A. H. DYSON.

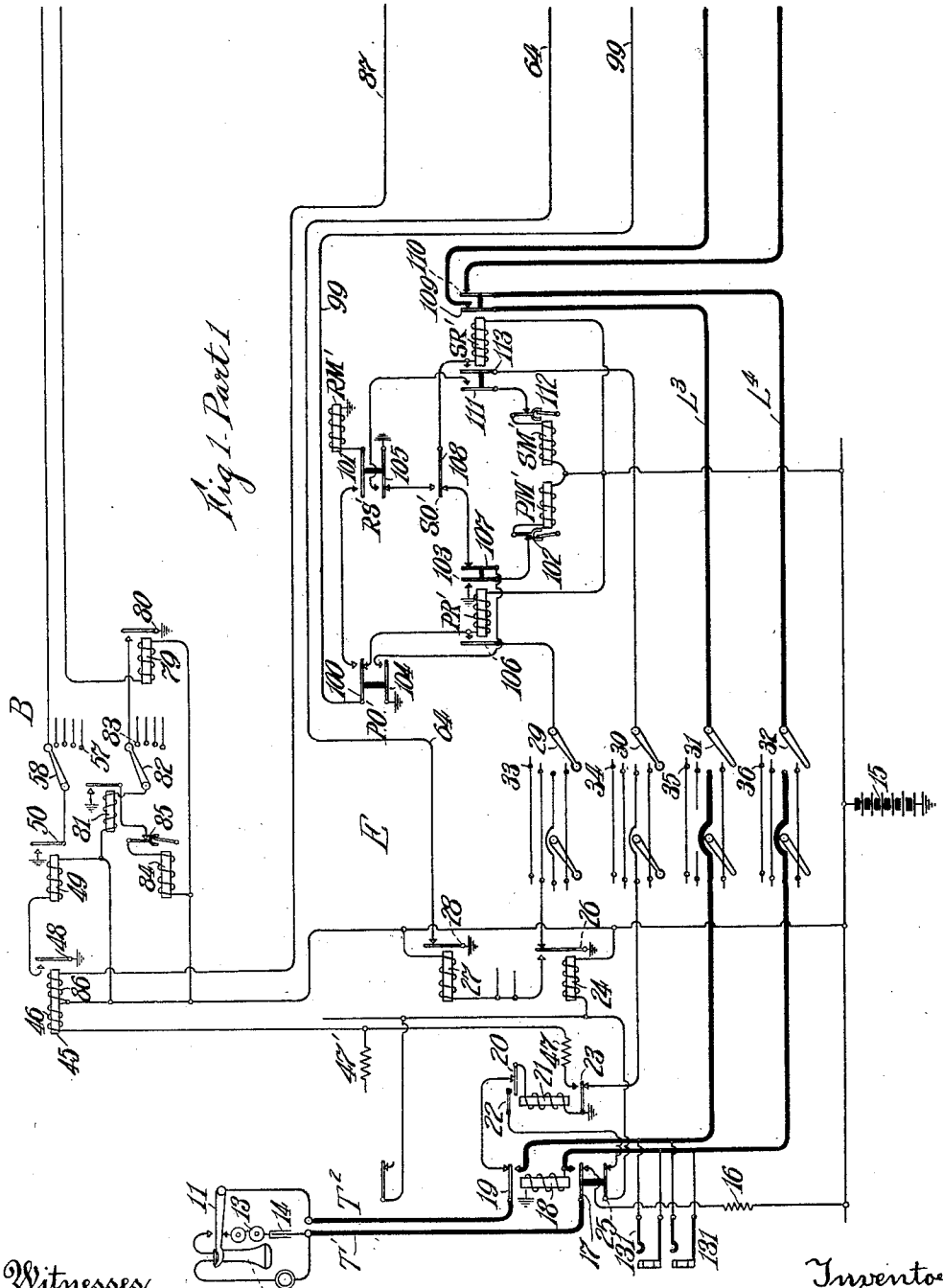
TELEPHONE SYSTEM.

APPLICATION FILED DEC. 4, 1906.

1,097,307.

Patented May 19, 1914.

4 SHEETS—SHEET 1.



Witnesses
H. G. Olmsted.
L. D. Kellogg

Inventor
Alfred H. Dyson
by Thomas H. Ferguson
Atty.

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4 SHEETS—SHEET 2.

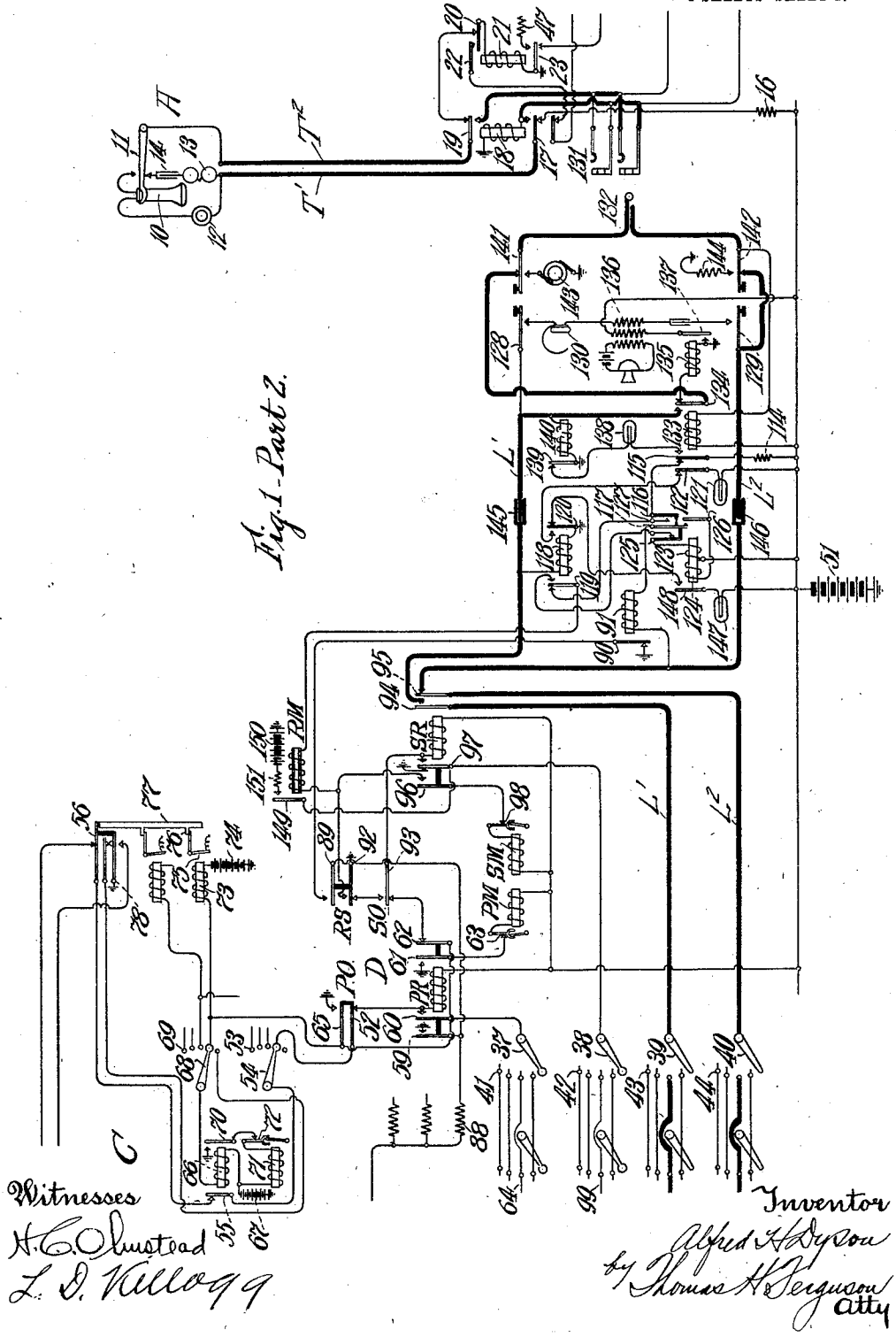

Fig. 1-Part 2.

Witnesses
H. C. Olmstead
L. D. Kellogg

Inventor
Alfred H. Dyson
by Thomas H. Ferguson
Atty

COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

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4 SHEETS—SHEET 3.

Fig. 2.

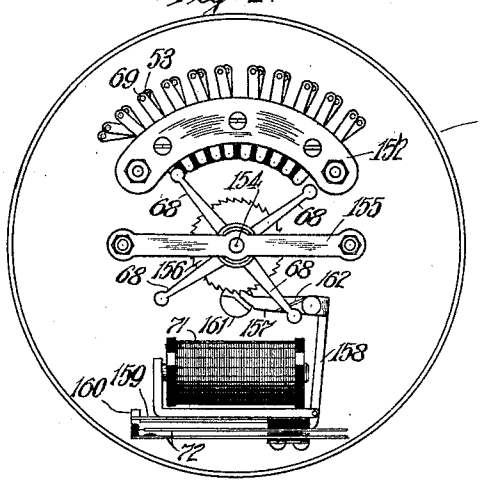


Fig. 3.

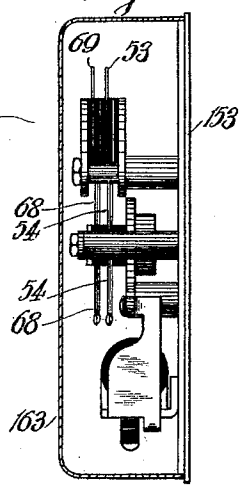


Fig. 4.

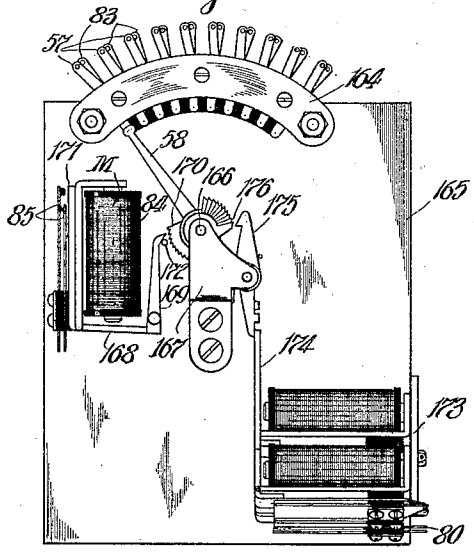
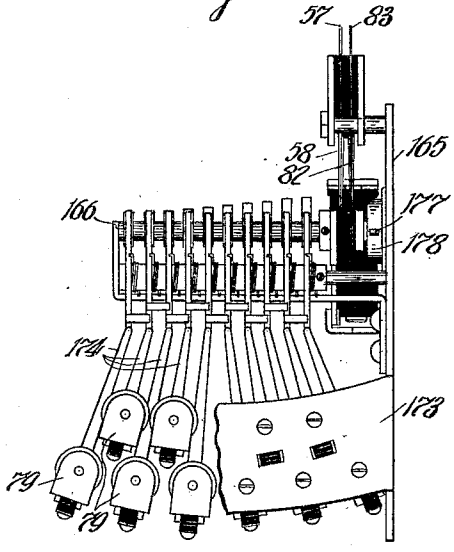


Fig. 5.



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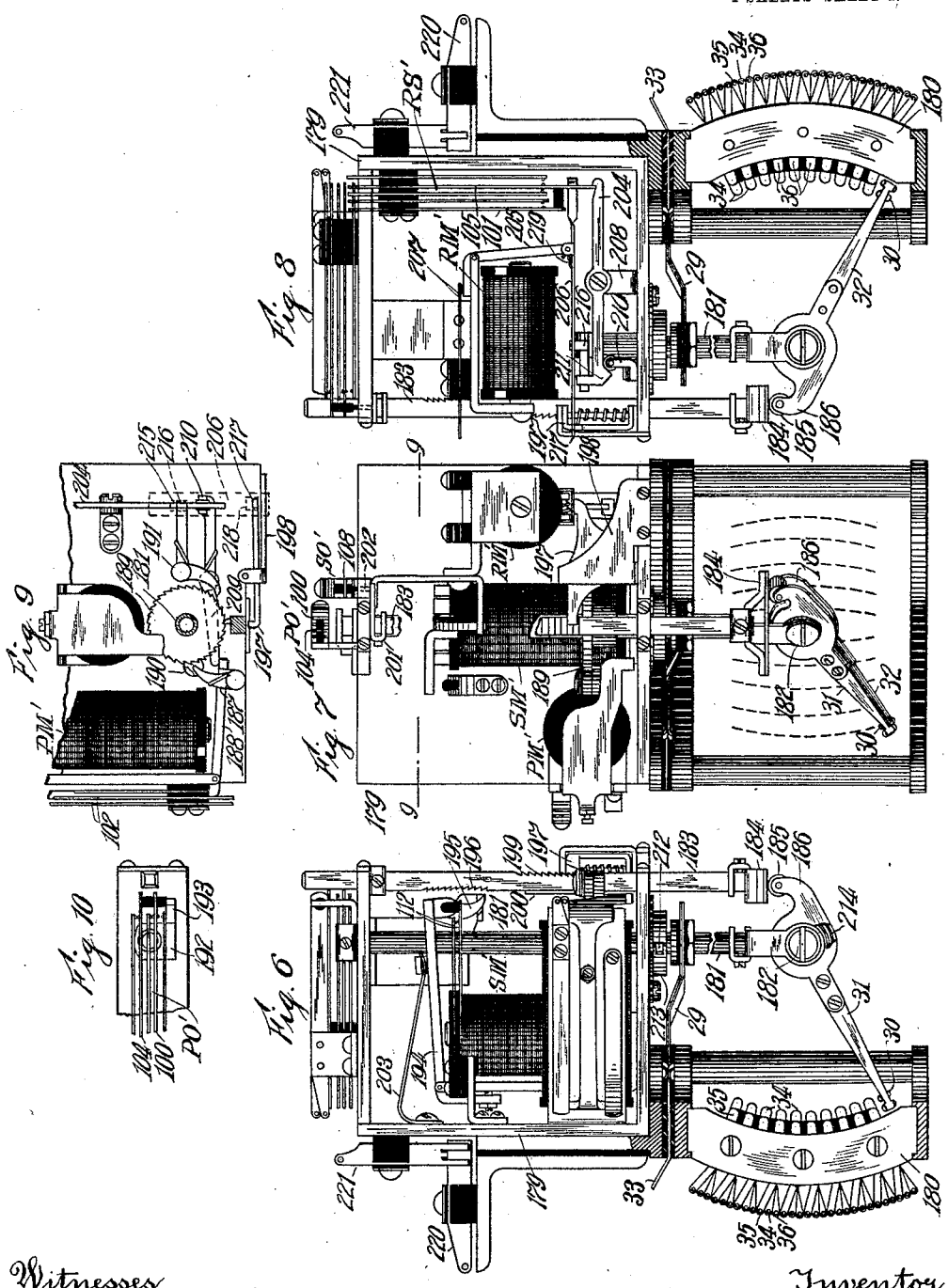
4 SHEETS—SHEET 4.



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L. D. Kellogg

Inventor
Alfred H. Dyson
by Thomas H. Ferguson
Atty

UNITED STATES PATENT OFFICE.

ALFRED H. DYSON, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

1,097,307. Specification of Letters Patent. Patented May 19, 1914.

Application filed December 4, 1906. Serial No. 346,289.

To all whom it may concern:

Be it known that I, ALFRED H. DYSON, a citizen of the United States, and resident of Chicago, county of Cook, and State of Illinois, have invented certain 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 switch-hook to establish connection between the line of the calling party and an idle interconnecting link-circuit and it has to do more particularly with that class of such systems in which the electrically controlled switches are instrumental in extending the circuit of an idle link-circuit by selecting and establishing connection with the calling subscribers' lines in contradistinction to extending the circuit of a calling line by selecting and establishing connection with an idle link-circuit associated with the line.

In systems of the class heretofore proposed, only switches having direct access to the subscribers' lines have been employed in establishing such connections. With such an arrangement, only a very limited number of link-circuits is available to a calling line.

The general object of the present invention is to increase the number of such link-circuits available to any one calling line, while at the same time employing selecting switches which work from the link-circuits toward the subscribers' lines in selecting and establishing connections. This is preferably accomplished by providing means for selecting an idle link-circuit and then extending its circuit back to a calling line through a series of selecting switches. Thus with two one-hundred-point selecting switches in such a series, one hundred link-circuits are made available for connection with one thousand subscribers' lines, while with more switches in the series, more subscribers' lines will have access to the link-circuits. This principle of operation is capable of very wide application, both in automatic and semi-automatic systems, and I do not wish to be unduly limited with respect to the same. In the present case, I have chosen to illustrate this principle in the system of the semi-automatic type, and have shown two selecting switches in the above-mentioned series. One of these which has direct access to the calling lines, I have denominated a "secondary selecting switch;" and the other which has access to these secondary switches, I have termed a "primary selecting switch." These primary and secondary selecting switches are under the control of master-switch mechanism, which in turn comprises a primary switch and a plurality of secondary switches dominated thereby. Preferably, the master-switches normally provide a path for current to an idle primary selecting switch, and as soon as a call is initiated, the particular primary selecting switch in circuit is set in operation to pick out and establish connection with an idle secondary selecting switch having access to the calling line, and the selected secondary selecting switch is thereupon set in operation to seek out and establish connection with the calling line. The master-switches are preferably arranged so that as soon as the selected primary selecting switch is set in operation, a new control path will be established through another, then idle, primary selecting switch. Thus in the application of the invention chosen, on a basis of ten per cent. trunking, there will be, for one hundred link-circuits, one hundred primary selectors, one hundred secondary selectors, ten secondary master-switches and one primary master-switch. With this arrangement, each subscriber's line will be multiply connected to ten secondary selectors; each secondary selector will be multiply connected to one hundred primary selectors; and each primary selector will be arranged for connection with a single link-circuit. Obviously, these figures may be varied as desired to suit other percentages of trunking or affecting conditions.

It will be understood that in developing the invention along the lines indicated, various combinations, sub-combinations, circuit arrangements and details, which are capable of other application than herein disclosed, have been devised. All this will be more fully understood upon reference to the following detailed description and the accompanying drawing which disclose one embodiment of the invention, while the scope of the invention will be particularly pointed out in the appended claims.

Referring to the drawing, Figure 1, which

includes parts 1 and 2 shown on Sheets 1 and 2 and adapted to be placed end to end to complete the figure, is a diagram of a system embodying the preferred form of my invention; Figs. 2 and 3 are front and side elevations, respectively, of a secondary master-switch employed in such a system, the inclosing cover in Fig. 3 being shown in section; Figs. 4 and 5 are similar views of the primary master-switch; Figs. 6, 7 and 8 are elevations of a secondary selector, each viewed from a different side; Fig. 9 is a sectional detail view illustrating the primary magnet of the selector and its associated mechanism, the section being taken on a plane indicated by the line 9—9 of Fig. 7; and Fig. 10 is a detail view of an off-normal switch of said selector.

Throughout these views, like characters refer to like parts.

Referring in detail to the drawing and more particularly to the diagram of Fig. 1, A designates the substation equipment of two lines which terminate at the exchange in the multiple contacts of secondary selectors and in multiple jacks. Connection is obtained between a calling line and a called line through the agency of primary master-switch mechanism B, secondary master-switch mechanism C, primary selectors D, secondary selectors E, an operator's connecting plug and a jack of the called line. As previously indicated, with one thousand subscribers' lines and one hundred operators' link-circuits L'—L^2, there would be one hundred primary selectors D, one hundred link-circuits L^3—L^4, and one hundred secondary selectors E, these figures being based, of course, on ten per cent. trunking.

Briefly stated, connection is established between the calling party at the left in Fig. 1 and an idle operator's link-circuit L'—L^2 in the following manner: The primary and secondary master-switches are normally so positioned that a path for current extends from the primary master-switch to an idle primary selector. As soon, therefore, as the calling party removes his receiver from its switch-hook, the particular primary selector in circuit is set in operation to automatically pick out and establish connection with a link-circuit L^3—L^4 extending to a secondary selector E having access to the calling line; this secondary selector is thereupon set in operation to pick out and establish connection with the calling line. As soon as the primary selector has begun its movement, the primary and secondary master-switch mechanism is operated so as to provide a new path from the primary master-switch to another, then idle, primary selector. A signal is then displayed before the operator, who answers the call in the usual way and completes the connection by means of the manual connecting means under her control.

Briefly stated, the primary master-switch comprises two active contacts which pass over a bank of coöperating passive contacts, which are assigned to different secondary master-switches. Each secondary master-switch comprises similar active and passive contacts, the passive contacts being assigned to different primary selectors. Again, each of the selectors comprises active contacts and a plurality of passive contacts, which in the case of the primary selector are assigned to different secondary selectors; and in the case of the secondary selectors, are assigned to the subscribers' lines. The active contacts, or wipers, of these selectors are given a primary movement in one direction and a secondary movement at an angle thereto. In operation, these wipers are stepped to a definite group of passive or bank contacts and then over the contacts in that group until the desired contact is encountered. Thus in the case of the secondary selector, the wipers are stepped to that group of bank contacts in which the calling line contacts are located, and then they are moved over the contacts of the selected group until the calling line contacts are encountered. In the case of the primary selectors, the wipers are similarly stepped to that group of contacts in which the contacts of secondary selectors having access to the calling line are located, and are then moved over the contacts in that group until the contacts of an idle secondary selector are encountered. This selection both of groups and contacts in the groups is brought about by changing the normal electrical condition of passive contacts corresponding to the groups and the contacts in the groups. This action will be more fully understood from the description hereinafter given.

Considering the operation of these parts more in detail, it will be observed that the removal of the receiver 10 from its switch-hook 11 at the calling substation completes a bridge between the two line limbs T'—T^2 through the transmitter 12 and at the same time interrupts the normally closed bridge through the call-bell 13 and condenser 14. A circuit for battery current is thereupon completed over the line limbs. This circuit extends from the live pole of the battery 15, through the protective resistance 16, normal contact 17 of cut-off relay 18, line limb T', transmitter 12, receiver 10, switch-hook 11, line limb T^2, normal contact 19 of cut-off relay 18, normal contact 20 of relay 21 to the ground or return side of the battery. The closing of this circuit energizes relay 21 to attract its armatures 22—23. The attraction of armature 22 first closes circuit with contact 20 and then causes the latter to interrupt the circuit over the line limbs just traced. The engagement of armature 22 and contact 20 completes a path extending

from the live pole of battery 15, through the winding of relay 24, normal contact 25 of cut-off relay 18, armature 22, contact 20 and winding of relay 21 to ground, thereby providing a maintaining circuit for relay 21 and energizing relay 24 to move its grounded contact 26 to its alternate position. The movement of this contact thereupon completes a circuit for control relay 27 which is in turn energized to open its normally grounded contact 28. This energizing circuit may be traced from the live pole of the battery 15 through the winding of relay 27 and alternate contact 26 to ground. The movements of contacts 23, 26 and 28, each of which is grounded, produce circuit changes which are instrumental in determining the operation of the primary and secondary selectors D and E. The secondary selector's active contacts, or wipers, 29—30—31—32 cooperate with the passive bank contacts 33—34—35—36 respectively, while the active contacts, or wipers 37—38—39—40 of the primary selector coöperate with the passive bank contacts 41—42—43—44 respectively. The wipers 31—32 and their cooperating contacts 35—36 of the secondary selector E, and the corresponding wipers 39—40 and their coöperating contacts 43—44 are instrumental in establishing the talking circuit which is indicated in heavy lines in the diagram. Each of the contacts 33 of the secondary selector corresponds to a row or group of contacts 34 and in operation the wiper 29 partakes of a primary movement only and is advanced until it engages a contact corresponding to the group of contacts 34 in which the calling line contact is located. Thus in operation, wiper 29 passes over contacts 33 until an ungrounded contact is encountered. Thereupon the switch begins its secondary movement and the wiper 30 is carried over its contacts 34 until an ungrounded contact is encountered. Likewise in the case of the primary selector D, the wiper 37 and coöperating contacts 41 determine the group selection, and the wiper 38 and coöperating contacts 42 determine the individual selection. As previously indicated, the contacts 33—34 of the secondary selector, and the contacts 41—42 of the primary selector have their contacts in a given normal electrical condition. In the present instance, the contacts 33—34—41 are normally grounded, while contacts 42 are normally open. Upon the energization of relays 21—24—27 as a result of the initiation of a call, the normal grounds are removed from contact 34 corresponding to the calling line, contact 33 corresponding to the group in which the calling line contact is located, and contact 41 corresponding to the group of secondary selectors having access to the calling line. By this means, the conditions are established for causing the primary selection and stopping of the actuated selectors. Upon the energization of relay 21, a circuit is also completed for the differentially wound control relay 45 associated with the primary master-switch B. This circuit may be traced from the live pole of the battery 15, through the winding 46 of said relay, resistance 47 and alternate contact 23 to ground. The closing of this circuit energizes relay 45 to cause the closing of its grounded contact 48 to thereby complete a circuit from the live pole of battery 15, through the winding of control relay 49 and closed contact 48 to ground. Relay 49 is thereupon energized to close its contact 50 to ground and thereby complete a control circuit extending through the contacts of an associated secondary master-switch and the primary relay PR of the connected primary selector. As will hereinafter more fully appear, the construction and operation of the primary and secondary master-switches B and C are such that they will not come to rest until a path for current extends from the primary master-switch through the primary relay of an idle primary selector. This path is normally open at contact 50 and may be traced from the live pole of the battery 51, through the winding of primary relay PR, normal contact 52 of the primary off-normal switch PO of the primary selector D, engaged passive contact 53 of the secondary master-switch C, its wiper 54, normal contact 55, normal contact 56, engaged contact 57 of primary master-switch B, its wiper 58 to contact 50. As soon as this circuit is completed to ground at contact 50, primary relay PR is energized to close its contacts 59—60—61 and to open its contact 62. The closing of contact 61 completes a circuit for the primary magnet PM.

By reason of the vibratory character of the circuit which is alternately made and broken at contacts 63, and the mechanical relation of the parts which will be hereinafter more fully pointed out, the magnet PM is repeatedly energized and deënergized to step the wipers 37—38—39—40 in a primary direction. As soon as the first step has been taken, a maintaining circuit for the primary relay PR is completed from the live pole of the battery 51, through the winding of said relay, closed contact 60, wiper 37, contact 41, conductor 64 to ground at 28. In case the first contact 41 encountered is not grounded, the relay PR will be deënergized with a consequent interruption of the circuit of the primary magnet PM, and the primary movement of the switch wipers will be discontinued. If the first contact 41 encountered be grounded, the wiper 37 will continue its step-by-step movement until an ungrounded contact is met, whereupon the further movement of the switch in a primary direction will cease.

Upon the first primary movement of the selector D, the contacts 52—65 of its primary off-normal switch PO will be respectively opened and grounded. By the opening of contact 52, the initial energizing circuit for relay PR will be interrupted. By the grounding of contact 65, a circuit will be completed for the control relay 66 of the secondary master-switch C. This circuit will extend from the battery 67 through the winding of said relay, wiper 68, engaged contact 69, and contact 65 to ground. The closing of this circiut will energize relay 66 to close its contact 70 to thereby include motor magnet 71 of the switch C in a vibratory circuit adapted to be interrupted at contacts 72. The automatic energizations and deënergizations of this magnet will, by reason of the mechanical relation of the parts, cause the wipers 54 and 68 to move into engagement with the next pair of contacts 53—69. If the contact 69 thus engaged be associated with the busy primary selector D, said contact will be grounded by way of the primary off-normal switch contact 65 of said selector, and the circiut of relay 66 will be maintained. As soon as a contact 69, corresponding to an idle primary selector, is encountered, the maintaining circuit for the relay 66 will be interrupted; and by reason of the retraction of its armature 70, the circuit of motor magnet 71 will be broken and the further movement of the wipers 54 and 68 discontinued. It will be observed that there is a control relay 73 for each of the contacts 69 and these are individually energized as soon as the corresponding primary selector is set in operation. This energizing circuit extends from the live pole of the battery 74 through the winding of said relay and contact 65 of the corresponding primary selector to ground. The energization of this relay attracts its spring-retracted armature 75 and thereby removes an engaging portion of said armature out of engagement with a coöperating shoulder 76 on a longitudinally movable bar 77. This bar is secured to the end of the contact-spring 56, and when all of the armatures 75 have been attracted, the bar 77 is moved under the inherent tension of the spring 56 so as to change the circuit relations of the associated contact-springs. By this movement, contact 56 is opened, and grounded contact 78 is moved from its normal to its alternate position. This movement of bar 77 occurs only when all of the control relays 73 have been energized, and this condition arises only when all of the primary selectors D, controlled by the particular secondary master-switch C, are in use. Normally, the last contact 69 to be engaged by the wiper 68 is gounded by way of the normal contact 78, so that a wiper 68 will not stop on this contact, but will pass on until the contact corresponding to an idle primary selector is engaged. However, if all of the primary selectors be in use, as just explained the bar 77 will be moved and the normal ground of the last of the contacts 69 interrupted. As a result of this arrangement, it follows that when all of the primary selectors, corresponding to a given secondary master-switch, are in use, the wiper 68 will stop in engagement with the last of the series of contacts 69. At this point, it may be noted that the wipers 54 and 68 of the secondary master-switches move only in one direction—that is to say, they are always advanced by the operation of the motor magnet 71 and never retracted. Consequently this special contact 69 may be located at any desired point in the series of contacts.

It will be observed that the opening of contact 56 interrupts the circuit from the primary master-switch B through the particular secondary master-switch C. At the same time, by the movement of contact 78, a circuit is completed for the control relay 79 of the primary master-switch B, and said relay is energized to close its grounded contact 80 to thereby complete a circuit through control relay 81, wiper 82 and the engaged contact 83 of the primary master-switch. The energization of relay 81 will close a circuit for the motor magnet 84 of the primary master-switch; and by reason of its vibratory contacts 85, this magnet will be repeatedly energized and deënergized. The first energization and deënergization of this magnet will step the wipers 58—82 one step and thereby bring them into engagement with the next pair of passive contacts 57—83 assigned to a second secondary master-switch C. If this secondary master-switch has all its associated primary selectors D in use, its contact 78 will be in its alternate position, and the circuit for the relay 79 of the primary master-switch will be maintained with a consequent continued energization of relay 81 and motor magnet 84, which will cause the wipers 58—82 to advance to the next position. This advancing movement will continue until contacts 57—83, corresponding to, what I term, an idle secondary master-switch, are found. When such a switch is found, the wipers 58—82 will discontinue their advancing movement by reason of the consequent deënergization of relays 79—81 and motor magnet 84. When such a point is reached, a path for current will exist from open contact 50 of relay 49, through wiper 58, the engaged contact 57, closed contacts 56—55, wiper 54 of the selected secondary master-switch, its engaged contact 53, closed contact 52 of the primary off-normal switch PO of the primary selector corresponding to the engaged contact 53, the winding of primary relay PR of said selector and to the battery

51 to ground. By reason of this normal path, a minimum of time is employed in setting a primary selector in operation, since it is only necessary to energize the differential relay 45 to accomplish this result. At this point, it may be remarked that the primary master-switch is preferably of a type in which the wipers are advanced by the energizations and deënergizations of the motor magnet 84 and returned to previously occupied positions by the action of a return spring. As will be more particularly pointed out hereinafter, the construction of this switch is such as to cause its wipers 58—82 to move into engagement with the first in order of the coöperating contacts 57—83 corresponding to an idle secondary master-switch. In other words, if the said wipers be in engagement with contacts corresponding to an idle secondary master-switch and if, while so engaged, a secondary master-switch corresponding to contacts occupying a preceding position in the order of the contacts become idle, these wipers will immediately move into engagement with said contacts. Thus at all times the control path from the primary master-switch extends through the first idle secondary master-switch in order in the series of secondary master-switches.

Returning now to the operation of the primary selector D, it will be observed that the energization of the primary relay PR is instrumental not only in causing a primary movement of the wipers 37—38—39—40 but also in freeing the primary master-switch for the completing of subsequent control circuits. This is brought about through the grounding of contact 59, which completes a circuit from the live pole of the battery 15, through the winding 86 of the differential control relay 45, through conductor 87, resistance 88 and closed contact 59 to ground. It will be observed that this path is parallel to that through winding 46 and resistance 47. These resistances 47—88 are so proportioned that when both of these parallel paths are closed to ground, the combined energizing effect of the windings 46 and 86 of the relay 45 is such as to allow the retraction of its armature 48. Thus as soon as the particular primary selector D has been set in operation, the primary master-switch B is freed for subsequent operation. Likewise, as previously explained, a new control circuit through one of the secondary master-switches is immediately established. If at any time after the control relay 45 has been energized in response to the initiation of a call, and before it can be freed, another call is initiated, a new path for current will be completed through the winding 46 of differential relay 45, and a resistance, such as 47′, to ground, in addition to that through resistance 47 to ground. Then upon the establishment of the circuit through winding 86 of relay 45 in response to the operation of the selected primary selector D, the joint effects of the windings 46 and 86 will not be such as to permit the retraction of contact 48, but said contact will remain closed. The result of this will be that as soon as the master-switches have established their normal control path through another, then idle, primary selector, said selector will be set in operation, and this action will be repeated if additional calls are made sufficiently close together.

In order to maintain the balancing circuit through the winding 86 of relay 45, after the primary relay PR has been deenergized and its contact 59 opened, a path is provided through the contact 89 of the release switch RS of the actuated primary selector D and through closed contact 90 of control relay 91, associated with the link-circuit L'—L^2, to ground. The contacts 89—92 of the release switch RS are thrown over upon the first primary movement of the switch wipers. As will be more fully pointed out hereinafter, these parallel paths through the windings 46 and 86 are simultaneously interrupted so that the balance in the relay 45 is maintained continuously so far as the apparatus employed in a particular connection is concerned.

By the opening of contact 62 of primary relay PR of the actuated primary selector D, a possible circuit for the secondary relay SR, which controls the secondary movement of the wipers 38—39—40, is prevented. Upon the deënergization of this relay PR, the closing of contact 62 thereupon completes a circuit for the secondary relay SR, which may be traced from the live pole of the battery 51, through the winding of said relay, normal contact 93 of the secondary off-normal switch SO, closed contact 62 and closed contact 65 to ground. The relay SR will thereupon be energized to open its contacts 94—95 to disconnect the wipers 39—40 during operation so as to prevent interference with conversations over other lines having multiple connection with this particular primary selector. It will also close its contact 96 and move its contact 97 from its normal to its alternate position. The closing of contact 96 will complete a circuit for the secondary magnet SM, which may be traced from the live pole of the battery 51, through the winding of said magnet, its vibratory contacts 98, closed contact 96 and closed contact 92 to ground. By reason of the vibratory character of this circuit, the magnet SM will be energized and deenergized to cause the advance of the wipers 38—39—40 in a secondary direction, the wiper 37 not partaking of this secondary movement. The first step of the wipers will bring the wiper 38 into engagement with

a contact 42. If this contact correspond to an idle switch in the group of secondary selectors having access to the calling line, it will be connected to the live pole of battery 15 over conductor 99, contact 100 of the primary off-normal switch PO′ of the particular secondary selector, and through the winding of primary relay PR′ of said selector. The further advance of the wipers in a secondary direction will be thereby prevented, since upon the first movement in this direction, the original energizing circuit of relay SR is interrupted by the movement of contact 93 of the secondary off-normal switch SO to its alternate position, and a maintaining circuit for this relay does not exist. If the engaged contact 42 be that corresponding to a busy secondary selector in the group having access to the calling line, a maintaining circuit for the secondary relay SR will be provided over a path extending from the live pole of the battery 51, through alternate contact 97, wiper 38, engaged contact 42, conductor 99, alternate contact 100 of the primary off-normal switch PO′ of said secondary selector, closed contact 101 of the release switch RS′ of said selector, through the winding of the release magnet RM′ of said selector, to ground. It should be noted at this point that the characteristics of the relays SR and RM′ are such that the relay RM′ will not be energized sufficiently upon the completion of this circuit to cause the attraction of its armature and the consequent operation of its associated mechanism. The secondary magnet SM will therefore remain in circuit and the wipers 38—39—40 will be continued in their secondary movement until the contact 38 engages a contact 42 corresponding to an idle secondary selector. When this occurs, the relay SR will be deënergized, its contacts 94—95 will connect the adjacent portions of the link-circuit strands L′—L², the circuit for secondary magnet SM will be interrupted at contact 96, and the multiply connected contacts 42 will be grounded through contact 97.

Thus far in the operation of the system, an idle link-circuit L′—L² has been selected and its associated primary selector has been operated to pick out an idle secondary selector having access to the calling line. The grounding of the connected contact 42, by way of normal contact 97, will complete a circuit for the primary relay PR′ of the selected secondary selector, which may be traced from the live pole of the battery 15, through the winding of said relay, normal contact 100 of the primary off-normal switch PO′, conductor 99, contact 42, wiper 38 and normal contact 97 to ground. The relay PR′ will thereupon be energized to complete a circuit for the primary magnet PM′ through its vibratory contacts 102 and closed contact 103 to ground. The magnet PM′ will thereupon be energized and deënergized once to cause one step of the wipers 29—30—31—32 in a primary direction, which will be sufficient to bring the wiper 29 into engagement with the first of the bank contacts 33. Each of these contacts is normally grounded and only those, corresponding to groups in which calling line contacts are located, have this ground removed. Upon the first primary movement of the wipers, contacts 100 and 104 of the primary off-normal switch PO′ are actuated, the former to open its normal contact and close its alternate contact, and the latter to close its contact. At the same time, the contacts 101—105 of the release switch RS′ are actuated, the former to close its contact, and the latter to open its normal contact and close its alternate contact. Consequently, upon the first movement of the switch, the energizing circuit for the primary relay PR′ is interrupted at contact 100; and unless the wiper 29 engage a grounded contact 33, the further movement of the switch wipers in a primary direction will be prevented. In case such a grounded contact is engaged, a maintaining circuit for the relay PR′ will exist. This circuit may be traced from the live pole of the battery 15, through the winding of relay PR′, its closed contact 106, wiper 29, contact 33 and normal contact 26 to ground. The movement of the switch will therefore continue until an ungrounded contact 33 is encountered, whereupon the primary relay PR′ will be deenergized to prevent further primary movement of the switch. This will occur when a group of contacts containing the contacts of the calling line is reached. The opening of contact 107 upon the energization of relay PR′ prevents a possible circuit for the secondary relay SR′ until said relay PR′ is deënergized. As soon as this occurs, a circuit for relay SR′ is completed from the live pole of the battery 15, through the winding of said relay, normal contact 108 of the secondary off-normal switch SO′, closed contact 107 and closed contact 104 to ground. The relay SR′ will thereupon be energized to open its contacts 109—110 to disconnect the wipers 31—32 so as to prevent interference with conversation and to close its contacts 111—113. The closing of contact 111 will complete a circuit for the secondary magnet SM′, which may be traced from the live pole of the battery 15, through the winding of said magnet, its vibratory contacts 112, closed contact 111, alternate contact 105 to ground. Upon the closing of this circuit, magnet SM′ will be energized and deënergized to cause a movement of the wipers 30—31—32 in a secondary direction over the associated contacts 34—35—36 in the group containing the

contacts corresponding to the calling line. Upon the first secondary movement of these wipers, the contact 108 of the secondary off-normal switch SO′ is moved to its alternate position. The contacts 34 are normally grounded by way of contact 23. If, therefore, the contact first engaged by wiper 30 be that of the calling line, its ground will be removed at contact 23 and further movement of the wipers in a secondary direction will be prevented. If, however, the contact 34 thus engaged be not that of the calling line, the secondary relay SR′ will be maintained energized by reason of the circuit extending from the live pole of the battery 15, through the winding of said relay, closed contact 113, wiper 30, contact 34 and contact 23 to ground. Thus the vibratory circuit of the secondary magnet SM′ will be maintained until the wiper 30 engages an ungrounded contact. The resulting deënergization of secondary relay SR′ closes its contacts 109—110, thereby uniting the adjacent portions of the link-circuit strands L^3—L^4; opens its contact 111, thereby interrupting the vibratory circuit of its magnet SM′; and opens its maintaining circuit at contact 113.

It will be seen that connection is now established between an idle operator's link-circuit L′—L^2 and the limbs T′—T^2 of the calling line. As soon as this point is reached, a path for current is completed through the control relay 91 of the link-circuit and the cut-off relay 18 of the calling line. This circuit may be traced from the live pole of battery 51, through protective resistance 114, normal contact 115, contacts 116—117, the winding of relay 91, the sleeve side of the heavily marked circuit, through the winding of the cut-off relay 18 to ground. The relays 91 and 18 are thereupon energized, the former to interrupt the path for current through the winding 86 of the differential relay 45, and the latter to cause the deënergization of relay 21 with a like interruption of the parallel path through the winding 46 of said relay 45. The deenergization of relay 21 is brought about by the interruption of its maintaining circuit at contact 25 of the cut-off relay. The action of the cut-off relay also connects the line limbs T′—T^2 directly in circuit with the passive contacts 36—35, respectively. As soon as this connection is established, an additional path for current, in parallel with the winding of cut-off relay 18, extends from the sleeve side of the circuit through alternate contact 17, line limb T′, through the substation, line limb T^2, over the tip side of the heavily marked circuit, through the winding of supervisory relay 118 to ground. Sufficient current flows over this latter path to cause the relay 118 to move its contacts 119—120 from their normal to their alternate positions. By the movement of the latter, current is supplied to the call lamp 121 from the live pole of the battery 51, through said lamp, normal contact 122, alternate contact 120 to ground. The lamp 121 is thereupon lighted as a signal to the operator that a call has been made. The movement of the contact 119 of relay 118 closes a circuit extending from the like pole of the battery 51, through the winding 123 of relay 124, through closed contact 125 of said relay, alternate contact 119, winding of release magnet RM and alternate contact 92 to ground. Relay 124 is thereupon energized to interrupt this circuit at contact 125 after closing a circuit through contacts 126—117, the winding of relay 91, the sleeve side of the heavily marked circuit and the winding of cut-off relay 18 to ground. The winding 123 of relay 124, and the winding of release magnet RM, are of such resistances, and the relay and magnet are so constructed, that the release magnet RM will not attract its armature upon the closing of this circuit. The energization of relay 124, in addition to making contact 126—117 before breaking contact 125, also makes said contact 126—117 before interrupting contacts 116—117, and this latter is followed by the making of contact 116—127. Upon observing the display of the call signal, the operator will depress the listening-key springs 128—129 to include her telephone receiver 130 in circuit and will thereupon learn the wishes of the calling party. She will then test one of the multiple jacks 131 of the called-for line by touching the tip of her plug 132 against the sleeve or test contact of said jack. From the previous explanation, it will be apparent that as soon as the secondary selector wipers engage the contacts of the calling line, potential above that of ground will be supplied to the sleeve contacts of the multiple jacks 131 of said line by way of the circuit, previously traced, from the live pole of the battery 51 over the sleeve side of the heavily marked circuit. In case the line is in service as a called line, it will be seen that this potential is supplied over a path extending from the live pole of battery 51, through the winding of sleeve supervisory relay 133, the sleeve of plug 132 to the sleeves of the several jacks 131 of the line. Consequently upon touching the tip of the plug 132 to the test contact of a jack of a busy line, a flow of current will result over a path extending from the tip contact of the plug, through the tip strand L′, normal contact 134, and the winding of test relay 135 to ground. The test relay will thereupon be energized to complete a circuit through the tertiary winding of the induction coil 136 and closed contact 137 of relay 135 to ground. This momentary flow of current will cause a "click" in

the receiver 130 as an indication to the operator that the line is busy. In the present instance, the operator's transmitter is shown in a local circuit with a local battery and one winding of the induction coil 136. On finding the line busy, the operator will inform the calling party to that effect. In case the line is found to be idle, the operator will insert the plug 132 into a jack 131 and thereby complete a circuit through the supervisory relay 133 and the cut-off relay 18 of the called line. This circuit extends from the live pole of the battery 51, through the winding of relay 133, plug and jack sleeve contacts and the winding of cut-off relay 18 to ground. Both relays 133—18 are thereupon energized to close their alternate contacts.

Contact 134 of relay 133 cuts the test relay 135 out of circuit and completes the tip strand L′ in bridge of the listening-key lever 128. The movement of contact 122 interrupts the circuit of the call lamp 121 and causes its extinguishment. The movement of contact 115 to its alternate position completes a circuit through the supervisory lamp 138 by way of the grounded contact 139 of the tip supervisory relay 140. The movement of contacts 17—19 of the cut-off relay 18 destroys the normal control exercised by the subscriber over the associated master-switch mechanism and extends the line limbs to the jack contacts. The operator will next depress her ringing-key levers 141—142 and thereby complete a circuit for ringing current extending from the grounded pole of the generator 143, through said generator, key lever 141, plug and jack tip contacts, line limb T^2, switch-hook 11, condenser 14, call-bell 13, line limb T′, plug and jack sleeve contacts and resistance 144 to ground, thereby actuating the call-bell 13 as a signal to the called party. Upon the response of the called party, the normal bridge between the line limbs through the call-bell 13 will be broken and a bridge for battery current will be provided in its stead through the receiver 10 and transmitter 12. As soon as this occurs, a path for current in parallel to that through the winding of the cut-off relay 18 will be provided over alternate contact 17, line limb T′, through the substation, line limb T^2, plug and jack tip contacts, key lever 141, tip strand L′ and winding of tip supervisory relay 140 to ground. The latter relay will thereupon be energized and its contact 139 will be opened, thereby extinguishing the supervisory lamp 138. With the parties thus connected, transmission current will be furnished to the called line from the battery 51 to the tip side of the circuit by way of tip relay 140, and to the sleeve side of the circuit by way of sleeve relay 133. In the case of the calling line, transmission current will be supplied from the same battery to the tip side of the circuit by way of relay 118, and to the sleeve side of the circuit by way of the left-hand winding of relay 124, contacts 126—117 and relay 91. The calling and called portions of the talking circuit thus established are conductively divided, but inductively united, by condenser 145 included in strand L′, and condenser 146 included in strand L^2. During conversation, relays 91—118—124—133—140 are energized; and at the end of conversation, relays 118 and 140 are individually deënergized upon the restoration of the corresponding receiver to its switch-hook. Thus when the called party hangs up his receiver, contact 139 is again closed and a circuit through supervisory lamp 138 completed. Likewise when the calling party hangs up his receiver, contact 120 returns to its normal position and thereby completes a circuit for supervisory lamp 147 by way of closed contact 148 of relay 124. The lighting of both lamps 138 and 147 is a signal to the operator to take down the connection. As soon as the plug 132 is withdrawn from the jack in pursuance of this purpose, the sleeve supervisory relay 133 and the cut-off relay 18 of the called line are deenergized. The contacts of these relays thereupon assume their normal positions. At this time, only the relays 91 and 124 of the link-circuit L′—L^2 remain energized. Consequently upon the deënergization of relay 133, a circuit is completed for the release magnet RM of the primary selector, which may be traced from the live pole of the battery 51, through resistance 114, normal contact 115, contacts 116—127, normal contact 119, winding of said release magnet RM, alternate contact 92 of the release springs RS to ground. The release magnet RM is thereupon energized and, by reason of the mechanical relation of the parts, the release springs 89—92 are thereupon returned to their normal positions. Release magnet RM is rendered slow-acting by any suitable construction, such as the provision of a copper shell for its core, so that its contact 149 will remain closed long enough to cause the energization of the release magnet RM′ of the connected secondary selector E. This circuit extends from the live pole of the battery 150, through resistance 151, closed contact 149, wiper 38, engaged contact 42, conductor 99, alternate contact 100, normal contact 101 and winding of release magnet RM′ to ground. The energization of release magnet RM′ will cause the movement of the release springs 101—105 to their normal positions, thereby interrupting the circuit, just traced, at contact 101. As soon as the contacts of release switch RS are returned to normal, a circuit will be completed through the secondary relay SR by way of alternate contact 93 and normal contact 92, and said relay

will be energized to disconnect the wipers 39—40 at contact 94—95. At this time, no circuit will be provided for the secondary magnet SM. Upon the deënergization of the release magnet RM, wipers 37—38—39—40 will be free to return to their normal positions under the action of suitable spring mechanism hereinafter described. Likewise upon the return of the contacts of the release switch RS′ to normal, secondary relay SR′ of the secondary selector will be energized over a path including alternate contact 108 and normal contact 105. This energization will result in the disconnection of the wipers 31—32 at contacts 109—110. Upon the deënergization of release magnet RM′, the wipers 29—30—31—32 will return to their normal positions. By disconnecting the wipers of the switches at this time, interference is prevented with conversations over multiply connected contacts. The relays SR and SR′ are deënergized as soon as the switches are returned to normal. As soon as the secondary relay SR is energized so as to interrupt the link-circuit strand L^2 at contact 95, the circuit through the relays 124—91, and the cut-off relay 18 of the calling line, is interrupted and these relays return to their normal positions. Thus the switch parts are restored to normal and are in condition for subsequent selection and operation.

Obviously, in the practice of the system above described, any preferred construction of mechanical switch mechanism may be employed for accomplishing the various switching functions therein indicated. However, for this purpose I preferably employ the switching mechanism illustrated in Figs. 2 to 10 inclusive.

Referring to Figs. 2 and 3, which illustrate the preferred form of secondary master-switch mechanism C, it will be observed that the passive contacts 53 and 69 are arranged in a suitable bank 152, arranged in the form of the arc of a circle and suitably secured to the base 153. Ten of these contacts are shown, although, obviously, a greater or less number might be employed. Coöperating with these contacts are the movable wipers 54 and 68, of each of which four are shown mounted upon a shaft 154, journaled in the base 153 and a suitably mounted bridge-piece 155. The wipers are so positioned with reference to the bank contacts that, as soon as one wiper passes beyond the last bank contact, another wiper will pass into engagement with the first contact. At this point, it may be noted that for ten per cent. trunking, there should be eleven of these passive contacts for each set of wipers, since one position is required to bring the wipers 68 into engagement with that contact which is normally grounded through contact-spring 78. Shaft 154 is provided with a ratchet-wheel 156 which is adapted to be actuated by a pawl 157, carried by the armature 158 of the actuating or motor magnet 71, which, as previously indicated, is included in a vibratory circuit. This circuit is made and broken by the contacts 72 in response to the movements of the armature 158. A suitable retractile spring 159 is here shown. This spring engages the end 160 of the armature 158, which is angular is form, and normally maintains said armature in its retracted position. A beveled stop 161 coöperates with the inclined end of the pawl 157 to limit its movement so that the wipers 54 and 68 are moved by a single step upon each energization and deënergization of the motor magnet 71. A suitable spring 162, cooperating between the pawl 157 and the armature 158, tends to hold the pawl in engaging position. The switch parts are all preferably incased within a cover 163, fitted upon the base 153.

Referring now to Figs. 4 and 5 which illustrate the preferred form of primary master-switch, it will be observed that the passive contacts 57 and 83 are also mounted in an arcuate frame 164, suitably supported upon a base 165. These contacts are arranged to be engaged by the wipers 58—82 which are also mounted upon a shaft 166, journaled between the base 165 and a suitable supporting bracket 167. The motor magnet 84 is located in proximity to the shaft 166 and its armature 168 actuates a driving pawl 169 to engage the teeth of the ratchet 170 carried by the shaft. By this means, the wipers 58 and 82 are stepped, upon each energization and deënergization of the magnet 84, from engagement with one set of passive contacts into engagement with the next. The circuit of the motor magnet 84 is interrupted at the contacts 85, carried by the magnet frame, through the agency of the end 171 of the armature 168. The stop 172 coöperates with the pawl 169, and its position and the stroke of the armature 168 are such as to give the wipers the proper length of step. The base 165 also carries a suitable support 173 for the control relays 79, of which there are but ten shown. Obviously, this number would be modified in case a different trunking percentage were employed. Each of the relays 79 carries a contact-spring 80 and a coöperating contact-spring for establishing the grounded connection heretofore described. Each of the relays 79 also controls an armature 174 which in turn controls a retaining pawl 175, adapted to engage a suitable stop 176 carried by the shaft 166. As clearly illustrated, the stops 176 are differently positioned upon the shaft 166 and these positions correspond to the various contacting positions of the wipers. Thus for example, the first stop 176 corresponds to the first po-

sition of the wipers from normal, the second stop to the second position, and so on. As previously stated, this switch is constructed so as to return to normal. This return movement is brought about by the spiral retractile spring 177 coöperating between the shaft 166 and the spring casing 178, carried by the base 165. By reason of the arrangement of the stop 176 and the coöperating retaining pawls 175, it will be seen that the various relays 79 control the position to which the wipers will return. Thus if the wipers be advanced to the tenth position and retained in that position by the operation of the tenth relay 79 and its retaining pawl 175, it will happen that upon the release of this retaining pawl, due to the deënergization of the tenth relay 79, the wipers will begin to return toward their normal position. If at this time, the secondary master-switches, corresponding to the first and second positions of the wipers, be in use—that is, have all the primary selectors available thereto in use—the second relay 79 will be energized and its retaining pawl 175 will be in a position to stop the wipers when they reach the second position from normal. By this means, the circuit to the first idle secondary master-switch in order in the series is established. Since the relay 79 of each secondary master-switch is deënergized as soon as any primary selector accessible to said secondary master-switch is rendered idle, it follows that the wipers 58 and 82 will tend to occupy at all times a position such as to establish a path for current through the first idle secondary master-switch in order in the series of secondary master-switches.

Referring now to Figs. 6 to 10 inclusive, which illustrate in general construction both of the selector switches, and in specific construction the secondary selector switch E, 179 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′, which are suitably supported on the frame 179. The frame also carries the fixed contacts 34—35—36, which are arranged in a bank 180 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 coöperate with the wipers 30—31—32, which are pivoted at the center of rotation of the spherical surface to the lower end of a rotary shaft 181, suitably journaled in the frame 179. The wipers are rotatable with the shaft in a primary (horizontal) direction and about the pivot 182 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 183 having a broad foot 184, which engages an anti-friction roller 185, carried on a rearward projection 186 of the wipers. With this arrangement, the wipers may be given a 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 184 at the lower end of the shaft 183 is made sufficiently large to engage the roller 185, no matter what the position of the wipers may be. In addition to the wipers and bank contacts thus provided, the frame 179 also carries a horizontal row of fixed contacts 33, which are arranged above the bank 180 and in the arc of a circle to have their inner ends engaged by the wiper 29 carried by, and insulated from, the shaft 181. As will be apparent, the wiper 29 is capable of a horizontal movement only and does not partake of the secondary movement of the wipers 30—31—32. The mechanism associated with the primary magnet PM′, by which the shaft 181 is given its primary step-by-step movement, comprises an actuating pawl 187 carried by the armature 188 of the magnet PM′ and adapted to engage the teeth of a ratchet wheel 189 to step the shaft 181 around. The pawl 187, which is spring-pressed, coöperates with a beveled stop 190 to give the ratchet wheel 189 a single step upon each energization of the primary magnet PM′. The shaft 181 is retained in its various positions by the retaining pawl 191 which is normally spring-pressed into engagement with the teeth of the ratchet wheel. The upper end of the shaft 181 carries a member 192 having a projection 193 which normally maintains the spring-contacts 100—104 of the primary off-normal switch PO′ in their normal positions; but 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 194, actuating pawl 195 and the ratchet teeth 196 on the shaft 183, steps the latter downward to carry the contacting ends of the wipers 30—31—32 in a secondary direction into the desired positions. A suitable retaining pawl 197, pivotally mounted between the frame 179 and a bracket 198 carried thereby, engages the teeth 199 on the shaft 183 to hold it in its different positions. The shaft 183 is also provided with a suitable spline 200, which, after the first movement of the shaft, engages the teeth of the ratchet wheel 189 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 179 also carries the contacts of the secondary off-normal switch SO′. The contact 108 of this switch is held against its own spring tension in its

normal position through the agency of a projection 201 carried at the upper end of the shaft 183. The outer end of this projection normally engages a pin 202, which in turn presses the contact-spring 108 into its normal position. The vibratory circuit of the primary magnet PM′ is completed through the contact-springs 102 which are actuated by the projecting end of the armature 188. The vibratory circuit of the secondary magnet SM′ is completed through the contact-springs 112, carried by the magnet frame and coöperating with the armature 194. This armature, as clearly illustrated, is retracted through the agency of a suitable spring 203. The frame 179 also carries the contacts of the release switch RS′. As previously indicated, the contacts 101—105 of this switch have such spring tension as to hold them in their alternate positions, but are normally held out of such positions through the agency of a catch 204. 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 188 of the primary magnet and the associated member 209. The member 206 is pivoted at an intermediate point to the lower end of the armature 205 and extends beyond the contact spring 105 and into a position to draw it to its normal position upon the attraction of the armature 205. The armature is retracted by the spring 207.

The catch 204, which is pivoted at an intermediate point to the post 208 carried by the frame 179, is moved from its retaining position so as to allow the springs 101—105 of the release switch RS′ to move to their alternate positions upon the first energization of the primary magnet PM′. This is brought about through the agency of a lever 209, pivotally supported near its center upon the frame 179 and having one end lying in the path of movement of the armature 188 of the primary magnet. Its opposite end is provided with an upturned projection 210 which bears against the under side of the catch lever 204. Upon the first movement of the armature 188, lever 209 is rocked about its pivot, and its upturned end 210 rides over the inclined surface 211 on the under side of the catch lever 204 so as to rock the latter about its pivot and thereby release the springs 101—105 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 191 and the secondary retaining pawl 197. In giving the wipers their primary movement, the shaft 181 is rotated against the tension of a spiral spring 212 contained in a suitable case 213 carried by the frame 179. Similarly, in giving the wipers their secondary movement, they are rotated against the tension of a spiral spring 214 located about the pivot 182 and coöperating 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 191 and 197. As previously indicated, this is brought about upon the deenergization of the release magnet RM′. Upon such release, the retraction of the armature 205 draws the member 206 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 191 is provided with a tail having an upturned end 215 which is adapted to pass through a coöperating opening 216 in the member 206. Similarly, the secondary retaining pawl 197 is provided with a tail having a similar upturned end 217, similarly adapted to pass into an opening 218 in the member 206. Upon the attraction of the release magnet armature 205, the member 206 passes over the upturned ends 215 and 217 until the openings 216 and 218 come into registration therewith. The member 206 then, by the action of its spring 219, moves downward far enough to engage the projecting ends of the pawls. Then, upon the retraction of the armature 205, these pawls are moved out of engaging position; and through the agency of the springs 212—214, 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, connecting strips 220—221 are carried by, and suitably insulated from, the frame 179.

It will be apparent from the previous description, together with the nature of the reference characters employed, that in the case of a primary selector the same general construction as that shown in Figs. 6 to 10 inclusive may be employed with the necessary changes in relay and off-normal and release switch spring contacts. Thus in the case of the primary selector, the primary off-normal switch will require only four contact springs, while the primary relay will require an additional pair of contact springs to perform the functions of armature contact 59 and its coöperating grounded contact.

To provide against the possibility of improper operation of the selecting switches where, as the result of two calls being ini-

tiated 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 the provision of additional contacts connected in circuit with the release magnet of the switch, as fully explained in my prior application, Serial Number 320,158, filed June 4th, 1906.

Obviously, in the practice of my invention, many alterations and modifications may be made both in the circuit arrangements and in the mechanical structural details, without departing from the spirit and scope of my invention. Thus, for example, where I have shown several separate batteries, one and the same battery may be employed. I therefore do not wish to be limited to the specific matter contained in the present disclosure, 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 telephone line, a plurality of secondary automatic selecting switches having access to said line to establish connection therewith, a plurality of primary automatic selecting switches having access to said secondary switches, link-circuits associated with said primary switches, and means responsive to a control exercised over said telephone line to cause the successive operation of idle primary and secondary switches to establish connection between an idle one of said link-circuits and said telephone line.

2. A telephone exchange system comprising a telephone line, a plurality of secondary automatic selecting switches having access to said line to establish connection therewith, a plurality of primary automatic selecting switches having access to said secondary switches, link-circuits associated with said primary switches, means responsive to a control exercised over said telephone line to cause the successive operation of idle primary and secondary switches to establish connection between an idle one of said link-circuits and said telephone line, other telephone lines, and means for extending the circuit of the selected link-circuit to a desired one of said other telephone lines.

3. A telephone exchange system comprising a telephone line, a plurality of secondary automatic selecting switches having access to said line to establish connection therewith, a plurality of primary automatic selecting switches having access to said secondary switches, link-circuits associated with said primary switches, means responsive to a control exercised over said telephone line to cause the successive operation of idle primary and secondary switches to establish connection between an idle one of said link-circuits and said telephone line, other telephone lines, and connecting plugs and jacks constituting terminals of said link-circuits and said other telephone lines respectively by which a selected link-circuit may be connected to a desired other telephone line.

4. A telephone exchange system comprising a plurality of telephone lines, a plurality of secondary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said telephone lines, link-circuits extending from said active contacts, a plurality of primary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said link-circuits, other link-circuits extending from said primary switch active contacts, means responsive to a control exercised over a definite one of said telephone lines to cause the successive operation of the active contacts of idle primary and secondary switches to establish connection between an idle one of said other link-circuits and said definite telephone line.

5. A telephone exchange system comprising a plurality of telephone lines, a plurality of secondary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said telephone lines, link-circuits extending from said active contacts, a plurality of primary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said link-circuits, other link-circuits extending from said primary switch active contacts, means responsive to a control exercised over a calling one of said telephone lines to cause the successive operation of the active contacts of idle primary and secondary switches to establish connection between an idle one of said other link-circuits and said calling telephone line, other telephone lines, and means for extending the circuit of the selected said other link-circuit to a desired one of said other telephone lines.

6. A telephone exchange system comprising a plurality of telephone lines, a plurality of secondary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said telephone lines, link-circuits extending from said active contacts, a plurality of primary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said link-circuits, other link-circuits extending from said primary

switch active contacts, means responsive to a control exercised over a calling one of said telephone lines to cause the successive operation of the active contacts of idle primary and secondary switches to establish connection between an idle one of said other link-circuits and said calling telephone line, other telephone lines, and connecting plugs and jacks constituting terminals of said other link-circuits and said other telephone lines respectively by which a selected other link-circuit may be connected to a desired other telephone line.

7. A telephone system comprising a telephone line, a plurality of secondary automatic selecting switches having access to said line to establish connection therewith, a plurality of primary automatic selecting switches having access to said secondary switches, link-circuits associated with said primary switches, electrically controlled master-switch mechanism common to a plurality of said link-circuits and responsive to a control exercised over said telephone line to cause the successive operation of idle primary and secondary switches to establish connection between an idle one of said link-circuits and said telephone line.

8. A telephone system comprising a telephone line, a plurality of secondary automatic selecting switches having access to said line to establish connection therewith, a plurality of primary automatic selecting switches having access to said secondary switches, link-circuits associated with said primary switches, electrically controlled master-switch mechanism common to a plurality of said link-circuits and responsive to a control exercised over said telephone line to cause the successive operation of idle primary and secondary switches to establish connection between an idle one of said link-circuits and said telephone line, other telephone lines, and means for extending the circuit of the selected link-circuit to a desired one of said other telephone lines.

9. A telephone system comprising a telephone line, a plurality of secondary automatic selecting switches having access to said line to establish connection therewith, a plurality of primary automatic selecting switches having access to said secondary switches, link-circuits associated with said primary switches, electrically controlled master-switch mechanism common to a plurality of said link-circuits and responsive to a control exercised over said telephone line to cause the successive operation of idle primary and secondary switches to establish connection between an idle one of said link-circuits and said telephone line, other telephone lines, and connecting plugs and jacks constituting terminals of said link-circuits and said other telephone lines respectively by which said link-circuits may be connected to a desired other telephone line.

10. A telephone system comprising a plurality of telephone lines, a plurality of secondary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said telephone lines, link-circuits extending from said active contacts, a plurality of primary automatic selecting switches, each having an active contact and a plurality of passive contacts severally assigned to said link-circuits, other link-circuits extending from said primary switch active contacts, electrically controlled master-switch mechanism common to a plurality of said other link-circuits and responsive to a control exercised over a definite one of said telephone lines to cause the successive operation of the active contacts of idle primary and secondary switches to establish connection between an idle one of said other link-circuits and said definite telephone line.

11. A telephone system comprising a plurality of telephone lines, a plurality of secondary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said telephone lines, link-circuits extending from said active contacts, a plurality of primary automatic selecting switches, each having an active contact and a plurality of passive contacts severally assigned to said link-circuits, other link-circuits extending from said primary switch active contacts, electrically controlled master-switch mechanism common to a plurality of said other link-circuits and responsive to a control exercised over a calling one of said telephone lines to cause the successive operation of the active contacts of idle primary and secondary switches to establish connection between an idle one of said other link-circuits and said calling telephone line, other telephone lines, and means for extending the circuit of the selected other link-circuit to a desired one of said other telephone lines.

12. A telephone system comprising a plurality of telephone lines, a plurality of secondary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said telephone lines, link-circuits extending from said active contacts, a plurality of primary automatic selecting switches, each having an active contact and a plurality of passive contacts severally assigned to said link-circuits, other link-circuits extending from said primary switch active contacts, electrically controlled master-switch mechanism common to a plurality of said other link-circuits and responsive to a control exercised over a calling one of said telephone lines to cause the successive operation of the active contacts of idle primary and secondary switches to establish connec-

tion between an idle one of said other link-circuits and said calling telephone line, other telephone lines to cause the successive operacircuit of the selected other link-circuit to a desired one of said other telephone lines, and connecting plugs and jacks constituting terminals of said other link-circuits and said other telephone lines respectively by which a selected other link-circuit may be connected to a desired other telephone line.

13. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting link-circuits, means for severally connecting said link-circuits between calling and called lines, secondary master-switches for designating idle ones of said link-circuits for such connection, a primary master-switch for selecting and operating an idle secondary master-switch, and means for operating said primary master-switch.

14. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting link-circuits, manually operated terminals and automatically operated terminals for said link-circuits by which they may be severally connected between calling and called lines, secondary master-switches for designating idle ones of said link-circuits for such connection, a primary master-switch for selecting and operating an idle secondary master-switch, and means for operating said primary master-switch.

15. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting link-circuits, plug and jack connecting means and automatic switching means for said link-circuits whereby they may be severally connected between calling and called lines, secondary master-switches for designating idle ones of said link-circuits for such connection, a primary master-switch for connecting and operating an idle secondary master-switch, and means for operating said primary master-switch.

16. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting link-circuits, means for severally connecting said link-circuits between calling and called lines, secondary master-switches for designating idle ones of said link-circuits for such connection, a primary master switch for selecting and operating an idle secondary master-switch, and means responsive to a control exercised over a circuit including a calling line for operating said primary master-switch.

17. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting link-circuits, manually operated terminals and automatically operated terminals for said link-circuits by which they may be severally connected between calling and called lines, secondary master-switches for designating idle ones of said link-circuits for such connection, a primary master-switch for selecting and operating an idle secondary master-switch, and means responsive to a control exercised over a circuit including a calling line for operating said primary master-switch.

18. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting link-circuits, plug and jack connecting means and automatic switching means for said link-circuits whereby they may be severally connected between calling and called lines, secondary master-switches for designating idle ones of said link-circuits for such connection, a primary master-switch for connecting and operating an idle secondary master-switch, and means responsive to a control exercised over a circuit including a calling line for operating said primary master-switch.

19. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting link-circuits, automatic switching means employed in severally connecting said link-circuits between calling and called lines, secondary master-switches for operating said automatic switching means, a primary master-switch for operating an idle secondary master-switch, and means for operating said primary master-switch.

20. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting link-circuits, automatic switching means employed in severally connecting said link-circuits between calling and called lines, secondary master-switches for operating said automatic switching means, a primary master-switch for operating an idle secondary master-switch, and means responsive to a control exercised over a circuit including a calling line to operate said primary master-switch.

21. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting link-circuits, automatic switching means employed in severally connecting said link-circuits between calling and called lines, secondary master-switches for operating said automatic switching means, a primary master-switch common to a plurality of said telephone lines for operating an idle secondary master-switch, and means for operating said primary master-switch.

22. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting link-circuits, automatic switching means associated

with the answering ends of said link-circuits and operative to extend the circuit of an idle link-circuit to a calling telephone line, means for extending the circuit of a selected link-circuit to a desired called line, secondary master-switches for operating said automatic switching means, a primary master-switch for operating an idle secondary master-switch, and means responsive to a control exercised over a circuit including said calling line to operate said primary master-switch.

23. A telephone exchange system comprising a plurality of telephone lines, a plurality of associated interconnecting link-circuits, automatic switching means associated with the answering ends of said link-circuits and operative to extend the circuit of an idle link-circuit to a calling telephone line, other telephone lines, connecting plugs and jacks constituting terminals of said link-circuits and said other telephone lines respectively by which a selected link-circuit may be connected to a desired telephone line, secondary master-switches for operating said automatic switching means, a primary master-switch for operating an idle secondary master-switch, and means responsive to a control exercised over a circuit including said calling line to operate said primary master-switch.

24. A telephone exchange system comprising a plurality of telephone lines, line selecting switches associated with said lines, primary selecting switches for selecting and operating said line selecting switches, secondary master-switches for operating said primary selecting switches, a primary master-switch for operating an idle secondary master-switch, and means for operating said primary master-switch.

25. A telephone exchange system comprising a plurality of telephone lines, line selecting switches associated with said lines, primary selecting switches for selecting and operating said line selecting switches, secondary master-switches for operating said primary selecting switches, a primary master-switch for operating an idle secondary master-switch, and means responsive to a control exercised over a circuit including a calling telephone line for operating said primary master-switch.

26. A telephone exchange system comprising a plurality of telephone lines, line selecting switches associated with said lines, primary selecting switches for selecting and operating said line selecting switches, link-circuits extending from said primary selecting switches, means for extending the circuits of a selected link-circuit to a desired called line, secondary master-switches for selecting an idle link-circuit and operating the associated primary selecting switch, a primary master-switch for operating an idle secondary master-switch, and means for operating said primary master-switch.

27. A telephone exchange system comprising a plurality of telephone lines, line selecting switches associated with said lines, primary selecting switches for selecting and operating said line selecting switches, link-circuits extending from said primary selecting switches, means for extending the circuits of a selected link-circuit to a desired called line, secondary master-switches for selecting an idle link-circuit and operating the associated primary selecting switch, a primary master-switch for operating an idle secondary master-switch, and means responsive to a control exercised over a circuit including a calling telephone line for operating said primary master-switch.

28. A telephone exchange system comprising a plurality of telephone lines, line selecting switches associated with said lines, primary selecting switches for selecting and operating said line selecting switches, link-circuits extending from said primary selecting switches, other telephone lines, connecting plugs and jacks constituting terminals of said link-circuits and said other telephone lines respectively by which a selected link-circuit may be connected to a desired other telephone line, secondary master-switches for selecting an idle link-circuit and operating the associated primary selecting switch, a primary master-switch for operating an idle secondary master-switch, and means for operating said primary master-switch.

29. A telephone exchange system comprising a plurality of telephone lines, line selecting switches associated with said lines, primary selecting switches for selecting and operating said line selecting switches, link-circuits extending from said primary selecting switches, other telephone lines, connecting plugs and jacks constituting terminals of said link-circuits and said other telephone lines respectively by which a selected link-circuit may be connected to a desired other telephone line, secondary master-switches for selecting an idle link-circuit and operating the associated primary selecting switch, a primary master-switch for operating an idle secondary master-switch, and means responsive to a control exercised over a circuit including a calling telephone line for operating said primary master-switch.

30. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary switches each controlling a plurality of said devices, a primary switch for controlling said secondary switches, means for actuating said switches so as to provide a normal path for current through the primary and secondary switch contacts to an idle one of said devices.

31. A telephone exchange system compris-

ing a plurality of electrically controlled selector devices, a plurality of secondary switches each controlling a plurality of said devices, a primary switch for controlling said secondary switches, and operating means for said switches at rest only when a path for current extends through the primary and secondary switch contacts to an idle one of said devices.

32. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary switches each controlling a plurality of said devices, a primary switch for controlling said secondary switches, said primary and secondary switches normally occupying positions such as to provide a path for current through the primary and secondary switch contacts to an idle one of said devices, and means operative in response to the operation of such device to bring said switches into position to again establish a path for current through the primary and secondary switch contacts to another, then idle, device.

33. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary switches each controlling a plurality of said devices, a primary switch for controlling said secondary switches, said switches normally occupying positions such as to provide a path for current through the primary and secondary switch contacts to an idle one of said devices, means for operating the device so included in response to the closing of a circuit including said path, and means for bringing said switches into position to again establish a path for current through the primary and secondary switch contacts to another, then idle, device.

34. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary switches, each having an active contact and a plurality of passive contacts severally assigned to said devices, a primary switch having an active contact and a plurality of passive contacts severally assigned to said secondary switch active contacts, means for maintaining the primary and secondary active contacts normally in engagement with idle passive contacts.

35. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary switches, each having an active contact and a plurality of passive contacts severally assigned to said devices, a primary switch having an active contact and a plurality of passive contacts severally assigned to said secondary switch active contacts, means for moving said active contacts over their cooperating passive contacts, means for stopping the secondary active contacts in engagement with passive contacts whose assigned devices are idle, and means for stopping the primary active contact in engagement with a passive contact whose secondary switch has idle passive contacts.

36. A telephone exchange system comprising a series of electrically controlled master switch devices, means for individually operating said devices, and connected switching means at rest only when a path for current extends through its contacts to the first idle device in order in the series.

37. A telephone exchange system comprising a series of electrically controlled master switch devices, means for individually operating said devices, and connected switching means for providing at all times a control path through its contacts to the first idle device in order in the series.

38. A telephone exchange system comprising a series of electrically controlled master switch devices, a series of passive switch-contacts severally assigned to said devices, a coöperating active contact, means for actuating said devices, and driving means for said active contact at rest only when said active contact rests on the passive contact corresponding to the first idle device in order in the series.

39. A telephone exchange system comprising a series of electrically controlled master switch devices, a series of passive switch-contacts severally assigned to said devices, a coöperating active contact, means for actuating said devices, and means for moving said active contact over the associated passive contact to maintain at all times a control path to the first idle device in order in the series.

40. A telephone exchange system comprising a series of electrically controlled master switch devices, means for placing said devices in use for varying periods of time, a series of passive contacts severally assigned to said devices, a coöperating active contact normally resting in engagement with the passive contact of the first idle device in order in the series, means for moving said active contact out of engagement with said passive contact as soon as the associated device is placed in use, and means for stopping said active contact in engagement with the passive contact of the then first idle device in order in the series.

41. A telephone exchange system comprising a series of electrically controlled master switch devices, means for placing said devices in use for varying periods of time, a series of passive contacts severally assigned to said devices, a coöperating active contact normally resting in engagement with the passive contact of the first idle device in order in the series, and means for actuating said active contact to maintain it in engagement with the passive contact of the first

idle device in order in the series, no matter what the order of operation of the devices may be.

42. A telephone exchange system comprising a series of electrically controlled master switch devices, means for placing said devices in use for varying periods of time, a series of passive contacts severally assigned to said devices, a coöperating active contact, means for moving said active contact over said passive contacts, means individual to each of said devices for retaining said active contact in different operative positions, means for restoring said retaining means and means whereby the first retaining means in order to be restored will restore all the retaining means following it in order.

43. A telephone exchange system comprising a series of electrically controlled master switch switches, means for individually placing said switches in use for varying periods of time, a series of passive contacts severally assigned to said switches, a cooperating active contact, means for moving said active contact over said passive contacts, means individual to each of said switches for retaining said active contact in different operative positions, means for restoring said retaining means, and means whereby the first retaining means in order to be restored will restore the retaining means following it in order.

44. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary switches each controlling a plurality of said devices, a primary switch for controlling said secondary switches, and means for actuating said switches so as to provide a normal path for current to an idle one of said devices by way of the primary switch and the first one in order of the series of secondary switches which has access to an idle device.

45. 45. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary switches each controlling a plurality of said devices, a primary switch for controlling said secondary switches, and actuating means for said switches at rest only when a path for current extends to an idle one of said devices by way of the primary switch and the first one in order of the series of secondary switches which has access to an idle device.

46. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary switches each controlling a plurality of said devices, a primary switch for controlling said secondary switches, said primary and secondary switches normally occupying positions such as to provide a path for current to an idle one of said devices by way of the primary switch and the first one in order of the series of secondary switches which had access to an idle device, and means operative in response to the operation of said device to bring said switches into position to again establish a path for current to another, then idle, device by way of the primary switch and the first in order of the series of secondary switches which has access to an idle device.

47. A telephone exchange system comprising a telephone line, operator's link-circuits, automatic switching means for establishing connection between said telephone line and an idle one of said link-circuits, control mechanism including a differential relay, means for initially completing a circuit through one of the windings of said relay to energize it to set said switching means in operation, means for completing a circuit through the other winding of said relay to neutralize the effect of said first winding, and means for interrupting said circuits upon the establishment of said connection between the telephone line and link-circuit.

48. A telephone exchange system comprising a telephone line, operator's link-circuits, automatic switching means for establishing connection between said telephone line and an idle one of said link-circuits, control mechanism including a differential relay, means for initially completing a circuit through one of the windings of said relay to energize it to set said switching means in operation, means for completing a circuit through the other winding of said relay to neutralize the effect of said first winding, a relay associated with said line operative, when energized, to interrupt one of said circuits, a relay associated with the connected link-circuit operative, when energized, to interrupt the other of said circuits, and means for energizing said relays upon the establishment of said connection between the telephone line and link-circuit.

49. A telephone exchange system comprising an operator's link-circuit having two strands only, a pair of relays associated with the answering end of said link-circuit, a signal controlled by said relays, an initial energizing circuit for one of said relays controlled by the other, and a locking circuit for the former relay completed upon its energization.

50. A telephone exchange system comprising a subscriber's telephone line, an operator's link-circuit having two strands only and adapted for connection to said telephone line, a pair of relays associated with the answering end of said link-circuit, a signal controlled by said relays, means under the control of the subscriber during connection for energizing and deënergizing one of said relays, an initial energizing cir-

cuit for the other relay controlled by said first-mentioned relay, and a locking circuit for said other relay completed upon its energization.

51. A telephone exchange system comprising a telephone line, a plurality of secondary automatic selecting switches having access to said line to establish connection therewith, a plurality of primary automatic selecting switches having access to said secondary switches, link-circuits associated with said primary switches, means for initiating a call over said telephone line, and means for causing the successive operation of idle primary and secondary switches to establish connection between an idle one of said link-circuits and said calling telephone line.

52. A telephone exchange system comprising a telephone line, a plurality of secondary automatic selecting switches having access to said line to establish connection therewith, a plurality of primary automatic selecting switches having access to said secondary switches, link-circuits associated with said primary switches, means for initiating a call over said telephone line, means for causing the successive operation of idle primary and secondary switches to establish connection between an idle one of said link-circuits and said calling telephone line, other telephone lines, and means for extending the circuit of the selected link-circuit to a desired one of said other telephone lines.

53. A telephone exchange system comprising a telephone line, a plurality of secondary automatic selecting switches having access to said line to establish connection therewith, a plurality of primary automatic selecting switches having access to said secondary switches, link-circuits associated with said primary switches, means for initiating a call over said telephone line, means for causing the successive operation of idle primary and secondary switches to establish connection between an idle one of said link-circuits and said calling telephone line, other telephone lines, and connecting plugs and jacks constituting terminals of said link-circuits and said other telephone lines, respectively, by which the selected link-circuits may be connected to a desired other telephone line.

54. A telephone exchange system comprising a plurality of telephone lines, a plurality of secondary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said telephone lines, link-circuits extending from said active contacts, a plurality of primary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said link-circuits, other link-circuits extending from primary switch active contacts, means for initiating a call from one of said telephone lines, and means for causing the successive operation of the active contacts of idle primary and secondary switches to establish connection between an idle one of said other link-circuits and said calling telephone line.

55. A telephone exchange system comprising a plurality of telephone lines, a plurality of secondary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said telephone lines, link-circuits extending from said active contacts, a plurality of primary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said link-circuits, other link-circuits extending from said primary switch active contacts, means for initiating a call over one of said telephone lines, means for causing the successive operation of the active contacts of idle primary and secondary switches to establish connection between an idle one of said link-circuits and said calling telephone line, other telephone lines, and means for extending the circuits of the selected said other link-circuit to a desired one of said other telephone lines.

56. A telephone exchange system comprising a plurality of telephone lines, a plurality of secondary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said telephone lines, link-circuits extending from said active contacts, a plurality of primary automatic switches, each having an active contact and a plurality of passive contacts severally assigned to said link-circuits, other link-circuits extending from said primary switch active contacts, means for initiating a call over one of said telephone lines, means for causing the successive operation of the active contacts of idle primary and secondary switches to establish connection between an idle one of said other link-circuits and said calling telephone line, other telephone lines, and connecting plug and jacks constituting terminals of said other link-circuits and said other telephone lines respectively, by which a selected other link-circuit may be connected to a desired other telephone line.

57. A telephone exchange system comprising a plurality of groups of telephone lines, automatic selecting switch mechanism for successively selecting groups of said lines and then lines in said groups, group relays for designating the groups to be selected, line relays for designating the lines in the groups to be selected, means for initially energizing said line relay and its group relay and locking said relays in series.

58. A telephone exchange system comprising a plurality of groups of telephone lines, automatic selecting switch mechanism for successively selecting groups of said lines and then lines in said groups, group relays for designating the groups to be selected, line relays for designating the lines in the

groups to be selected, means for initially energizing said line relay and its group relay and locking said relays in series, and means for unlocking said relays at a definite point in the operation of said switch mechanism.

59. A telephone exchange system comprising a plurality of groups of telephone lines, automatic selecting switch mechanism for successively selecting groups of said lines and then lines in said groups, group relays for designating the groups to be selected, line relays for designating the lines in the groups to be selected, means for initially energizing said line relay and its group relay and locking said relays in series, a relay for unlocking said relays, and means for energizing said relay upon the completion of the selecting operation of said switch mechanism.

60. A telephone exchange system comprising a plurality of groups of telephone lines, automatic selecting switch mechanism for successively selecting groups of said lines and then lines in said groups, group relays for designating the groups to be selected, line relays for designating the lines in the groups to be selected, means controlled over said telephone lines individually for causing the operation of the associated line relay, and means operated by said line relay to include its group relay in series circuit with itself.

61. A telephone exchange system comprising a plurality of groups of telephone lines, automatic selecting switch mechanism for successively selecting groups of said lines and then lines in said groups, group relays for designating the groups to be selected, line relays for designating the lines in the groups to be selected, means controlled over said telephone lines individually for causing the operation of the associated line relay, means operated by said line relay to include its group relay in series circuit with itself, and means for interrupting said circuit upon the selection of said line by the actuated selecting switch mechanism.

62. A telephone exchange system comprising telephone lines divided into major groups and said major groups into minor groups; a link-circuit; control means; automatic switching means responsive to a single operation of said control means to cause the connection of said link-circuit to any one of said telephone lines by selecting successively a major group, a minor group of said major group and a telephone line of said minor group; and test contacts for determining the groups and line to be selected for connection to said link-circuit.

63. A telephone exchange system comprising telephone lines divided into major groups and said major groups into minor groups; a link-circuit; automatic switching means for causing the connection of said link-circuit to any one of said telephone lines by selecting successively a major group, a minor group of said major group and a telephone line of said minor group; test contacts for determining the groups and line to be selected for connection to said link-circuit; and means for modifying the condition of predetermined group and line test contacts controlled from a given point.

64. A telephone exchange system comprising telephone lines divided into major groups and said major groups into minor groups; a link-circuit; automatic switching means for causing the connection of said link-circuit to any one of said telephone lines by selecting successively a major group, a minor group of said major group and a telephone line of said minor group; test contacts for determining the groups and line to be selected for connection to said link-circuit; and means for modifying the condition of predetermined group and line test contacts controlled over the telephone line to be connected to said link-circuit.

65. A telephone exchange system comprising telephone lines extending from substations to the exchange, said lines being divided into major groups and said major groups into minor groups; a link-circuit; automatic switching means for causing the connection of said link-circuit to any one of said telephone lines by selecting successively a major group, a minor group included in said major group and a line included in said minor group; test contacts for determining the groups and line to be selected for connection to said link-circuit; and means under the control of any subscriber for modifying the test contacts of his line, the minor group including his line and the major group including said minor group, whereby the selection and connection of his line is determined.

66. A telephone exchange system comprising conductors, electrically controlled switches for uniting said conductors into conversational circuits, means for holding conversation over said conversational circuits, secondary master switches for controlling said switches, said secondary master-switches having all their contacts excluded from said conversational circuits, a primary master-switch for controlling said secondary master-switches, and means for operating said primary master-switch.

67. A telephone exchange system comprising conductors, electrically controlled switches for uniting said conductors into conversational circuits, means for holding conversation over said conversational circuits, secondary master-switches for controlling the operation of an idle one of said switches, said secondary master-switches having all their contacts excluded from said conversational circuits, a primary mas-

ter-switch for controlling the operation of an idle secondary master-switch, and means for operating said primary master-switch.

68. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary master switches for controlling said devices, primary master switch mechanism having a passive contact assigned to each secondary master switch and an active contact normally engaging a passive contact corresponding to a secondary master switch having access to an idle one of said devices, and means for causing the operation of said primary master switch mechanism to select another secondary master switch having access to an idle one of said devices as soon as all the devices accessible to the first secondary master switch are brought into service.

69. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary master switches for controlling said devices, primary master switch mechanism having a passive contact assigned to each secondary master switch and an active contact normally engaging a passive contact corresponding to a secondary master switch having access to an idle one of said devices, means for causing the operation of said primary master switch mechanism to select another secondary master switch having access to an idle one of said devices as soon as all the devices accessible to the first secondary master switch are brought into service, and means controlled through the primary master switch mechanism for bringing the selected idle device into service.

70. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary master switches for controlling said devices, a primary master switch for controlling said secondary master switches, starting means for said primary master switch common to a group of said secondary master switches, and means for actuating said starting means as soon as all the secondary master switches in said group are brought into service.

71. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary master switches for controlling said devices, a primary master switch for controlling said secondary master switches, starting means for said primary master switch common to a group of said secondary master switches, means for actuating said starting means as soon as all the secondary master switches in said group are brought into service, and means controlled through said primary master switch for bringing all the secondary master switches of said group into service.

72. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary master switches for controlling said devices, a primary master switch having an active contact and passive contacts assigned to said secondary master switches, and means whereby said active contact normally engages a passive contact having access to an idle secondary master switch.

73. A telephone exchange system comprising a plurality of electrically controlled selector devices, a plurality of secondary master switches for controlling said devices, a primary master switch for controlling said secondary master switches, means for starting said primary master switch, a switch common to said secondary master switches for controlling said starting means, and means for operating said switch whenever all said secondary master switches are brought into service.

74. In a telephone exchange system, a plurality of electrically controlled selector devices, a master switch for controlling said devices, starting means for said master switch, and means for operating said starting means only when all of said devices are brought into service.

75. In a telephone exchange system, a plurality of electrically controlled selector devices, a master switch for controlling said devices, a starting relay for said master switch, a control circuit for said relay, and means for closing said circuit whenever all of said devices are brought into service.

76. In a telephone exchange system, groups of electrically controlled selector devices, means for individually placing said devices in use, a master switch having an active contact and passive contacts severally assigned to said groups, means for changing the condition of passive contacts corresponding to groups whose devices are all in use, and means for causing the master switch active contact to pass over said passive contacts until one whose condition has not been changed is encountered and then to remain in a position corresponding therewith.

77. In a telephone exchange system, a plurality of electrically controlled selector devices, a master switch having an active contact and passive contacts severally assigned to said devices, means for causing said switch to move to a definite position when all of said devices are in use, and means operative as soon as one of said devices becomes idle to cause said switch to move its active contact to a position corresponding to such idle device.

78. A telephone exchange system comprising telephone lines divided for calling purposes into major groups and said major groups into minor groups; a link-circuit; and automatic switching means responsive to the initiation of a call over any one of said lines for causing the connection of said

link-circuit to said line by selecting successively a major group, a minor group, and said line.

79. A telephone exchange system comprising telephone lines divided for calling purposes into major groups and said major groups into minor groups; a link-circuit; automatic switching means responsive to the initiation of a call over any one of said lines for causing the connection of said link-circuit to said line by selecting successively a major group, a minor group, and said line; and test contacts for determining the selection of the groups and calling line.

80. A telephone exchange system comprising telephone lines divided into major groups and said major groups into minor groups; a link-circuit; control means; and automatic switching means responsive to a single operation of said control means to cause the connection of said link-circuit to any one of said telephone lines by selecting succesively a major group, a minor group of said major group and a telephone line of said minor group.

81. A telephone exchange system comprising a series of groups of electrically controlled selector switch devices, means for individually placing said devices in use for varying periods of time, connected switching means at rest only when a path for current extends through its contacts to the first group in order in the series in which there is an idle device.

82. A telephone exchange system comprising a series of groups of electrically controlled selector switch devices, means for individually placing said devices in use for varying periods of time, and connected switching means for providing at all times a control path through its contacts to the first group in order in the series in which there is an idle device.

83. A telephone exchange system comprising a series of groups of electrically controlled selector switch devices, a series of passive switch-contacts severally assigned to said groups of devices, a coöperating active contact, means for individually placing said devices in use for varying periods of time, and driving means for said active contact at rest only when said active contact rests on the passive contact corresponding to the first group in order in the series in which there is an idle device.

84. A telephone exchange system comprising a series of groups of electrically controlled selector switch devices, a series of passive switch-contacts severally assigned to said groups, a coöperating active contact, means for individually placing said devices in use for varying periods of time, and means for moving said active contact over the associated passive contacts to maintain at all times a control path to the first group in order in the series in which there is an idle device.

85. A telephone exchange system comprising telephone lines, secondary automatic selecting switches having access to said lines, primary automatic selective switches having access to said secondary switches, a link circuit individual to each of said primary switches and means responsive to an initiation of a call over one of said lines to cause the successive operation of an idle primary and secondary switch to establish connection between the associated link circuit and said telephone line.

86. A telephone system comprising telephone lines, secondary automatic selecting switches having access to said line, primary automatic selecting switches including wipers adapted to connect to said secondary switches, link circuits individual to said primary switches, and means responsive to an initiation of a call over one of said lines upon the removal of the receiver at a substation thereof to cause the successive operation of idle primary and secondary switches to extend connection from an associated link circuit to the calling line.

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

ALFRED H. DYSON.

Witnesses:
L. D. KELLOGG,
CAROLYN WEBER.