a telephone-line, of substa-  
120 tion apparatus, a source of current and a relay, each connected in an independent bridge of said telephone-line, the resistance of said relay being such that closure of the line  
125 through the substation apparatus prevents operation of said relay by said source, substantially as described.

13. In a telephone-exchange system, the combination with a telephone-line, of substa-  
130



tion apparatus, a source of current and a relay, each connected in an independent bridge of said telephone-line, the resistance of said relay being high and the resistance of said substation apparatus being comparatively low, substantially as described.

14. In a telephone-exchange system, the combination with a source of current, of a telephone-line connected to the terminals of said source, subscriber's substation apparatus connected to said line, and a supervisory relay connected in shunt of said substation apparatus, the resistance of said supervisory relay being such that its actuation is prevented by the conductive continuity of the line-circuit through said substation apparatus, substantially as described.

15. In a telephone-exchange system, the combination with a bimetallic telephone-line extending by its limbs from a substation to an exchange, of a source of current at the exchange in bridge connection with the limbs of said line, two cord-strands at the exchange for

telephonically connecting said line with another for conversation, and a high-resistance supervisory relay connected in bridge of said cord-strands, substantially as described.

16. In a telephone-exchange system, the combination with a telephone-line extending from a substation to an exchange, of a source of current at the exchange connected in bridge of the limbs of said line, two cord-strands at the exchange telephonically connecting said line with another for conversation, a high-resistance supervisory relay in bridge connection with said cord-strands, and means whereby the subscriber at the substation may control the operation of said relay, substantially as described.

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

WILLIAM M. DAVIS.

Witnesses:

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