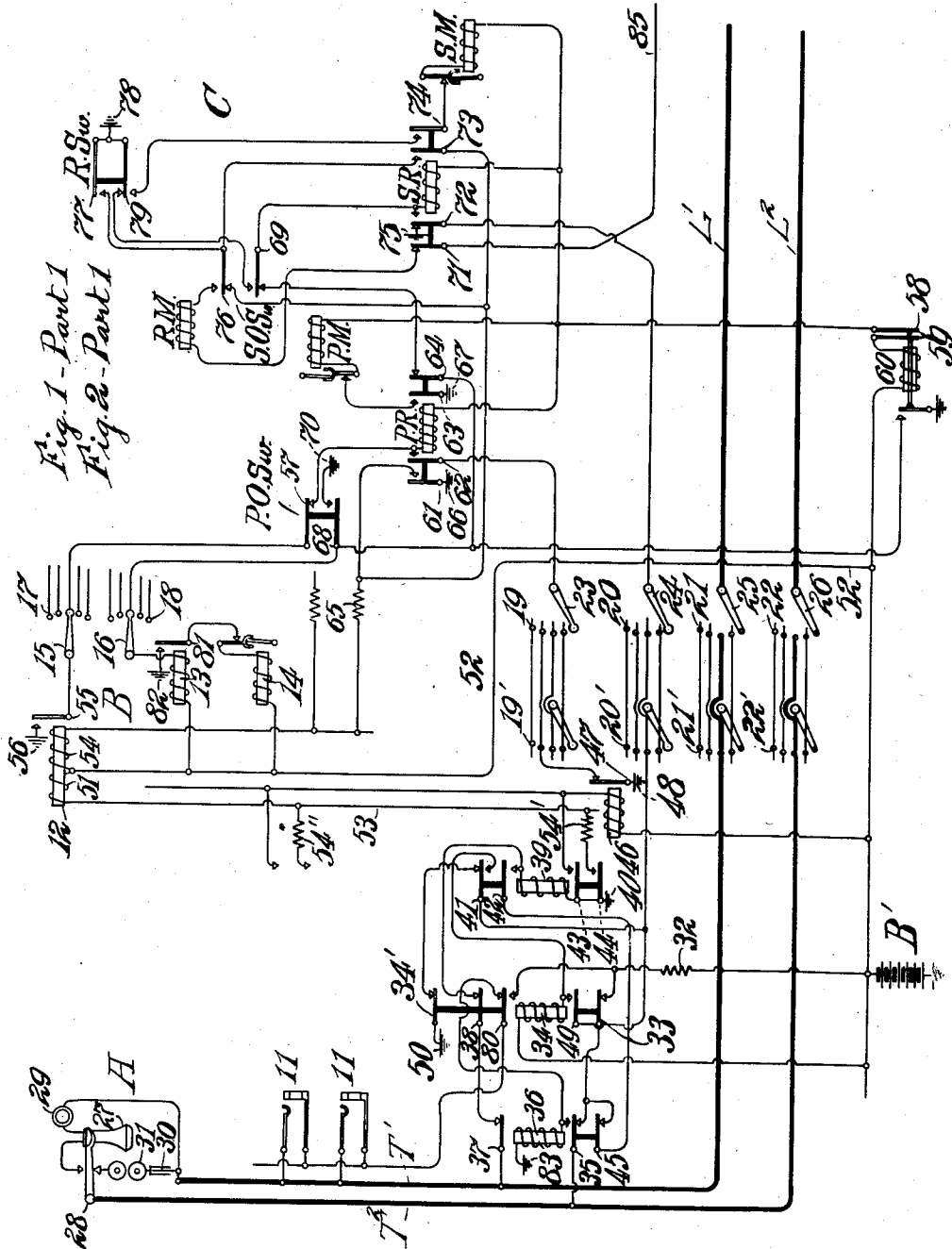


1,259,967.

A. H. DYSON.
TELEPHONE SYSTEM.
APPLICATION FILED SEPT. 6, 1906.

Patented Mar. 19, 1918.
11 SHEETS—SHEET 1.



Witnesses
H. C. Olmstead.
H. W. Webster

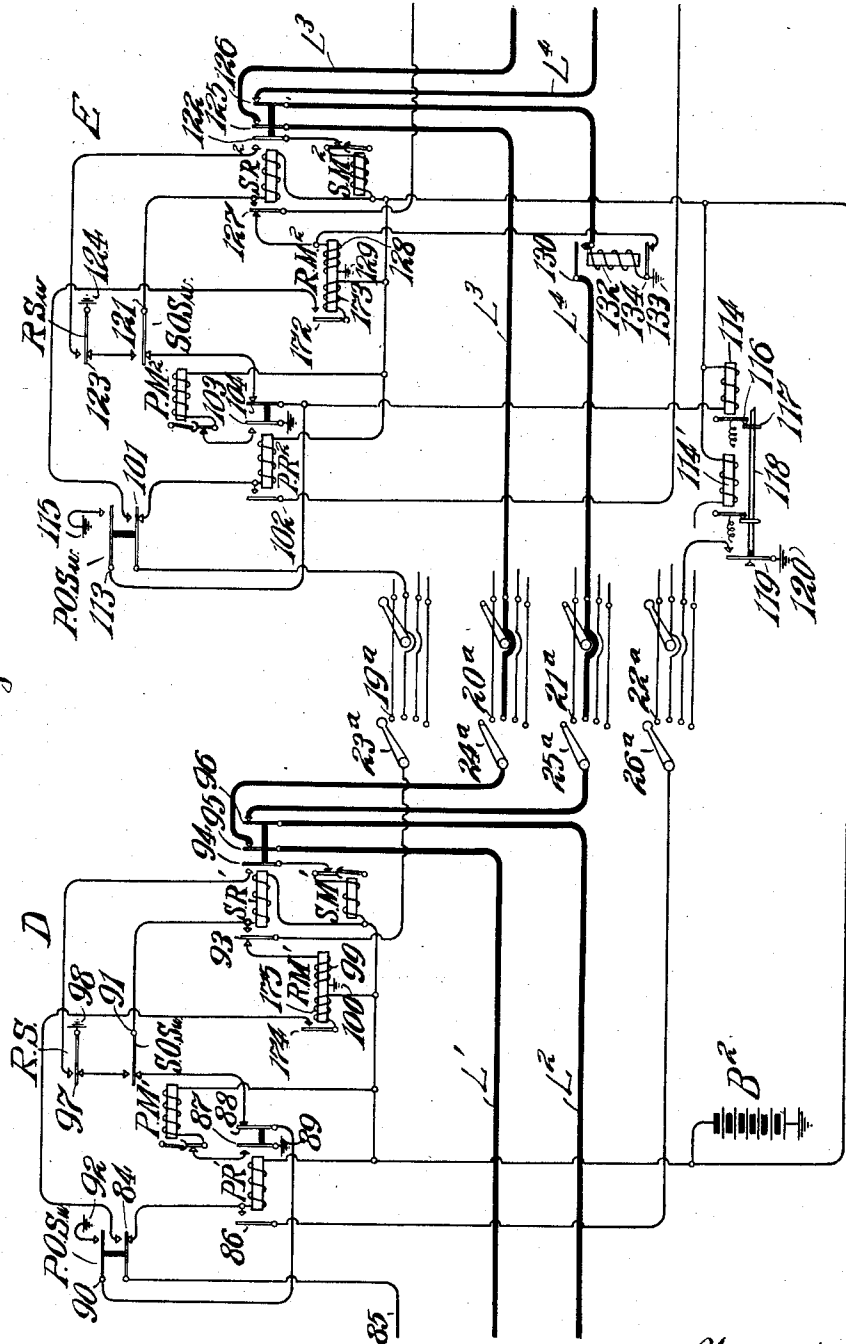
Inventor
by Alfred H. Dyson
Thomas H. Ferguson
Attorney

1,259,967.

A. H. DYSON.
TELEPHONE SYSTEM.
APPLICATION FILED SEPT. 6, 1906.

Patented Mar. 19, 1918.
11 SHEETS—SHEET 2.

Fig. 1—Part 2



Witnesses
H.C. Olmstead.
H. H. H. H.

Inventor
Alfred H. Dyson
by Thomas H. Ferguson
Attorney

1,259,967.

A. H. DYSON.
TELEPHONE SYSTEM.
APPLICATION FILED SEPT. 6, 1906.

Patented Mar. 19, 1918.
11 SHEETS—SHEET 3.

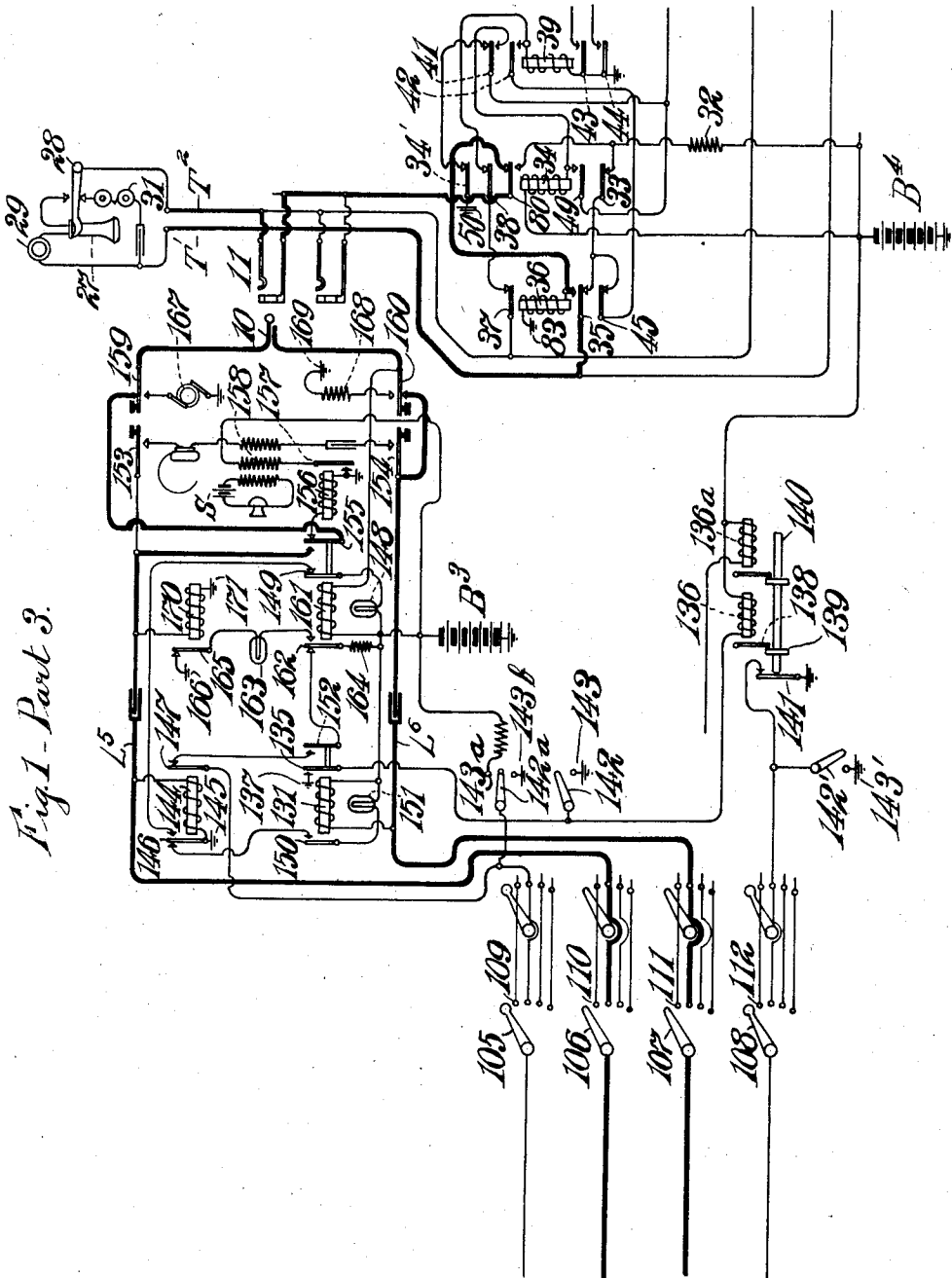


Fig. 1 - Part 3.

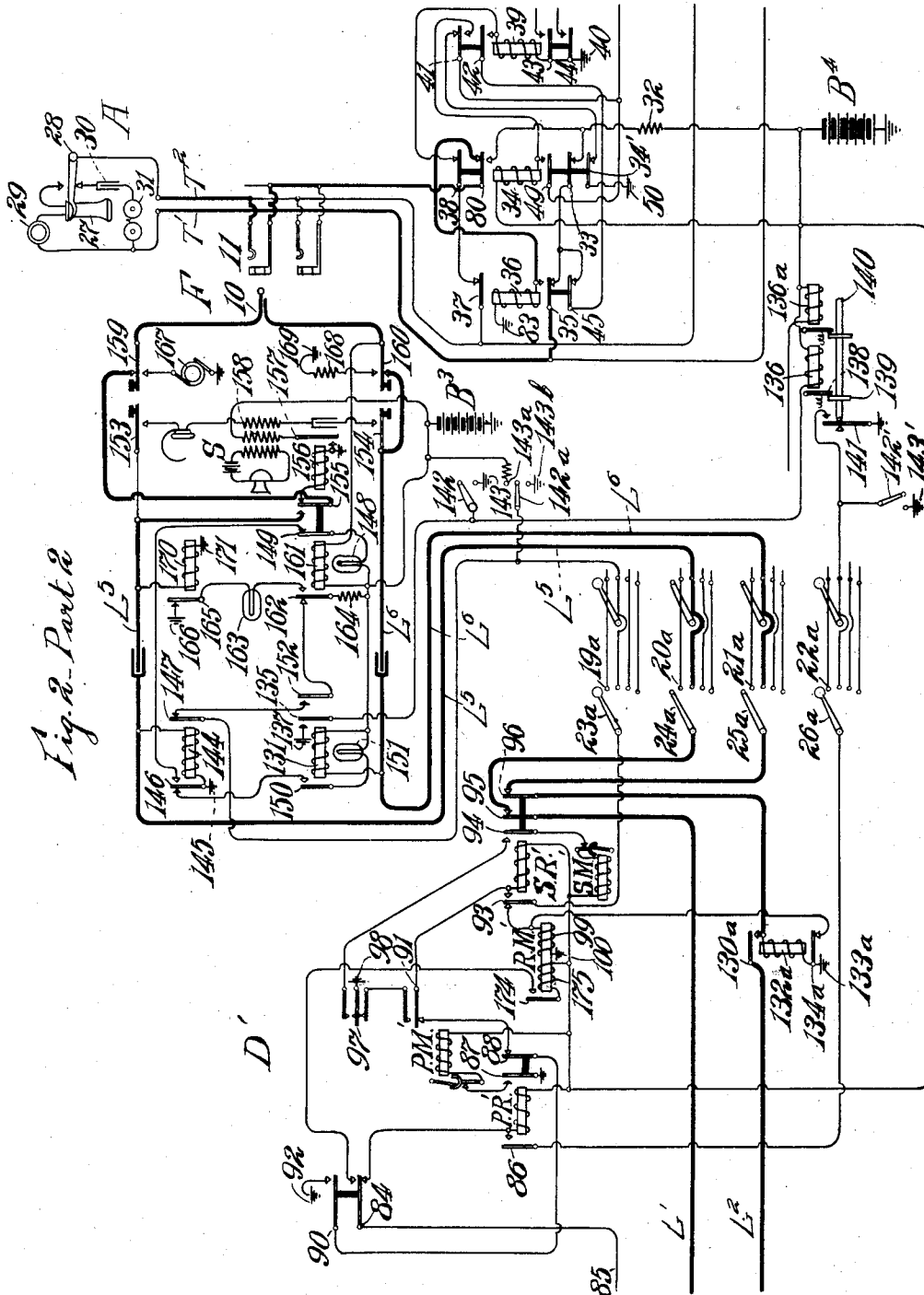
Witnesses
H. C. Olmstead.
H. W. Webster

Inventor
Alfred H. Dyson
by Thomas H. Ferguson
Attorney

1,259,967.

Patented Mar. 19, 1918.

11 SHEETS—SHEET 4.



Witnesses
H. C. Olmstead.
H. H. Webster

Inventor
Alfred H. Dyson
by Thomas H. Ferguson
Attorney

1,259,967.

Patented Mar. 19, 1918.

11 SHEETS—SHEET 5.

Fig. 3

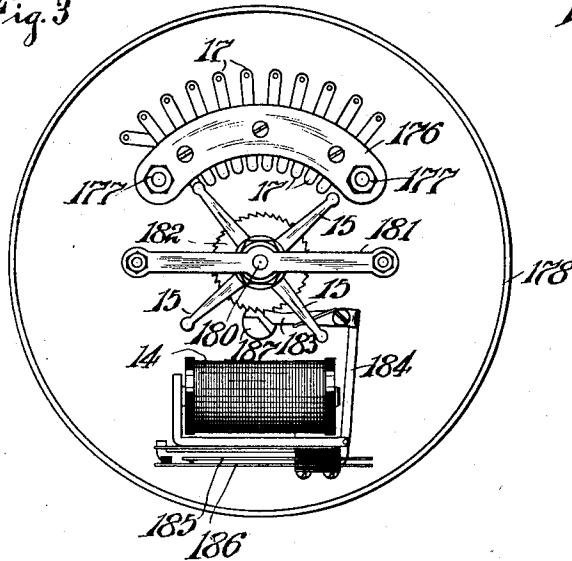


Fig. 4

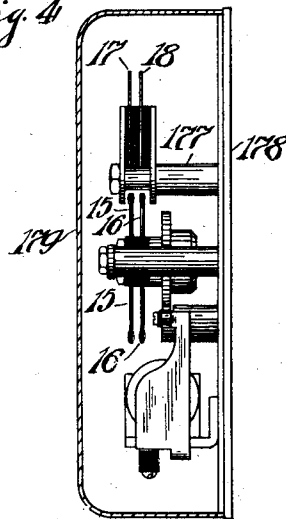


Fig. 5

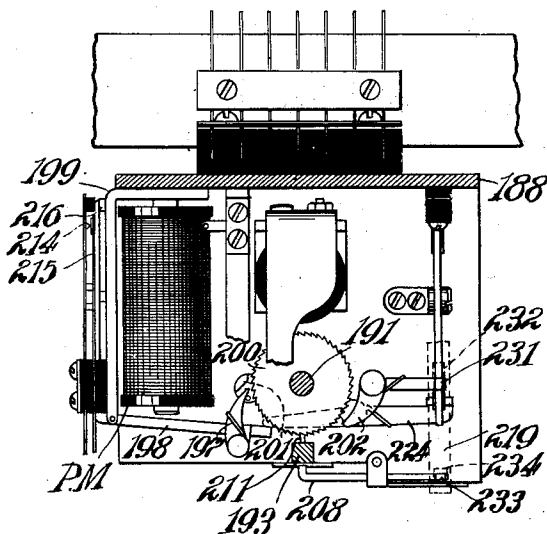
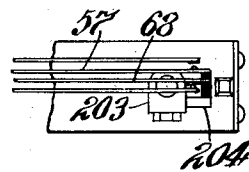


Fig. 5a



Witnesses
H. C. Olmstead.
H. Webster

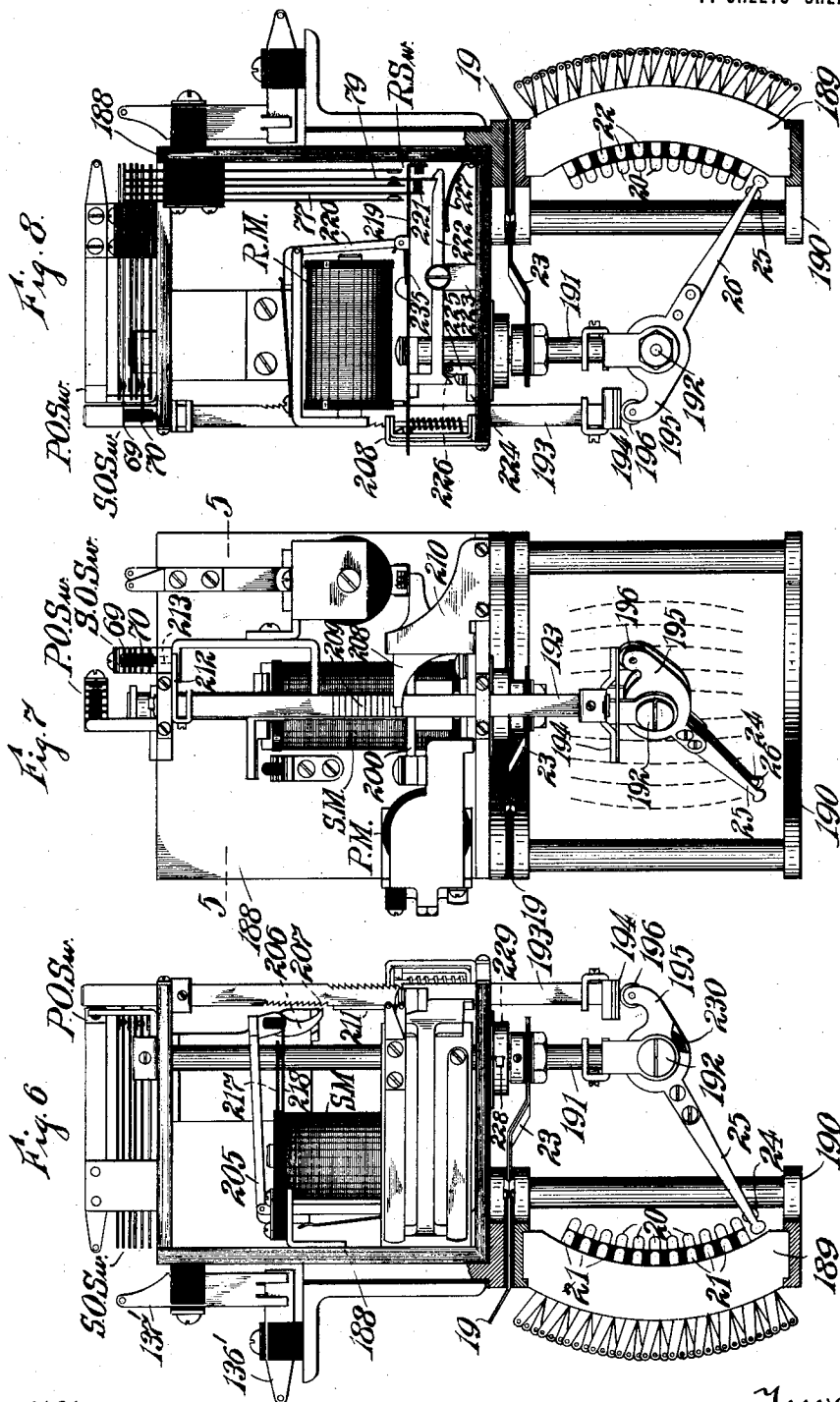
Inventor
Alfred H. Dyson
by Thomas Ferguson
Attorney

1,259,967.

A. H. DYSON.
TELEPHONE SYSTEM.
APPLICATION FILED SEPT. 6, 1906.

Patented Mar. 19, 1918.

11 SHEETS—SHEET 6.



Witnesses
H. C. Olmstead.
R. M. Webster

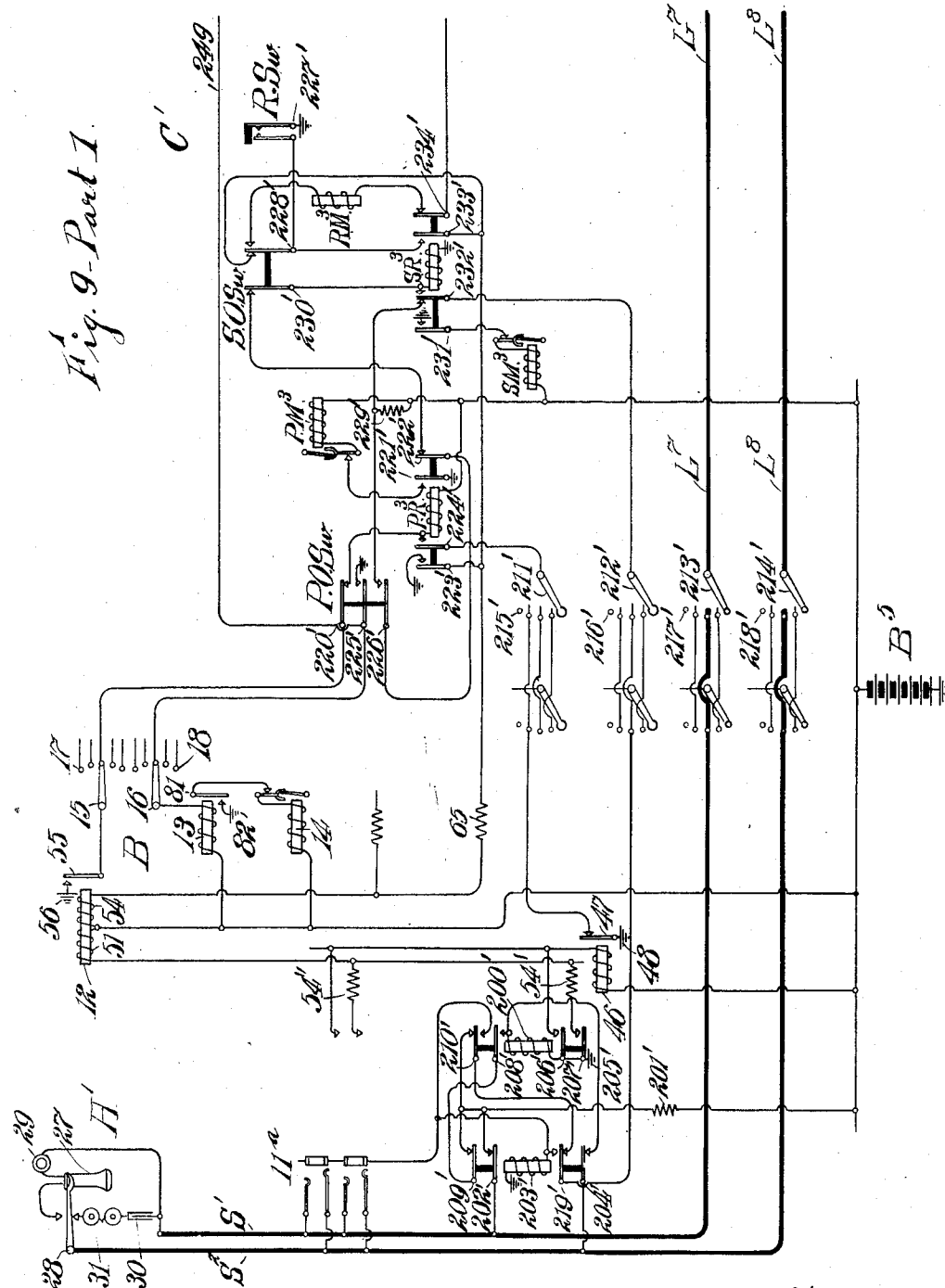
Inventor
Alfred H. Dyson
by Thomas H. Ferguson
Attorney

1,259,967.

A. H. DYSON.
TELEPHONE SYSTEM.
APPLICATION FILED SEPT. 6, 1906.

Patented Mar. 19, 1918.

11 SHEETS—SHEET 7.



Witnesses
H. G. Olmstead
H. Webster

Inventor
Alfred H. Dyson
by Thomas H. Ferguson
Attorney

A. H. DYSON.
TELEPHONE SYSTEM.

APPLICATION FILED SEPT. 6, 1906.

Patented Mar. 19, 1918.

11 SHEETS—SHEET 8.

1,259,967.

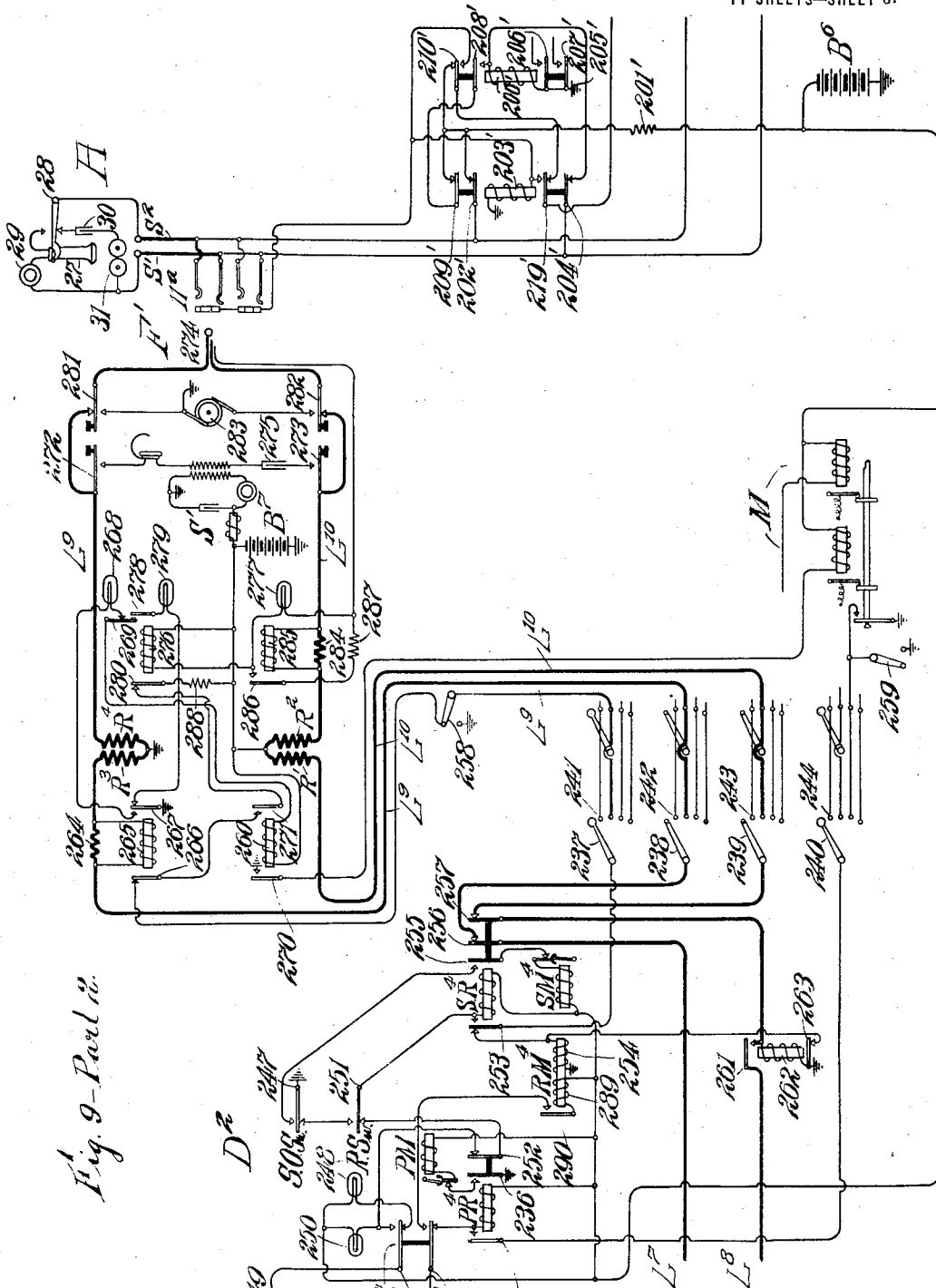


Fig. 9-Part 11.

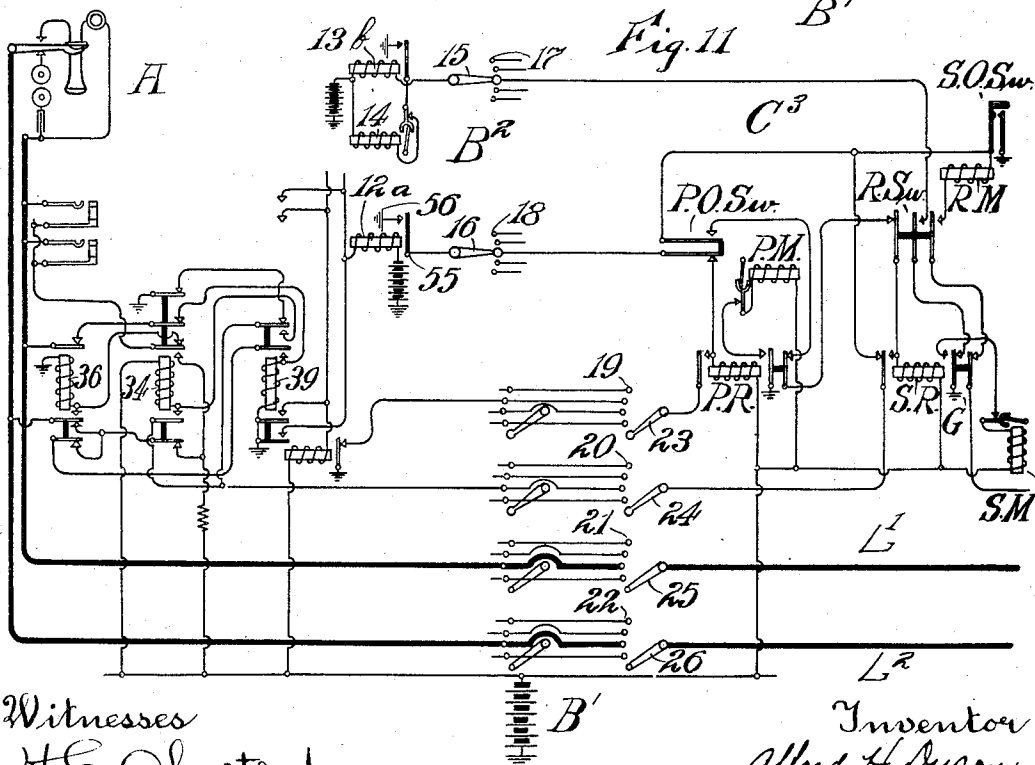
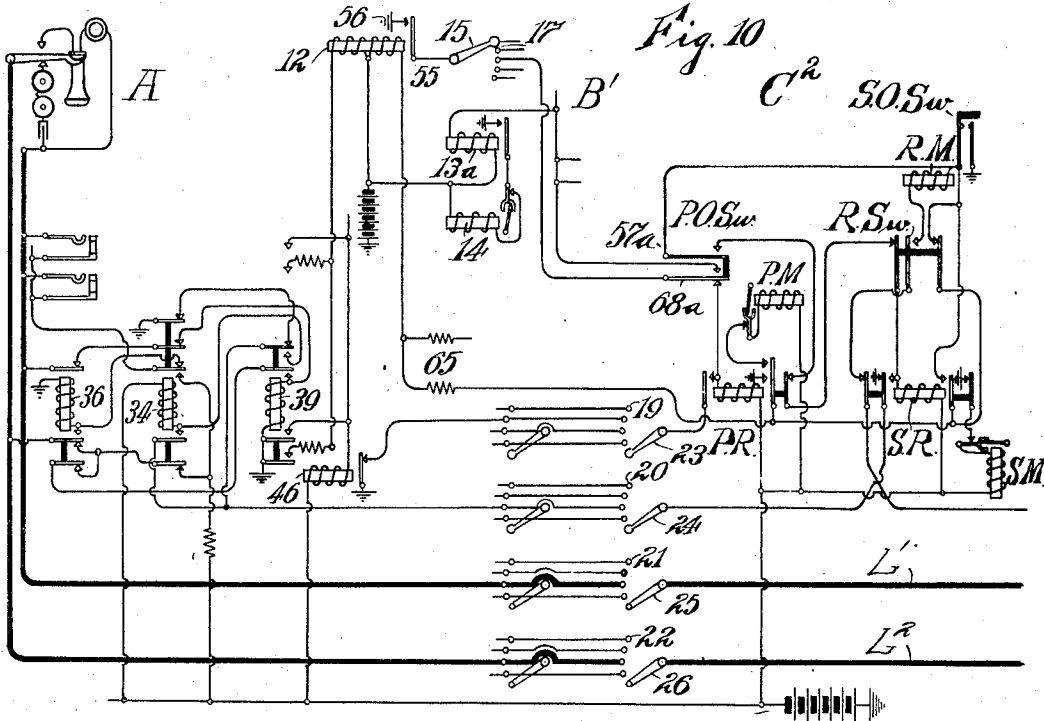
Witnesses.
H. C. Olmstead
H. W. Webster

Inventor
A. H. Dyson
by Thomas H. Ferguson
Attorney

1,259,967.

Patented Mar. 19, 1918.

11 SHEETS—SHEET 9.



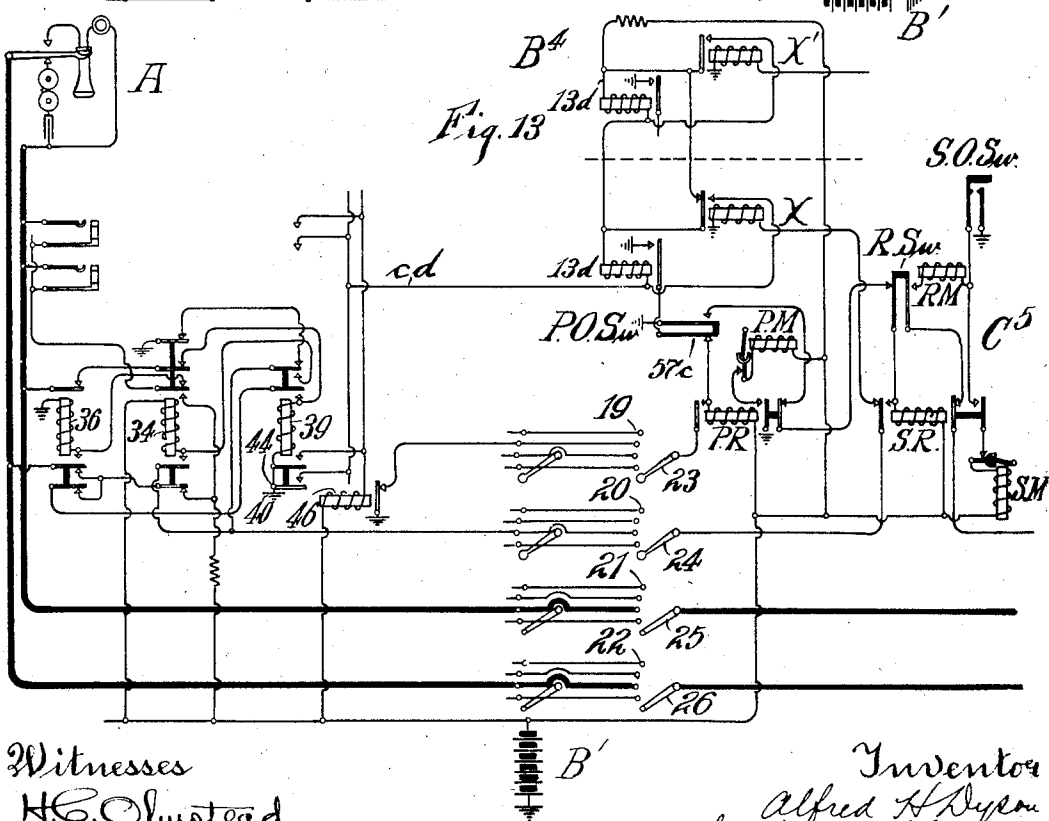
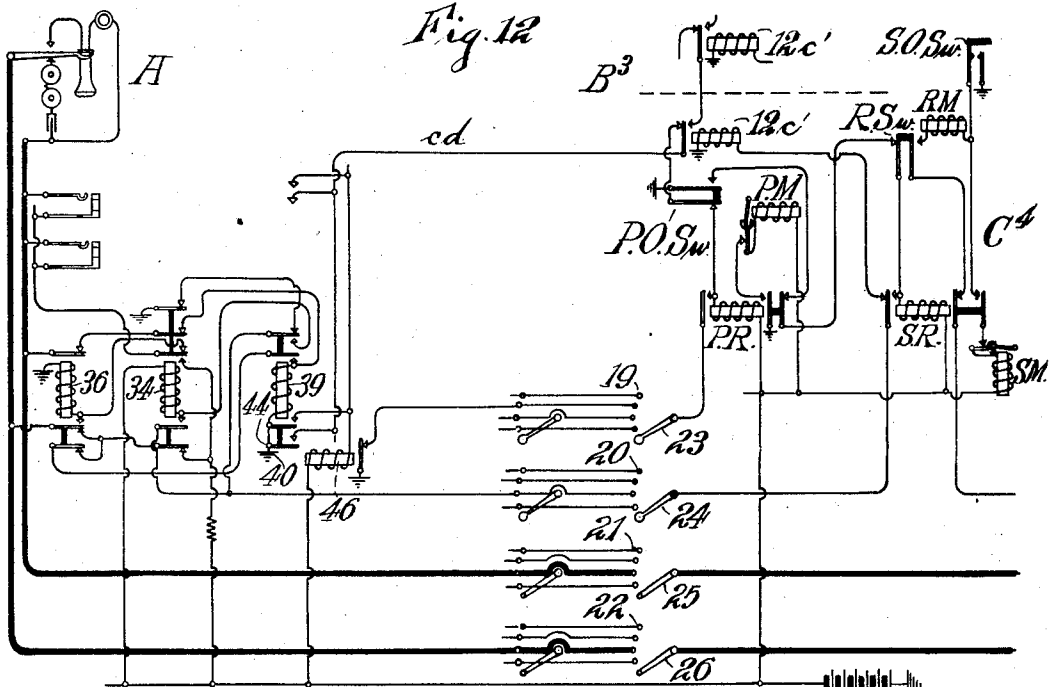
Witnesses
H. C. Olmstead.
H. H. Webster

Inventor
Alfred H. Dyson
by Thomas H. Ferguson
Attorney

1,259,967.

Patented Mar. 19, 1918.

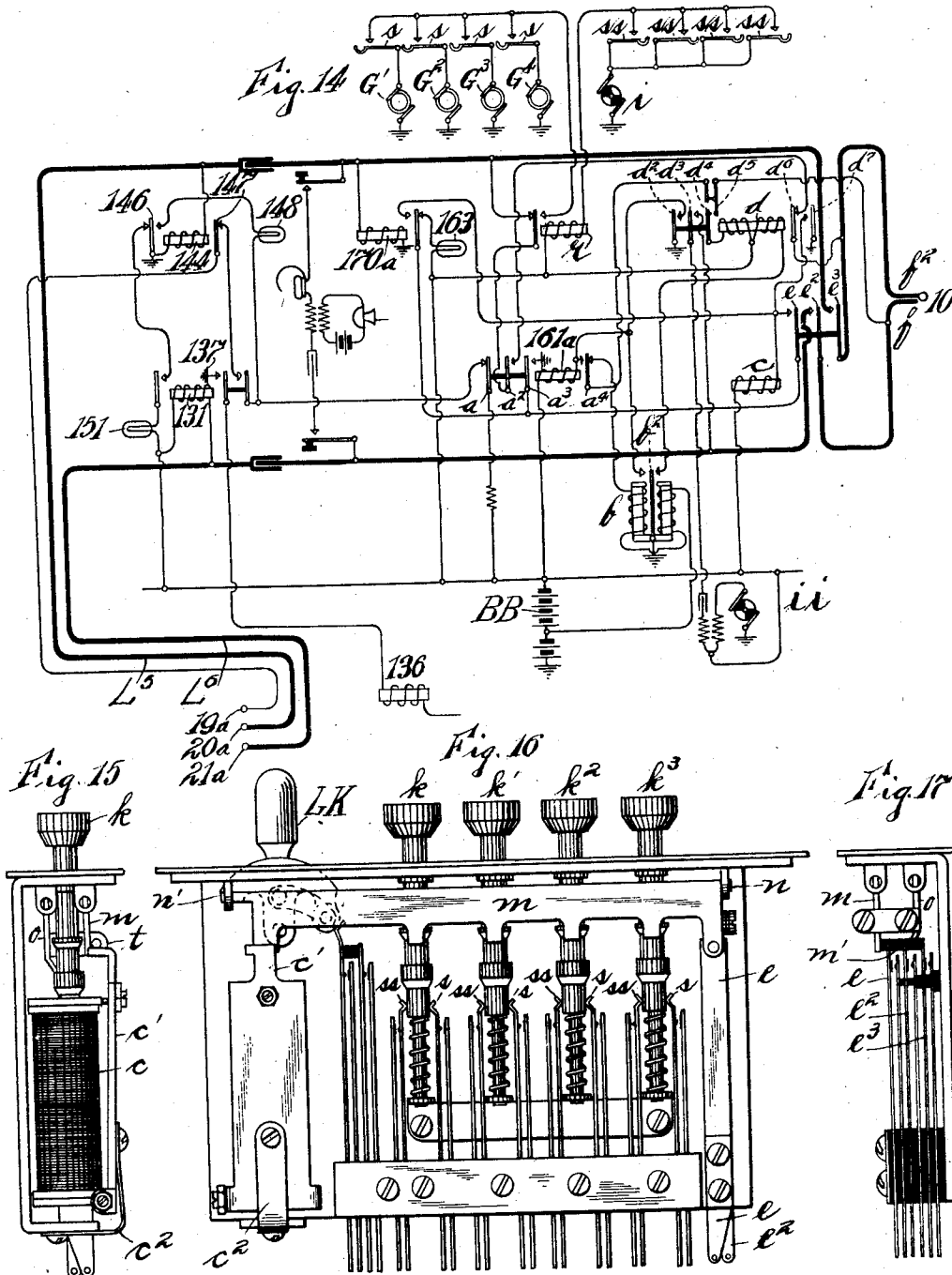
11 SHEETS—SHEET 10.



Witnesses
H. G. Olmstead
H. M. Webster

Inventor
Alfred H. Dyson
by Thomas H. Ferguson
Attorney

1,259,967.



Witnesses.
H. E. Olmstead.
H. W. Webster

Inventor
Alfred H. Dyson
by Thomas H. Ferguson
Attorney

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.

1,259,967.

Specification of Letters Patent.

Patented Mar. 19, 1918.

Application filed September 6, 1906. Serial No. 333,460.

To all whom it may concern:

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

The present invention relates to telephone exchange systems generally, and more particularly to that class in which automatic switch mechanism operates in response to the removal of a calling party's receiver from its hook, to automatically establish connection between a calling subscriber's line and an idle link-circuit terminating before an operator in manually controlled connecting means by which the circuit of the calling line may be extended to a desired called substation.

In systems of this class heretofore proposed, the subscribers' lines have usually been divided into groups and a definite number of operators' link-circuits assigned to each group, thereby providing a system in which a given subscriber would have access only to a limited number of operators. With such an arrangement, it is impossible to obtain the maximum efficiency, since at times the operators of one group may be over-worked, while those of other groups may be comparatively idle.

One of the objects of the present invention is to devise a system in which any subscriber's line may have access to any operator's link-circuit. Generally stated, this is accomplished by a particular grouping of the link-circuits in association with the interconnecting switch mechanism. This switch mechanism comprises a plurality of electrically controlled switches which operate, when once set in operation by a calling party, to progressively link together idle link-circuits of the different groups until the calling line circuit is extended to the first idle operator's link-circuit. In the preferred form of my invention, I do not employ switches individual to the subscribers' lines, as has heretofore been proposed; but I make use of an arrangement, heretofore proposed by me, according to which the subscribers' lines are arranged in groups and each group is provided with a plurality of switches which I term "line selectors," fewer in number than the number of lines in the group, and each group of line selectors is

controlled by a simple switch mechanism common to the group. These line selectors are connected to an equal number of similar switches called "first selectors," which are operated to establish connection through other link-circuits to the first idle ones of certain so-called "second selectors" which are in turn operated to establish connection with the first idle operator's link or cord-circuits. On a basis of ten per cent. trunking, which is that commonly employed, a ten thousand line exchange, equipped in accordance with my invention, may provide means by which any subscriber may obtain connection with the first idle one of a thousand operators' link-circuits. In such a system, the ten thousand subscribers' lines would be divided into one hundred groups of one hundred lines each, the line and first selectors would be united by one hundred groups of ten link-circuits each, first and second selectors would be similarly united by one hundred groups of ten link-circuits each, while the second selectors would be connected to one thousand manually equipped operators' link-circuits, thus requiring one thousand selectors of each type and one hundred control or master-switch mechanisms. With this organization, the single act of removing the receiver from its switch-hook at the calling station causes the successive operation of a line selector, a first selector, and finally of a second selector to establish connection between a calling line and the first idle operator's link-circuit.

In such an exchange system, that is, one having ten thousand subscribers' lines employing one thousand cords, my invention contemplates dividing these into ten great groups of one hundred cords each, the cords of the first group being assigned in regular numerical order, by tens, to operators one to ten, the cords of the second group to operators eleven to twenty, and so on.

The cords of the first one hundred cord group are provided each with passive multiple contacts at the banks of one hundred "second selectors," which, when operated, test the cords and connect with the first idle one, so that if operator number one has one idle cord among her ten, the second selector will pick out and connect with that cord; if all her cords are busy, the second selector will pass on to the cords of the second operator; and if an idle cord is there found,

will connect with it, and so on to the third and succeeding operators.

Similarly, the cords of the second, third and fourth great groups of one hundred cords each are provided with multiple passive contacts appearing at each of one hundred second selectors; one hundred such switches being assigned to the second group of one hundred cords belonging to operators 11-20; one hundred to the third group of cords belonging to operators 21-30, and so on up.

These second selectors are connected to link-circuits, each link-circuit terminating in multiple passive contacts at the banks of one hundred "first selectors;" the arrangement being such that each first selector bank includes multiple passive terminals of ten link-circuits extending to second selectors belonging to each great group of cords, aggregating for each first selector one hundred multiple link-circuit terminals. The terminals of link-circuits extending to the second selectors of the first one hundred group of cords—those belonging to operators 1-10—are so positioned at the first selector banks as to be first tested when a first selector is operated. If one of them be found idle, the first selector connects with it, and the second selector then selects the first idle cord of its one hundred cord group.

The terminals of link-circuits extending to the second selectors of the second one hundred group of cords—those of operators 11 to 20—are so positioned at the first selector banks that they will be tested by the first selector when operated, as soon as the first selector has tested the link-circuits of the before-mentioned first group, provided these have been found busy; and if one of the second group of second selectors is idle, the first selector will connect with it and the second selector will pick out the first idle cord of its one hundred line group; and so on with the other groups of second selector link-circuits.

The first selectors are provided in number, less than the number of lines of the exchange, and need be in number only about ten per cent. of the lines. They are connected to link-circuits terminating in switches called "line selectors," there being one line selector for each first selector; the line selectors and first selectors being in permanently united pairs.

By the instrumentality of the line selectors, the first selectors are capable of being temporarily interchangeably associated with different calling lines.

Having assumed an exchange employing one thousand cords, as many as ten thousand lines may be led into the exchange without overtaxing the effective capacity of the cords.

These lines would be divided into one hundred groups of one hundred lines each. The

one hundred lines of each group would have their individual passive multiple contacts appearing at the banks of ten line selectors, which would be assigned to them. The lines would, of course, be also provided with multiple jacks in the usual manner. If a calling subscriber of any group removes his receiver, he thereby automatically starts the operation of an idle one of the line selectors belonging to the line group which includes his line. This started line selector seeks out the multiple contacts of his line and connects thereto, thereby of course connecting to the calling line an idle first selector. The idle first selector automatically operates and tests multiple contacts of the link-circuits terminating at second selectors of cords belonging to operators 1-10. If one of these second selectors is idle, it means that one or more of these operators has one or more idle cords. In such case, the first selector stops connected to the idle second selector; and the latter (now in connection with the calling line) begins its operation, testing first the cords of operator number one; finding one idle, it will connect the calling line to it and signal the operator; finding all busy, it will pass on to operator number two, and so on until it finds and connects with the first idle cord included somewhere before operators 1-10, as tacitly promised by the second selector when it permitted itself to be selected by the first selector.

Of course, it will be understood that if the first selector, being operated, found the ten link-circuit terminals of second selectors of cords belonging to the group of operators 1-10 all busy, it would pass on and test those of operators 11-20; those being all busy, it would pass on and test those of operators 21-30, and so on up until it found an idle second selector.

Thus it may be stated that a first selector, temporarily associated with a calling line, tests the operators' positions of the exchange in groups of ten, connecting the calling line to a second selector representing the first such idle group; and that the selected second selector then tests the operators' positions of its group connecting the calling line through to the first idle cord-circuit of the first idle operator's position. It will of course be understood that the numerical values given are for purposes of a concrete example and may be varied as commercial conditions require.

My invention also contemplates a structure wherein the first selectors are omitted and the individual line selectors are connected, by their link-circuits, with individual second selectors which connect directly with cords. In such case, the one hundred cord selecting switches of cords 1-100 (those belonging to operators 1-10) would be, of

course, connected to one hundred line selectors, which number would be sufficient for one thousand subscribers' lines which might be lines 1-1000. The one hundred cord selecting switches of cords 101-200 (belonging to operators 11-20) would be connected to one hundred line selectors which might be assigned to lines 1001-2000, and so on up with the other groups of cords, operators and lines. It will be understood in this case that the calls from subscribers 1-1000 would always come in on the one hundred cords of operators 1-10, the first operator receiving all calls until her cords are all busy, when operator number 2 would begin to receive calls, and so on up; while all calls from subscribers 1001-2000 would similarly come in on the one hundred cords of operators 11-20, etc.

I also contemplate an arrangement of cords before the operators, such that operator number one would have before her the first cord from each one thousand line subscriber's group; operator number two the second cord from each such group; operator number three the third cord from each such group, etc.

Various arrangements, varying from those suggested, may be readily made without departing from the spirit of my invention. In carrying out my invention, I prefer to employ mechanical switches whose active contacts are capable of movement in two intersecting planes; the movements in the first plane being called primary movements, while those in a second plane are called secondary movements. A more rapid operation may be secured by the employment of such switches as each primary movement may be employed to test a group of bank contacts, while the secondary movement may be employed to test the individual contact sets of a group, wherein the preceding group-test has indicated the presence of idle contacts. My invention is, however, not limited to the employment of switches wherein the contacts are groupwise arranged.

Another object of my invention is to provide a system of the character indicated which shall be simple and compact in construction, efficient in operation, and economical to manufacture, install and maintain.

It will also be understood that in developing the invention along the lines indicated, I provide certain novel features and arrangements which are capable of use in many relations and need not be limited in their application to the system and its modifications herein disclosed.

The various features and aspects of the invention will be more fully understood upon reference to the following detailed description taken in connection with the ac-

companying drawings, and the scope of the invention will be particularly pointed out in the appended claims.

Referring to said drawing, Figure 1, which includes parts 1, 2 and 3, which are adapted to be placed end to end to complete the figure, is a diagram of a system embodying the preferred form of my invention in which line, first and second selectors are employed. Fig. 2, which includes parts 1 and 2, is a diagram of substantially the same system with one set of selectors omitted. Fig. 3 is a front elevation of the master-switch mechanism for the control of the line selector. Fig. 4 is a side elevation of the same, the inclosing cover being shown in section. Fig. 5 is a partial sectional view of a line selector switch, illustrating principally the primary magnet and its associated mechanism, the section being taken on a plane indicated by the line 5-5 of Fig. 7. Fig. 5^a is a detail view of an off-normal switch of the line selector. Figs. 6, 7 and 8 are elevations of a line selector, each viewed from a different side. Fig. 9, which includes parts 1 and 2, is a diagram similar to Fig. 2 of a three wire system constructed in accordance with the present invention. Figs. 10, 11, 12 and 13 illustrate modifications of that portion of the system shown in part 1 of Fig. 1. Fig. 14 illustrates an alternative operator's link-circuit arrangement, which may replace that of Figs. 1 or 2. Figs. 15, 16 and 17 are views of a party line key of the character illustrated diagrammatically in Fig. 14. Throughout these views, like characters refer to like parts.

Referring in detail to the drawing and more particularly for the present to the diagram of Fig. 1, A designates the substitution equipment of two lines which terminate at the exchange in multiple contacts of line selectors and in multiple jacks. Connection is obtained between a calling and a called line through the agency of the master-switch mechanism B, line selectors C, first selectors D, second selectors E and the manually operated connecting means F. In practice, on a basis of ten thousand subscribers' lines and ten per cent. trunking, as previously indicated, there would be one hundred control switches B, one thousand first selectors D, one thousand second selectors E, one thousand link-circuits L¹, L², uniting the line- and first selectors, one thousand link-circuits L³, L⁴, uniting the first and second selectors, and one thousand manually equipped link-circuits L⁵, L⁶. With this apportionment, each subscriber's line would be multiplied to ten line selectors, each link-circuit L³, L⁴ to one hundred first selectors, and each operator's link-circuit L⁵, L⁶ to one hundred second selectors. It is of course to be understood that this ex-

ample is given largely for the purpose of making clear the arrangements of the link-circuits and interconnecting switches and that the values given may be varied to suit any required condition.

The operation establishing connection between a calling line and an idle operator's link-circuit L^5 , L^6 , briefly stated, involves the following steps: The calling party removes his receiver and thereby, through the agency of the control or master-switch mechanism B, sets an idle line selector C into operation to automatically pick out and establish connection with the calling line, thus extending the calling line circuit over the link-circuits L^1 , L^2 , to a first selector D. Thereupon the first selector is automatically set into operation to pick out an idle link-circuit L^3 , L^4 , extended to a second selector; and in turn the second selector is automatically operated to pick out an idle operator's link-circuit L^5 , L^6 . A signal is then displayed before the operator and she completes the connection, after making the usual busy test, by inserting the plug 10, in which the link-circuit strands L^5 , L^6 terminate, into a jack 11 of the called line. Supervision is then had in the usual way; and at the termination of conversation, all parts may be restored to normal.

In the form of the invention illustrated in this figure, the control switch mechanism B comprises a differential relay 12, which controls the circuit which is instrumental in starting an idle line selector. It also comprises a relay 13 which is energized after a definite movement of the first selector to in turn energize a motor magnet 14 to step the wipers 15—16 over their associated contacts 17 and 18 respectively.

The line selector switch C comprises the bank contacts 19, 20, 21 and 22, with which the wipers 23, 24, 25 and 26 cooperate in making connection between the link-circuit strands L^1 , L^2 , and the limbs T^1 , T^2 of the calling line. The wipers 24, 25 and 26 are given both a primary movement and a secondary movement in response to the energizations and deenergizations of the primary magnet PM and the secondary magnet SM respectively. By the primary movement, these wipers are stepped to that group of bank contacts in which the calling line contacts are located; and by the secondary movement, they are moved over the contacts of the selected group until the calling line contacts are encountered. The selection of the group is obtained through the provision of the passive contacts 19, each of which corresponds to a group of bank contacts, and the wiper 23 cooperates with these in selecting the group in which the calling line contacts are located. Normally, the contacts 19—20 are grounded; but as soon as a call is initiated, the contact 20, cor-

responding to the calling line, and the contact 19, corresponding to the group in which the contacts 20 of the calling line are located, have their normal grounds removed. Thus in the operation of the switch, all the wipers are stepped around until the wiper 23 engages an ungrounded contact 19; then the secondary movement of the wipers 24, 25 and 26 takes place and is continued until the wiper 24 engages the ungrounded contact 20 of the calling line, the wiper 23 not partaking of the secondary movements. The bank contacts 19, 20, 21 and 22, as previously indicated, are multiplied to the corresponding bank contacts of other line selectors, one set of which is shown at 19', 20', 21' and 22'.

The first and second selectors D and E are similar in construction and operation to the line selectors C, but their wipers are caused to be moved in a primary direction to a group of bank contacts in which contacts connected with a first idle link-circuit are located; then three of the wipers are moved in a secondary direction until they reach the bank contacts of the first idle link-circuit. In this way, as soon as the line selector has established connection with a calling line, the first selector associated with it is set in operation and this selector automatically picks out an idle link-circuit running to a second selector, which in turn is set in operation and establishes connection with an idle operator's link-circuit, thereby extending the calling line circuit through idle link-circuits of the different groups of link-circuits to an idle operator's link- or cord-circuit.

Considering this operation more in detail, it will be observed that the removal of the receiver 27 from its switch-hook 28 at the substation of the calling party completes a bridge between the two line limbs T^1 and T^2 , through the transmitter 29, at the same time interrupting the normally closed bridge between said line limbs through the condenser 30 and call-bell 31. A circuit is then closed from the live pole of the battery B' through the protective resistance 32, normal contact 33 of the relay 34, normal contact 35 of the relay 36, line limb T^2 , switch-hook 28, receiver 27, transmitter 29, line limb T^1 , normal contact 37 of relay 36, normal contact 38 of relay 34, winding of the relay 39, to ground at 40. The closing of this circuit energizes the relay 39 to attract its contacts 41, 42, 43 and 44. Contact 42, moving to its alternate position, completes a locking circuit for the relay 39 extending from the live pole of the battery B', through resistance 32, normal contact 33 of relay 34, normal contact 45 of relay 36, alternate contact 42 and winding of relay 39 to ground at 40, thereby preventing interference from the substation. Contact 43, 130

moving to its alternate position, completes a circuit for the control magnet 46 from the live pole of the battery B', through the winding of said magnet and alternate contact 43 to ground at 40. The magnet 46 is thereby energized to attract contact 47 to remove the normal ground at 48 from the group contacts 19—19' corresponding to the line T'—T². The contacts 20—20', corresponding to this line, are normally grounded over a path extending through normal contact 41 to ground at 50. The contact 41, moving to its alternate position, therefore, removes the normal ground from these contacts 20—20' and also provides a path for current from the live pole of the battery B', through the winding of relay 34, alternate contact 41 and to the contacts 20—20' corresponding to the calling line. The movement of the contact 44 to its alternate position completes a circuit for the winding 51 of the differential relay 12 extending from the live pole of the battery B' over conductor 52, winding 51, conductor 53 and resistance 54' to ground at 40. As will appear more fully hereinafter, the contacts 15—16 of the master-switch mechanism B are left, after each operation, upon contacts 17 and 18 respectively, extending to an idle line selector. As illustrated, normally there is no path for current through winding 54 of the relay 12. Consequently the completion of the circuit through the winding 51 energizes the relay 12 sufficiently to move its contact 55 to its alternate position, thereby placing ground at 56 upon the wiper 15 and completing a circuit through the primary off-normal switch contact 57, the winding of the primary relay PR of an idle line selector, through the normally closed contacts 58—59 of the heat-coil 60 to the live pole of the battery B'. The closing of this circuit energizes the primary relay PR to move its contacts 61, 62, 63 and 64 to their alternate positions. The movement of the contact 61 completes a path for current through the winding 54 of the differential relay 12 extending from battery conductor 52 through said winding, through resistance 65 and alternate contact of 61 to ground at 66. The resistance 65 in the circuit of the winding 54 balances resistance 54' in the circuit of winding 51 so that one winding substantially neutralizes the other in its magnetizing effects and the contact 55 is allowed to return to normal. The contact 62 of the primary relay PR, moving to its alternate position, closes current through said relay from the live pole of the battery B' through the heat-coil 60, winding of the relay PR, alternate contact 62 to wiper 23. Contact 64 of the primary relay PR, moving to its alternate position, interrupts the normal circuit extending through the secondary relay SR; while the movement of the contact 63 to its alternate position completes a vibratory circuit through the primary magnet PM to ground at 67. The repeated energization and deenergization of the magnet PM, by reason of its vibratory circuit and its mechanical connection to the wipers 23, 24, 25 and 26, hereinafter referred to more fully, will cause said wipers to move in a primary direction until the group of contacts, in which the contacts corresponding to the calling line are located, is reached. Upon the first primary movement of these wipers, the off-normal switch contacts 57 and 68 are moved to their alternate positions. The movement of the former interrupts the initial energizing circuit of the primary relay PR; but by reason of the movement of the wiper 23 into engagement with a contact 19, the circuit of relay PR is maintained through said wiper 23, contact 19 and contact 62, in case contact 19 is grounded. Thus the circuit of the relay PR will be maintained as long as the wiper 23 is passing over grounded contacts 19, and it in turn will maintain the vibratory circuit of the primary magnet PM. As soon, however, as the contact 19, corresponding to the group in which the calling line contacts are located, is reached, the maintaining circuit of the primary relay PR will be interrupted at the attracted contact 47 of the relay 46. Thereupon the circuit of the primary magnet PM will be also interrupted at the then retracted contact 63; and at the same time, the circuit for the secondary relay SR will be completed at the retracted contact 64. This circuit extends from the live pole of the battery B', through the heat-coil 60, winding of the relay SR, normal contact 69, normal contact 64 and alternate contact 68 to ground at 70. The closing of this circuit will energize the relay SR to move its contacts 71, 72, 73 and 74 to their alternate positions. Contact 71, by its movement, interrupts the circuit of the release magnet RM; and contact 72 by its movement removes ground at 75 from the wiper 24 and completes a path for current through the winding of the relay SR to said wiper. The movement of the contact 73 to its alternate position maintains a path for the winding 54 of the differential relay 12. This path, upon the return of the contact 61 of the primary relay PR, extends through normal contact 76 and alternate contact 77 to ground at 78. At this point, it may be noted that the release switch (R. Sw.) contacts 77 and 79, as well as 57 and 68, are moved to their alternate positions upon the first primary movement of the wipers of the switch; while the secondary off-normal switch (S. O. Sw.) contacts 69 and 76 are moved to their alternate positions upon the first secondary movement of the wipers.

As soon, therefore, as the wipers have begun their secondary movement, this path to ground for the winding 54 of the differential relay 12 is maintained through alternate contact 73 of the secondary relay SR and alternate contact 77 to ground at 78. The movement of the contact 74 to its alternate position closes a vibratory circuit for the secondary magnet SM which extends from the live pole of the battery B', through the heat-coil 60, the winding of the magnet SM, alternate contact 74, alternate contact 79 to ground at 78. The repeated energizations and deenergizations of this magnet, by reason of the mechanical relations of the parts, cause the wipers 24, 25 and 26 to move in a secondary direction over the contacts 20, 21 and 22 until an ungrounded contact is encountered. It may be stated at this time that wiper 23 moves along with the wipers 24, 25 and 26 only when the primary movement of the switch is being performed. The just described secondary movement of wipers 24, 25 and 26 is performed independently of wiper 23, the latter remaining stationary, engaging the ungrounded contact 19 sought out by it. As before indicated, upon the first secondary movement, contact 69 is moved to its alternate position, thereby interrupting the initial circuit of the magnet SR which thereafter maintains its circuit through alternate contact 72, wiper 24 and contact 20 to ground until an ungrounded contact 20 is encountered. When such a contact is reached, the relay SR is deenergized and its contacts 71, 72, 73 and 74 return to normal, leaving the wipers 25 and 26 in engagement with the passive contacts 21 and 22 of the calling line and thereby extending the calling line circuit through the link circuit strands L'-L² to the first selector D pertaining to the operated line selector C. The return of the contact 72 to its normal position again places ground on the wiper 24 and thereby completes a circuit for the relay 34 extending from the live pole of the battery B' through the winding of said relay, alternate contact 41 of relay 39, contact 20, wiper 24, normal contact 72 to ground at 75. The completion of this circuit energizes the relay 34 to cause the attraction of its contacts 34', 38, 80, 49 and 33. By the movement of contact 49, a locking circuit is completed for the relay 34 extending from the live pole of the battery B', through the winding of said relay, alternate contact 49, contact 20, wiper 24, normal contact 72 to ground at 75. The movement of contact 33 interrupts the circuit of the relay 39, thereby allowing its contacts 41, 42, 43 and 44 to return to their normal positions. The return of the contact 44 interrupts the circuit through the winding 51 of the differential relay 12, while the return of the contact 73 of the relay SR to its normal position similarly interrupts the circuit of the other winding 54 of said differential relay. Since these interruptions of the circuits of the windings 51 and 54 occur practically simultaneously, the contact 55 of said relay is not attracted. However, it will be observed that if at any time while they are thus included in circuit, a second call causes the grounding of the conductor 53 through the resistance 54', the flow of current through the winding 51 will exceed that through the winding 54 and the previous balance in said windings will be destroyed and the contact 55 again moved to its alternate position to cause the operation of a second line selector. Of course this cannot occur until the contacts 15 and 16 of the control switch mechanism B have been moved into engagement with contacts 17 and 18 associated with such a selector. This movement, however, occurs as soon as the previous line selector has made its first primary movement, since, by that movement, its primary off-normal switch contact 68 is moved to its alternate position, thereby completing a circuit for the relay 13 of the switch mechanism B, which may be traced from the live pole of the battery B', over conductor 52, through winding of relay 13, contacts 16-18, and alternate contact 68 to ground at 70. The closing of this circuit energizes the relay 13 and thereby closes a vibratory circuit for the motor magnet 14 of said mechanism, which may be traced from the conductor 52 through the winding of said magnet, and alternate contact 81 to ground at 82. By reason of the mechanical relation of the parts, the energizations and deenergizations of the motor magnet 14 step the wipers 15 and 16 over the contacts 17 and 18 until a contact 18 of an idle switch C is encountered. As soon as this occurs, the circuit of the relay 13 is open at contact 68 of this switch with a consequent interruption of the vibratory circuit of the magnet 14 and cessation of movement of the wipers 15 and 16. Returning again to the consideration of the effect of the energization of the relay 34, it will be seen that (in addition to deenergizing the relay 39) by movement of its contact 80 to its alternate position, battery is connected through the resistance 32 to the sleeve contacts of the jacks 11 associated with the calling line, thereby putting them in condition to indicate the busy condition of the line upon the usual manual test.

By the movement of contact 38 of relay 34, the circuit extending from the substation through the winding of the relay 39 is interrupted, thereby placing said relay beyond the control of the calling party. The relay 34 thus serves as a cut-off relay to remove the normal substation control of the relay 39 whenever the line with which it is as-

sociated is used as a calling line. However, when the line is to be used as a called line, the application of battery to the sleeve of one of the jacks 11, associated therewith, completes a circuit for the relay 36 through the normal contact 80 and the winding of said relay to ground at 83. The energization of this relay causes the movement of its contacts 35—37—45 to their alternate positions. By the movement of contacts 35 and 37, the substation control of the relay 39 is removed.

Referring now to the first selector switch D, which is associated with the distant ends of the link-circuit L'—L², it will be seen that it is similar in all essentials to the line selector switch previously described. It is automatically set in operation upon the return of the contact 71 of the secondary relay SR of the line selector, which completes circuit for the primary relay PR' from the live pole of the battery B², through the winding of said relay PR', normal contact 84, conductor 85, normal contact 71, winding of the release magnet RM of the line selector, alternate contacts 76 and 77 to ground at 78. The completion of this circuit does not cause any effective energization of release magnet RM, the winding of RM and PR' being properly proportioned to this end, the latter being relatively high, while relay PR' is energized sufficiently to attract its contacts 86—87—88 to cause the operation of the first selector D in a manner similar to that heretofore described in connection with the line selector C. Thus the movement of the contact 87 completes a vibratory circuit for the primary magnet PM' through the alternate contact 87 to ground at 89, thereby causing the wipers 23^a—24^a—25^a—26^a to move in a primary direction along the associated passive contacts 19^a—20^a—21^a—22^a. The first movement of the wipers in a primary direction moves the primary off-normal switch contacts 84—90 to their alternate positions. This movement of the contact 84 interrupts the initial circuit of primary relay PR', but in the meantime the wiper 26^a has been moved into engagement with the first contact 22^a. If the latter be associated with a group of ten contact sets whose switches E are all in use, the contact 22^a will be grounded through alternate contact 119 at 120, because each of the ten switches E of a group has its individual relay 114 or 114', etc., whose armatures, when attracted, remove tension from bar 118. When a switch E is in use, its magnet 114 is energized; and when all ten are so energized, all tension is removed from bar 118, and contact 119 is allowed to assume its alternate position. In such case, a locking circuit for relay PR' from ground 120, alternate contact 119, contact 22^a—26^a, alternate contact 86 to battery, is completed,

and successive primary steps of the wipers are made until wiper 26^a engages a contact 22^a which is ungrounded, or in other words, a contact 22^a pertaining to a group of ten contact sets of switches such as E, among which one or more idle switches E are to be found, and consequently one or more deenergized relays 114, 114', so that contact 119 is retracted. When such contact is reached, the locking circuit through relay PR' is of course interrupted, the relay deenergized, and the wipers cease their primary movement. During the energization of the relay PR', normal circuit of the secondary magnet SR' is interrupted at contact 88. As soon, however, as this contact returns to its normal position, the secondary relay SR' is energized over a circuit extending from the live pole of the battery B², through the winding of said relay SR', normal contact 91, normal contact 88, alternate contact 90 to ground at 92. The energization of the relay SR' will move its contacts 93—94—95—96 to their alternate positions. The movement of the contact 93 will interrupt the normal circuit of the release magnet RM'. The movement of the contact 94 will close a vibratory circuit for the secondary magnet SM' extending from the live pole of the battery B², through the winding of said magnet, alternate contact 94, alternate contact 97 to ground at 98. In this connection it should be noted that the release switch (R. Sw.) contact 97 moves to its alternate position upon the first primary movement of the first selector D; and the secondary off-normal switch (S. O. Sw.) contact 91 moves to its alternate position upon the first secondary movement of said selector. The movement of the contact 91 to its alternate position, therefore, interrupts the initial circuit of the secondary relay SR', but its circuit is maintained as long as the wiper 23^a engages a grounded contact 19^a over a path extending from the live pole of the battery, through winding of said relay SR', alternate contact 93, wiper 23^a and contact 19^a to ground. Contacts 19^a, engaged by the wiper 23^a, when associated with link-circuits L³—L⁴ which are in use, will be connected to ground through a multiple contact 19^a, a wiper 23^a engaging said contact, a normal contact 93 and winding 99 of release magnet RM' of another switch D to ground at 100. The winding 99 of release magnet RM' and the winding of secondary relay SR' are so proportioned (the windings of the latter being high), that when thus placed in series circuit, the energization of the winding 99 will be so slight as not to cause any effective energization of the release magnet RM', while relay SR' will continue effectively energized. As soon, however, as contact 19^a of an idle link-circuit in the group is encountered, the maintaining cir-

cuit for the secondary relay SR' will be interrupted because such contact will be open at contact 102 of its switch E and said relay will be deenergized. During the energization of relay SR' , it will be observed that the attracted contacts 95—96 interrupt the link strands $L'-L^2$ so as to prevent interference with possible conversations existing over the multiple contacts over which wipers 24^a—25^a pass. Upon the deenergization of the relay SR' , the continuity of these link-circuit strands is restored, the circuit of the secondary magnet SM' is interrupted and continued motion of the wipers in a secondary direction is prevented. Thus, the circuit of the calling line is extended through the link-circuit strands $L'-L^2$, wipers 24^a—25^a, contacts 20^a—21^a and link-circuit strands L^3-L^4 to a second selector E .

Having thus extended the line circuit to an idle second selector E , the latter is automatically set in operation to pick out and establish connection with the first idle operator's link-circuit. The circuits for this selector are substantially the same as those of the first selector previously described. The second selector thus selected is set in operation by the return of the contact 93 of the first selector secondary relay SR' to its normal position, thereby completing a circuit from the live pole of the battery B^2 , through the winding of the primary relay PR^2 of the second selector E , normal contact 101 of the primary off-normal switch, contact 19^a, wiper 23^a, normal contact 93, winding 99 of the release magnet RM' (without causing any effective energization of RM') to ground at 100. This relay PR^2 attracts contacts 102, 103 and 104. Contact 103 now completes the circuit of the primary magnet PM^2 which moves the wipers 105, 106, 107 and 108 in a primary direction along the associated contacts 109, 110, 111 and 112 until the wiper 108 engages the first ungrounded group contact 112, thereby interrupting the circuit extending through the winding of the relay PR^2 , alternate contact 102, wiper 108, contact 112 to ground through alternate contacts 141 controlled by magnets 136, 136^a, individual to the cords F . Upon the first primary movement of the wipers, the primary off-normal switch contacts 101—113 are moved to their alternate position, contact 113 then completing a circuit from the live pole of the battery B^2 through the winding of the electromagnet 114 and thence by way of alternate contact 113 to ground at 115. The closing of this circuit energizes the electromagnet 114 to move its spring retracted armature 116 out of engagement with a shoulder 117 carried on a rod 118 associated with the spring contact 119. Each link-circuit of a group is provided with an electromagnet corresponding to the electromagnet 114, one other of which (designated 114') is shown. These electromagnets jointly control the common spring contact 119 which is biased so as to close its normally open contact and thereby ground its associated group contacts 22^a at 120 whenever all the link-circuits in the group are busy. As previously pointed out, under these conditions the wiper 26^a of the first selector passes to the next group contact and thus continues its movement until the first ungrounded group contact is encountered.

Upon the deenergization of the relay PR^2 , the circuit of the primary magnet PM^2 is interrupted and the further primary movement of the wipers discontinued as before. Likewise, as before, the return of the contact 104 to its normal position completes a circuit from ground 115 through the normal contact 121 for the secondary relay SR^2 , which, upon being energized, closes a circuit for the secondary magnet SM^2 , which extends through the alternate contact 122 of the secondary relay SR^2 and the alternate contact 123 to ground at 124, the release switch ($R. Sw.$) contact 123 being thrown to its alternate position upon the first primary movement of the switch wipers. At the same time, the link-circuit strands L^3-L^4 are interrupted at the contacts 125—126 of the secondary relay SR^2 while the circuit of the release magnet RM^2 is interrupted at the contact 127. The movement of this latter contact to its alternate position also closes a maintaining circuit for the secondary relay SR^2 through the wiper 105. The ground upon the busy contact 109 is provided by a connection through a multiple contact 109 engaged by a wiper 105 of another switch through its alternate contact 127, the winding 128 of its release magnet RM^2 to ground at 129. Secondary movements of wipers 105, 106 and 107 continue until the wiper 105 engages a contact 109 of a first idle cord which will be open at contact 152, and as before, this interrupts the circuit of the secondary relay SR^2 and causes its contacts to return to their normal positions, thereby closing the path from ground through the winding 128 of the release magnet RM^2 to wiper 105 and the multiple contacts of the selected cord to render it busy, interrupting the circuit of the secondary magnet SM^2 , and rendering the link-circuit strands L^3-L^4 continuous. Thus it will be seen that the circuit of the calling line is completed through first idle link-circuits of available groups to the strands L^5-L^6 of an idle link- or cord circuit before an operator, with the exception that so far as we have gone, the link-circuit strand L^4 is interrupted at contact 130. As soon as the wipers 106 and 107 of the second selector engage contacts 110—111 of the idle link-circuit, and contact 126 is closed, a path for current is completed from the live

pole of the battery B³, through the sleeve supervisory relay 131, over the strand L⁶ and strand L⁴, through the winding of relay 132 to ground at 133. The closing of this circuit will energize both relays 131 and 132. The energization of relay 132 will complete the continuity of the link strand L⁴ by closing contact 130; and by opening its contacts 134, will remove the shunt about the winding 128 of the release magnet RM². The movement of the contact 135 of the sleeve supervisory relay 131 will complete a circuit for control electromagnet 136 from the live pole of the battery B⁴, through the winding of said relay and alternate contact 135 to ground at 137. The closing of this circuit will energize the electromagnet 136 so as to move its spring retracted armature 138 out of engagement with the collar 139 on the rod 140 associated with the grounded spring 141, by which ground is placed upon the group contacts 112 whenever all the link-circuits in the group are in use, in a manner similar to that previously explained in connection with the electromagnets 114 associated with the link-circuits L³—L⁴.

It will be apparent, of course, that if desired, a given operator's link-circuit may be rendered busy by completing a circuit through the winding of the electromagnet 136 at a manually operated switch such as 142 to ground as at 143. It will also be apparent that any desired group of link-circuits may be rendered artificially busy by grounding the associated contacts 112 by a manually controlled switch such as the switch 142', adapted to connect said contacts to ground at 143'. Similarly, by means of a manual switch 142^a, cooperating with a battery connection 143^a and a grounded connection 143^b, the private contacts 109 associated with the link-circuits of any particular group may be rendered artificially busy by throwing the switch to ground, or the second selector connecting therewith may be released by throwing the said switch to its battery connection 143^a, as will more fully hereinafter appear.

As soon as the relay 132 has been energized and the link-circuit strand L⁴ completed at contact 130, a path for current will also be completed through the strands L⁴—L², line limb T², through the switch-hook at the calling substation, line limb T', strands L'—L³—L⁵, through the winding of the tip supervisory relay 144 to ground at 145. The flow of current over this path energizes the relay 144 and thereby moves its contacts 146—147 to their alternate positions. Contact 146 will then complete a circuit from the live pole of the battery B³ through the call lamp 148, normal contact 149, alternate contact 146 to ground at 145, thereby lighting said lamp as a signal to the operator that connection is desired. The operation of contact 134 of relay 132 at second selector E is to be rendered slow as compared with that of contact 130, so that the latter will close before the former opens. The closing of 134 will thus complete circuit for relay 144 before the short circuit is removed from winding 128 of RM². Relay 144 will then open its normal contact 147 while magnet RM² is still short-circuited, thus insuring against a premature operation of RM² at the moment of selection. The attraction of the sleeve supervisory relay contact 150 closes the circuit for the supervisory lamp 151; but as the tip supervisory relay 144 is energized, this circuit is interrupted at the contact 146.

Upon observing the display of the call signal 148, the operator will throw over her listening-key levers 153—154 and include her telephone set S in bridge of the link strands L⁵—L⁶, thereby placing herself in communication with the calling party. At this time, transmission current is supplied from the live pole of the battery B³ through the winding of the relay 131 to one side of the talking circuit and from the grounded side at 145 of the battery B³ through the relay 144 to the other side of the talking circuit. Upon learning the number of the called line, the operator will test in the usual way, touching the tip contact of plug 10 against the sleeve contact of a jack 11 in which the called line terminates. If the called line is busy, a potential above that of ground will exist upon the test contact of the jack, and the touching of the tip of the plug will result in a flow of current over the strand L⁵ through normal contact 155, test relay 156 to ground, attracting contact 157 and completing a circuit through one of the windings of the induction coil 158 of the operator's set S and causing the usual "click" in the operator's receiver. If the line be thus found busy, the operator will then inform the calling party, and the restoration of his receiver to its hook will cause the release of the interconnecting switches and their return to normal, as will hereinafter be more fully explained.

If the called line is found to be idle, the operator will insert the plug 10 into a jack 11 and depress her ringing-key levers 159—160. The insertion of the plug will result in the completion of a circuit through the winding of the sleeve supervisory relay 161 and the cut-off relay 36 of the called line as follows: from the live pole of the battery B³, through the winding of relay 161, sleeve plug and jack contacts, normal contact 80 of relay 34 and winding of relay 36 to ground at 83. The energization of supervisory relay 161, by reason of the attraction of its contact 162, will complete a circuit for the supervisory lamp 163, which may be traced from the live pole of the bat-

tery B, through the protective resistance 164, alternate contact 162, supervisory lamp 163 and normal contact 165 to ground at 166, thereby causing the lamp 163 to light.

5 The energization of the cut-off relay 36 will result in connecting the sleeve contact of the jack to the line limb T' over the heavily lined path indicated; that is, through normal contact 80 of relay 34 and alternate contact 35 of relay 36. The depression of the

10 ringing-key levers 159 and 160 will result in applying ringing current from the non-grounded pole of the generator 167 to the limb T² of the called line, thereby operating

15 the call-bell 31 of the called party by current over a path returning by way of the line limb T', alternate contact 35, normal contact 80, plug and jack sleeve contacts, resistance 168 to ground at 169. As soon as

20 the called party responds to the call by removing his receiver 27 from its hook 28, an additional path for current will be closed from the contact 35 of cut-off relay 36, over line limb T', through the transmitter 29, receiver 27, switch-hook 28 at the substation,

25 returning over the line limb T², plug and jack tip contacts and contacts 159 and 155 of the tip strand L⁵, through the winding of the tip supervisory relay 170 to ground at 171, thereby energizing the relay 170 and

30 interrupting the circuit of the supervisory lamp 163 at contact 165. It will also be noted that upon the energization of the relay 161, as a result of plugging into the called line, the normally interrupted strand

35 L⁵ will be closed at contact 155 and the circuit of the call lamp 148 will be interrupted at contact 149. With the parties thus connected, the supervisory lamps 151 and 163

40 will remain dark until either or both parties hang up their receivers. When this is done, the circuit of the corresponding tip relay 144 or 170 will be interrupted at the substation and its contact or contacts will be

45 allowed to return to normal, thereby closing the circuit of the corresponding supervisory lamp. The lighting of both supervisory lamps 151 and 163 will signal the operator to take down the connection. During conversation

50 between the two parties, transmission current will be supplied to the called party from the live pole of the battery B³ through the winding of supervisory relay 161 to one side of the talking circuit; and

55 from the grounded pole of said battery, through the winding of relay 170, to the other side of the talking circuit. This talking circuit is shown in heavy lines between the substations.

60 Upon the display of the two supervisory lamps 151 and 163, the operator will remove the plug 110 from its jack, thereby interrupting the circuit through the supervisory relay 161 and the cut-off relay 36, deenergizing

65 them. The restoration of the receiver to its hook at the calling station having deenergized the associated tip supervisory relay 144, by the return of its contact 147, a circuit for the release magnet RM² of the

70 connected second selector switch is now completed. This circuit extends from the live pole of the battery B³, through resistance 164, normal contact 162, alternate contact 152, normal contact 147, contact 109, wiper

75 105, normal contact 127 and winding 128 of the release magnet RM² to ground at 129. The release magnet will thereupon be energized.

By reason of the mechanical relation of the parts, this energization of the release magnet RM² will cause the contact 123 to return

80 to its normal position; and since at this time the contact 121 is in its alternate position, a circuit will be completed for the secondary relay SR². The secondary relay

85 will thereupon be energized to move its contact 127 to its alternate position and interrupt the initial energizing circuit of the release magnet RM². However, upon the energization of magnet RM², its contact 172

90 is closed so that a new circuit is provided extending from the live pole of the battery B², through the winding 173 of release magnet RM², alternate contacts 172, 101, contact 19^a, wiper 23^a, normal contact 93, winding

95 99 of release magnet RM', to ground at 100. The completion of this circuit will maintain the release magnet RM² energized and will also energize release magnet RM'. The energization of release magnet RM'

100 will in turn cause the contact 97 to return to its normal position, thereby similarly completing a circuit for the secondary relay SR' and causing its energization. This

105 energization will interrupt the circuit through the windings 173 and 99 of the release magnets RM² and RM' respectively; and since there is no other maintaining circuit for the release magnet RM², it will be

110 deenergized; and upon its deenergization, due to the mechanical relation of the parts, the second selector switch E will be returned to its normal position. The energization of the release magnet RM' will also close

115 its contact 174 and thereby complete a circuit extending from the live pole of the battery B², through the winding 175 of release magnet RM', closed contact 174, alternate contact 84, conductor 85, normal contact

120 71, release magnet RM, alternate contacts 76 and 77 to ground at 78. The completion of this circuit will maintain the release magnet RM' energized and will initially energize the release magnet RM.

The energization of the latter will, by

125 reason of the mechanical relation of the parts, cause the contacts 77 and 79 to return to their normal positions, thereby interrupting the circuit through the winding 175 of the release magnet RM' and the winding of

130

the release magnet RM at contact 77. The deenergization of each of these magnets will cause the restoration of the parts of the first selector D and the line selector C respectively.

From the above it will be seen that I have devised a system in which groups of link-circuits L^1-L^2 , L^2-L^4 , L^5-L^6 , are so arranged that first idle link-circuits of the different groups may be automatically picked out by the operation of automatic switch mechanism to thread, as it were, a connection from the calling line through the link-circuits of the different groups to a first idle operator at an exchange, who may thereupon complete the connection.

Referring now to Fig. 2, which shows a system in which the second selector switches E are omitted, it will be observed that the first selector switch D', associated with the distant ends of the link-circuit L^1-L^2 , is substantially the same in construction and circuit arrangement as the selector switch D, already described. In this instance, the battery B⁴ replaces the battery B² as a source of current supply, and the link-circuit strand L^2 is normally interrupted at contact 130^a in the same manner as link-circuit strand L^4 was interrupted at contact 130 in Fig. 1. The control electromagnet 132^a, its contacts 130^a—134^a, and ground connection 133^a, perform substantially the same functions as the corresponding contacts and connections of relay 132 of Fig. 1. In view of these slight changes it is thought that the operation of the system shown in Fig. 2 will be fully understood when taken in connection with the description of Fig. 1 and therefore need not be explained in detail.

Obviously in the practice of the systems above described, many different forms of mechanical switch mechanism may be employed for performing the switching functions therein indicated. However, I preferably employ the switching mechanism illustrated in Figs. 3 to 8 inclusive.

Referring first to the master-switch mechanism B, which is illustrated in Figs. 3 and 4, it will be observed that the passive contacts 17 and 18 are arranged in a suitable arcuate bank 176 carried by suitable supporters 177 extending from base plate 178 to which an inclosing casing 179 is fitted. In the form illustrated, ten of each of these contacts 17 and 18 are shown, although obviously a greater or less number might be employed. The wipers 15 and 16, which cooperate with the contacts 17 and 18 respectively, are mounted upon the shaft 180, suitably journaled in the frame 181 and the base 178. Four of each of these wipers are employed and they are so positioned with reference to the cooperating bank contacts that as soon as one pair of wipers 15—16 passes beyond the last pair of contacts 17—18, another pair of wipers will pass

into engagement with the first pair of such bank contacts. The shaft 180 is provided with a ratchet wheel 182 which is adapted to be actuated by a pawl 183 carried by the armature 184 of the motor magnet 14 which was previously described as adapted to be included in the vibratory circuit. This circuit is made and broken by the contact 185—186 carried by the frame of the magnet in response to the movements of the armature 184. The beveled stop 187 cooperates with the beveled end of the pawl 183 to limit its forward movement so that the wipers are moved but a single step upon each energization and deenergization of the motor magnet 14. In the present instance, the wipers 15—16 are composed of spring material and, in wiping over the bank contacts, are frictionally held against return movement after the stroke of the actuated pawl 183.

Referring now to the line selector C, which is illustrated in Figs. 5 to 8 inclusive, 188 designates a suitable supporting frame for the switch parts which include the primary magnet PM, secondary magnet SM and release magnet RM. The frame also carries the fixed or passive contacts 20—21—22 which are arranged in the bank 189 with their free or outer ends adapted for the attachment of suitable conductors and have their contacting or inner ends terminating in a spherical surface. These contacts are suitably insulated from each other and the metal parts of the supporting frame 190 by which the bank is carried, and they cooperate with the wipers 24, 25 and 26 which are pivoted at the center of rotation of the spherical surface to the lower end of a rotary shaft 191, suitably journaled in the main supporting frame 188. The wipers are rotatable with the shaft 191 in a horizontal direction and in addition may be rotated vertically about their common pivot 192 through the agency of an additional, longitudinally movable shaft 193, having a broad foot 194, which engages a projection 195 extending rearwardly from the wipers. Thus, by rotating the shaft 191, the wipers may be given their primary movements to the group of bank contacts having their contact 19 ungrounded; and by subsequently moving the shaft 193 longitudinally, they may be given their secondary movement to ungrounded bank contacts in the selected group. The foot 194 on the shaft 193 is made sufficiently large to engage the projection 195, no matter in what position the wipers may be. For ease in operation, the projection 195 is provided with an anti-friction roller 196, which bears against the under side of the foot 194. In addition to the wipers and bank contacts thus provided, a horizontal row of passive contacts 19 is carried by the upper side of the bank con-

tacts 20—21—22. These contacts are arranged in an arc of a circle in a position to have their inner ends engaged by the wiper 23 carried by and insulated from the shaft 191. As will be apparent, wiper 23 is capable of a primary movement only, being operatively related to primary shaft 191 only, and does not partake of the secondary movement of the wipers 24, 25 and 26. The mechanism associated with the primary magnet PM, by which the shaft 191 is given its primary movement, or is rotated, to give the wipers their primary or rotary movement, comprises an actuating pawl 197 (Fig. 5), carried by the armature 198 which is suitably fitted to the magnet frame 199, carried by the main frame 188. The pawl 197 is adapted to engage the teeth of the ratchet wheel 200 to step the shaft 191 around. The movements of the pawl 197 are limited by the beveled stop 201 and the shaft is retained in its various positions by the retaining pawl 202 which is pivotally supported on the frame and is normally disengaged from the teeth of the ratchet wheel 200.

The upper end of the shaft 191, as illustrated in Fig. 5^a, carries a member 203 having a projection 204 which normally maintains the primary off-normal switch (P.O.Sw.) spring contacts 57 and 68 in their normal position; 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 205, actuating pawl 206, and the ratchet teeth 207 of the secondary shaft 193, steps the latter downward to carry the contacting ends of the wipers 24, 25 and 26 in a secondary direction to the desired passive contacts. A suitable retaining pawl 208 engages the teeth 209 upon the shaft 193 to hold it in its different operative positions. This retaining pawl is suitably mounted upon the main frame 188 through the agency of a plate 210 secured to said frame. The shaft 193 is also provided with a suitable spline 211, which, after the first movement of the shaft, engages a tooth of the ratchet wheel 200 to lock the shaft 191 against rotation. The secondary off-normal switch (S.O.Sw.) contact springs 69 and 70 are held at normal against their spring tension, as illustrated in Fig. 7, through the agency of a projection 212 carried by the upper end of the shaft 193. The outer end of this projection normally engages a pin 213 to hold the contacts in this position. The vibratory circuit of the primary magnet PM is completed through the contact 214—215 carried by the magnet frame 199 and actuated by the rearward projection 216 upon the armature 198 of said magnet. The vibratory circuit of the secondary magnet SM is completed through

the contacts 217—218 carried on a secondary magnet frame and cooperating with the armature 205 in the making and breaking of the circuit.

Upon the energization of the release magnet as previously pointed out, the release switch (R. Sw.) contacts 77 and 79 are moved to their normal positions, which is that illustrated in Fig. 8. This movement is brought about through the agency of a member 219 carried by the armature 220 of the release magnet. This member extends beyond the contact spring 79, which spring it brings up to its normal position upon the attraction of the armature 220. The movement of the contact spring 79 is transmitted to the spring 77 through the agency of an intervening insulating block 221. These contact springs have a tendency to move to their alternate position, but they are normally restrained against such movement by the catch 222 pivotally supported at its middle upon the support 223 carried by the main supporting frame 188. The catch 222 is removed from its retaining position to allow springs 77 and 79 to move to their alternate positions upon the first energization of the primary magnet PM, through the agency of a lever 224 pivotally supported upon the frame 188 and having one end lying in the path of movement of the armature 198 of the primary magnet. This end is provided with an upturned projection 225 which bears against the under side of the catch 222. Upon the first movement of the armature 198, the lever 224 is rocked about its pivot; and its upturned end, which is provided with an anti-friction roller, rides over the inclined surface 226 on the under side of catch lever 222 so as to rock the latter about its pivot and thereby release the springs 77—79 and allow them to move to their alternate positions. A spring 227 holds the catch lever 222 in its engaging position.

As previously indicated, after the wipers have been given their primary and secondary movements, they are retained in their connected positions by means of the primary and secondary retaining pawls 202 and 208. In giving the wipers their primary movements, the shaft 191 is rotated against the tension of a spiral spring 228 contained in the suitable casing 229, carried by the frame 188, one end of the spring being secured to the casing, and the other to the shaft in a common well-known manner. Similarly, in giving the wipers their secondary movement, they are rotated against the tension of a spiral spring 230 located about the pivot 192 and cooperating with the secondary shaft and said wipers to move the contacting ends of the wipers below the passive contacts and the bank 189. In view of this, it is therefore only necessary, in order to

return the wipers and their switch parts to their normal positions, to disengage the pawls 202 and 208 from the primary and secondary shafts, respectively. As previously indicated, this is brought about upon the deenergization of the release magnet RM. Upon said deenergization, the retraction of the armature 220 draws the member 219 with it (Fig. 8) and this member is arranged to engage the retaining pawls at this time and to move them out of their engaging position. This will be more apparent from an inspection of Fig. 5, from which it will be seen that the primary retaining pawl 202 is provided with a tail having an upturned end 231 which is adapted to pass through a cooperating opening 232 in the member 219. Similarly, the secondary retaining pawl 208 is provided with a tail having a similar upturned end 233, similarly adapted to pass into an opening 234 in the member 219. Upon the attraction of the release magnet armature 220, the member 219 passes over the upturned ends 231 and 233 until the openings 232 and 234 respectively come into registration therewith. The member 219 then, by the action of its spring 235, moves downward far enough to engage, by its openings, these projecting ends of the pawls. Then, upon the retraction of the armature 220, these pawls are moved out of engaging position and, through the agency of the springs 228 and 230, the wipers are returned to their normal positions. For convenience in establishing connections between a multiplicity of wires and the many contacts of the switch, connecting strips 136' and 137' are carried by and suitably insulated from the frame 188.

The mechanical construction of the first and second selector switches D and E is substantially the same as that of the line selector C, just described. The only difference consists in the number of contact springs actuated upon the primary, secondary and release movements of the switch. For instance, in the case of the first selector D, the contacts 84 and 90 take the place of the contacts 57 and 68 of the line selector C; while in the case of the second selector, these same contacts are replaced by contacts 101—113. Again, the contacts 69 and 76 of the line selector are replaced by the single contact 91 of the first selector, or the single contact 121 of the second selector. Likewise, the contacts 77 and 79 of the line selector are replaced by the single contact 97 in the case of the first selector, or the single contact 123 in the case of the second selector.

Referring now to Fig. 9, which illustrates the application of the invention to a three-wire system, it will be seen that the master-switch mechanism B and its circuit connections are the same as those shown in Fig.

1, while the substations A' are provided with the same equipment. In this instance, the line limbs S'—S² extend to the passive contacts of line selectors C', which are in general the same as the line selectors C of Fig. 1, slight differences in the circuits, however, being required to adapt the switch to the three-wire system. The first selectors D² are also similar to the first selectors D, but differ somewhat in their circuit arrangements; while the cord circuits, terminating in the manually operated connecting means F', have materially different circuit arrangements.

Considering the operation in detail, it will be observed that the removal of the receiver 27 from its switch-hook at a calling station closes a circuit through the relay 200' which may be traced from the live pole of the battery B⁵, through resistance 201', normal contact 202' of the cut-off relay 203', line limb S', through the substation, line limb S², normal contact 204' of the cut-off relay, and winding of relay 200' to ground at 205'. The energization of this relay, by the movement of its contact 206', completes a circuit for the electromagnet 46, by which the normal ground of the associated group contact is removed. The movement of the contact 207' of the relay 200' completes a circuit through the winding 51 of the differential control relay 12 to cause it to close its contact 55 to ground, as heretofore explained. The movement of the armature 208' of relay 200' closes a locking circuit for said relay which extends from the live pole of the battery B⁵ through resistance 201', normal contact 209' of the cut-off relay, alternate contact 208' of relay 200', through the winding of said relay to ground at 205', thereby placing said relay beyond the control of the calling party. The movement of the contact 210' of the relay 200' interrupts the normal circuit from the live pole of the battery to the private contacts of the line selector corresponding to the calling line. The wipers 211', 212', 213' and 214' of the line selector cooperate with the passive bank contacts 215', 216', 217' and 218' respectively. The contacts 215' are normally grounded through contacts 47, and the contacts 216' are normally connected to the live pole of the battery B⁵ through the relay contacts 219' and 210'. As soon as the differential relay 12 is energized by current through its winding 51, a path for current is completed from the live pole of the battery B⁵ through the winding of the primary relay PR³, normal contact 220', contact 17, wiper 15 and alternate contact 55 to ground at 56. The consequent energization of the relay PR³, closes a circuit to ground at its contact 221' for the primary magnet PM³, which immediately causes the wipers 211', 212', 213' and 214' to move in a primary direction. By

the movement of the contact 222' of this relay, a possible circuit for the secondary relay SR³ is interrupted. By a movement of its contact 223' a circuit is completed from the winding 54 of the differential relay 12 through the resistance 65, with a consequent return of the contact 55 of said relay to its normal position. By the movement of the contact 224' of relay PR³, a maintaining circuit is established for said relay through the wiper 211' and passive contacts 215' so long as said contacts are grounded. As soon as an ungrounded contact is encountered, however, this maintaining circuit is interrupted and the relay contacts of PR³ return to their normal positions, thereby discontinuing further primary movement of the switch. Upon the first primary movement of the switch, the contacts 220', 225', 226' and 227', by reason of the mechanical relation of the parts, are moved to their alternate positions. Thus it follows that as soon as the relay PR³ is deenergized, the path to ground through the winding 54 of differential relay 12, and resistance 65, is maintained by way of normal contact 228' and alternate contact 227'. It also follows that by the deenergization of this relay, a circuit is completed for the secondary relay SR³. This circuit extends from the live pole of the battery B⁵, through resistance 229', alternate contact 226', normal contact 222', normal contact 230', winding of relay SR³ to ground. The energization of this relay immediately closes a circuit for the secondary magnet SM³ at contact 231', and the wipers 212', 213' and 214' begin their movement in a secondary direction. So long as the wiper 212' is passing over the contacts 216' of non-calling lines, a maintaining circuit will be established for the relay SR³, extending from the live pole of the battery B⁵, through resistance 201', normal contacts 210' and 219', contact 216', wiper 212', alternate contact 232', winding of said relay to ground. By the closing of the contact 233' of this relay, a path to ground for the winding 54 of the differential relay 12 is provided by way of the alternate contact 227'. Upon the first secondary movement of the wipers 212', 213' and 214', the contacts 228' and 230' will be moved to their alternate positions. The contact 228' thereby interrupts the previous path to ground for the winding 54 and necessitates the provision of the contact 233'. The contact 234' of the relay SR³, upon the energization of said relay, interrupts a possible circuit for the release magnet RM³. As soon as the wiper 212' reaches a contact 216' corresponding to the calling line, the maintaining circuit for the relay SR³ will be discontinued, since the relay 200' of the calling line is energized, and the battery connection to the corresponding contact 216' is interrupted at contact 210'. As soon as this oc-

curs, the further secondary movement of the wipers is discontinued, and the wipers 213' and 214' are left in engagement with contacts 217' and 218', in which the line limbs S'²—S² of the calling line terminate, thereby extending the circuit of the calling line to the link-circuit L⁷—L⁸. It will be noted that upon the return of the contact 234' of the relay SR³ to its normal position, a circuit will be completed through the cut-off relay 203' which may be traced from the live pole of the battery B⁵, through resistance 229', normal contact 232', wiper 212', contact 216', normal contact 219', alternate contact 210', winding of the cut-off relay 203' to ground. It will also be noted that the test contacts of the jacks 11^a of the calling line are connected to ground through the winding of said cut-off relay, thereby providing means by which a potential above ground will now exist at the test contacts in case said telephone line is tested as a called line. The energization of the cut-off relay 203' causes the interruption of the previously established locking circuit for the relay 200' at its contact 209'. By the movement of its contact 202', it also disconnects battery from the line limb S'; and by the movement of its contact 204', disconnects the winding of the relay 200' from the line limb S², thereby removing all subsequent substitution control of the relay 200'. The movement of the cut-off relay contact 219' interrupts the initial circuit of the cut-off relay 203' and closes a locking circuit which extends from the contact 216' through alternate contact 219' and the winding of the relay 203' to ground.

When the line selector switch C' has completed its secondary movement, and its secondary relay contacts have returned to their normal position, the first selector D² is immediately set in operation to connect the opposite ends of the link-circuit strands L⁷—L⁸ to the strands L⁹—L¹⁰ of an idle operator's link-circuit. The return of the contact 234' of the relay SR³ to normal starts the selector D², by closing a circuit through the primary relay PR⁴ of the selector D², traced from the live pole of the battery B⁶, through the winding of said relay, normal contacts 235'—234', winding of the release magnet RM³, alternate contacts 228' and 227' to ground. The completion of this circuit causes the energization of the relay PR⁴ sufficiently to move its contacts to their alternate positions. The turns of the relay PR⁴ and the release magnet RM³, however, are so proportioned that upon the completion of this circuit, the release magnet RM³ will not be energized sufficiently to draw up its armature and actuate the associated switch parts. The movement of the contact 236 of the relay PR⁴ closes a circuit through the primary magnet PM⁴ and at once the

wipers 237, 238, 239 and 240 begin their primary movement. These wipers cooperate with the passive contacts 241, 242, 243 and 244 respectively. The maintaining circuit for the relay PR^4 is completed through the contact 245, wiper 240 and contact 244 to ground so long as a grounded contact is encountered. As soon, however, as an ungrounded contact is encountered, this circuit is interrupted and the primary movement of the switch discontinued. Upon the first primary movement of the switch, the contacts 235', 246 and 247 are moved to their alternate positions. Prior to this movement of the contact 246, a circuit is completed through the signal lamp 248, which may be traced from the live pole of the battery B^6 , through said lamp 248, normal contact 246, conductor 249 and alternate contact 225' to ground. Since the latter contact is moved to its alternate position upon the first primary movement of the line selector C' , it will at once be apparent that the signal 248 will be displayed throughout the period intervening between the first primary movements of the two selectors C' and D^2 . The continued display of this signal for an unreasonable length of time will indicate to the switch attendants that the line selector has operated without the subsequent operation of the first selector, and the trouble may then be located and removed. As soon as the contact 246 is moved to its alternate position, a path will be completed through the second signal lamp 250 to ground at contact 225', and its display will serve as an indication to the attendant that the switches are in use. It will be apparent of course that as soon as the line selector C' is restored to its normal position, neither signal 248 nor 250 will be displayed, since the ground at contact 225' will be removed.

Contact 251 of the selector D^2 moves to its alternate position upon the first secondary movement of the wipers 238, 239 and 240. Therefore, upon the return of contact 252 of primary relay PR^4 to its normal position, a circuit will be completed for the secondary relay SR^4 , which may be traced from the live pole of the battery B^6 , through the winding of said relay, normal contacts 251—252, alternate contact 246, conductor 249 and alternate contact 225' to ground. The maintaining circuit for this relay will be completed through its closed contact 253, wiper 237, contact 241 to ground, so long as a grounded contact 241 is encountered. This ground will be obtained in the case of busy contacts through wiper 237, normal contacts 253, and winding 254 of the release magnet RM^4 of another switch. As soon as an idle link-circuit is encountered, no such ground will be present and the circuit of the secondary relay SR^4 will be interrupted. So long as this relay remains energized, the cir-

cuit for the secondary magnet SM^4 will remain unbroken at the contact 255, and said magnet will be instrumental in moving the wipers 238, 239 and 240 in their secondary direction over the associated bank contacts. The movement of the contacts 256 and 257 disconnects the wipers 238 and 239 while they are wiping over contacts 242 and 243 and thereby prevents possible interference with conversation over other link-circuits multiply connected to such contacts. Upon the deenergization, therefore, of the secondary magnet SR^4 , the circuit of the calling line is completed through the link strands L^7 — L^8 to the strands L^9 — L^{10} of an idle operator's link-circuit. As previously indicated in connection with Fig. 1, any particular link-circuit may be rendered artificially busy by means of a manually operated switch. This is accomplished in the present system by the switch 258 by which the contacts 241 may be grounded. Similarly, an entire group of link-circuits may be rendered busy by means of the switch 259 which is adapted to ground the group contacts 244 of any particular group. The mechanism M , by which the contacts 244 of the group are grounded in response to the busy condition of all of the link-circuits in the group, is the same in operation as that described in connection with Fig. 1, and in this instance is similarly controlled by the sleeve supervisory relay 260. Likewise, as before, the link-circuit strand L^8 is normally interrupted at contact 261, but is adapted to be completed at this point upon the energization of the electromagnet 262, which also, by means of its contact 263, controls a shunt about the winding 254 of the release magnet RM^4 . As soon as the wipers 238 and 239 engage the contacts 242 and 243 of an idle link-circuit L^9 — L^{10} , current is supplied from the battery B^7 to the electromagnet 262, over a path extending from the live pole of the battery B^7 , through the repeating coil winding R^7 , strand L^{10} , contact 243, wiper 239, contact 257 and winding of electromagnet 262 to ground, energizing this electromagnet. As soon as the contact 261 is closed as a result of the energization of the electromagnet 262, a path for current will extend over the link-circuit strand L^8 , line limb S^2 , through the switch-hook at the substation, line limb S' , link-circuit strand L^7 , wiper 238, contact 242, strand L^9 , the resistance 264 and the winding of the tip supervisory relay 265 in parallel, repeating coil winding R^3 to ground. The completion of this branch will move the contact 266 to its alternate position, thereby interrupting a possible circuit for the release magnet RM^4 . Its energization will also move its contact 267 to its alternate position, thereby grounding one terminal of the call lamp 268, which has its circuit completed through contact

269, the winding of relay 260 to the live pole of the battery B'. This lamp signals the operator that connection is desired over the particular link-circuit with which it is associated. The relay 260 will also be energized by the completion of this circuit, and through its contact 270 it will effect its control over the mechanism M associated with the group contacts 244. Its contact 271 will close one break-point in the circuit of the release magnet RM⁴.

In response to the display of the signal 268, the operator will throw over the listening-key levers 272 and 273, and after communicating with the calling party and learning the number of the called line, she will touch the tip of her plug 274 against the test contact of a jack 11^a of the called line. As previously indicated, if this line is in use, a potential above ground will exist at the test contact. Consequently, if a line be busy, a flow of current will result from the tip contact of the plug 274, through the repeating coil winding R⁴ to ground. The key lever 272 being thrown over at this time, the condenser 275 will be charged; and upon the removal of the plug, the discharge of this condenser through the winding R⁴ to ground will produce the customary "click" in the operator's receiver. If the line be found busy, the operator will then so inform the calling party; and upon hanging up his receiver, the tip supervisory relay 265 will be deenergized and a releasing circuit established similar to that described in connection with Fig. 1 and more fully described hereinafter in this connection. If the line is found to be idle, the operator will insert the plug 274 into a jack 11^a. Thereupon a circuit will be completed from the live pole of the battery B', through the winding of the supervisory relay 276, supervisory lamp 277, plug and jack sleeve and test contacts, winding of the cut-off relay 203' to ground. The energization of the cut-off relay will remove the normal substation control of the relay 200' associated with said line and of the master switch mechanism associated with said line. The energization of the relay 276 will break normal contact 269 and make contact 269—278. The breaking of the former will interrupt the circuit of the call lamp 268, while the making of the latter will not complete the circuit of the lamp 279, since at this time the contact 267 is in its alternate position. The energization of relay 276 will also interrupt the circuit of the release relay RM⁴ at contact 280.

The operator will now throw over the ringing-key levers 281—282 applying ringing current from the generator 283 to the line S'—S² to ring call-bell 31 at the called station. As soon as the called party responds by removing his receiver 27 from its

hook, a path for current will be completed from the live pole of the battery, through the repeating coil winding R², the resistance 284, and the winding of the supervisory relay 285 in parallel, over the sleeve side of the line, back over the tip side and through the repeating coil winding R⁴ to ground. The flow of current through the winding of the supervisory relay 285 will energize said relay to close its contact 286 and thereby close the shunt including the resistance 287 about the lamp 277 and causing its extinguishment, as an indication to the operator that the called party has responded.

Throughout conversation, the lamps 277 and 279 remain dark. But upon the restoration of the called party's receiver, the relay 285 is deenergized, the shunt about the lamp 277 removed and said lamp lighted. Likewise, upon the restoration of the calling party's receiver to its hook, the supervisory relay 265 is deenergized; and by the return of its contact 267, a circuit is completed for the supervisory lamp 279, which may be traced from the live pole of the battery B', through the winding of relay 260, alternate contact 269—278, signal lamp 279 and alternate contact 267 to ground. The lighting of both of these lamps will signal the operator to take down the connection. This she does by removing the plug 274, thereby causing the restoration of all the parts to normal. The removal of the plug breaks the circuit through the test contact of the jack, thereby deenergizing the cut-off relay 203' and allowing its contacts to return to normal. The interruption of this circuit also deenergizes the relay 276 and causes the return of its contacts to normal, thereby extinguishing the supervisory lamp 279. The lamp 277 is also extinguished by the interruption of this circuit. The restoration of the contacts of relay 276 to normal also interrupts the circuit of the relay 260; but before the relay 260 has been deenergized to allow its contact 271 to return to normal, a momentary release circuit has been completed. This circuit extends from the live pole of the battery B' through resistance 288, normal contact 280, alternate contact 271, normal contact 266, contact 241, wiper 237, normal contact 253, winding 254 of the release magnet RM⁴ to ground energizing said magnet. Obviously, if desired, any suitable relay construction may be employed for rendering the relay 260 slow acting. Upon the energization of release magnet RM⁴, contact 251 is moved to its normal position, thereby completing a circuit for the secondary relay SR⁴ through normal contacts 252—251, alternate contact 246, conductor 249 and alternate contact 225' to ground. The consequent energization of relay SR⁴ interrupts the release circuit just traced, but the release magnet RM⁴ is maintained energized over a cir-

cuit extending through its winding 289, alternate contacts 290—235', normal contact 234', winding of release magnet RM³, alternate contacts 228' and 227' to ground. The energization of the release magnet RM³ causes the contact 227' to return to normal, thereby interrupting the release circuit through the winding 289 of release magnet RM⁴ and the winding of release magnet RM³. The interruption of this circuit causes the deenergization of these magnets with a consequent return of the switch parts to normal.

The mechanical construction of the switch for use in this system is the same as that heretofore described, but the switch contacts operated upon the initial primary, secondary and release movements may in some instances differ in number. From the description of the operation, it is thought that it will be clearly understood what contacts in the diagram are to be substituted for the primary and secondary, off-normal switch contacts and the release contacts of Fig. 1 and the figures illustrating the mechanical construction of the switch.

In Figs. 10, 11, 12 and 13, I have illustrated four varying methods of controlling the line selectors pertaining to a group of subscribers' lines. It will be understood that, inasmuch as ten line selectors are assigned to each 100 line group of subscribers, the means whereby I procure the method of operation wherein one calling subscriber starts only one of the line selectors, capable of connecting with it, in search of his line is an important feature of my invention.

Referring back to Fig. 1, it will be remembered that wiper 15 normally rests engaging a contact 17 of an idle line selector C, so that when a call comes in resulting in the attraction of armature 55, an idle line selector C is instantly started, which selector by throwing over on its first step primary off-normal switch spring 68, closes circuit through relay 13 resulting in the operation of stepping magnet 14 to move wipers 15, 16 over contacts 17, 18 successive locking circuits for relay 13 being established via contacts 18 and alternate contacts 68 of busy selectors, until contact 18 of an idle one is reached when of course, owing to the normal position of contact 68, circuit through relay 13 is broken and consequently through magnet 14, wipers 15, 16 resting in engagement with contacts 17, 18 of such idle line selector "waiting" for a call to come in.

In the structure of Fig. 10 but one wiper 15 is provided for the master-switch B' and this wiper normally rests engaging the contact 17 of the line selector it last started. If at the time a call comes in line selector C² is busy it is apparent that as soon as armature 55 of relay 12 is attracted, circuit

is established from ground 56 through contact 15, 17 alternate contact 68^a (shifted when the busy switch first started) relay 13^a to battery. The attracted armature of 13^a is effective to cause stepping magnet 14 to move the wiper along and relay 13^a will continue energized over successive locking paths via alternate contacts 68^a of busy selectors until an idle one is reached, when owing to its contact 68^a being at normal relay 13^a has its circuit opened and wiper 15 stops on the idle contact 17. Of course relay 12 held its armature 55 attracted during this process, and when contact 17 of the idle line selector was reached circuit was instantly closed from ground 56 via normal contact 68^a primary relay PR to battery at B', energizing the relay which starts the switch and cuts resistance 65 and the neutralizing winding of relay 12 into circuits, when armature 55 falls back.

If wiper 15 rests on contact 17 of an idle line selector C² when a call comes in the attracting of 55 closes circuit through relay PR which cuts in the neutralizing winding of relay 12 to release armature 55. This armature falls back before the shifting of spring 68^a and therefore in time to prevent the operation of relay 13^a which would otherwise occur. In this case therefore no movement of wiper 15 occurs, but it remains on the contact 17 until a call comes in while the switch, whose contact 17 is engaged by the wiper, is busy. The circuit of switch C² is similar to that of switch C of Fig. 1 and further description is deemed unnecessary.

In Fig. 11 I show a structure wherein two wipers 15 and 16 are used in the master-switch B², normally engaging contacts 17, 18 of an idle line selector, but wherein the starting relay 12^a is provided with but a single winding, the differential characteristics of the corresponding relay 12 of Fig. 1 being omitted. In Fig. 11 each line of the group has its appropriate tap from an armature contact of its line relay 39 to the winding of relay 12^a to cause its energization and start a line selector by the attraction of armature 55. The first primary movement of a line selector as in preceding structures throws over the primary off-normal switch contacts (P. O. Sw.) and the release switch contacts (R. Sw.). The actuation of the former disconnects the primary relay from contact 55 in the usual manner while the actuation of the release switch connects ground G through contacts 17, 15 and relay 13^b to battery. The attracted armature of 13^b causes magnet 14 to move wipers 15, 16 over terminals 17, 18 of line selectors, which movement of course continues until wiper 15 engages a contact 17 of a line selector which is idle and whose release switch R. Sw. is consequently at normal as shown in

Fig. 11, when circuit through relay 13^b is broken and wipers 15, 16 come to rest. If another call has come in to relay 12^a in the meantime, the stopping of wipers 15, 16 will be momentary only, or until the line selector makes its first movement throwing over its release switch.

In Fig. 12 I show a structure wherein the master-switch B of the previous figures is omitted, its function being assumed by the relays 12^c, 12^{c'}, etc., of which one is provided for each of the ten line selectors of a hundred lines. Each such line has its tap from an armature contact of its relay 39 to the armature of its relay 12^{c'}. Thus when a first call comes in the actuation of relay 39 closes circuit directly from ground through attracted armature 44, back contact of relay 12^{c'}, normal contact of P. O. Sw., primary relay PR to battery. The operation of the line selector C⁴ of Fig. 12 is similar to that of Fig. 1 and need not be particularly described. It will be remembered that when the line selector has finally selected the calling line, relay SR becomes deenergized. When this occurs in the structure of Fig. 12, circuit is closed from ground through relay 12^{c'}, back contact of relay SR, contact 24—20, alternate contact of relay 39, through relay 34 to battery. This current energizes relay 12^{c'} and its attracted armature connects common conductor *cd* through to the back contact of relay 12^{c'} belonging to the next line selector which line selector will then be started as soon as a call comes in, in a manner similar to that just described.

It will be seen that by this arrangement a released line selector, by the opening of contact 24—20, deenergizes its relay 12^{c'} and so puts itself in position to be again operated responsive to an incoming call. The switches are thus in a series and the first one of the series not in use will always be operated by an incoming call.

The method of operation of the arrangement of Fig. 12 is such that until a started line selector has completed its selection, a second one cannot be started; and if two or more calls were to be made by subscribers at practically the same time, one or more would have to wait relatively longer than in the previously described systems. This delay is, however, theoretical rather than real, since with groups of one hundred subscribers, calls coming in close enough together to find the above conditions will rarely, if ever, occur.

In Fig. 13, I show a relay arrangement which may be called a series shunt structure. The relays 13^d, 13^{d'}, etc., of which there is one for each line selector, are serially connected from battery B' to the armature contacts of relays 39 of the one hundred line group. In the normal condition of affairs all the relays 13^d, 13^{d'}, etc., except the first

are short circuited by conductors, the continuity of whose circuits is controlled by armature contacts of relays X, X', etc., of which one is provided for each line selector except the last. When a call comes in, one of the relays 13^d, 13^{d'}, and one only, will be energized, and by attracting its armature close circuit through the primary relay PR of its line selector C⁵, starting it. Assuming relay 13^d is the relay thus operated; as soon as the line selector has completed its selection, circuit will be closed from ground through relay X, back contact of SR, contact 24—20, alternate contact of relay 39, relay 34 to battery. Relay X is thereby energized and its attracted armature removes the short circuit from relay 13^{d'} at the same time short circuiting relay 13^d. This condition will of course continue until on the ultimate release of the line selector C⁵, the circuit of relays 34 and X is broken at contact 24, 20, relay X consequently deenergized and the shunt removed from 13^d and placed about 13^{d'}. The operation of relay X removing the shunt from relay 13^{d'} places it in position to be energized as soon as a second call comes when its attracted armature will start its associated line selector. As soon as this line selector has completed selection, relay X' will become energized, removing a short circuit from about the starting relay of the next line selector and so on.

In Fig. 14 I show the structure of a cord circuit which may be substituted for that shown in Figs. 1 and 2. Its method of operation with respect to the cord selecting switch E of Fig. 1 or D' of Fig. 2 is the same as that of the circuit in said figures shown and need not be at length detailed. The structure of Fig. 14 goes a step further than those previously described in relieving the operator of work, namely in this, that no special act for testing a called line is required by the operator when the circuit of Fig. 14 is employed. She merely after ascertaining what number is wanted inserts the plug 10 into a multiple jack of the called line. A busy signal will then be automatically extended to the calling subscriber or a call signal extended to the called subscriber depending upon the idle or busy condition of the wanted line. In addition the structure of Fig. 14 embodies means for selective party line ringing, four generators G', G², G³ and G⁴ being provided for ringing purposes adapted to deliver ringing current of different predetermined frequencies to selectively ring party line substation bells tuned to respond separately to the frequencies of ringing current impressed on a line after the well-known manner.

The structure of Fig. 14 is such that it is adapted for operation in the before outlined manner when the plug 10 is inserted in

a multiple jack 11 of any one of the two wire line circuits shown in the preceding figures.

Let it be assumed that the circuit of Fig. 14 has been selected by switch D' of Fig. 2, line signal lamp 148 displayed and the operator has learned the number of the wanted subscriber, say A of Fig. 2, part 2. The operator now immediately inserts plug 10 into jack 11 of the line. Assuming that the line is idle, current will flow from the intermediate tap of battery BB, which may be assumed as having a potential of 8 volts, through the windings of polarized relay b , normal contact a^4 , normal contact d^5 to sleeve f , thence via sleeve of jack 11 (Fig. 2, part 2), normal contact 80, relay 36 to ground 83. This current is of polarity to tilt armature b^2 to the left, when circuit is closed from said grounded armature b^2 , winding of relay 161^a to the main tap of battery BB; assumed to have a potential of 24 volts. Relay 161^a is immediately locked on the attraction of armature a^4 by current from BB via attracted armature a^4 to ground at 83, via cut-off relay 36 of the called line A. Assuming the relay 36 to be of substantially 500 ohms resistance, the establishment of the locking circuit just described will have impressed a potential at the sleeve contacts of jacks 11 of from 12 to 15 volts, so that if a second plug 10 be now inserted in another jack 11 of the same line, the potential at sleeve 11 (12—15 v.) will overcome the potential at the intermediate tap of battery BB (8 v.) and current will flow through polarized relay b of the second cord in the opposite direction to that previously described and armature b^2 will be tilted to the right thereby preventing completion of the attempted connection and extending the busy signal as hereafter more fully detailed.

Returning now to energized relay 161^a of Fig. 14, attracted armature a puts out call lamp 148, armature a^3 closes circuit through supervisory signal 163 to display it, while armature a^2 connects plug tip f^2 with the armature of relay r . The operator now (or she may have previously done so) throws over a lever s belonging to whichever generator is of proper frequency to ring the bell of the subscriber wanted; simultaneously, a lever ss is thrown over to connect interrupter i with relay r . The levers s and ss are controlled by apparatus such that when thrown over they remain so until magnet c is energized as hereafter explained. Being connected from battery BB to a closed lever ss , relay r will alternately be energized and deenergized as interrupter i revolves; when its armature is attracted ringing current will pass from the selected generator through a lever s , contact of relay r ,

alternate contact a^2 , contact d^5 to tip f^2 , through the bell at the called station, ringing it, returning via sleeve f of the plug, contact d^5 , relay 161^a, to battery. When the called subscriber answers, he of course closes the metallic circuit of his substation, and, as soon as interrupter i in its rotation reaches a position such that relay r is deenergized and its armature retracted, circuit will be closed from ground through relay 170^a, retracted armature of relay r , contacts a^2 , d^5 , via contact f^2 to and metallicly over the called line returning via contacts f , d^5 and relay 161^a to battery. The attracted armature of relay 170^a puts out calling supervisory signal 163 and completes circuit from grounded contact a^3 through magnet c to battery BB. Energized magnet c by its mechanical connections releases levers s and ss , and the generator and interrupter i are thereby disconnected from the contact and the winding of relay r respectively. In addition thereto, relay c shifts springs e , e^2 , e^3 , the two latter completing the talking strands of the cord, while spring e completes a locking circuit for relay c .

When at the end of conversation the subscribers replace their receivers, relays 144 and 170^a become deenergized and disconnect signals 151 and 163 will be displayed instructing the operator to remove the calling plug from the jack of the called line, and when this is done the restoration of the selectors will proceed after the manner before described.

It has already been explained that when a plug is inserted in a jack of an already busy called line, relay b is energized by current flowing in such direction as to cause its armature b^2 to tilt to the right. This occurring, circuit will be closed from grounded armature b^2 through right hand winding of relay d to battery, energizing d whose attracted armature d^2 closes a local circuit through relay 161^a, which being energized by armature a , puts out calling lamp 148 and by a^3 lights supervisory lamp 163. Attracted armature d^3 connects busy back interrupter i into operative relation with the calling line via conductor L^6 to signal the calling subscriber that the line wanted is busy, while armature d^4 completes a locking circuit for relay d from battery BB via said armature, sleeve contact f to ground through the cut-off relay of the called line. Armature d^6 disconnects the tip f^2 of the plug from the alternate contact of a^2 whereby ringing current cannot be projected over the busy called line. The attracted armature d^7 closes circuit through magnet c whose energization allows the release of whatever levers s and ss have been thrown over by the operator. The calling subscriber hearing the busy signal replaces his receiver

deenergizing relay 144 whose retracted armature 146 lights lamp 151 and the two supervisory signals being now displayed, the operator withdraws plug 10 and the selectors are restored as before, the withdrawal of the plug destroying the locking circuit of relay *d* upon whose deenergization the deenergization of relay 161^a follows.

It will be remembered that when line A of Fig. 1, part 1, is a busy line, as a calling line, relay 34 is energized on selection of said line by the line selector. In such case, the insertion of a plug 10 of a cord circuit Fig. 14 in a jack 11 of the line, the full potential of battery B' which may be 24 volts will be opposed to the 8 volt potential of the intermediate tap of battery BB of Fig. 14 and armature *b*² will tilt to the right to cause the busy signal switching operations before described.

In Figs. 15, 16 and 17, I show the mechanism of magnet *c* and that for operating levers *s*, *ss*. The general view Fig. 16 shows a manually operated listening key LK and four ringing buttons *k*, *k'*, *k*², *k*³ extending through the key shelf, each being provided with two collars and a spiral spring tending when a button is depressed to raise it to the normal position shown. Each button has its springs *s* and *ss* adapted to be operated when the button is depressed, by the lower collar of the button, to engage their alternate contacts, connected to generator and interrupter respectively as shown in Fig. 14. Two pivoted levers *m* and *o*, having each four pawls, one for each button, are provided; a front view of lever *m* being shown in Fig. 16, while in Figs. 15 and 17 side views of both levers are shown. Levers *m* and *o* are linked together by the plate *t* so that movement of one effects similar movement of the other. The pawls of lever *o* as indicated in Fig. 15 normally rest against the ringing buttons while the pawls of *m* are held away from the buttons. The levers are held in their normal position by armature *c*¹ of magnet *c* which interlocks with lever *m* and is normally held retracted by spring *c*². Assume that plunger *k* is depressed, its lower collar of course operates the springs *s* and *ss*. Its upper collar passes below the end of the appropriate pawl of lever *o* (see Fig. 15) which then presses against the shaft of the button *k*, engaging the top of the collar and temporarily preventing restoration of the button by its spring. This is the ringing position and in it the button remains until magnet *c* is energized when its attracted armature *c*¹ presses lever *m* against the buttons, a corresponding movement of *o* away therefrom occurring at the same time. This causes *o* to disengage the collar of the depressed button and it rises to an intermediate or indicating position where it is held while mag-

net *c* remains energized by the engagement of a pawl of lever *m* with the upper collar of the button. When the button is in the indicating position, the lower collar has been raised sufficiently to allow springs *s* and *ss* to disengage their alternate contacts.

The shifting of springs *e*, *e*² and *e*³ described in connection with Fig. 14 is effected when magnet *c* is energized by a stud *m'* upon lever *m*, which lever is turned on its pivots *n*, *n'* by the attracted armature *c*¹ of magnet *c*. When magnet *c* is, on the removal of the plug of Fig. 14, again deenergized, spring *c*² of Figs. 15 and 16 causes the armature *c*¹ to withdraw lever *m* from engagement with the depressed button whose spring then raises it to its normal position. The movement of lever *m* moves stud *m'* to normal and springs *e*, *e*², *e*³ disengage their alternate contacts.

Obviously in carrying out my invention, many alterations and modifications may be made in the mechanical details and circuit arrangements herein disclosed, without departing from the spirit and scope of my invention. I therefore do not wish to be limited to the specific matter described and illustrated, but aim to cover by the terms of the appended claims all such alterations and modifications.

What I consider new and novel and desire to secure by Letters Patent of the United States is:—

1. A telephone exchange system comprising a telephone line, a plurality of groups of link-circuits, electrically controlled switches for automatically extending the circuit of said telephone line through a plurality of said groups by linking together idle link-circuits of the said groups, means for setting one of said switches in operation, and means responsive to the operation of said switch for causing the operation of the other switches required in extending said line circuit.

2. A telephone exchange system comprising a telephone line, a plurality of groups of link circuits, electrically controlled switches for automatically extending the circuit of said telephone line through a plurality of said groups by linking together idle link-circuits of the said groups, means for setting one of said switches in operation, and means responsive to the operation of said switch for causing the successive operation of the other switches required in extending said line circuit.

3. A telephone exchange system comprising a subscriber's telephone line, a plurality of groups of link-circuits, electrically controlled switches for automatically extending the circuit of said telephone line through a plurality of said groups by linking together idle link-circuits of the said groups, means under the control of the subscriber for set-

ting one of said switches in operation, and means responsive to the operation of said switch for causing the operation of the other switches required in extending said line circuit.

4. A telephone exchange system comprising a subscriber's telephone line, a plurality of groups of link-circuits, electrically controlled switches for automatically extending the circuit of said telephone line through a plurality of said groups by linking together idle link-circuits of the said groups, means under the control of the subscriber for setting one of said switches in operation, and means responsive to the operation of said switch for causing the successive operation of the other switches required in extending said line circuit.

5. A telephone exchange system comprising a telephone line, a plurality of groups of link-circuits, manually actuated means for extending the circuit of each of the link-circuits of one of said groups, electrically controlled switches for automatically extending the circuit of said telephone line to one of the manually equipped link-circuits by linking together idle link-circuits of the intervening group or groups, means for setting one of said switches in operation, and means responsive to the operation of said switch for causing the operation of the other switches required in extending said line circuit.

6. A telephone exchange system comprising a telephone line, a plurality of groups of link-circuits, manually actuated means for extending the circuit of each of the link-circuits of one of said groups, electrically controlled switches for automatically extending the circuit of said telephone line to one of the manually equipped link-circuits by linking together idle link-circuits of the intervening group or groups, means for setting one of said switches in operation and means responsive to the operation of said switch for causing the successive operation of the other switches required in extending said line circuits.

7. A telephone exchange system comprising a subscriber's telephone line, a plurality of groups of link-circuits, manually actuated means for extending the circuit of each of the link-circuits of one of said groups, electrically controlled switches for automatically extending the circuit of said telephone line to one of the manually equipped link-circuits by linking together idle link-circuits of the intervening group or groups, means under the control of the subscriber for setting one of said switches in operation, and means responsive to the operation of said switch for causing the operation of the other switches required in extending said line circuit.

8. A telephone exchange system compris-

ing a subscriber's telephone line, a plurality of groups of link-circuits, manually actuated means for extending the circuit of each of the link-circuits of one of said groups, electrically controlled switches for automatically extending the circuit of said telephone line to one of the manually equipped link-circuits by linking together idle link-circuits of the intervening group or groups, means under the control of the subscriber for setting one of said switches in operation, and means responsive to the operation of said switch for causing the successive operation of the other switches required in extending said line circuit.

9. A telephone exchange system comprising a telephone line, a plurality of groups of link-circuits, a plurality of electrically controlled switches associated with the answering ends of the link-circuits of one of said groups and operative to establish connection between said telephone line and an idle link-circuit of said group, means for setting an idle one of said switches in operation to establish such connection, other electrically controlled switches responsive to the operation of said switch to extend the circuit of the selected idle link-circuit through other groups of said link-circuits by linking other idle link-circuits together.

10. A telephone exchange system comprising a subscriber's telephone line, a plurality of groups of link-circuits, a plurality of electrically controlled switches associated with the answering ends of the link-circuits of one of said groups and operative to establish connection between said telephone line and an idle link-circuit of said group, means under the control of the subscriber for setting an idle one of said switches in operation to establish such connection, other electrically controlled switches responsive to the operation of said switch to extend the circuit of the selected idle link circuit through other groups of said link-circuits by linking other idle link-circuits together.

11. A telephone exchange system comprising a plurality of telephone lines, a plurality of groups of link-circuits, an electrically controlled switch associated with the answering end of each of the link-circuits of one of said groups and operative to establish connection between its link-circuit and a calling telephone line, means for setting an idle one of said switches in operation to establish such connection, other electrically controlled switches responsive to the operation of said switch to extend the circuit of the selected idle link-circuit through other groups of said link-circuits by linking other idle link-circuits together.

12. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of groups of link-circuits, an electrically controlled switch associated

with the answering end of each of the link-circuits of one of said groups and operative to establish connection between its link-circuit and a calling telephone line, means under the control of the calling party for setting an idle one of said switches in operation to establish such connection, other electrically controlled switches responsive to the operation of said switch to extend the circuit of the selected idle link-circuit through other groups of said link-circuits by linking other idle link-circuits together.

13. A telephone exchange system comprising a telephone line, a plurality of groups of link-circuits, manually actuated means for extending the circuit of each of the link-circuits of one of said groups, a plurality of electrically controlled switches associated with the answering ends of the link-circuits of another of said groups and operative to establish connection between said telephone line and an idle link-circuit of said latter group, means for setting an idle one of said switches in operation to establish such connection, other electrically controlled switches responsive to the operation of said switch to extend the circuit of the selected idle link-circuit through other groups of said link-circuits to one of the manually equipped link-circuits by linking idle link-circuits of said other groups together.

14. A telephone exchange system comprising a subscriber's telephone line, a plurality of groups of link-circuits, manually actuated means for extending the circuit of each of the link circuits of one of said groups, a plurality of electrically controlled switches associated with the answering ends of the link-circuits of another of said groups and operative to establish connection between said telephone line and an idle link-circuit of said latter group, means under the control of the subscriber for setting an idle one of said switches in operation to establish such connection, other electrically controlled switches responsive to the operation of said switch to extend the circuit of the selected idle link-circuit through other groups of said link-circuits to one of the manually equipped link-circuits by linking idle link-circuits of said other groups together.

15. A telephone exchange system comprising a plurality of telephone lines, a plurality of groups of link-circuits, manually actuated means for extending the circuit of each of the link-circuits of one of said groups, an electrically controlled switch associated with the answering end of each of the link-circuits of another of said groups and operative to establish connection between its link-circuit and a calling telephone line, means for setting an idle one of said switches in operation to establish such connection, other electrically controlled switches responsive to

the operation of said switch to extend the circuit of the selected idle link-circuit through other groups of said link-circuits to one of the manually equipped link-circuits by linking idle link-circuits of said other groups together.

16. A telephone exchange system comprising a plurality of subscribers' telephone lines, a plurality of groups of telephone circuits, manually actuated means for extending the circuit of each of the link-circuits of one of said groups, an electrically controlled switch associated with answering end of each of the link-circuits of another of said groups and operative to establish connection between its link-circuit and a calling telephone line, means under the control of the calling party for setting an idle one of said switches in operation to establish such connection, other electrically controlled switches responsive to the operation of said switch to extend the circuit of the selected idle link-circuit through other groups of said link-circuits to one of the manually equipped link-circuits by linking idle link-circuits of said other groups together.

17. A telephone exchange system including an interconnecting link circuit terminating at its opposite ends in sets of movable contacts, each set of movable contacts being capable of assuming a plurality of selective positions and including line and test contacts, sets of passive contacts accessible to said movable contacts, conductors terminating in part of said sets of passive contacts, subscribers' telephone lines terminating in other of said sets of passive contacts, means including an individual line relay located at the central office energizable over the two sides of a calling one of said subscribers' lines in series responsive to the removal of the receiver at the calling substation for causing one set of said movable contacts to automatically connect one end of said link circuit to said calling subscriber's line, and means responsive to such operation to cause said other set of movable contacts to automatically select and connect one of said conductors to the other end of said link circuit.

18. A telephone exchange system including a normally conductively-continuous interconnecting link-circuit terminating at its opposite ends in movable switch contacts, a plurality of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, a single control device, and means responsive to the operation of said device to cause said movable contacts to automatically select and connect with definite conductors.

19. A telephone exchange system including an interconnecting link-circuit terminating at its opposite ends in movable switch contacts, a plurality of passive contacts ac-

cessible to each movable contact, conductors terminating in said passive contacts, automatic means responsive to the electrical condition of encountered contacts for causing
 5 ing said movable contacts to automatically select and connect with definite conductors, control circuits for said means, and master-switch mechanism for said control circuits having its relatively movable contacts included in said control circuits only.

20. A telephone exchange system including an interconnecting link circuit terminating at its opposite ends in sets of movable switch contacts, each set of movable
 15 switch contacts including test and line contacts and capable of assuming a plurality of positions, sets of passive contacts accessible to said movable switch contacts, subscribers' telephone lines terminating in part of said sets of passive
 20 contacts, conductors terminating in other of said sets of passive contacts, control circuits independent of said link circuit, a control device having relatively movable contacts included in said control circuits, an individual line relay energizable over the two
 25 sides of a calling one of said lines in series responsive to the removal of the receiver at the calling substation for operating said control device, and means responsive to the
 30 operation of said device and to the electrical condition of the encountered passive test contacts to cause said sets of movable contacts to automatically connect the said
 35 calling subscriber's line to an idle one of said conductors.

21. A telephone system including an interconnecting link circuit terminating at its opposite ends in sets of movable switch contacts capable of assuming a plurality of
 40 selective positions, each set of movable contacts including test and line contacts, sets of passive contacts accessible to said movable contacts, conductors terminating in certain of said passive contacts, subscribers' lines terminating in other of said passive
 45 contacts, means for causing said sets of movable contacts to automatically select and connect with definite subscribers' lines and sets of conductors, and a single control device for causing the operation of said means in
 50 response to a single act on the part of a calling subscriber.

22. A telephone exchange system including an interconnecting link circuit terminating at its opposite ends in sets of movable contacts, each set of movable contacts being capable of assuming a plurality of
 55 selective positions and including line and test contacts, sets of passive contacts accessible to said sets of movable contacts, conductors terminating in certain of said passive contacts, subscribers' lines terminating in other of said passive contacts, means for causing
 65 said sets of movable contacts to automati-

cally select and connect with definite subscribers' lines and conductors, substation equipment associated with each subscriber's line including a switchhook and a single
 70 control device for causing the operation of said means in response to the single operation of the switchhook of a calling subscriber.

23. A telephone exchange system including an interconnecting link-circuit terminating at its opposite ends in movable switch
 75 contacts, a plurality of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, means for setting one of said movable contacts in operation, means for changing the
 80 normal relative condition of the passive contacts associated therewith, automatic means dependent upon the changed condition of the said passive contacts for causing
 85 the further movement of said movable contact to a definite passive contact, and means responsive to such operation to cause said other movable contact to move to a definite one of the passive contacts associated with it.

24. A telephone exchange system including an interconnecting link-circuit terminating at its opposite ends in movable switch
 90 contacts, a plurality of passive contacts accessible to each movable contact, conductors terminating in said passive contact, means for changing the normal relative condition of the contacts of each set of passive contacts, means for setting one of said movable
 95 contacts in operation, automatic means dependent upon the changed condition of the passive contacts associated with said movable contact for causing its further movement to a definite passive contact, means responsive to such operation to set the other
 100 movable contact in operation, and means dependent upon the changed condition of the passive contacts associated with it for causing its further movement to a definite passive contact.

25. A telephone exchange system including an interconnecting link circuit terminating at its opposite ends in sets of movable switch contacts, each set of movable
 105 contacts being capable of assuming a plurality of selective positions and including test and line contacts, passive contacts including test and line contacts accessible to said movable contacts, conductors terminating in part of said passive contacts, subscribers' telephone lines terminating in other of said passive contacts, means for changing
 110 the normal electrical condition of the test contacts of said passive contacts, a single control device an individual line relay energizable over the two sides of a calling one of said lines in series responsive to the removal of the receiver at the calling substation for causing the operation of said control device, and means responsive to the
 115
 120
 125
 130

operation of said device and dependent upon the changed condition of said passive test contacts to cause said movable contacts to automatically connect said calling subscriber's line with a definite conductor.

26. A telephone exchange system comprising a plurality of telephone lines, passive test and line contacts for said lines at an exchange, an interconnecting link circuit, sets of movable test and line contacts associated with the ends of said link circuit, each capable of assuming a plurality of selective positions, one of said sets of movable contacts cooperating with said passive contacts, other passive test and line contacts associated with said other set of movable contacts, trunks leading from said other passive contacts, means including an individual line relay located at the central office energizable over the two sides of a calling one of said lines in series responsive to the removal of the receiver at the calling substation for causing the first set of movable contacts to select and connect to the calling line, and means responsive to the actuation of said first set of movable contacts to cause the other set of movable contacts to automatically select and connect to an idle trunk.

27. A telephone exchange system comprising a plurality of telephone lines, passive test and line contacts for said lines at an exchange, an interconnecting link circuit, sets of movable switch contacts associated with the ends of said link circuit capable of assuming a plurality of selective positions, one of said sets of movable contacts cooperating with said passive contacts, other passive test and line contacts associated with said other set of movable contacts, trunk lines leading from said other passive contacts, means for causing the set of said movable contacts associated with said first passive contacts to select and connect to a calling line, means responsive to the actuation of said set of movable contacts to cause the other set of movable contacts to automatically select and connect to an idle trunk, and manually controlled connecting means associated with the distant ends of said trunks.

28. A telephone exchange system including a plurality of subscribers' lines, passive test and line contacts for said lines at an exchange, an interconnecting link circuit, sets of movable test and line contacts associated with the ends of said link circuit, each set being capable of assuming a plurality of selective positions, one of said sets of movable contacts cooperating with said passive contacts, other passive test and line contacts associated with said other set of movable contacts, trunk lines leading from said other passive contacts, means including an individual line relay controlled over the two sides of a calling one of said lines in series responsive to the removal of the receiver at

the calling substation for causing the set of movable contacts associated with the passive contacts of the subscribers' lines to select and connect to the said calling line, and means responsive to an actuation of said movable contacts to cause the other set of movable contacts to automatically select and connect to an idle trunk.

29. A telephone exchange system including a plurality of subscribers' lines, passive test and line contacts for said lines at an exchange, an interconnecting link circuit, sets of movable test and line contacts associated with the ends of said link circuit each set being capable of assuming a plurality of selective positions, one of said sets of movable contacts cooperating with said passive contacts, other passive test and lines contacts associated with said other set of movable contacts, trunk lines leading from said other passive contacts, means under the control of a calling party for causing the set of movable contacts associated with the passive contacts of the subscribers' lines to select and connect to a calling line, means responsive to an actuation of said movable contacts to cause the other set of movable contacts to automatically select and connect to an idle trunk, and manually controlled connecting means associated with the distant ends of said trunks.

30. A telephone exchange system including a plurality of normally conductively-continuous interconnecting link-circuits each terminating at its opposite ends in movable switch contacts, a set of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, and control means common to a plurality of said link-circuits for causing the movable contacts of an idle link-circuit to establish connection with definite conductors.

31. A telephone exchange system including a plurality of interconnecting link-circuits each terminating at its opposite ends in movable switch contacts, a set of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, control circuits independent of said link-circuits, control means common to a plurality of said link-circuits and having relatively movable contacts included in said control circuits for starting the movable contacts of an idle link-circuit, and means dependent upon the electrical condition of encountered contacts for stopping said movable contacts to establish connection with definite conductors.

32. A telephone exchange system including a plurality of interconnecting link-circuits each terminating at its opposite ends in movable switch contacts, a set of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, automatic means dependent upon the

electrical condition of encountered contacts for causing the movable contacts of an idle link-circuit to establish connection with definite conductors, control circuits for said means, and master switch mechanism for said control circuits having its relatively movable contacts included in said control circuits only.

33. A telephone exchange system including a plurality of link circuits, each terminating at its opposite ends in movable line and test contacts, the said line and test contacts being capable of assuming a plurality of selective positions, passive line and test contacts accessible to said movable contacts, conductors terminating at certain of said passive contacts, subscribers' lines terminating in other of said passive contacts, and control means including a master switch common to a plurality of said link circuits and operative in response to a single act on the part of a calling subscriber to cause the sets of movable contacts of an idle link circuit to establish a connection between the calling line and a definite set of said conductors.

34. A telephone exchange system including a plurality of interconnecting link circuits, each terminating at its opposite ends in movable sets of test and line contacts, each set of movable contacts being capable of assuming a plurality of selective positions, line and test contacts accessible to said sets of movable contacts, conductors terminating in certain of said passive contacts, subscribers' lines terminating in other of said passive contacts, substation equipment associated with each subscriber's line including a switchhook, and control means common to a plurality of said link circuits for causing the sets of movable contacts of an idle link circuit to establish a connection between a calling line and a definite set of said conductors in response to the single operation of the switchhook of a calling subscriber.

35. A telephone exchange system comprising a plurality of telephone lines, an individual line relay for each of said lines at the exchange energizable over the two sides of the subscribers' lines in series, passive test and line contacts for said lines at the exchange, a plurality of interconnecting link circuits each terminating at its opposite ends in movable sets of normally at rest test and line contacts, the set of movable contacts at one end of said link circuits operating with said passive test and line contacts, other passive test and line contacts associated with said other set of movable contacts, trunk lines leading from said other passive contacts, means for rendering some of said trunks busy, and means common to a plurality of said link circuits operable by the energization of one of said line relays

for causing the acts of movable contacts of an idle link circuit to establish connection between the calling line associated with said relay and an idle trunk.

36. A telephone exchange system comprising a plurality of telephone lines, passive test and line contacts for said lines at the exchange, a plurality of interconnecting link circuits each terminating at its opposite ends in normally at rest movable sets of test and line contacts capable of assuming a plurality of selective positions, the set of movable contacts at one end of said link circuits operating with said passive test and line contacts, other passive test and line contacts associated with said other set of movable contacts, trunk lines leading from said other passive contacts, means for rendering some of said trunks busy, means common to a plurality of said link circuits for causing the sets of movable contacts of an idle link circuit to establish connection between a calling line and an idle trunk, and manually controlled connecting means associated with the distant ends of said trunks.

37. A telephone exchange system comprising a plurality of subscribers' telephone lines, passive switch contacts for said lines at the exchange, a plurality of normally conductively-continuous interconnecting link-circuits each terminating at its opposite ends in movable switch contacts, the movable contact at one end of said link-circuits cooperating with said passive contacts, other passive contacts associated with said other movable contacts, trunks leading from said other passive contacts, means for rendering some of said trunks busy, and means under the control of calling subscribers and common to a plurality of said link-circuits for causing the movable contacts of an idle link-circuit to establish connection between a calling line and an idle trunk.

38. A telephone exchange system comprising a plurality of subscribers' lines, a line relay for each of said lines located at the central exchange, each of said line relays being controllable over the two sides of a subscriber's line in series responsive to the removal of the receiver at the subscribers' substations, passive test and line contacts for said lines at an exchange, a plurality of interconnecting link circuits each terminating at its opposite ends in movable sets of test and line contacts capable of assuming a plurality of selective positions, the sets of movable contacts at one end cooperating with said passive contacts, other passive test and line contacts associated with said other sets of movable contacts, trunks leading from certain other passive contacts, means for rendering some of said trunks busy, and means common to a plurality of said link

circuits responsive to the energization of the line relay of a calling one of said subscribers to cause the sets of movable contacts of an idle link circuit to establish connection between the calling line and an idle trunk.

39. A telephone exchange system comprising a plurality of subscribers' lines, passive test and line switch contacts for said lines at an exchange, a plurality of interconnecting link circuits each terminating at its opposite ends in movable sets of line and test contacts, the sets of movable contacts at one end coöperating with said passive contacts, other passive test and line contacts associated with said other sets of movable contacts, trunks leading from certain other passive contacts, substation equipments including switchhooks, means for rendering some of said trunks busy, and means common to a plurality of said link circuits and responsive to a single movement of the switchhook at a calling substation to cause the sets of movable contacts at both ends of an idle link circuit to establish connection between a calling line and an idle trunk.

40. A telephone exchange system including a plurality of subscribers' telephone lines, passive test and line contacts for said lines at the exchange, a plurality of interconnecting link circuits, each terminating at its opposite ends in sets of movable test and line switch contacts capable of assuming a plurality of selective positions, the sets of movable contacts at one end of said link circuits coöperating with said passive contacts, other passive line and test contacts associated with said other sets of movable contacts, trunks leading from said other passive contacts, means for rendering some of said trunks busy, means under the control of the calling subscriber and common to a plurality of said link circuits for causing the sets of movable contacts of an idle link circuit to establish connection between a calling line and an idle trunk, and a manually controlled connecting means associated with the distant ends of said trunks.

41. A telephone exchange system including an interconnecting normally conductively continuous link-circuit terminating at its opposite ends in movable switch contacts, a plurality of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, electromagnetically actuated means for causing said movable contacts to automatically select and connect with definite conductors, and control circuits for said electromagnetically actuated means independent of said link-circuit.

42. A telephone exchange system including an interconnecting normally conductively-continuous link-circuit terminating at its ends in movable switch contacts, a plu-

rality of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, automatic electromagnetically actuated means for causing said movable contacts to automatically select and connect with definite conductors, and control circuits for said electromagnetically actuated means independent of said link-circuit.

43. A telephone exchange system including an interconnecting link-circuit, step-by-step switch mechanisms comprising relatively movable contacts associated with each end of said link-circuit, conductors leading to each of said switch mechanisms, automatic electromagnetically actuated means for extending the circuit of one of said conductors to another of said conductors via said link-circuit by the operation of said switch mechanisms only, and means external to said link-circuit for controlling said electromagnetically actuated means.

44. A telephone system including an interconnecting link circuit terminating at its opposite ends in sets of movable switch contacts capable of assuming a plurality of selective positions, sets of passive line and test contacts accessible to each set of movable contacts, conductors terminating in certain of said passive contacts, subscribers' lines terminating in other of said passive contacts, electromagnetically actuated means for causing said sets of movable contacts to automatically select and connect a calling subscriber's line and a definite set of said conductors, control circuits for said electromagnetically actuated means independent of said link circuit, and means operated in response to a single act of the calling subscribers to cause said control circuits to operate said electromagnetically actuated means.

45. A telephone exchange system including an interconnecting link circuit terminating at its opposite ends in sets of movable test and line contacts, sets of passive line and test contacts accessible to each set of movable contacts, subscribers' telephone lines terminating in part of said sets of passive line and test contacts, conductors terminating in other of said sets of passive test and line contacts, means for changing the normal electrical condition of the test contacts of each set of passive contacts, electromagnetically actuated means dependent upon the changed condition of said passive contacts for causing said sets of movable contacts to automatically connect a calling one of said subscribers' lines with a definite set of conductors and control circuits for said electromagnetically actuated means independent of said link circuit, said control circuits being controlled by line relays which are individual to the subscribers' lines and which

are energizable over the two sides of the subscribers' lines in response to the removal of the receivers at the subscribers' substations.

46. A telephone exchange system including a plurality of normally conductively-continuous interconnecting link-circuits, each terminating at its opposite ends in movable switch contacts, a plurality of passive contacts accessible to each movable contact, conductors terminating in said passive contacts, automatic electromagnetically actuated means common to a plurality of said link-circuits for causing the movable contacts of an idle link-circuit to establish connection with definite conductors, and control circuits for said electromagnetically actuated means independent of said connected link-circuit.

47. A telephone exchange system comprising electric switch mechanism having passive contacts arranged in groups, means outside of said mechanism for rendering said contacts busy, a cooperating active contact, and means for causing said active contact to seek out and establish connection with an idle passive contact by first selecting a group having an idle contact in it and then selecting an idle contact in that group.

48. A telephone exchange system comprising electric switch mechanism having passive contacts arranged in groups, means outside of said mechanism for rendering said contacts busy, a cooperating active contact, and means for causing said active contact to seek out and establish connection with the first available idle passive contact by first selecting the first encountered group having an idle contact in it and then selecting the first encountered idle contact in that group.

49. A telephone exchange system comprising electric switch mechanism having passive contacts arranged in groups, means outside of said mechanism for rendering said contacts busy, a cooperating active contact, means for moving said active contact to a group of passive contacts, means for causing said contact to move to another group in case all the contacts in the first mentioned group are busy, and means for causing a secondary movement of said contact.

50. A telephone exchange system comprising electric switch mechanism having passive contacts arranged in groups, means outside of said mechanism for rendering said contacts busy, a cooperating active contact, means for moving said contact from group to group of passive contacts until it finds a group having an idle contact in it and then moving it over the contacts in that group until an idle contact is encountered, whereupon said contact comes to rest.

51. A telephone exchange system comprising electric switch mechanism having a plurality of passive contacts arranged in groups, conductors extending therefrom, a

cooperating contact movable in a primary direction to the said groups and in a secondary direction to the contacts in the groups, and automatic means dependent upon the idle or busy condition of the contacts in the groups for causing said movable contact to move in a primary direction to the first group of passive contacts containing a contact to which an idle conductor is connected and then in a secondary direction to such idle conductor contact.

52. A telephone exchange system comprising electric switch mechanism having a plurality of passive contacts arranged in groups, trunk lines extending therefrom, a cooperating contact movable in a primary direction to the said groups, automatic means dependent upon the idle or busy condition of the contacts in the groups for causing said movable contact to move in a primary direction to the first group of passive contacts containing a contact to which an idle trunk line is connected and then in a secondary direction to such idle trunk line contact, and manually controlled connecting and signaling means associated with the distant ends of said trunk lines.

53. A telephone exchange system comprising electric switch mechanism having a plurality of passive contacts arranged in groups, trunk lines extending therefrom, a cooperating contact movable in a primary direction to the said groups and in a secondary direction to the contacts in the groups, means for moving said movable contact in a primary direction to a group, and means dependent upon the busy or idle condition of the contacts in said group for determining whether the further movement of said movable contact shall be in a primary or a secondary direction, means for producing such further movement, and manually controlled connecting and signaling means associated with the distant ends of said trunk lines.

54. A telephone exchange system comprising electric switch mechanism having a plurality of passive contacts arranged in groups, conductors extending therefrom, a cooperating contact movable in a primary direction over certain of said passive contacts to said groups, a second cooperating contact movable with said first movable contact and also movable in a secondary direction to the contacts in the groups, means for moving said first-mentioned movable contact to a group, means dependent upon the condition of the passive contact engaged thereby for determining the further movement of said movable contact, and means for changing the condition of said passive contact only when all the conductors connected to the passive contacts in said group are busy.

55. A telephone exchange system comprising

ing electric switch mechanism having a plurality of passive contacts arranged in groups, conductors connected to certain of said contacts, a cooperating contact movable over certain of said passive contacts to said groups, a second cooperating contact movable in a secondary direction to the contacts in the groups, means for moving said first-mentioned movable contact to a group, means for causing a further movement of said contact in case the passive contact engaged thereby is grounded, and means for grounding said passive contact whenever all the conductors connected to the passive contacts in its group are in use.

56. A telephone exchange system comprising electric switch mechanism having a plurality of passive contacts arranged in groups, conductors connected to certain of said contacts, a cooperating contact movable over certain of said passive contacts to said groups, a second cooperating contact movable in a secondary direction to the contacts in the groups, means for moving said first-mentioned movable contact to a group, means for causing a further movement of said contact in case the passive contact engaged thereby is grounded, means for grounding said passive contact whenever all the conductors connected to the passive contacts in its group are in use, means for stopping said first-mentioned movable contact whenever a non-grounded contact is encountered, means for causing a subsequent movement of the second movable contact in a secondary direction, and means for stopping said second contact whenever an idle passive contact is encountered.

57. A telephone exchange system comprising a plurality of subscribers' telephone lines, substation equipment including a control switch, a plurality of link-circuits at the exchange having manually operated connection terminals, other link-circuits for interconnecting said telephone lines and said manually equipped link-circuits, switching means for interchangeably connecting said former link-circuits and said telephone lines, switching means for interchangeably connecting said former and latter link-circuits, and means responsive to a single movement of the control switch of a calling subscriber for operating said switching means to link said link-circuits together to complete a connection between the calling line and any one of said manually equipped link-circuits.

58. A telephone system including telephone lines, manually controlled operators' signaling and connecting apparatus, link-circuits comprising conductors and active terminals at either end of said conductors operative to interconnect a calling line and a connecting apparatus, and means for automatically des-

ignating a link-circuit for such connection and uniting it to the calling line and connecting apparatus.

59. A telephone system including telephone lines, manually controlled operators' connecting apparatus and a link-circuit having automatically controlled normally at rest active terminals at one end to select the line and similar terminals at the other end to select the connecting apparatus.

60. A telephone system including telephone lines, manually controlled operators' signaling and connection apparatus, a link circuit provided with active test and line contacts capable of assuming a plurality of selective positions for automatically selecting the first idle connecting apparatus, and automatically controlled mechanism for connecting said link circuit with any one of said lines as a calling line.

61. A telephone system including a plurality of telephone lines, a less plurality of operators' signals at the exchange and a link-circuit having automatically controlled normally at rest active test and line terminals at either end to respectively select the calling line and select and display one of said signals.

62. A telephone system including telephone lines, a smaller number of operators' signals at the exchange and normally at rest mechanism for automatically temporarily associating said signals with calling lines comprising link-circuits adapted to select said signals and normally at rest automatically controlled means provided with active test and line contacts for connecting any one of said link-circuits with any one of said lines as a calling line.

63. A telephone system comprising telephone lines provided with multiple terminals at the exchange normally unselectable in character, mechanism operative when a subscriber initiates a call to render the terminals of his line selectable, manually controlled operators' connecting apparatus at the exchange provided with multiple terminals normally selectable in character, a link-circuit provided with normally at rest electrically controlled selectors provided with active test and line contacts at each end operated responsive to the initiation of a call to respectively select terminals of the calling line and of the first idle connecting apparatus to connect said apparatus and line, and means automatically effective to thereon render both sets of terminals unselectable in character.

64. A telephone system comprising telephone lines, manually controlled operators' connecting means, and normally at rest selector switches connected in pairs provided with electromagnetically actuated test and line contacts, one switch of a pair being

adapted to select the calling line and the other to select the first idle connecting means.

65. A telephone system including telephone lines, multiple spring-jacks for said lines at the exchange, operators' cords for connecting with said spring-jacks, call signals associated with said cord-circuits, and normally at rest selector switches connected in pairs provided with electromagnetically actuated test and line contacts, one switch of a pair being adapted to select the calling line and the other to select the first idle cord and display its signal.

66. A telephone system comprising a group of telephone lines, a group of operators' connecting apparatus for interconnecting said lines and an intermediate link-circuit provided with normally at rest automatically controlled mechanism having active electromagnetically controlled test and line contacts for interchangeably connecting one end of said link with the lines of the group and the other end interchangeably with the connecting apparatus of the group.

67. A telephone system comprising telephone lines, manually controlled operators' connecting apparatus, line selectors for selecting the calling lines, less in number than said lines, other selectors, one associated with each line selector for selecting the idle connecting apparatus, control apparatus adapted to start a single line selector for each call initiated over said lines, a common conductor for said control apparatus having branches one for each line, and apparatus for each line for changing the electrical condition of said common conductor to operate said control apparatus.

68. A telephone system including a telephone line, selective switching mechanism at the exchange, a plurality of operators' link-circuits having terminals associated with said switching mechanism divided into groups, a group contact for each group, means outside of said switching mechanism for rendering some of said link-circuits busy, mechanism for changing the normal electrical condition of a group contact when all the link-circuits of its group are busy, apparatus for automatically starting said switching mechanism in operation on initiation of a call at the substation of said line, an active test contact for said switching mechanism adapted to successively engage said group contacts passing over those in their changed electrical condition, a second active test contact for said switching mechanism movable over contacts of the different groups of contacts, and mechanism operating responsive to the engagement of said first active contact with a group contact in its normal electrical condition; to initiate travel of said second active test contact over the terminals of the link-circuits of the normal group contact, to connect the

calling line with the first idle link-circuit of the group.

69. A telephone system including telephone lines, a link-circuit at the exchange, selective switching mechanism at one end of said link-circuit, terminals for said lines associated with said switching mechanism and divided into groups, a group contact for each group, means operating on the initiation of a call at the substation of one of said lines to alter the normal electrical character of the group contact of the group among which the terminal of the calling line is included and the normal electrical character of the terminal of said line, apparatus similarly operated for automatically starting said switching mechanism in operation, an active test contact for said switching mechanism adapted to successively engage said group contacts passing over those in their normal electrical condition, a second active test contact for said switching mechanism, means operating responsive to the engagement of said first active contact with a group contact in its changed electrical condition to initiate travel of said second active test contact over the terminals of the lines of the group to connect said link-circuit with the calling line, other selective switching mechanism pertaining to said link-circuit, a plurality of operators' link-circuits having terminals associated therewith, and means for automatically operating said second switching mechanism to connect said link-circuit with the first idle operator's link-circuit.

70. A telephone system including telephone lines, a link-circuit at the exchange, selective switching mechanism at one end of said link-circuit, terminals for said lines associated with said switching mechanism, a division of said terminals into groups, a group contact for each group, means operating on the initiation of a call at the substation of one of said lines to alter the normal electrical character of the group contact of the group among which the terminal of the calling line is included and the normal electrical character of the terminal of said line, apparatus similarly operated for automatically starting said switching mechanism in operation, an active test contact for said switching mechanism adapted to successively engage said group contacts passing over those in their normal electrical condition, a second active test contact for said switching mechanism, means operating responsive to the engagement of said first active contact with a group contact in its changed electrical condition to initiate travel of said second active test contact over the terminals of the lines of the group to connect said link-circuit with the calling line, other selective switching mechanism associated with said link-circuit, a plu-

5 rality of operators' link-circuits having terminals associated with said second switching mechanism and divided into groups, a group contact for each group, means for
 10 rendering some of said operators' link-circuits busy, mechanism for changing the normal electrical condition of a group contact when all the operators' link-circuits of its group are busy, means for automatically
 15 starting said switching mechanism in operation responsive to the initiation of the call at said substation, an active test contact for said second switching mechanism adapted to successively engage said group contacts
 20 passing over those in their changed electrical condition, a second active test contact for said switching mechanism, and mechanism operating responsive to the engagement of said first active contact with a group
 25 contact in its normal electrical condition to initiate travel of said second active test contact over the terminals of the link-circuits of the normal group contacts to connect the calling line with the first idle operator's
 link-circuit of the group.

30 71. A telephone system including a telephone line, a selective switch provided with a wiper movable to groups of contacts and to contacts in the groups, a plurality of operators' cord-circuits having terminals associated with said switch arranged in groups, means outside of said switch for rendering
 35 some of said groups busy, mechanism for operating said switch on initiation of a call at the substation of said line whereby said switch automatically tests said cords by groups avoiding busy groups, and means for
 40 causing said switch to automatically move over the terminals of the first idle group to extend said line to an idle cord-circuit therein.

45 72. A telephone exchange system comprising a plurality of telephone lines, a plurality of first selectors each having an active contact and a plurality of passive contacts arranged in groups, conductors multiply
 50 connected to said passive contacts, similar second selectors in whose active contacts said conductors terminate, and other conductors multiply connected to the passive contacts of said second selectors, means for starting
 55 the active contact of a first selector associated with a calling line, means independent of said starting means for causing said active contact to automatically select a group of passive contacts having an idle contact in it and then select an idle contact in that group, whereby the circuit of the calling line is extended to one of said first-mentioned conductors, and means for thereupon causing the active contact of the second selector connected to that conductor to likewise automatically select a group of its passive contacts having an idle contact in it and then

select an idle contact in that group, whereby
 said calling line circuit is extended to an
 idle one of said other conductors.

73. A telephone exchange system comprising a plurality of telephone lines, a plurality of first selectors each having an active
 75 contact and a plurality of passive contacts arranged in groups, conductors multiply connected to said passive contacts, similar second selectors in whose active contacts said conductors terminate and other conductors multiply connected to the passive contacts of said second selectors, means for starting the active contact of a first selector associated with a calling line, means independent of said starting means for causing said active
 80 contact to automatically select a group of passive contacts having an idle contact in it and then select an idle contact in that group, whereby the circuit of the calling line is extended to one of said first-mentioned conductors, means for thereupon causing the active contact of the second selector connected to that conductor to likewise automatically select a group of its passive contacts having an idle contact in it and then
 85 select an idle contact in that group, whereby said calling line circuit is extended to an idle one of said other conductors, operators' connecting means forming the terminals of said other conductors, and means for indicating to the operator the selection of an idle other conductor.

74. A telephone exchange system including an interconnecting link circuit, switch mechanism including sets of relative movable test and line contacts associated with each end of said link circuit, each of said sets being capable of assuming a plurality of selective positions, conductors leading to one of said switch mechanism terminating
 100 in passive test and line contacts, subscribers' telephone lines leading to the other of said switch mechanism terminating in passive line and test contacts, means for varying the electrical condition of certain of the passive test contacts of said mechanism, electromagnetically actuated means dependent for operation upon the varying condition of said passive test contacts for extending the circuit of a calling one of said subscribers' lines to one of said conductors via said link circuit by the operation of said switch mechanism, and a line relay for said subscriber's telephone line energizable over the two sides of said line in series when the calling subscriber removes his receiver for controlling
 105 said electromagnetically actuated means.

75. In a telephone exchange system, means for distributing calls from incoming lines or trunks among the several units of the
 110 exchange connective apparatus, comprising primary selector switches containing answering multiples of the lines, connective units,

secondary selector switches containing multiples of the circuits of the said connective units, each of said primary and secondary switches being adapted to move in one direction to select groups of contacts and in a second direction to select contacts in the groups, and trunk lines connecting the primary and secondary selector switches in pairs, each pair of switches constituting an initial link between a calling line and the actual connective apparatus in the exchange, each pair adapted to complete its function in response to the initiation of a call by removing the receiver at a calling station, by connecting the calling line to an idle unit, and then to connect the calling line to an idle connective unit, substantially as described.

76. In a telephone exchange system, means for distributing calls comprising normally at rest primary selector switches divided into groups, a group of line circuits multiplied to terminal contacts in each corresponding group of primary selectors, operator controlled cord circuits, normally at rest, secondary selectors connected to the primary selectors, and multiple terminals in said secondary selectors for the cord circuits, each pair of primary and secondary selector switches being provided with active test and line contacts and adapted to complete its function of connecting a calling line to an idle cord circuit as a preliminary to the selection of the wanted subscriber, substantially as described.

77. In a telephone exchange system, a plurality of lines and manually controlled connective central office circuits therefor, means for distributing calls comprising primary and secondary selectors normally connected in pairs independent of the lines and connective central office circuits, said primary and secondary selectors each having motion in one direction to select groups of terminals and motion in a second direction to select terminals in the groups of terminals, and means to operate said selectors to effect through their respective pairs a combination between any calling line and any operator-controlled connective circuit associated with the selectors, substantially as described.

78. In a telephone exchange system, a subscriber's station and a metallic circuit extending therefrom to a central station, an individual relay and battery connections for the line at the central station, manual link circuits, a primary selector switch and a secondary selector switch containing talking circuit terminals and testing means for the line and link circuits respectively, each of said switches having motion in one direction to select groups of terminals and in a second direction to select terminals in the groups of terminals, said line-relay control-

ling the condition of the said line testing means, and a cut-off relay for the line-relay energized when the connection of the primary selector with the line is made, substantially as described.

79. In a telephone exchange system, a plurality of line circuits, a number of central office operator controlled connective circuits less than the number of lines, and selector switches in double connected sets having motion in one direction to select groups of circuits and motion in another direction to select circuits in the groups of circuits for receiving calls and connecting the calling lines to idle ones of said operator controlled connective circuits, substantially as described.

80. A telephone system including a calling subscriber's line, operators' trunk circuits provided with manually controlled terminals, an automatic non-numerical switch, an automatic switch having motion in one plane to select groups of lines and motion in another plane to select lines in the groups, a second automatic switch having motion in one plane to select groups of lines and motion in another plane to select lines in the groups, said switches being responsive to a control exercised over the two sides of the calling subscriber's line in series for extending a connection from said calling subscriber's line to an idle one of said operators' trunk circuits.

81. A telephone system including a calling subscriber's line, operators' trunk circuits provided with manually controlled terminals, a non-numerical switch, an automatic switch having motion in one plane to select groups of lines and motion in another plane to select lines in the groups, a second automatic switch having motion in one plane to select groups of lines and motion in another plane to select lines in the groups, said switches being responsive to a control exercised over the two sides of the calling subscriber's line in series for extending a connection from said calling subscriber's line to an idle one of said operators' trunk circuits, and means for extending the connection from the selected trunk circuit to a called subscriber's line.

82. A telephone system including a calling subscriber's line, operators' trunk circuits provided with manually controlled terminals, a non-numerical switch, an automatic switch having motion in one plane to select groups of trunk lines and motion in another plane to select lines in the groups of lines, and a second automatic switch having motion in one plane to select groups of lines and motion in another plane to select lines in the groups, said switches being controlled over the two sides of a calling one of said subscriber's lines in series for con-

necting the calling subscriber's line with an idle one of said trunk circuits.

83. A telephone system including a calling subscriber's line, operators' trunk circuits provided with manually controlled terminals, a non-numerical switch, an automatic switch having motion in one plane to select groups of lines and motion in another plane to select lines in a group, a second automatic switch having motion in one plane to select groups of lines and motion in another plane to select a line in a selected group, said switches being responsive to a control exercised over the two sides of the calling subscriber's line in series for extending a connection from said calling subscriber's line to an idle one of said operators' trunk circuits, means for extending the connection from the selected trunk circuit to a called subscriber's line, and subscriber controlled means for releasing said switches by opening the subscriber's metallic line circuit.

84. A telephone system including subscribers' telephone lines, operators' trunk circuits, pairs of normally connected automatic switches for interconnecting the operators' trunk circuits and the calling subscribers' lines; active test and line contacts for each of said automatic switches, and means controlled by a calling subscriber to set in motion a pair of said automatic switches to cause one of said pair of switches to test for and connect with a calling subscriber's line, and to cause the other of said pair of switches to connect with an idle one of said trunk circuits to extend the connection from the calling subscriber's line through its line contacts to the selected trunk.

85. A telephone system including subscribers' telephone lines, operators' trunk circuits, pairs of normally connected automatic switches for interconnecting the operators' trunk circuits and the calling subscribers' lines, active test and line contacts for each of said automatic switches, and means controlled by a calling subscriber to set in motion a pair of said automatic switches to cause one of said pair of switches to test for and connect with a calling subscriber's line and to cause the other of said pair of switches to connect with an idle one of said trunk circuits to extend the connection from the calling subscriber's line through its line contacts to the selected trunk, and means for extending the connection to a called one of said subscribers' lines.

86. A telephone system including subscribers' telephone lines terminating in multiply connected contacts, operators' trunk circuits, pairs of non-numerically controlled automatic switches for interconnecting the

subscribers' lines and said operators' trunk circuits, each pair of switches being provided with test and line wipers for testing the multiple terminals of the calling lines and multiple terminals of the trunk lines, and normally at rest mechanism for selecting an idle pair of automatic switches and starting the same in operation to connect a calling one of said subscribers' lines to an idle one of said trunk circuits.

87. A telephone system including subscribers' telephone lines, operators' trunk circuits, a pair of normally at rest normally connected automatic switches for interconnecting the subscribers' lines and idle trunk circuits, and means controlled over the two sides of a calling one of said subscribers' lines in series for initiating the operation of said automatic switches to cause the same to connect the calling subscriber's line to an idle one of said trunk circuits.

88. A telephone exchange system including subscribers' telephone lines terminating in multiply connected contacts at a central exchange, operators' trunk circuits also terminating in multiply connected contacts at the exchange, pairs of normally at rest automatic switches for interconnecting the subscribers' lines and the operators' trunks, mechanism controlled over two sides in series of a calling one of said subscribers' lines to cause an idle pair of said switches to connect with the calling subscriber's line via its multiple contacts and to connect said subscriber's line with an idle one of said trunk circuits via its multiple contacts.

89. A telephone system including subscribers' telephone lines, operators' trunk circuits, a pair of normally connected normally at rest automatic switches for interconnecting the subscribers' lines and idle trunk circuits, means controlled over the two sides of a calling one of said subscriber's line in series for initiating the operation of said automatic switches to cause the same to connect the calling subscriber's line to an idle one of said trunk circuits, and means for connecting said selected trunk circuit to a called one of said lines.

90. A telephone exchange system comprising a telephone line, line selecting switches including contacts having primary and secondary movements, primary and secondary relays for controlling said movements respectively, a control switch for said selecting switches, starting circuits one for each of said selecting switches, each starting circuit including contacts of said control switch and the winding of one of said primary relays, and starting circuits for said control switch one from each selector switch, each of the latter starting circuits including contacts of one of said secondary relays.

91. A telephone exchange system comprising a telephone line, line selecting switches including contacts having primary and secondary movements, primary and secondary 5 relays for controlling said movements respectively, a control switch having a pair of movable contacts, cooperating fixed contacts arranged in pairs severally assigned to said selecting switches, a starting circuit 10 for each selecting switch including one of the fixed contacts assigned to it and the winding of its primary relay; and a starting circuit for said control switch including the other fixed contact assigned to said selecting switch and contacts of the secondary relay associated with said selecting switch. 15

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

ALFRED H. DYSON.

Witnesses:

H. G. WEBSTER,

H. C. OLMESTEAD.