A. H. DYSON.

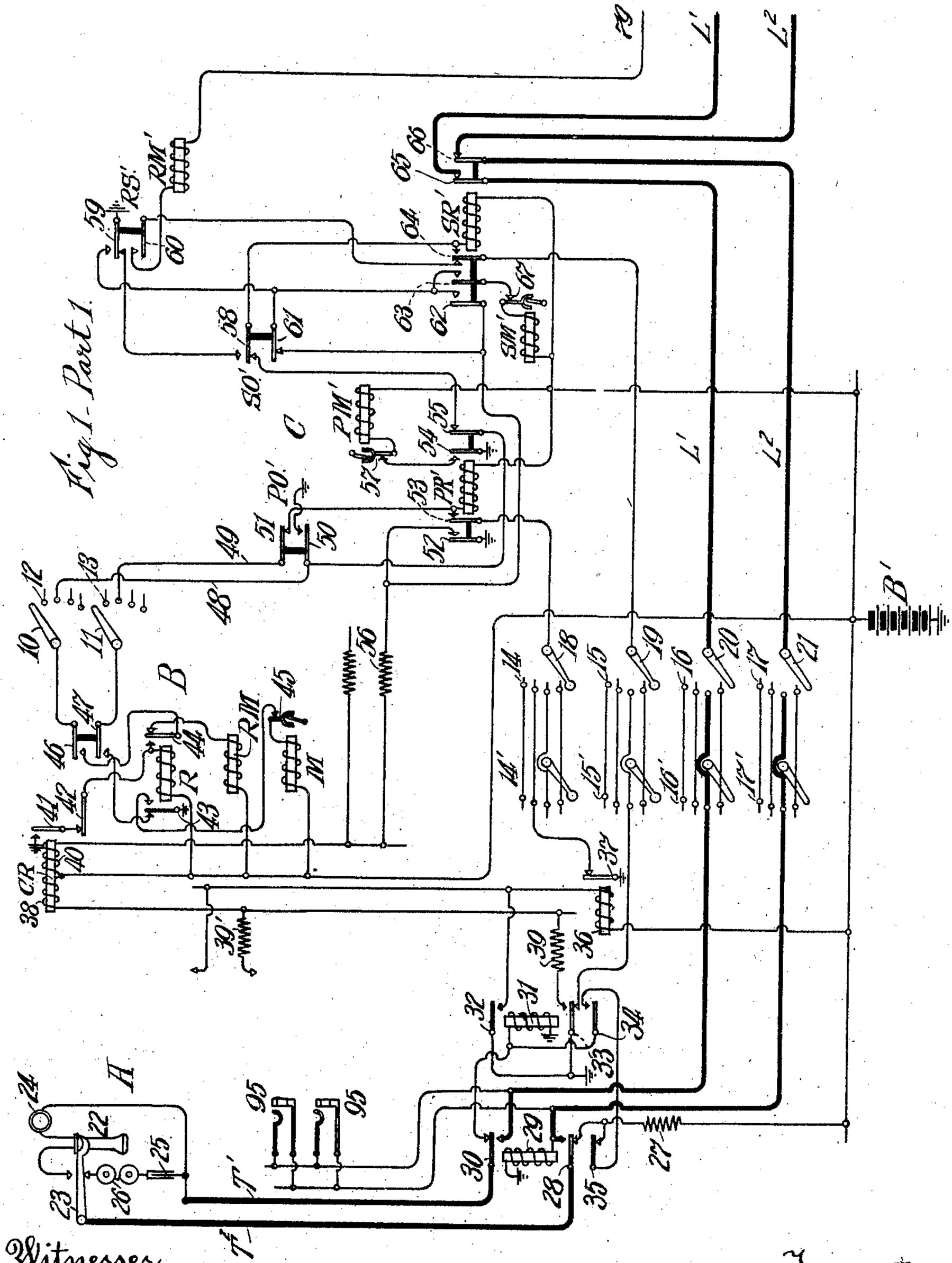
TELEPHONE SYSTEM.

APPLICATION FILED DEC. 4, 1906.

975,338.

Patented Nov. 8, 1910.

4 SHEETS—SHEET 1.



Witnesses

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4 SHEETS—SHEET 2.

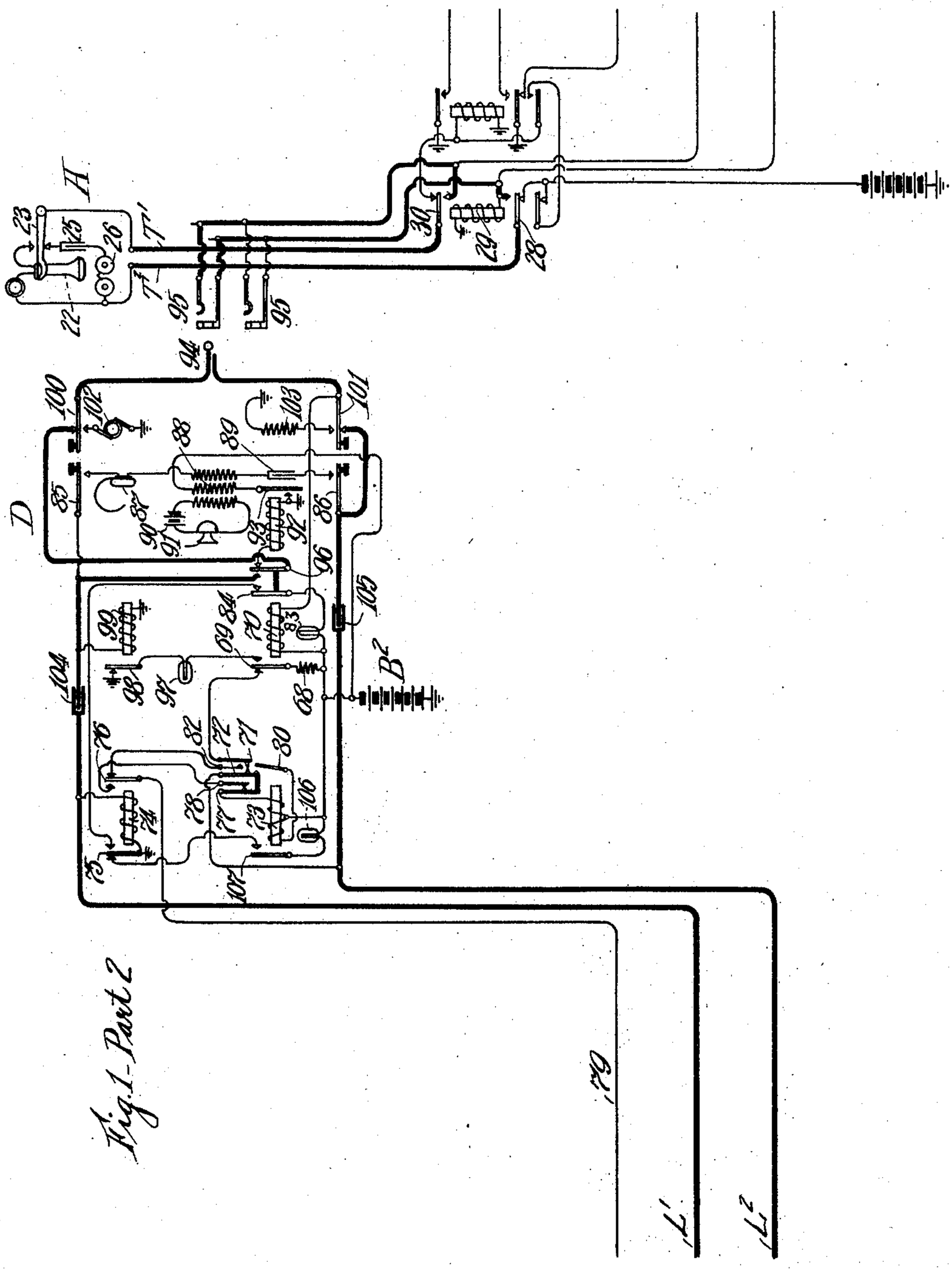

Fig. 1-Part 2

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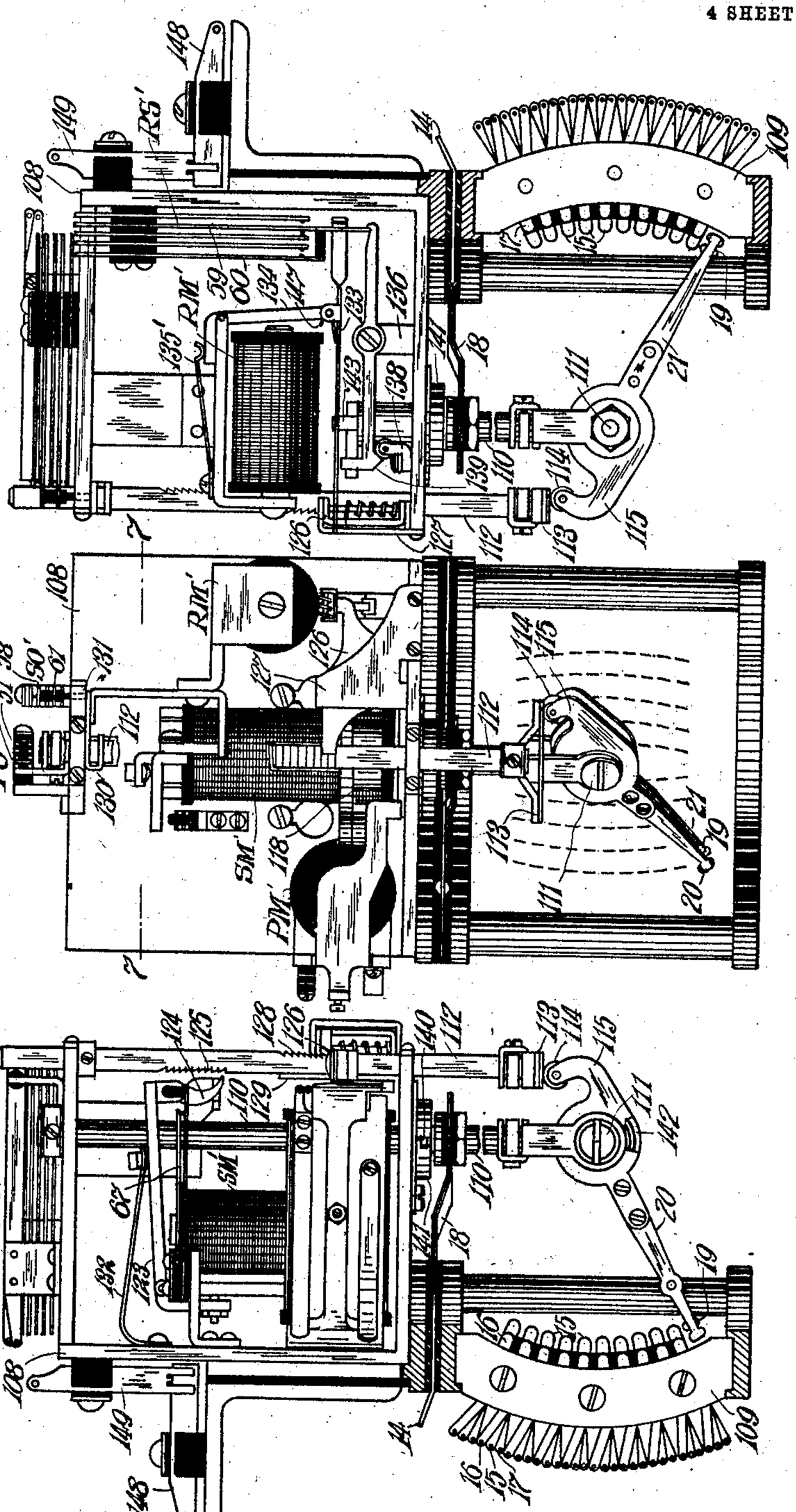
4 SHEETS—SHEET 3.

Fig. 4



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4 SHEETS—SHEET 4.

Fig. 5

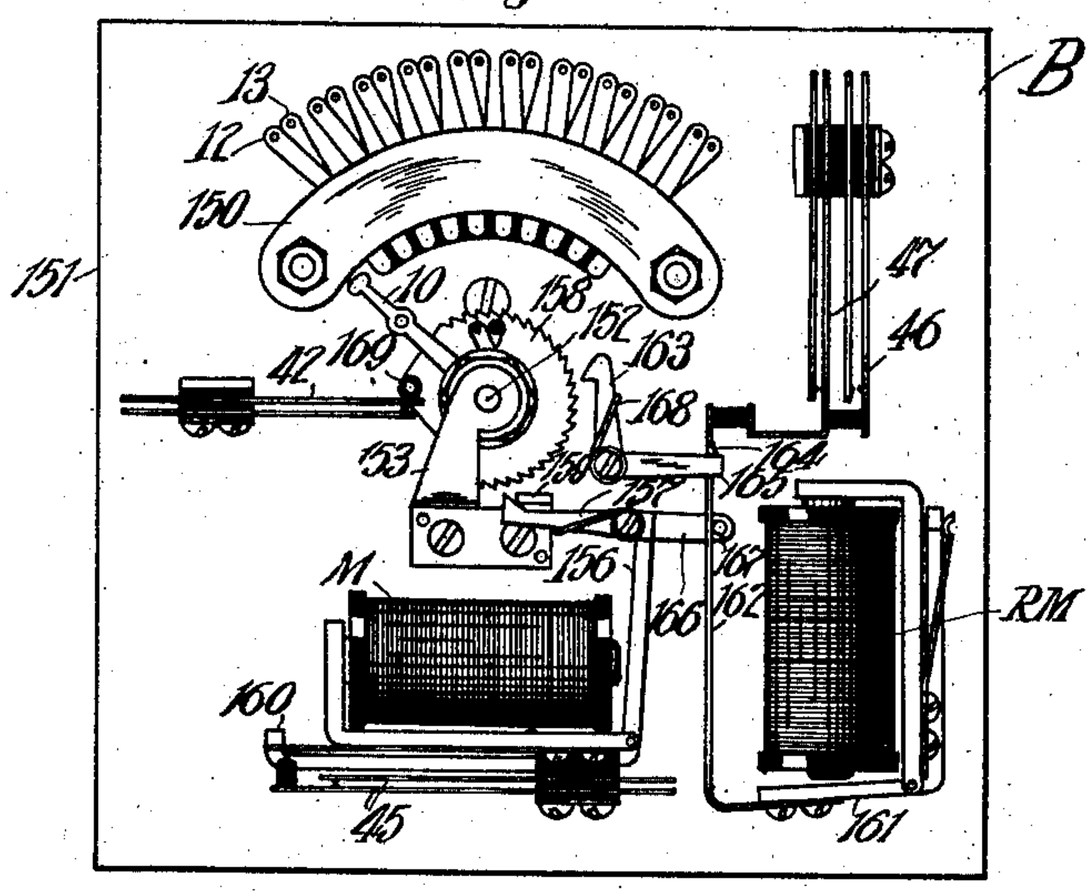


Fig. 6

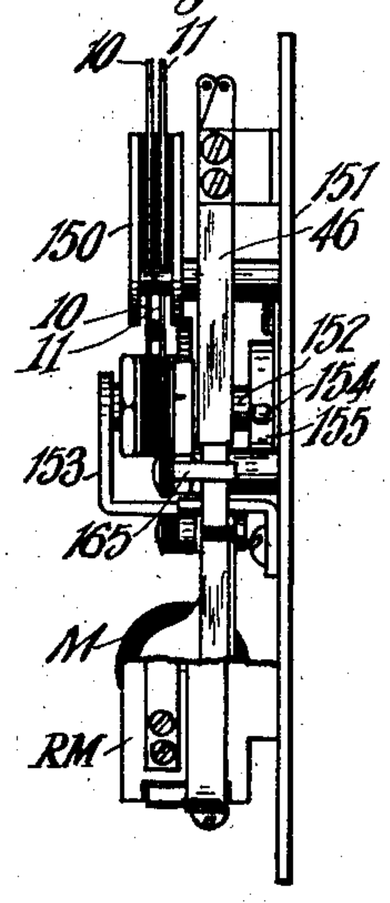


Fig. 7

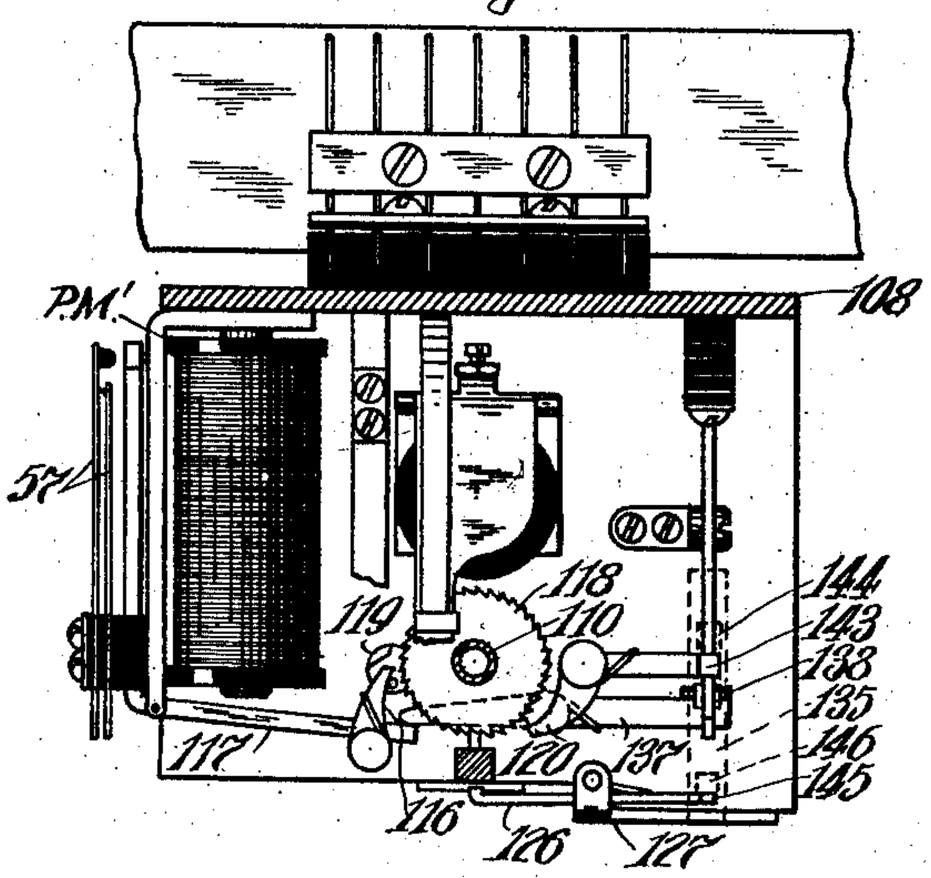
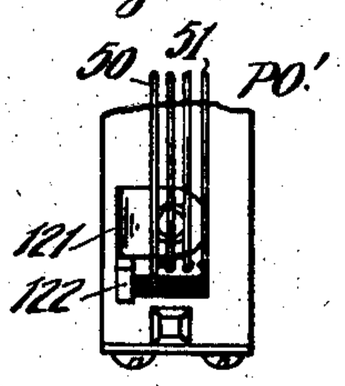


Fig. 8.



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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

975,338. Specification of Letters Patent. **Patented Nov. 8, 1910.**

Application filed December 4, 1906. Serial No. 346,265.

To all whom it may concern:

Be it known that I, ALFRED H. DYSON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented new and useful Improvements in Telephone Systems, of which the following is a specification.

The present invention relates generally to telephone exchange systems of the so-called "automatic" and "semi-automatic" types in which electrically controlled switches are operated in response to the removal of the calling party's receiver from its hook to establish connection between the line of the calling subscriber and any other desired line, and has to do more particularly with that class of automatic systems in which the subscribers' lines are divided into groups and a relatively small number of connecting switches is assigned to each group under the control of a master-switch which, upon the initiation of a call, will start an idle connecting switch to pick out and establish connection with the calling line. In systems of this character heretofore proposed, either the master-switch has been incapable of starting a second selecting switch after a second calling line until the first connecting switch has completed its operation, or, so constructed that when it returns to its normal position after setting a connecting switch in operation, it will, in case said connecting switch had not completed its operation, immediately set a second connecting switch in operation to establish connection with the same calling line. In the former case, much time is lost in making connections, while in the latter case the switches are unnecessarily operated.

One object of the present invention is to provide a novel master-switch mechanism which shall be free from these defects.

The master-switch mechanism herein disclosed will, upon reaching its normal position after having set a connecting switch in operation, immediately set a second switch in operation to establish connection with a second calling line, in case a second call has come in, without waiting for a previously started connecting switch to complete its connection with the first calling line.

My invention also comprises certain novel circuit arrangements and minor details which will, together with the above, be more fully understood upon reference to the following description taken in connection with the accompanying drawing.

Referring to said drawing, Figure 1, which includes parts 1 and 2, is a diagram of a so-called "semi-automatic" system embodying the features of my invention; Figs. 2, 3 and 4 are elevations of the connecting, or line selecting, switch diagrammatically illustrated in Fig. 1, each view being taken from a different side; Figs. 5 and 6 are front and side elevations respectively of the preferred master-switch for controlling the line selecting switches; Fig. 7 is a partial sectional view of a line selecting switch illustrating in plan the primary magnet together with its associated mechanism, the section being taken on a plane indicated by the line 7—7 of Fig. 3; and Fig. 8 is a detail of the off-normal switch associated with said line selecting switch.

Throughout these views, like characters refer to like parts.

Referring to the drawing and more particularly to the diagram of Fig. 1, A designates the substation equipment of two telephone lines which terminate at the exchange in multiple jacks and in multiple contacts of line selecting switches. Connection is obtained between a calling and a called line through the agency of the master-switch mechanism B, the line selecting switches C and the manually operated link-circuit apparatus D. In practice, the subscribers' lines are divided into groups of, say, one hundred, and each group of one hundred lines is provided with ten line selecting switches C under the control of one master, or control, switch B. With this arrangement, each subscriber's line would be multipled to ten line selecting switches. It is of course to be understood that these values may be varied to suit any required condition. Briefly stated, the operation of establishing connection between the calling and the called line involves the following steps: The calling party removes his receiver and thereby, through the agency of the control or master-switch B, sets an idle line selecting switch C into operation to automatically pick out and establish connection with the calling line, thereby extending the calling line circuit to an operator. Thereby a signal is displayed and the operator, in response thereto, after

making the usual busy test of the desired called line, completes the connection or notifies the calling party of the busy condition of the line. During conversation, supervision is had in the usual way; and at its termination, all the parts are restored to normal.

In the particular embodiment of the invention herein presented, the control switch mechanism B comprises a pair of wipers 10—11 coöperating with two sets of bank contacts 12—13, together with a motor magnet M for moving the wipers over their associated bank contacts, a control relay R by which the circuits of the motor magnet are controlled, a release magnet RM by which the wipers are returned to normal, and a differential control relay CR for governing the action of the relay R.

The line selecting switch C comprises the fixed, or bank, contacts 14, 15, 16 and 17 with which the wipers 18, 19, 20 and 21 respectively coöperate in making connection between the link-circuit strands L′—L² and the limbs T′—T² of the calling line. The wipers 19, 20 and 21 are given both a primary movement and a secondary movement in response to the energizations and de-energizations of the primary magnet PM′ and the secondary magnet SM′ respectively. By the primary movement, these wipers are stepped to that group of bank contacts in which the calling line contacts are located; and by the secondary movement, they are moved over the contacts of the selected group until the calling line contacts are encountered. The selection of the group is obtained through the provision of the passive contacts 14, each of which corresponds to a group of bank contacts; and the wiper 18 coöperates with these in selecting the group in which the calling line contacts are located. Normally, the contacts 14 and 15 are grounded; but as soon as a call is initiated, the contact 15, corresponding to the calling line, and the contact 14, corresponding to the group in which the contacts 15 of the calling line are located, have their normal grounds removed. Thus, in the operation of the switch, all the wipers are stepped around until the wiper 18 engages an ungrounded contact 14; then the secondary movement of the wipers 19, 20 and 21 takes place and is continued until the wiper 19 engages the ungrounded contact 15 of the calling line, the wiper 18 not partaking of this secondary movement. As illustrated, the bank contacts 14, 15, 16 and 17 are multipled to the corresponding bank contacts of other line selecting switches in the group. One such set of bank contacts is indicated at 14′, 15′, 16′ and 17′.

The link-circuit equipment D may consist of any preferred apparatus and arrangement of circuits and in the present instance consists in general of a four relay circuit of well known construction.

Considering the operation of the system more in detail, it will be observed that the removal of the receiver 22 from its switch-hook 23 at the substation of the calling party (which may be assumed to be that at the left of the diagram) completes a bridge between the two line limbs T′—T², through the transmitter 24, at the same time interrupting the normally closed bridge between said line limbs, through the condenser 25 and call-bell 26. A circuit is then closed from the live pole of the battery B′, located at the central office, through the protective resistance 27, normal contact 28 of cut-off relay 29, line limb T², switch-hook 23, receiver 22, transmitter 24, line limb T′, normal contact 30 of relay 29 and winding of relay 31 to ground and the return side of the battery B′. The closing of this circuit energizes the relay 31 sufficiently to cause the attraction of its contacts 32, 33, 34. The movement of contact 34 to its closed position completes a locking circuit for the relay 31 which extends from the live pole of the battery B′ through resistance 27, contact 35, closed contact 34 and winding of relay 31 to ground, thereby preventing interference with the energization of said relay from the substation. Contact 32, upon being moved to its closed position, completes a circuit for the control magnet 36, which may be traced from the live pole of the battery B′, through the winding of said magnet and closed contact 32 to ground. Magnet 36 is thereby energized to attract its grounded contact 37 to remove the normal ground from the group contacts 14—14′ corresponding to the calling line. Contacts 15—15′, corresponding to this line, are normally grounded over a path extending through normal contact 33. The movement of the contact 33 to its alternate position upon the energization of relay 31 therefore removes the normal ground from these contacts 15—15′ and also provides a path for current by which the control relay CR of the master-switch mechanism B will be energized. This circuit extends from the live pole of the battery B′ through the winding 38 of said relay, resistance 39 and alternate contact 33 to ground. As illustrated, normally there is no closed circuit including the winding 40 of the control relay CR. Consequently, the completion of the circuit through the winding 38 energizes the said relay sufficiently to move its contact 41 to its closed position, thereby completing a circuit through the winding of the relay R which may be traced from the live pole of the battery B′ through the winding of said relay, closed contact 42 and contact 41 to ground. Relay R is thereby energized and its contacts 43 and 44 moved to their alter-

nate positions. The movement of contact 43 to its alternate position closes a vibratory circuit through the motor magnet M which may be traced from the live pole of the battery B′ through the winding of said magnet, the vibratory contacts 45 and alternate contact 43 to ground. By reason of the mechanical relation of the parts hereinafter more particularly pointed out, the closing of the circuit through the motor magnet M causes the wipers 10—11 to be stepped over their associated bank contacts 12 and 13 respectively. Upon the energization of motor magnet M, contacts 46 and 47 are closed and immediately thereafter contact 42 is opened, so that the circuit for relay R now extends from the winding of said relay through alternate contact 44, closed contact 46, wiper 10 to the engaged contact 12 associated therewith.

The contacts 12 and 13 are connected by conductors 48 and 49 with the circuits of the line selecting switches C. If the line selecting switch, corresponding to the contact 12 first encountered, be busy, its switch contacts 50 and 51 will be in their abnormal positions and the engaged contact 12 will be grounded by way of the closed contact 50. Thus, so long as the wiper 10 engages the contacts 12 associated with busy line selecting switches, a circuit will be maintained through relay R and hence through motor magnet M, and the movement of wipers 10—11 continued. As soon, however, as a contact 12, associated with an idle line selecting switch is encountered, the maintaining circuit for relay R will be interrupted at contact 50 and the wipers 10 and 11 will stop in engagement with contacts 12 and 13 respectively, corresponding to such line selecting switch. As soon as an idle line selecting switch C is thus selected, a circuit will be completed through the winding of its primary relay PR′, which circuit may be traced from the live pole of the battery B′ through the winding of said relay, closed contact 51, engaged contact 13, wiper 11, closed contact 47, normal contact 43 to ground. The energization of the relay PR′ causes the attraction of its contacts 52, 53, 54 and 55. The closing of contact 52 completes a path for current through the winding 40 of the differential control relay CR, through the resistance 56, closed contact 52 to ground. As soon as this takes place, the current flows through the windings 38 and 40 of the control relay are substantially equal in their magnetizing effects; and the armature contact 41 of said relay is allowed to return to its normal position. The equalization of the magnetizing effects is brought about by suitably proportioning the resistances 39 and 56, and other parts included in the parallel grounded branches. The opening of contact 55 opens a possible circuit for the secondary relay SR′, while the closing of the contact 54 completes a vibratory circuit for the primary magnet PM′ which may be traced from the live pole of the battery B′, through the winding of said magnet, the vibratory contacts 57 and closed contact 54 to ground. The repeated energizations and deënergizations of the primary magnet PM′, resulting from the closing of this circuit, cause the wipers 18, 19, 20 and 21 of the line selecting switch to move step-by-step in a primary direction. Upon the first movement of the wipers, the contacts 50 and 51 of the primary off-normal switch PO′ are moved to their abnormal position, and the energizing circuit of the primary relay PR′ is interrupted at contact 51; but a maintaining circuit for this relay is continued from the relay winding through the closed contact 53 to wiper 18.

If the first contact 14, engaged by the wiper 18, be the contact of the group in which the contacts 15, 16 and 17 of the calling line are located, the maintaining circuit will be interrupted at the open contact 37 of the relay 36 associated with the calling line. Under such circumstances, the relay PR′ will be deënergized and the further movement of the wipers in a primary direction discontinued. On the other hand, if the first group contact 14 is not that associated with the calling line, the circuit of the primary relay PR′ will be extended from the wiper 18 through contact 14 and the associated contact 37 of relay 36 to ground. Thus a circuit will be maintained for the primary relay PR′ so long as the wiper 18 passes over grounded contacts 14. As soon, however, as an ungrounded contact is encountered, the movement of the switch wipers in a primary direction will be discontinued, as before indicated. In this connection, it should be noted that the engaging portion of the wipers 18 is of sufficient width to engage a second contact 14 before leaving the first, so that the maintaining circuit of the primary relay is only interrupted at the relay contacts 37. As soon as the line selecting switch has made its first primary movement, a circuit is completed for the release magnet RM of the master-switch mechanism B which may be traced from the live pole of the battery B′, through the winding of said magnet, normal contact 44, closed contact 46, wiper 10, contact 12 and closed contact 50 to ground. The release magnet RM is thereby energized and, due to the mechanical relation of the parts, the contacts 46—47 are restored to their normal positions; and upon its deënergization, due to the breaking of its circuit at contact 46, contact 42 is again closed, and the wipers 10—11 are allowed to return to their normal position under the influence of a retracting spring. Thus it will appear that as soon as

the selected line selecting switch has made its first movement, the master-switch is restored to its normal position and is available for the handling of other incoming calls. For example, if a second call is initiated over a line having access to the master-switch mechanism B, a branch path to ground for the winding 38 of the control relay CR would be completed through the resistance 39′; and then, when the path through the resistance 56 was closed, the magnetizing effects of windings 38 and 40 would still be out of balance, and the armature contact 41 would not return to its open position. Therefore, as soon as the contact 42 was returned to its normal position upon the deënergization of the release magnet RM, the circuit for relay R would be again completed and the wipers 10—11 again set in operation to select a second idle selecting switch to set it in operation to care for the second call. It will also be apparent from the description that in case no second call has been initiated by the time the master-switch is restored to normal, it will not be again set in operation to start a second line selecting switch.

Referring again to the operation of the line selecting switch C, it should be noted that the first primary movement of the switch wipers will be instrumental in moving the contacts 59—60 of the release switch RS′ to their abnormal positions. Therefore, upon the deënergization of primary relay PR′, the grounded branch through the winding 40 of the control relay CR will not be discontinued by reason of the opening of contact 52, but will extend through normal contact 61 of the secondary off-normal switch SO′ and alternate contact 59 of the release switch RS′ to ground. By this means, the balanced condition is maintained in the control relay CR. Upon the deënergization of the primary relay PR′, the maintaining circuit of said relay will be interrupted by the opening of contact 53; the vibratory circuit of the primary magnet PM′ will be interrupted by the opening of contact 54; and by the closing of contact 55, a circuit will be established for the secondary relay SR′. This circuit may be traced from the live pole of the battery B′, through the winding of said relay, closed contacts 58, 55 and 50, to ground. The closing of this circuit will cause the relay SR′ to move its contacts 62, 63, 64, 65 and 66 to their attracted positions. The movement of contacts 65 and 66 interrupts the strands L′—L² of the associated link-circuit and thereby disconnects the wipers 20 and 21 so as to prevent possible interference with conversations existing over the multiples of the contacts over which said wipers pass. The closing of contact 62 provides a path in bridge of contact 61 which is opened upon the first secondary movement of the switch wipers. The closing of contact 63 completes a circuit for the secondary magnet SM′ which extends from the live pole of battery B′ through the winding of said magnet, its vibratory contact 67, closing contacts 63 and 59 to ground. The energization of this magnet, by reason of the vibratory character of its circuit, advances the wipers 19, 20 and 21 one step in a secondary direction, thereby bringing wiper 19 into engagement with the first contact 15 corresponding to the row in which the calling line contacts are located. Since the first primary movement of these wipers causes the contacts of the secondary off-normal switch SO′ to be moved to their abnormal positions, the initial energizing circuit of the secondary relay SR′ is interrupted at contact 58. However, if the first contact 15 engaged by wiper 19 is grounded, a maintaining circuit for the relay SR′ will exist. This circuit extends from the live pole of the battery B′ through the winding of said relay, alternate contact 64, wiper 19, engaged contact 15 and normal contact 33 of relay 31, to ground. Since the ground is removed only from the contact 15 corresponding to the calling line, the secondary movement of the wipers will continue until the wiper 19 engages a contact 15 corresponding to the calling line. When this occurs, the maintaining circuit just traced will be interrupted at contact 33 of the relay 31 of the calling line. Thereupon the circuit for the secondary magnet SM′ will be interrupted at contact 63 and the further movement of the switch wipers in a secondary direction discontinued. As soon as contact 66 closes, a path for current will exist from the battery B² associated with the link-circuit apparatus D, through protective resistance 68, normal contact 69 of supervisory relay 70, contacts 71—72 of supervisory relay 73, link-circuit strand L², wiper 21, contact 17 and the winding of cut-off relay 29 to ground. Relay 29 will thereby be energized to attract its contacts 28, 30 and 35. By the opening of the latter, relay 31 will be deënergized and the parallel path through the winding 38 of relay CR and resistance 39 will be interrupted by the opening of contact 33. At substantially the same time, the parallel path through the other winding 40 of relay CR and resistance 56 will be interrupted at contact 62. If desired, the relay CR may be made slow-acting so as to give sufficient time for the operation of relays 29 and 31 to enable the parallel branches to be simultaneously interrupted. As soon as this interruption takes place, the relay CR is left in a deënergized condition, in so far as the circuits of this particular connection are concerned.

The energization of cut-off relay 29 interrupts the normal control circuit through the

substation and extends the circuit of the line limbs T′—T² to the contacts 16—17 of the selecting switch. As soon as cut-off relay 29 of the calling line is energized, an additional path for current will extend from the closed contact 28 of said relay, over the line limb T², through the substation switch-hook and transmitter, line limb T′, over the tip side of the heavily marked circuit including strand L′, and through the winding of supervisory relay 74 to ground. By the completion of this path in parallel to the winding of the cut-off relay, relay 74 is energized to attract its contacts 75—76. By this movement of contact 76, a path for current is completed from the live pole of battery B² through the right-hand winding of relay 73, contacts 77—78 of said relay, alternate contact 76, conductor 79, release magnet RM′, closed contact 60, normal contact 64, wiper 19, contact 15 and normal contact 33 to ground. The resistances and other characteristics of relays 73 and RM′ are such that the former will be sufficiently energized to attract its contacts, while the latter will not. The attraction of armature contact 80 causes the closing of contacts 80—72, followed by the opening of contacts 77—78 and 71—72, in turn followed by the closing of contacts 71—82. The closing of contacts 80—72 completes a path for current through the left-hand winding of relay 73, contacts 80—72, the sleeve side of the heavily marked circuit, through the winding of cut-off relay 29 to ground, thereby maintaining the relay 73 energized over a circuit independent of that through the calling station. As soon as relay 74 is energized, the movement of its contact 75 will complete a circuit for the calling lamp 83 extending from the live pole of the battery B², through said call lamp, normal contact 84 of relay 70, and alternate contact 75 to ground, thereby causing a display of the call lamp as an indication to the operator that connection is desired. As soon as the operator observes the signal, she will depress her listening-key levers 85—86 to include her telephone set in circuit with the calling line. Any desired operator's set may be employed. In the particular instance illustrated, a receiver 87, a winding of the induction coil 88, and a condenser 89 are adapted to be included in bridge of the link-circuit strands. Another winding of the induction coil 88 is included in a local circuit with the battery 90 and the transmitter 91. The third winding of the induction coil 88 is adapted to be included in a circuit between the live pole of the battery B² and ground upon the energization of test relay 92, which is normally connected to the tip side of the circuit. This ground connection is established to the contact 93 of said relay 92. Upon learning the wishes of the calling party, the operator will test the called-for line by touching the tip of her plug 94 against the sleeve or test contact of a jack 95 connected to said line.

From an inspection of the diagram, it will be seen that the contacts of jacks 95 are connected to the opposite sides of the line circuit upon the selecting switch side of the cut-off relay. Consequently, as soon as current is supplied to the cut-off relay, a potential above that of ground will exist at each of the sleeve contacts of the line with which said relay is associated. Consequently, if the line tested be a busy line, the engagement of the tip of the plug 94 with the sleeve of the jack 95 will result in a flow of current over the tip side of the link-circuit, through normal contact 96 of supervisory relay 70, and the winding of test relay 92 to ground. Relay 92 will thereby be energized momentarily to complete a momentary circuit through the tertiary winding of the induction coil 88 and thereby cause the customary "click" in the operator's receiver as an indication that the line wanted is busy. In such event, the operator will inform the calling party to this effect. If no such indication is obtained, the operator will insert the plug 94 into the tested jack 95. Thereupon a circuit will be completed from the live pole of the battery B² through the winding of supervisory relay 70, plug and jack sleeve contacts and cut-off relay 29 of the called-for line, which may be assumed to be that indicated at the right in Fig. 1. The cut-off relay will thereupon be energized with a consequent disconnection of the called-for line from the associated master-switch mechanism and with the consequent connection of the line limbs with the jack contacts. The energization of supervisory relay 70 will move its contact 69 to complete a circuit through supervisory signal lamp 97 by way of normal contact 98 of tip supervisory relay 99. By the movement of its contact 84, it will also interrupt the circuit of call lamp 83 and cause its extinguishment. Furthermore, the movement of its contact 96 will complete a path in bridge of the listening-key lever 85 and will simultaneously disconnect the test relay 92 from the tip side of the circuit. After inserting the plug 94 into the jack 95 of the called-for line, the operator will depress her ringing-key levers 100—101 and thereby include the generator 102 and resistance 103 in bridge of the link-circuit. With the parts so connected, a circuit for ringing current will extend from the grounded pole of the generator 102, through said generator, ringing-key lever 100, plug and jack tip contacts, alternate contact 30, line limb T′, switch-hook 23, condenser 25, call-bell 26, line limb T², alternate contact 28, jack and plug sleeve contacts, ringing-key lever 101 and resistance 103 to ground. By rea-

son of the character of current supplied by the generator 102, the call-bell 26 of the called-for line will be actuated as a signal to the called-for party. As soon as he responds by the removal of his receiver from its switch-hook, a path for current, in parallel with that through the winding of cut-off relay 29 of the called-for line, will extend from closed contact 28 of said relay, over line limb T^2, through the transmitter and receiver at the substation, line limb T', alternate contact 30, jack and plug tip contacts, the tip side of the link-circuit, through the winding of tip supervisory relay 99 to ground. This will result in energizing said relay sufficiently to open its contact 98 and thereby extinguish supervisory lamp 97. With the parts thus connected for conversation, transmission current will be supplied from battery B^2 to both calling and called-for lines. In the case of the calling line, current will be supplied from the live pole of the battery B^2 through the left-hand winding of relay 73 and contacts 80—72 to the sleeve side of the circuit; and from the grounded pole of battery B^2, through the winding of tip supervisory relay 74 to the tip side of the circuit. The condensers 104—105, included in the tip and sleeve sides of the circuit, conductively divide and inductively unite the adjacent portions of the link-circuit strands.

At the end of conversation, the restoration of the calling party's receiver will be instrumental in interrupting the path for current through the tip supervisory relay 74 and said relay will be deënergized. Upon the retraction of its contact 75, a path for current will exist through supervisory lamp 106, closed contact 107 of relay 73 and normal contact 75 to ground, thereby lighting lamp 106. Likewise, upon the restoration of the called party's receiver to its hook, the branch through the tip supervisory relay 99 will be interrupted and said relay will permit its contact 98 to again close and thereby cause the supervisory lamp 97 to light. The lighting of both lamps 106 and 97 constitutes a signal to the operator to take down the connection. This she does by removing the plug 94 from the jack 95. The supervisory relay 70 and the cut-off relay 29 of the called line are thereupon deënergized. The deënergization of the latter results in establishing the normal line connections and placing the line in condition for further connection as a calling or called line. The deënergization of the former interrupts the energizing circuit of the supervisory lamp 97 and causes its effacement. Since the connection is not taken down until both supervisory lamps 106 and 97 are lighted, the deënergization of relay 70 will also complete a release circuit for the associated selecting switch C. This circuit extends from the live pole of the battery B^2, through protective resistance 68, normal contact 69, contacts 71—82, normal contact 76, conductor 79, winding of release magnet RM', closed contact 60, normal contact 64, wiper 19, contact 15, and normal contact 33 to ground. This causes the energization of release magnet RM'; and by reason of the mechanical relation of the parts, this energization causes a movement of the spring contacts of the release switch RS' to their normal positions, thereby interrupting the energizing circuit of release magnet RM'. When this occurs, the various switch parts are returned to normal. This is accomplished by the mechanical relation of the parts which will hereinafter be more fully explained. During the release, wipers 20, 21 are open circuit at contacts 65, 66, circuit for relay SR' being closed through contact 59 (switch RS' being shifted to normal on energization of magnet RM'), alternate contact 58, relay SR' to battery B'. In this release operation, as soon as the sleeve side of the heavily marked circuit is interrupted at contact 66, the cut-off relay 29 of the calling line and the supervisory relay 73 of the associated link-circuit are deënergized, the former to restore the line connections to normal, and the latter to complete the restoration of the associated link-circuit apparatus to normal. Upon the complete secondary return movement of the wipers of the selecting switch C, the spring contacts of the secondary off-normal switch SO' are returned to normal; and upon the complete restoration of these wipers, the spring contacts of the primary off-normal switch PO' are returned to normal.

Obviously, in carrying out my invention according to the above description, any preferred construction of mechanical switch mechanisms may be employed for accomplishing the various functions therein indicated. However, for this purpose I preferably employ the switches illustrated in Figs. 2 to 8 inclusive.

Referring to Figs. 2, 3, 4, 7 and 8, which illustrate a preferred construction of a line selecting switch C, 108 designates a suitable supporting frame for the switch structure. This structure includes, as previously indicated, the primary magnet PM', secondary magnet SM' and release magnet RM', all suitably carried upon the frame 108. This frame also carries the fixed contacts 15, 16 and 17, which are arranged in a bank 109 with their free ends adapted for the attachment of suitable conductors and with their inner contacting ends terminating in a spherical surface. These contacts are suitably insulated from each other and cooperate with the wipers 19, 20 and 21, which are pivoted at the center of rotation of the spherical surface to the lower end of a ro-

tary shaft 110, suitably journaled in the frame 108. The wipers are rotatable with the shaft in a primary (horizontal) direction and about the pivot 111 at the lower end of the shaft in a secondary (vertical) direction. The secondary movement is accomplished through the agency of a longitudinally movable shaft 112 having a broad foot 113, which engages an anti-friction roller 114, carried on a rearward projection 115 of the wipers. With this arrangement, the wipers may be given primary movement to any desired group of bank contacts and subsequently they may be moved to any desired bank contact in the selected group. The foot 113 at the lower end of the shaft 112 is made sufficiently large to engage the roller 114, no matter what the position of the wipers may be. In addition to the wipers and bank contacts thus provided, the frame 108 also carries a horizontal row of fixed contacts 14, which are arranged above the bank 109 in the arc of a circle in a position to have their inner ends engaged by the wiper 18 carried by, and insulated from, the shaft 110. As will be apparent, the wiper 18 is capable of a horizontal, or primary, movement only and does not partake of the secondary movement of the wipers 19, 20 and 21. The mechanism associated with the primary magnet PM′, by which the shaft 110 is given its primary step-by-step movement, as clearly illustrated in Figs. 3 and 7, comprises an actuating pawl 116, carried by the armature 117 of the magnet PM′, and adapted to engage the teeth of the ratchet wheel 118 to step the shaft 110 around. The pawl 116, which is spring-pressed, coöperates with the beveled stop 119 to give the ratchet wheel 118 a single step upon each energization of the primary magnet. The shaft 110 is retained in its various positions by the retaining pawl 120 which is normally spring-pressed into engagement with the teeth of the ratchet wheel. The upper end of the shaft 110 carries a member 121 having a projection 122 which normally maintains the spring contacts 50 and 51 of the primary off-normal switch PO′ in their normal positions, but which, upon the first movement of the shaft, allows them to move under their inherent tension to their alternate positions. The secondary magnet SM′, through the agency of its armature 123, actuating pawl 124 and the ratchet teeth 125 on the shaft 112, steps the latter downward to carry the contacting ends of the wipers 19, 20 and 21 in a secondary direction to the desired position. A suitable retaining pawl 126, pivotally mounted between the frame 108 and a bracket 127 carried thereby, engages the teeth 128 on the shaft 112 to hold it in its different positions. The shaft 112 is also provided with a suitable spline 129, which, after the first movement of the shaft, engages the teeth of the ratchet wheel 118 to lock the shaft against rotation. By this means further movement of the wipers in a primary direction is prevented as soon as they have begun their movement in a secondary direction. The frame 108 also carries the contacts of the secondary off-normal switch SO′. The contacts 58—61 of this switch are held against their spring tension in their normal positions through the agency of a projection 130 carried by the upper end of the shaft 112. The outer end of this projection normally engages a pin 131, which in turn presses the contact springs 58—61 into their normal positions. The vibratory circuit of the primary magnet PM′ is completed through the contact springs 57 which are actuated by the projecting end of the armature 117. The vibratory circuit of the secondary magnet SM′, is completed through the contact springs 67 carried by the magnet frame and coöperating with the armature 123. This armature as clearly illustrated, is retracted by a suitable leaf spring 132. The frame 108 also carries the contact springs of the release switch RS′. As previously indicated, the contacts 59—60 of this switch have a spring tension tending to hold them in their alternate positions, but are normally held out of such position through the agency of a catch lever 133. Upon the energization of the primary magnet PM′, this catch is disengaged and the springs are allowed to move to their alternate positions. This is brought about through the agency of the armature 117 of the primary magnet and the associated member 137. The member 135 is pivoted at an intermediate point to the lower end of the armature 134 and extends beyond the contact spring 59, and into a position to draw it to its normal position upon the attraction of the armature 134. This armature is retracted by a suitable leaf spring 135′. The catch lever 133, which is pivoted at an intermediate point to the post 136 carried by the frame 108, is moved from its retaining position so as to allow the springs 59—60 of the release switch RS′ to move to their alternate positions upon the first energization of the primary magnet PM′. This is brought about by the lever 137 pivotally supported near its center upon the frame 108, and having one end lying in the path of movement of the armature 117 of the primary magnet. Its opposite end is provided with an upturned projection 138 which bears against the under side of the catch lever 133. Upon lever 137 is rocked about its pivot and its upturned end 138 rides over the inclined surface 139 on the under side of the catch lever 133, so as to rock the latter about its pivot and thereby release the springs 59—60

the first movement of the armature 117, and allow them to move to their alternate positions. As previously indicated, after the wipers have been given their primary and secondary movements, they are retained in position by means of the primary retaining pawl 120 and the secondary retaining pawl 126. In giving the wipers their primary movement, the shaft 112 is rotated against the tension of a spiral spring 140 contained in a suitable case 141 carried by the frame 108. Similarly, in giving the wipers their secondary movement they are rotated against the tension of a spiral spring 142 located about the pivot 111 and cooperating between the lower end of the shaft and said wipers. In view of this, it is therefore only necessary, in order to return the wipers and other switch parts to their normal positions, to disengage the retaining pawls 120—126. As previously indicated, this is brought about upon the deënergization of the release magnet RM'. Upon such release, the retraction of the armature 134 draws the member 135 with it and this member is arranged to engage the retaining pawls at this time, and to move them out of their engaging positions. To this end, the primary retaining pawl 120 is provided with a tail having an upturned end 143 which is adapted to pass through a coöperating opening 144 in the member 135. Similarly, the secondary retaining pawl 126 is provided with a tail having a similar upturned end 145, similarly adapted to pass into an opening 146 in the member 135. Upon the attraction of the release magnet armature 134, the member 135 passes over the upturned ends 143—145 until the openings 144—146 come into registration therewith. The member 135 by the action of its spring 147, moves downward far enough to engage the projecting ends of the pawls. Then upon the retraction of the armature 134, these pawls are moved out of engaging position and through the agency of the springs 140—142 the wipers are returned to their normal positions. As soon as the wipers reach the end of their secondary return movement, the contacts of the secondary off-normal switch SO' return to normal, and, as soon as the wipers reach the end of their primary return movement, the contacts of the primary off-normal switch PO' are returned to normal. For convenience in establishing electrical connection with the various parts of the switch, terminal connecting strips 148—149 are carried by, and suitably insulated from the frame 108.

To provide against the possibility of improper operation of the selecting switches where, as the result of two calls being initiated at practically the same time, the wipers of two switches stop at the same group of bank contacts and begin their secondary movement, (instead of the wipers of one of the switches continuing their primary movement to another group) thereby causing the wipers of two switches to attempt selection of the same calling line, I may employ any desired means, such as having the last contact set 15', 16', 17' a dummy set (*i. e.*, not connected to any line) whereof 15' and 17' would be permanently grounded, while 16' would be on open circuit. In such case wipers 19, 20 and 21, would connect with these contacts on a tenth secondary step and the switch be automatically released as will be evident from the release operations already described.

Referring to Figs. 5 and 6 which illustrate the master-switch mechanism B, it will be observed that the contacts 12—13 are mounted in an arcuate frame 150, suitably carried upon the base 151 and arranged so as to present their contacting ends for engagement with the coöperating wipers 10—11. These contacts are suitably insulated from each other and have their outer ends arranged for the attachment of suitable conductors. The wipers 10—11 are suitably mounted upon, and insulated from the shaft 152 journaled at its opposite ends in the base 151 and in the bracket 153 carried by said base. The wipers are adapted to be moved from their normal non-engaging positions to their various connecting positions by the mechanism of the motor magnet M, and to be returned to their normal positions by a spiral retracting spring 154 located in a suitable casing 155 and coöperating between a fixed point and the shaft 152. The motor magnet M is suitably mounted upon the base 151, and its armature 156 is provided with a suitable driving pawl 157 which is adapted to engage the teeth of a ratchet wheel 158 to cause the rotation of the shaft 152. The pawl 157 is spring pressed toward the ratchet wheel, but when in its retracted position, is withdrawn from engagement by the stop 159 riding upon the adjacent beveled surface of the pawl. This forward stroke is limited by any suitable means as, for instance, by the pawl engaging a portion of the bracket 153. The vibratory circuit of the motor magnet M is completed through the spring contacts 45 carried by the magnet frame and actuated by the projecting end 160 of the armature 156. The base 151 also carries the release magnet RM which has a spring retracted armature 161 provided with a spring extension 162 which coöperates with the retaining pawl 163 and the spring contacts 46—47 which are also suitably mounted upon the base 151. The yielding member 162 is provided with an angular projection 164 which coöperates with a lateral projection 165 carried by the tail of the retaining pawl 163. An extension 166 of the driving pawl 157 is also provided with a lateral projection 167

which engages the right-hand face of the yielding member 162. The arrangement of these parts is such that upon the first attraction of the armature 156, the member 162 is carried toward the left far enough to allow the lateral projection 165 on the pawl 163 to disengage with the shoulder formed by the lower face of the angular projection 164. This results in freeing the pawl 163 and thereby allowing it to move under the force of its spring 168 into position to engage the teeth of the ratchet wheel 158. This movement of the yielding member 162 allows the contact springs 46—47 to close with their coöperating springs. As soon as the retaining pawl 163 is free, its lateral projection 165 engages the outer or right hand face of projection 164 and thereby holds the member 162 far enough to the left to allow the contact springs 46—47 to remain in their contacting position. Thus it will be seen that as soon as the driving pawl 157 has made one stroke, the retaining pawl 163 is free to act and the springs 46—47 are moved to their closed positions. With the parts in this condition, the subsequent attraction of the armature 161 of the release magnet carries the projection 164 far enough to cause its lower face to engage the upper face of the lateral projection 165 on the retaining pawl 163, so that upon the retraction of said armature, the retaining pawl is moved from its engaging position. As soon as the projection 164 passes beyond projection 165 and thereby allows the yielding member 162 to move slightly toward the right, it will be apparent that contact springs 46—47 will be opened. Thus upon the energization of the release magnet RM, contacts 46—47 are opened, and upon the deënergization of said magnet, the retaining pawl 163 disengages the ratchet wheel 158 and allows the wipers 10—11 to return to normal under the retracting action of the spring 154. It should also be noted that as soon as ratchet wheel 158 and shaft 152 begin to rotate, contact 42 is allowed to open since at this time the stop 169 is moved out of engagement with contact spring 42.

Obviously in the practice of my invention many alterations and modifications may be made both in the circuit arrangement and the mechanical structure of the device without departing from the spirit and scope of the invention, thus, for example, the several batteries shown herein as separate and distinct may be one and the same. Other like modifications may be made. I therefore, do not wish to be limited to the specific matter disclosed, but aim to cover by the terms of the appended claims all such alterations and modifications.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A telephone exchange system comprising a plurality of telephone lines, a plurality of selecting switches, each having access to said lines, a master-switch for selecting and starting idle selecting switches to establish connections with calling lines, means for restoring said master-switch to a definite position after each selecting operation, means actuated during the operation of an actuated selecting switch to free said master-switch for further use, and means for permitting the further operation of said master-switch during the use of said actuated selecting switch only in response to an additional call.

2. A telephone exchange system comprising a plurality of telephone lines, a plurality of selecting switches each having access to said lines, a master-switch for selecting and starting idle selecting switches to establish connections with calling lines, means for restoring said master-switch to a definite position after each selecting operation, a control switch associated with each of said lines for causing the operation of said master-switch, means actuated during the operation of any one selecting switch to free said master-switch for further use in selecting and starting a second selecting switch, and means for permitting such further operation of said master-switch during the use of said actuated selecting switch only in response to the manipulation of a second control switch.

3. A telephone exchange system comprising a plurality of telephone lines, a plurality of selecting switches, each having access to said lines, a master-switch for selecting and starting idle selecting switches to establish connections with said lines, means for restoring said master-switch to a definite position after each selecting operation, a plurality of control devices for individually causing the operation of said master-switch, means actuated during the operation of an actuated selecting switch to free said master switch for further use in selecting and starting another selecting switch, and means for permitting such further operation of said master-switch during the use of said actuated selecting switch only in response to the manipulation of a second control device.

4. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting switches, a master-switch for selecting and starting idle ones of said switches, means for restoring said master-switch to a definite position after each selecting operation, a plurality of control devices for individually causing the operation of said master switch, means actuated during the operation of an actuated switch to free said master-switch for further operation in selecting and starting another idle interconnecting switch, and means for permitting such further oper-

ation during the use of said actuated selecting switch only in response to the manipulation of a second control device.

5. A telephone exchange system comprising a plurality of electrically controlled operating devices, a master-switch for selecting and starting idle ones of said devices, means for restoring said master-switch to a definite position after each selecting operation, a plurality of control devices for individually causing the operation of said master-switch, means actuated during the operation of an actuated operating device to free said master-switch for further operation in selecting and starting another idle operating device, and means for permitting such further operation during the use of said actuated operating device only in response to the manipulation of a second control device.

6. A telephone exchange system comprising a plurality of electrically controlled operating devices, a plurality of master-switch passive contacts severally assigned to said operating devices, a coöperating movable contact normally occupying a definite position, means for moving said movable contact over said passive contacts and stopping it in engagement with the passive contact corresponding to an idle one of said operating devices, a plurality of control devices for individually causing the operation of said master-switch, means operated during the operation of any one of said operating devices to return said movable contact to its normal position, and means for preventing another advance of said movable contact during the use of a previously actuated operating device except in response to the actuation of a second control device.

7. A telephone exchange system comprising a plurality of electrically controlled operating devices, a plurality of master-switch passive contacts severally assigned to said operating devices, a coöperating movable contact normally occupying a definite position, means for moving said movable contact over said passive contacts and stopping it in engagement with the passive contact corresponding to the first idle one of said operating devices, a plurality of control devices for individually causing the operation of said master-switch, means operated during the operation of any one of said operating devices to return said movable contact to its normal position, and means for preventing another advance of said movable contact during the use of a previously actuated operating device except in response to the actuation of a second control device.

8. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting switches, a plurality of master-switch passive contacts severally assigned to said switches, a coöperating movable contact normally occupying a definite position, means for moving said movable contact over said passive contacts and stopping it in engagement with the passive contact corresponding to an idle one of said interconnecting switches, a plurality of control devices for individually causing the operation of said master-switch, means operated during the operation of any one of said interconnecting switches to return said movable contact to its normal position, and means for preventing another advance of said movable contact during the use of a previously actuated interconnecting switch except in response to the actuation of a second control device.

9. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting switches, a plurality of master-switch passive contacts severally assigned to said switches, a cooperating movable contact normally occupying a definite position, means for moving said movable contact over said passive contacts and stopping it in engagement with the passive contact corresponding to the first idle one of said interconnecting switches, a plurality of control devices for individually causing the operation of said master-switch, means operated during the operation of any one of said interconnecting switches to return said movable contact to its normal position, and means for preventing another advance of said movable contact during the use of a previously actuated interconnecting switch except in response to the actuation of a second control device.

10. A telephone exchange system comprising a plurality of telephone lines, a plurality of selecting switches each having access to said lines and operative to hunt out and establish connection with calling ones of said lines, a plurality of master-switch passive contacts severally assigned to said switches, a coöperating movable contact normally occupying a definite position, means for moving said movable contact over said passive contacts and stopping it in engagement with the passive contact corresponding to an idle one of said selecting switches, a plurality of control devices for individually causing the operation of said master switch, means operated during the operation of any one of said selecting switches to return said movable contact to its normal position, and means for preventing another advance of said movable contact during the use of a previously actuated interconnecting switch except in response to the actuation of a second control device.

11. A telephone exchange system comprising a plurality of electrically controlled devices, a master-switch for controlling said devices having a normal position and positions corresponding to said devices, control

devices for said master-switch, means responsive to the operation of a control device to cause a movement of said master-switch from its normal position to a position corresponding to an idle device, means actuated thereby to start the operation of said idle operating device, means actuated by the starting of said operating device to restore said master switch to its normal position, a switch contact of said master-switch shifted in response to said starting to render said control device ineffective to reoperate said master-switch.

12. A telephone exchange system comprising a plurality of telephone lines and interconnecting switches, a master-switch for controlling said switches having a normal position and positions corresponding to said switches, control devices for individually operating said master-switch, means responsive to the operation of a control device to cause a movement of the master-switch from its normal position to a position corresponding to an idle interconnecting switch, means actuated thereby to start the operation of said idle interconnecting switch, means actuated by the starting of said interconnecting switch to restore said master-switch to its normal position, a relay for said master-switch, and means for deenergizing said relay by said starting to operatively dissociate said master switch and said control device.

13. A telephone exchange system comprising a plurality of telephone lines, a plurality of selecting switches each having access to said lines, a master-switch for controlling said switches having a normal position and positions corresponding to said switches, control devices for individually operating said master-switch, means responsive to the operation of a control device to cause a movement of the master switch from its normal position to a position corresponding to an idle selecting switch, means actuated thereby to start the operation of said idle selecting switch, means actuated by the starting of said selecting switch to restore said master-switch to its normal position, a relay initially energized responsive to said control device to start said movement of said master-switch, a neutralizing winding therefor, and means controlled by the starting of the idle selecting switch to cause a flow of current through said winding whereby said relay is deënergized.

14. A telephone exchange system comprising telephone lines, a plurality of selecting switches each having access to said lines, a master-switch for starting said switches having a normal position and positions corresponding to each of said switches, means responsive to the initiation of a call to initiate travel of said master-switch to select and start an idle selective switch, a relay of said master-switch controlling said travel, a release magnet for restoring said master-switch, a circuit for said magnet, and a switch contact of said circuit maintained open by said relay during the travel of said switch.

15. A telephone exchange system comprising telephone lines, a plurality of selecting switches each having access to said lines, a master-switch for starting said switches having a normal position and positions corresponding to each of said switches, means responsive to the initiation of a call to initiate travel of said master-switch to select and start an idle selective switch, a relay of said master-switch controlling said travel, a circuit for energizing said relay, a locking switch contact of said relay for holding it energized until said master-switch selects an idle selecting switch, and an off-normal contact of said master-switch actuated on the first step thereof to open the initial energizing circuit of said relay.

16. A telephone exchange system comprising telephone lines, a plurality of selecting switches each having access to said lines, a master-switch for starting said switches having a normal position and positions corresponding to each of said switches, means responsive to the initiation of a call to initiate travel of said master-switch to select and start an idle selective switch, a relay of said master-switch controlling said travel, a circuit for energizing said relay, a locking switch contact of said relay for holding it energized until said master-switch selects an idle selecting switch, an off-normal contact of said master-switch actuated on the first step thereof to open the initial energizing circuit of said relay, a release magnet for restoring said master-switch, a circuit for said magnet, and a switch contact of said circuit maintained open by said relay during the travel of said switch.

17. A telephone exchange system comprising telephone lines, a plurality of selecting switches each having access to said lines, a master-switch for starting said switches having a normal position and positions corresponding to each of said switches, means responsive to the initiation of a call to initiate travel of said master-switch to select and start an idle selective switch, a relay of said master-switch controlling said travel, a circuit for energizing said relay, an off-normal contact of said master-switch actuated on the first step thereof to open the initial energizing circuit of said relay, and a release magnet for restoring said master-switch, a circuit for said magnet, and a switch contact of said circuit maintained open by said relay during the travel of said switch.

18. The combination in a selective switch with an operating relay R, for determining

the travel of said switch, of a release magnet RM for returning said switch to normal, contacts selectable by said switch, means for deënergizing said relay on selection of an idle contact, and an armature switch contact closed on deënergization thereof to energize said release magnet.

In witness whereof, I hereunto subscribe my name this 1st day of December 1906.

ALFRED H. DYSON.

Witnesses:
L. D. KELLOGG,
CAROLYN WEBER.