

A. R. KAHL.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED JAN. 31, 1906.

2 SHEETS—SHEET 1.

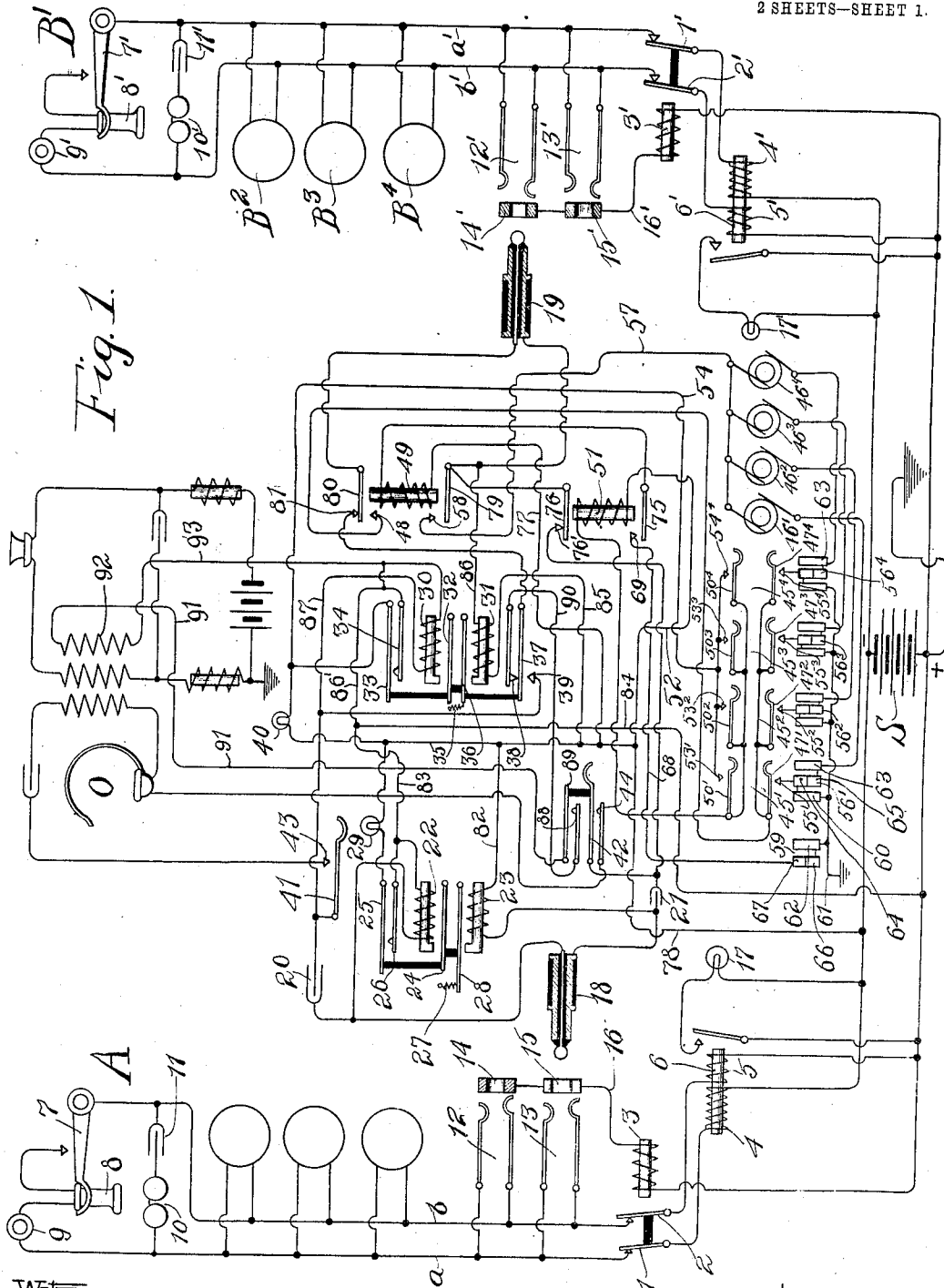


Fig. 1.

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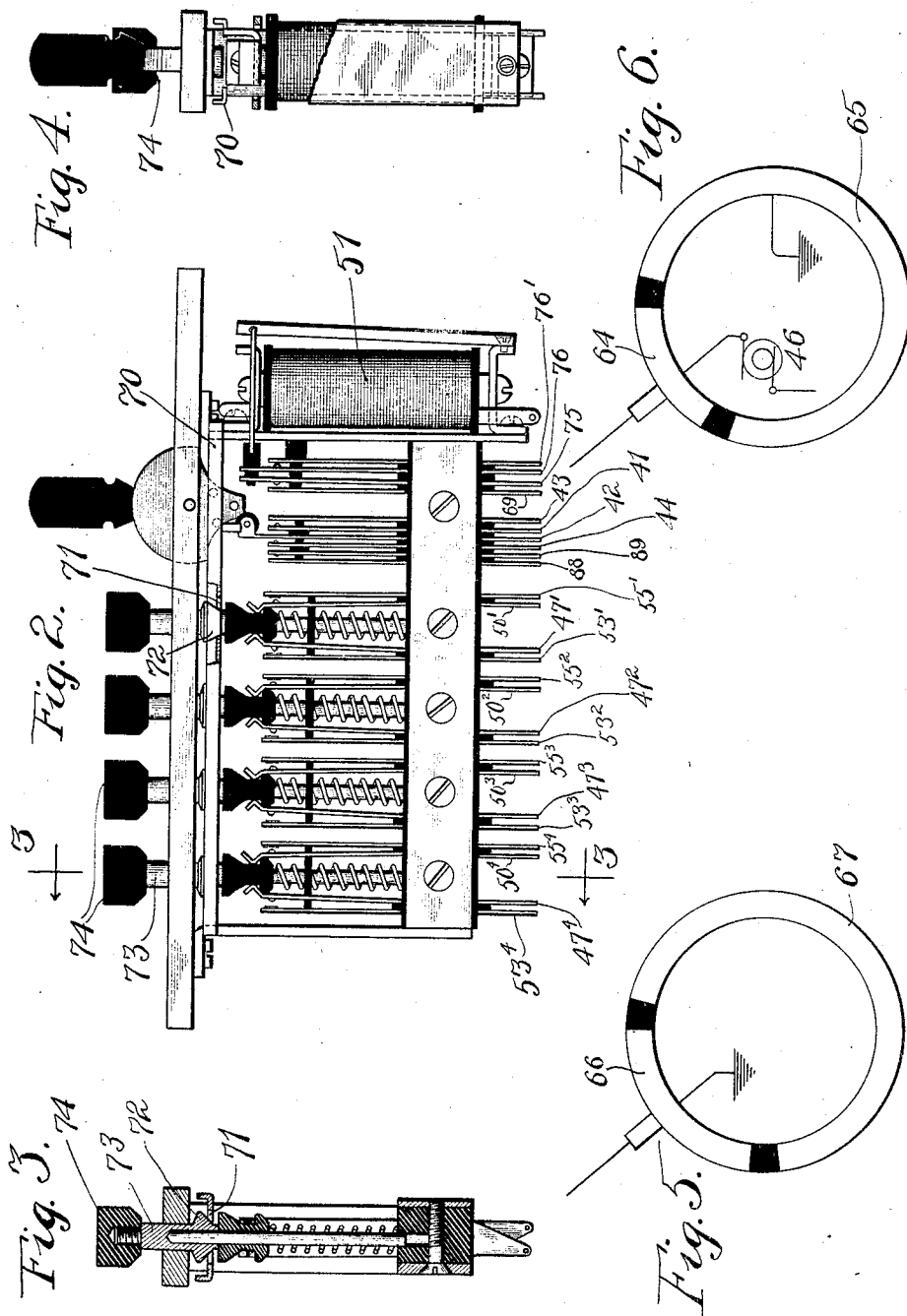


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TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED JAN. 31, 1906.

2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

ARTHUR R. KAHL, OF ROCHESTER, NEW YORK, ASSIGNOR TO STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

No. 853,304.

Specification of Letters Patent.

Patented May 14, 1907.

Application filed January 31, 1906. Serial No. 298,741.

To all whom it may concern:

Be it known that I, ARTHUR R. KAHL, a citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, 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, particularly to automatic selective ringing arrangements therein.

In systems of this kind it is usual to employ a plurality of selective ringing keys connected with selective signaling current sources, locking means being also provided for the keys and controlled by locking relay mechanism, and other relay mechanisms are employed acting in conjunction with the locking relay mechanism, and keys to automatically maintain connection of the ringing current with the called line and to automatically disconnect the ringing current when the called subscriber has answered.

It is the object of my invention to provide improved relations and arrangements for these various automatic mechanisms, and the details of my invention will be best understood by reference to the accompanying drawings, in which

Figure 1 diagrammatically illustrates the arrangements and relations of the parts. Fig. 2 illustrates the mechanical embodiment of the various selective keys and controlling magnet therefor. Fig. 3 is a sectional view on line 3—3 of Fig. 2. Fig. 4 is an end view of the key shown in Fig. 2, and Figs. 5 and 6 diagrammatically illustrate the relation of members of pulsating mechanism.

In Fig. 1 is shown the substation A connected by line limbs *a*, *b* with the central exchange, these line limbs being continuous normally through armatures 1 and 2 of the cut off relay 3 and including the windings 4 and 5 of the indicator relay 6, connecting then with the terminals of the common source of current *S*. At the substation is provided the usual telephonic apparatus comprising a switch hook 7, receiver 8, transmitter 9, signal bells 10 and condenser 11. The multiple springjacks 12 and 13 are connected in bridge of the line limbs, and the

test thimbles 14 and 15 thereof are connected together by conductor 16 which includes the cut-off relay 3 and terminates at the positive pole of battery *S*. Line signal 17 is controlled by the relay 6. The substation B is provided with similar apparatus as substation A, and connects through the line limbs with the central exchange, the cut-off relay mechanism and the connections therefor being the same as those connected with the substation A. The reference characters of the substation telephonic apparatus, line and central station apparatus are primed, however. This line is shown as a party line, and besides the substation B' are shown the substations B², B³ and B⁴.

The cord circuit at the central exchange terminates in the answering plug 18 and the calling plug 19. Condensers 20 and 21 are included in the tip strands of the cord circuit, respectively, to conductively separate the answering and the calling sides thereof. The supervisory relay for the answering side is of the compound type comprising windings 22 and 23. The armature 24 of the winding 22 is mechanically connected with the spring 25, whose tendency is to engage with the contact 26 but prevented from doing so by the action of the spring 27 engaging the armature 28 for the winding 23. The contacts 25 and 26 are in circuit with the supervisory lamp 29. The supervisory relay for the calling side comprises windings 30 and 31. The armature 32 for the winding 30 is mechanically connected with the spring 33, whose tendency is to connect with the contact 34 but prevented from doing so by the force of the spring 35 connected with the armature 36 for the winding 31. This armature 36 is mechanically connected with the contact spring 37 which normally engages the contact 38, and upon energization of the winding being engaged with contact 39. The contacts 33 and 34 control the circuit through the supervisory lamp 40.

The connection with the line of the operator's telephonic apparatus O is controlled by the position of the key springs 41 and 42, this telephonic apparatus being connected with the alternate contacts 43 and 44. The selective automatic ringing apparatus comprises the keys 45¹, 45², 45³, and 45⁴ which are associated the sources 46¹, 46², 46³

of selective ringing current. The actuating springs 47¹, 47², 47³ and 47⁴ are connected together with the alternate contact 48 of the relay 49. The actuating springs 50¹, 50², 50³ and 50⁴ are connected together with one terminal of the relay 51, whose other terminal connects through conductor 52 with the negative side of the common battery. The alternate contacts 53¹, 53², 53³ and 53⁴ of the springs 50¹, 50², 50³ and 50⁴ are connected together and through conductor 54 with the supervisory contact 33. The alternate contacts 55¹, 55², 55³ and 55⁴ for the actuating springs 47¹, 47², 47³ and 47⁴ are connected through interrupters 56¹, 56², 56³ and 56⁴ with one terminal of one of the signaling generators, whose other terminals are connected with the conductor 57 terminating in the alternate contact 58 of the relay 49. An auxiliary interrupter 59 is associated with these other interrupters, being mounted on a common shaft therewith. Each of the interrupters 56¹, 56², 56³ and 56⁴ comprises a ring 60 all connected to the grounded conductor 61 and with the contact ring 62 of the interrupter 59, the ring 63 of the interrupters being connected with the generators, as before stated. A third ring comprising segments 64 and 65 is also provided for each interrupter, the segment 64 being connected with the ring 60 and the segment 65 being connected with the ring 63, this segment 65 being the part of the interrupter connected with the corresponding alternate contact 55¹, 55², 55³ and 55⁴ for the selective key. A ring comprising the insulated segments 66 and 67 is provided for interrupter 59, the segment 66 being connected with ring 62 and thus with ground, while the segment 67 connects through conductor 68 with the contact 69 for the relay 51. This relay 51 is the locking relay and its mechanical association with the selective keys is best shown in Figs. 2, 3 and 4, the reference characters in these figures applied to the various switch springs and contacts corresponding to those shown in the diagrammatic view in Fig. 1. The locking relay, besides controlling the various electrical connections, is mechanically associated with the locking bar or plate 70, this plate being provided with the openings 71 through which may pass the cams 72 carried on the stems 73 of the actuating buttons 74, the arrangement being such that upon depression of a key and subsequent lateral movement of the plate 70 the depressed key will be locked in its depressed position until the relay 51 becomes deenergized. This relay controls the armatures or springs 75 and 76, the springs 75 being connected with one terminal of the relay 49, whose other terminal connects through conductors 77 and 78 with the negative side of the common battery. The armature or spring 76 of relay 51 normally engages its contact 76' to close the

sleeve strand of the calling side of the cord circuit, which sleeve strand is also in contact with armature 79 of the relay 49.

The other armature 80 of this relay connects with the tip strand of the calling side of the cord circuit and the contact 81 for this armature connects with the supervisory relay spring 37.

Having thus described in general the various arrangements and relations of the mechanisms the operation of the system is easily understood. The subscriber at substation A, removing his receiver, causes current flow through the indicating relay to actuate the indicating lamp 17, whereupon the operator inserts plug 18 into one of the spring jacks connected with the calling line, and upon actuation of her key to move the springs 41 and 42 into engagement with the contacts 43 and 44 the telephonic apparatus O is connected in circuit and she ascertains the connection desired. Immediately upon connection of the cord circuit with the calling line the following circuit is closed: negative side of battery S, conductor 78, conductor 82, supervisory winding 23 to the sleeve strand of the answering side through the plug sleeve contact and jack thimble, through conductor 16 and through the cut off relay 3 to the positive side of the battery. The cut off relay, becoming energized, disconnects the relay from circuit and the indicating lamp 17 is extinguished. Current flow through the winding 23 causes attraction of the armature 28 which normally will have a tendency to allow spring 25 to engage contact 26 to cause illumination of the supervisory lamp 29 through the circuit leading from negative side of battery through supervisory lamp 29, contacts 25 and 26 and conductors 83 and 84 to positive side of battery. Circuit, however, is also closed through winding 22 of the supervisory relay through the following path: negative side of battery S, conductor 78, winding 23, sleeve strand and contact through the springjack to line limb b, through the telephonic apparatus at the substation back through limb a, through the springjack to the tip contact and strand of the cord circuit, through conductor 84, winding 22 and conductors 83 and 84 to positive side of battery, the armature 24 being then attracted to prevent engagement of contacts 25 and 26, thus preventing illumination of the supervisory lamp 29. Supposing that the desired connection were with substation B', the operator inserts the calling plug 19 into the springjack, thereby causing closure of a circuit on the negative side of battery S through conductor 78, conductor 85, winding 31 of the supervisory relay, through conductor 86, through sleeve strand and contact on the calling side of the plug circuit, through the engaged jack thimble to the corresponding cut-off relay back to posi-

tive side of battery. The armature 36 being attracted carries the spring 37 into engagement with contact 39 and allows spring 33 to engage contact 34 whereby the supervisory lamp 40 is illuminated through the following circuit: battery S, conductor 78, lamp 40, contacts 33 and 34, conductor 86', through conductor 84 back to battery S. The operator now actuates the corresponding key 45¹ which is connected with the source 46¹ which supplies signaling current to which the bell at substation B' only is responsive. Engagement of actuating spring 50¹ with contact 53¹ causes circuit to be closed through locking relay 51 as follows: battery S, conductor 78, conductor 52, relay 51, spring 50¹ and contact 53¹, conductor 54, contacts 33 and 34 of the supervisory relay and conductors 86' and 84 back to battery. Energization of the relay 51 opens the sleeve strand of the calling side of the cord circuit, while the armature 75 engages the contact 69 to connect the segment 67 of the interrupter 59 with the relay 49. Engagement of the actuating spring 47¹ with the contact 55¹ carries the ringing current to the alternate contacts 48 and 58 of the relay 49, and upon energization of this relay this calling current will pass into the armatures 79 and 80 to be extended to the signal apparatus at the substation B'. Energization of the relay 49, however, takes place only during the time that the segment 66 is in contact with conductor 68 to complete circuit from ground through ring 62 and segment 66, conductor 68, contact 69 and armature 75 of relay 51, through relay 49, conductors 77 and 78 to the negative side of battery, the positive side of the battery being grounded, as shown. The relative dimensions of the segments of the interrupters 59 and 56¹ are shown in Figs. 5 and 6. Grounded segment 66 of the interrupter 59 has a slightly greater length than segment 64 connected with the generator 46¹, and the interrupters travel together with the same shaft. If these segments were of the same length, then when segment 66 connects conductor 68 with ground to cause operation of relay 49, which places the plug cords in the ringing position, segment 64 of the other interrupter will at the same instant connect the ringing current to the line, and when segment 66 opens the ground circuit to release relay 49 the ringing current would also be cut off by segment 64. Upon deenergization of relay 49 the tip strand is continued through armature 80 and contact 81, through contacts 37 and 39, winding 30 of the supervisory relay and through conductors 86 and 84 to the positive grounded side of the battery, and as the sleeve side of the cord circuit when connected with the line has always connection through winding 31 of the supervisory relay and through conductor 78 with the negative side of the battery, the entire charge which the condensers in the telephones and the lines have received will pass through the supervisory winding 30, and as this winding controls the contacts 33 and 34 included in the circuit for relay 51, which in turn controls the circuit through relay 49, the signaling would be seriously interfered with. It is, therefore, necessary to maintain the actuation of relay 51 and relay 49 controlled thereby a sufficient length of time to allow discharge of the line through the ground connection for the signaling current interrupters and this is accomplished by making the segment 66 slightly longer than segment 64, the exact operation of this arrangement being as follows: Suppose that the brushes for the interrupters are respectively at the beginning of the sections 66 and 64. Relay 49 is energized and ringing current at the same time applied to the cord conductors and connected line. After the corresponding brush leaves the section 64, section 66 on account of its greater length still connects with ground and maintains closure of the circuit for relay 49 and the charge retained in the condensers and line is led to ground through the grounded segment 65 of the ringing current interrupter. After the corresponding brush leaves the grounded segment 66 the circuit for relay 49 is opened and the relay deenergized to again complete the tip strand through the winding 30 of the supervisory relay to ground. The line and other circuits are thus entirely relieved of static charges before and after application of ringing impulses thereto. The ringing circuit to signal the subscriber may be traced as follows: from generator 46¹ to interrupter ring 63 and segment 64 to the key 45¹, through contact 48 and armature 80 of the relay 49 to the tip strand plug and spring jack to the line limb a' through the signal bell at substation B' back to the line limb b' through the springjack to sleeve contact of the plug 19 through the sleeve strand, through armature 79 and contact 58 of relay 49 and through conductor 57 to the other terminal of the generator 46¹. When segment 66 becomes disconnected from conductor 68 relay 49 becomes deenergized but on account of the adjustment above described the lines will be free from static charge. The length of such periods of current flow, grounding and interruption can be adjusted to suit the particular conditions.

Upon receiving the signal the called subscriber unhangs his receiver and closes the following circuit: from battery S through conductor 78, winding 31, conductor 86, sleeve strand, plug 19 and engaged springjack through the line and substation back through the springjack and plug to the tip strand, through armature 80, through spring 37 and contact 39 of the supervisory relay, through another part of the sleeve strand, through conductor 87, winding 30, conductor 86' and

through conductor 84 to the other side of the battery. This causes the energization of the armature 32 and the spring 33 is disengaged from the contact 34 to break the circuit through the supervisory lamp 40, thus notifying the operator that substation B' has answered. These contacts 33 and 34, however, were included in the circuit through the locking relay 51 and this relay upon breaking of said contacts becomes deenergized to release the locking plate 71, and consequently the actuated key 45¹, thus immediately causing actuation of the ringing apparatus. The subscribers are now connected for telephonic conversation and upon completion of conversation the receivers are replaced on their hooks to open the circuits through the windings 22 and 30 of the respective supervisory relays, thus allowing contacts 25 and 26 and contacts 33 and 34 to close the circuits through the supervisory lamps 29 and 40, respectively, to indicate to the operator that conversation has been closed, whereupon the operator removes the plugs to restore the apparatus to its normal condition.

The cord circuit may also be provided with a busy test arrangement controlled by the contacts 88 and 89 associated with the spring 42 of the operator's key. Before the calling plug is inserted in the jack the operator applies the tip thereof to the jack thimble and actuates her listening key. If the line is busy current will flow as follows: from negative battery through conductor 78, winding 23 of the supervisory relay connected with the busy cord circuit to the sleeve contact to the engaged thimble, to the tip of the applied testing plug to the tip strand of the testing cord circuit, through armature 80 and contact 81 of the corresponding relay 49, through the contacts 38 of the supervisory relay, through conductor 90, through engaging test contacts 88 and 89, through conductor 91, through the test winding 92, through conductor 93 and through conductors 86 and 84 to the positive side of battery, and the operator will be notified of the busy condition of the line. If the line is not busy this circuit will not be closed through the test winding and the operator connects the calling plug with the jack of the line to be called and then proceeds as hereinbefore described.

The relative arrangement between selective signaling apparatus and the cord circuit, as herein described, has been found to be very efficient and much more so than the arrangement heretofore used, in which both signaling and controlling current passed through a controlling relay which was adjusted to respond only to the direct current and which, consequently, was more or less dependent for its efficiency upon the character of the different currents. I do not wish,

however, to be limited to the exact arrangement and relation of the parts herein shown, as changes may readily be made without departing from the spirit of my invention.

I claim as new and desire to secure by Letters Patent:

1. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, a cord circuit at the central exchange, a source of ringing current at the central exchange normally disconnected from the cord circuit, a relay controlling the connection of said source with the cord circuit, a second relay controlling the circuit for said first relay, and interrupter means in said circuit for periodically causing closure of said circuit to periodically cause action of the first relay to connect the source with the cord circuit and with a line connected therewith.

2. In a telephone exchange system, the combination with a central exchange, of a plurality of substations for connection therewith through telephone lines, a cord circuit at the central exchange, a source of ringing current at the central exchange, a key primarily controlling the current flow from said source, a relay controlling the application of ringing current to the cord strands, a second relay controlling the circuit through said first relay, actuation of the key causing closure of a circuit through said second relay, and interrupter means for the first relay circuit for causing interrupted application of ringing current to the cord strands by the first relay.

3. In a telephone exchange system, the combination with a central exchange, of a plurality of substations for connection therewith through telephone lines, a cord circuit at the central exchange, a source of ringing current at the central exchange, a key primarily controlling the current flow from said source, a relay controlling the application of ringing current to the cord strands, a second relay controlling the circuit through said first relay, actuation of the key causing closure of a circuit through said second relay, interrupter means for the first relay circuit for causing interrupted application of ringing current to the cord strands by the first relay, and means for causing the cord circuit and connected line to be grounded during a short interval before the application thereto of ringing current.

4. In a telephone exchange system, the combination with a central exchange, of a plurality of substations for connection therewith through telephone lines, a cord circuit at the central exchange, a source of ringing current at the central exchange, a key primarily controlling the current flow from said source, a relay controlling the application of ringing current to the cord strands, a second relay controlling the circuit through said first relay, actuation of the key causing closure of

a circuit through said second relay, interrupter means for the first relay circuit for causing interrupted application of ringing current to the cord strands by the first relay, and means for causing the cord circuit and connected line to be grounded during a short interval before and after the application of ringing current thereto.

5. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, a cord circuit at the central exchange for connecting substations together for conversation, a source of ringing current at the central exchange, a key for primarily controlling the flow of current from said source, a relay directly controlling the application of the ringing current to the cord circuit strands, a second relay connected in circuit upon actuation of the key, a circuit for the first relay controlled by said second relay, and interrupter means for interrupting the circuit through the first relay whereby pulsations of ringing current will be applied to the cord circuit and line connected therewith, said second relay being associated with said key to lock said key in its actuated position.

6. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, a cord circuit at the central exchange for connecting substations together for conversation, a source of ringing current at the central exchange, a key for primarily controlling the flow of current from said source, a relay directly controlling the application of the ringing current to the cord circuit strands, a second relay connected in circuit upon actuation of the key, a circuit for the first relay controlled by said second relay, interrupter means for interrupting the circuit through the first relay whereby pulsations of ringing current will be applied to the cord circuit and line connected therewith, said second relay being associated with said key to lock said key in its actuated position, and means upon actuation of substation apparatus in answer to signaling current for causing the circuit through said second relay to be opened whereby said first relay is deenergized to disconnect the ringing current from the cord circuit, deenergization of the second relay causing also release of the actuated key.

7. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit at the central exchange for connecting telephone lines together, a source of signaling current at the exchange, a key primarily controlling the circuit from said source, a relay directly controlling the application of ringing current to the cord circuit and line connected therewith, a second relay controlling the circuit through

said first relay, the circuit through said second relay being normally controlled by said key, said second relay being associated with said key to lock said key in its actuated position, and means upon actuation of substation apparatus in answer to the signaling current for causing the circuit through said second relay to be broken whereby said key is released and the circuit through said first relay broken.

8. In a telephone system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit at the central exchange for connecting subscribers for conversation, a source of ringing current at the central exchange, a relay for controlling the connection of said source with the cord circuit, and a second relay for controlling the circuit through said first relay, each of said relays directly controlling the continuity of the cord circuit.

9. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit at the central exchange, a source of ringing current at the exchange, a relay controlling the connection of the source with the cord circuit, and a second relay controlling the circuit through said first relay and adapted upon energization to close circuit through the first relay whereby said source will be connected with the cord circuit each of said relays directly controlling the continuity of the cord circuit.

10. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, a cord circuit at the central exchange, a source of ringing current at the central exchange normally disconnected from the cord circuit, a relay controlling the connection of said source with the cord circuit, a second relay controlling the circuit for said first relay, and interrupter means in said circuit for periodically causing closure of said circuit to periodically cause action of the first relay to connect the source with the cord circuit and with a line connected therewith, said relay controlling the continuity of the cord circuit.

11. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, a cord circuit and a source of ringing current at the exchange, a source of direct current at the exchange for supplying talking and signaling currents, a relay for controlling the application of ringing current from said source to the cord circuit strands, a second relay controlling the circuit through said first relay, interrupter means for said first relay circuit for periodically interrupting the current flow therethrough, and interrupter means included in the ringing current

circuit adapted to alternately connect with ground and with the source of signaling current, said interrupters acting in harmony whereby the second interrupter will be connected with the source of signaling current during the time that the first interrupter closes circuit through the first relay, and means upon actuation of substation apparatus in response to the ringing current for causing opening of the second relay circuit whereby said first relay becomes inert.

12. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit at the central exchange, a source of signaling current at the central exchange, a relay for controlling the connection of the ringing circuit with the cord strands, interrupter mechanism for periodically closing circuit through said relay whereby signaling current is periodically applied to the cord circuit strands, and means for grounding the line and cord circuit during a short interval before and after each application of ringing current thereto.

13. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit at the central exchange, a source of signaling current at the central exchange, a relay for controlling the connection of the ringing circuit with the cord strands, interrupter mechanism for periodically closing circuit through said relay whereby signaling current is periodically applied to the cord circuit strands, and interrupter means associated with the ringing circuit, said first and second interrupter means acting in harmony and so adjusted that the cord circuit and line connected therewith will be grounded during a short interval immediately before and after the application of ringing current thereto.

14. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit and a source of ringing current at the exchange, a relay controlling the connection of the ringing current circuit with the ringing cord strands, an interrupter controlling the circuit through said relay and adapted during one interval to close circuit through the relay and at another interval to open the circuit there-through, and an interrupter for the ringing current circuit adapted during one interval to connect with ground and during another interval to connect with the source of ringing current, the length of the interval for applying ringing current by the one interrupter being less than the length of the interval of closure of the relay circuit by the other interrupter, whereby the cord strands and line connected therewith will be grounded during

a short interval directly before and after the application of ringing current thereto.

15. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit and a source of ringing current at the exchange, a relay controlling the application of the ringing circuit to the line to be called, an interrupter for controlling the circuit through said relay, said circuit being closed during part of the revolution of the interrupter and opened during the remaining part of the revolution, and an interrupter for the ringing circuit adapted during part of its revolution to connect with ground and during the other part of its revolution to connect with the source of ringing current, the interval of connection with the source of ringing current being slightly less than the interval of closure of the relay circuit, whereby the ground connection will be maintained a slight interval before and after application of ringing current and the connected line therefor grounded before and after receiving charges of ringing current.

16. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit and a source of ringing current at the exchange, a source of direct current at the exchange for supplying talking and signaling currents, a relay controlling the application of ringing circuit to the line to be signaled, a second relay controlling the circuit through said first relay, the circuit through said first relay being closed upon closure of the circuit through said second relay whereby the ringing circuit will be connected with the line, a supervisory relay, and switching means controlled by the supervisory relay and actuated upon actuation of substation apparatus in response to signaling current to open the circuit through said second relay whereby said first relay becomes inert and the ringing current circuit disconnected.

17. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit and a source of ringing current at the exchange, a source of direct current at the exchange for supplying talking and signaling currents, a relay controlling the application of ringing current to the line to be signaled, a second relay controlling the circuit through said first relay, a cut-off relay for the cord circuit closure, the circuit through said second relay causing closure of the circuit through the first relay whereby said first relay will be energized to connect the ringing circuit with the line, a supervisory relay, and switching means controlled by the supervisory relay

and actuated upon actuation of substation apparatus in response to signaling current to open the circuit through said second relay whereby said first relay becomes inert and the ringing current circuit disconnected, said relays jointly controlling the continuity of the cord circuit.

18. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit and a source of ringing current at the central exchange, a source of direct current at the exchange for providing talking and signaling current, a key primarily controlling the ringing circuit, a relay for directly controlling the application of the ringing circuit to the ringing cord circuit strands, a second relay controlling the circuit through said first relay, said second relay being associated with said key to lock said key in its actuated position after actuation thereof, a supervisory relay, said second relay becoming energized upon application of the key whereby the first relay is energized to connect the ringing circuit with the cord strands and line to be called, and switching mechanism controlled by the supervisory relay to open the circuit through the second relay upon actuation of substation apparatus in response to signaling current, deenergization of said second relay causing deenergization of the first relay and causing also release of the locked key.

19. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit and a source of ringing current at the central exchange, a source of direct current at the exchange for providing talking and signaling current, a relay for directly controlling the application of the ringing circuit to the ringing cord circuit strands, a second relay controlling the circuit through said first relay, a key primarily controlling the circuit through said second relay, said second relay being associated with said key to lock said key in its actuated position after actuation thereof, a supervisory relay, said second relay becoming energized upon actuation of said key to closed circuit through the first relay whereby the first relay is energized to connect the ringing circuit with the cord strands and line to be called, and switching mechanism controlled by the supervisory relay to open the circuit through the second relay upon actuation of substation apparatus in response to signaling current, deenergization of said second relay causing deenergization of the first relay and causing also release of the locked key, said relays jointly controlling the continuity of the cord circuit.

20. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit at the cen-

tral exchange, a source of signaling current at the central exchange, a relay for controlling the connection of the ringing circuit with the cord strands, interrupter mechanism for periodically closing a circuit through said relay whereby signaling current is periodically applied to the cord strands, and means for causing the line and circuits to be relieved from charges before and after each application of ringing current.

21. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit at the central exchange, supervisory apparatus for the cord circuit, a source of signaling current at the exchange, a calling plug for the cord circuit, a relay for disconnecting the calling plug from the supervisory apparatus and for connecting said plug with the source of signaling current, means for interrupting the circuit from said source whereby pulsations of ringing current are applied to the line connected with the calling plug, and means for relieving the line from static charges after each pulsation before said relay is restored to its normal position to connect the calling plug with the supervisory apparatus.

22. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit at the central exchange, a source of signaling current, indicating apparatus associated with the cord circuit, a calling side of said cord circuit normally connected with the indicating apparatus, a relay adapted upon actuation to disconnect the calling side of the cord circuit from the indicating apparatus and to connect said calling side with the source of signaling current, interrupter mechanism for causing alternate effective and ineffective periods for the relay whereby the flow of signaling current is caused to be intermittent, and means for connecting the calling side of the cord circuit with ground after each application of ringing current before said relay becomes ineffective whereby the line and calling side of the cord circuit are relieved of static charges before the connection of the calling side with the indicating apparatus.

23. In a telephone exchange system, the combination with a central exchange, of telephone lines leading therefrom and terminating in substations, a cord circuit at the central exchange, a source of signaling current at the exchange, a calling side for the cord circuit normally connected with the remainder of the cord circuit, a relay adapted normally to cause connection of the calling side with the remainder of the cord circuit and adapted when actuated to connect said calling side with a source of signaling current, interrupting means adapted when active to close circuit through said relay to cause actuation

thereof, additional interrupting mechanism
for causing interruptions in the flow of cur-
rent from said signaling source, said inter-
rupting means being adjusted so that cur-
5 rent will flow from said source during the
time that the first interrupting means is ac-
tive, the active period of the first interrupt-
ing means being slightly prolonged for an in-
terval beyond the period of current flow from
10 said source, and means during such interval
for connecting the calling side of the cord cir-

cuit with ground, whereby the connected
lines are relieved of static charges before said
relay becomes inactive to allow reconnection
of the calling side of the cord circuit with the 15
remainder thereof.

In witness whereof, I hereunto subscribe
my name this 27 day of January A. D., 1906.

ARTHUR R. KAHL.

Witnesses:

CHARLES E. HAGUE,
OSCAR M. LEICH.