H. G. WEBSTER.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED MAR. 9, 1908.

1,425,728.

Patented Aug. 15, 1922.

14 SHEETS—SHEET 1.

Fig. 2.

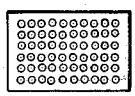

Fig. 1.

Witnesses:

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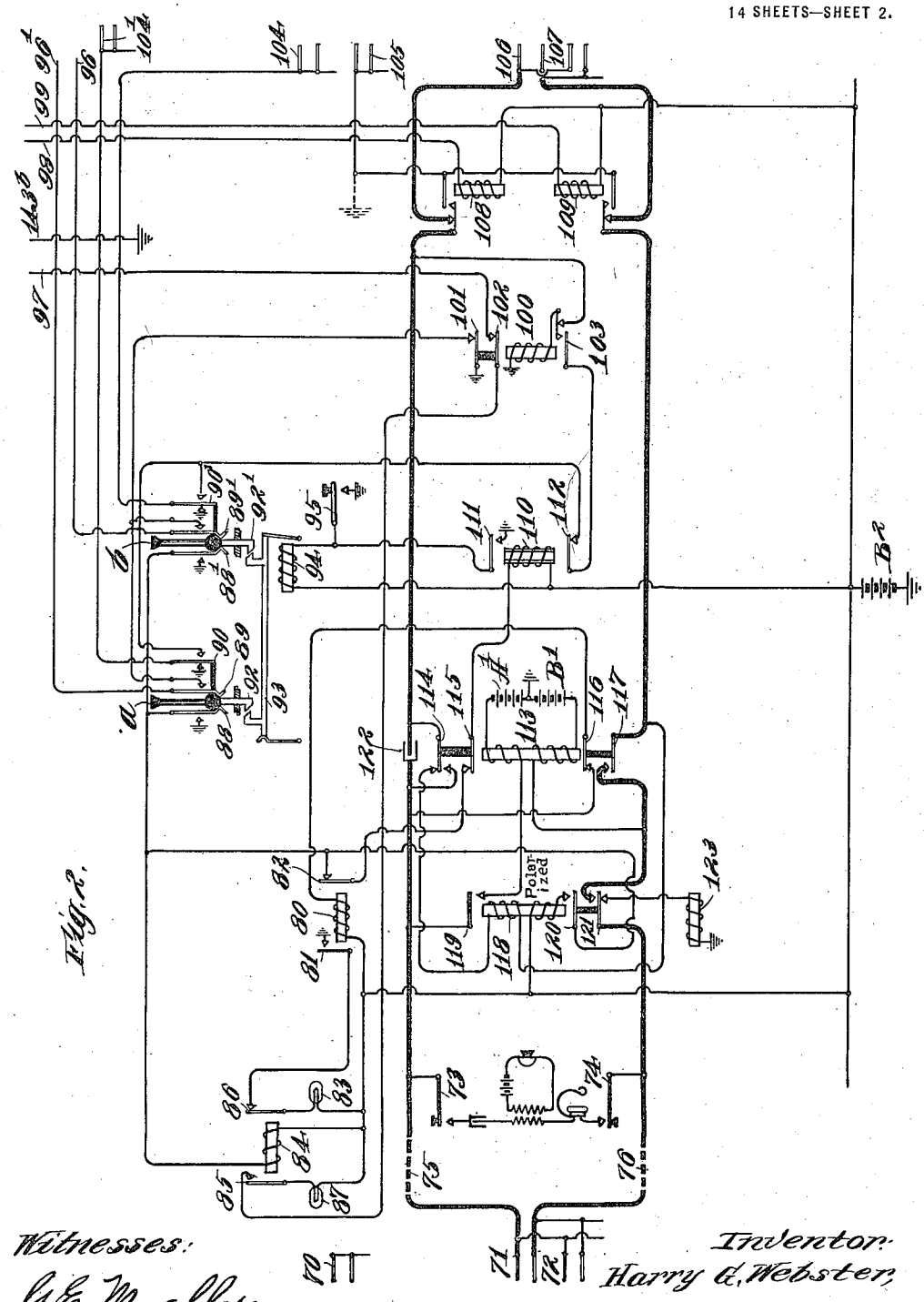

Fig. 2.

Witnesses:

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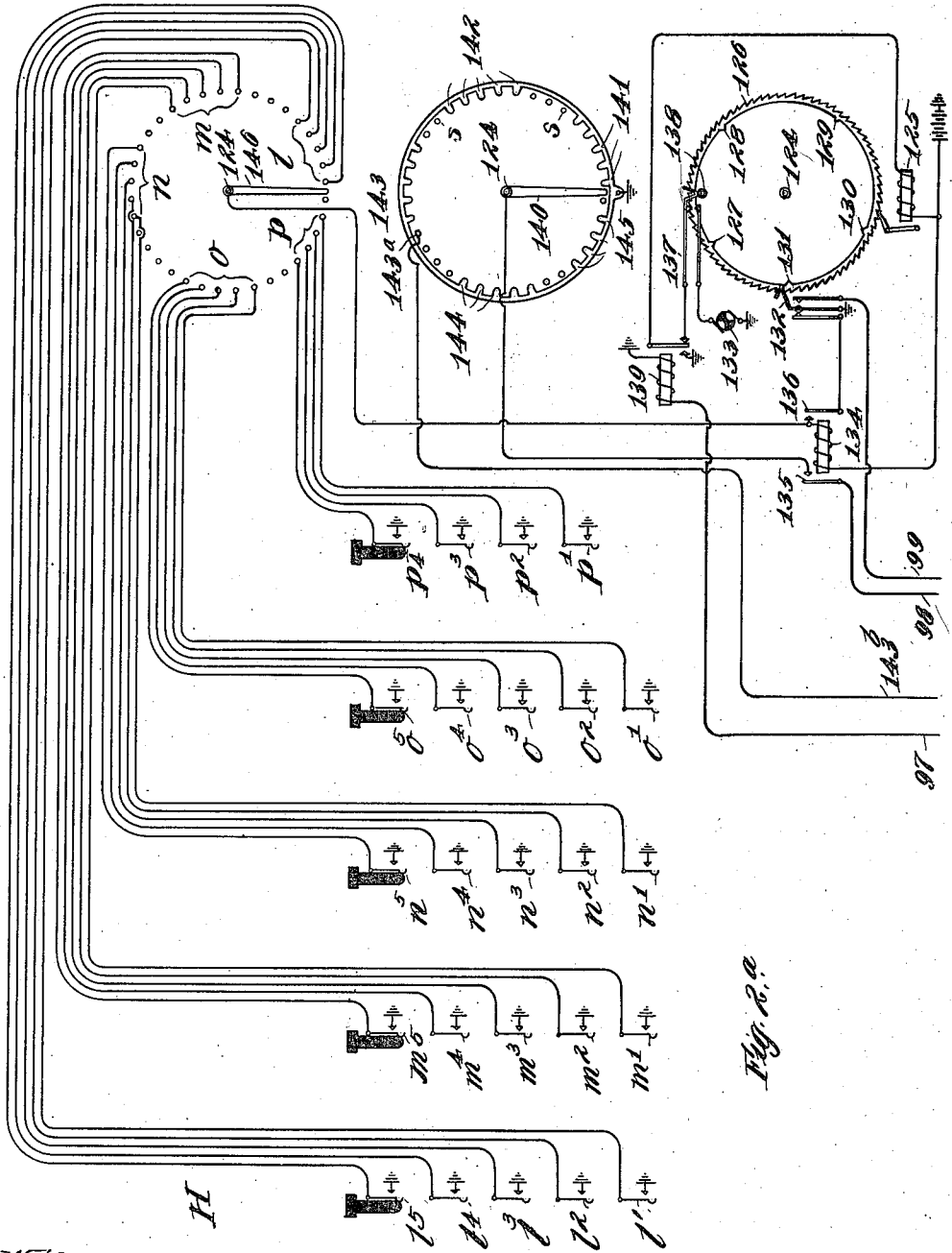

Fig. 2.a.

Witnesses:

G. E. Mueller.

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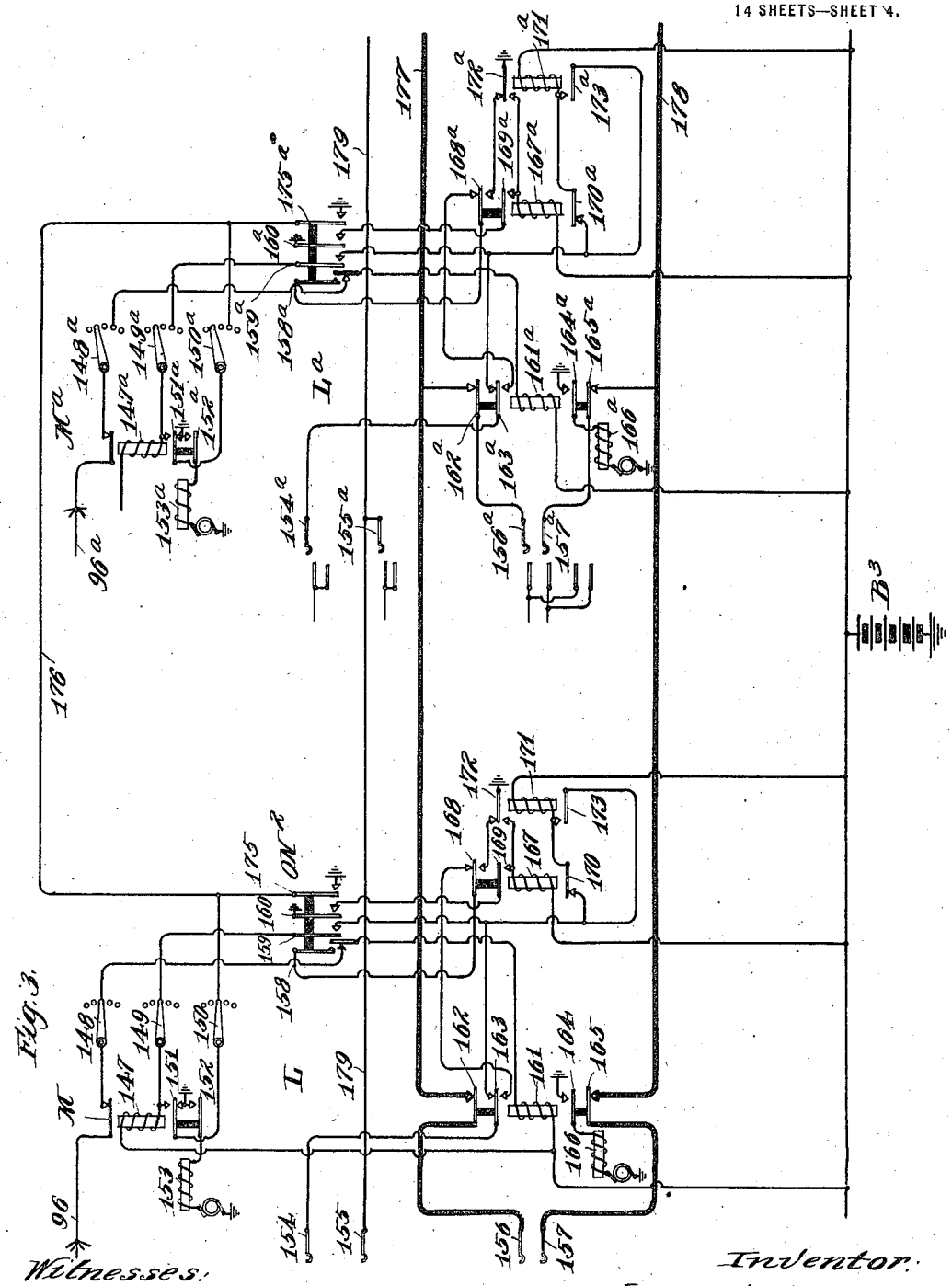

Fig. 3.

Witnesses:
G. E. Mueller
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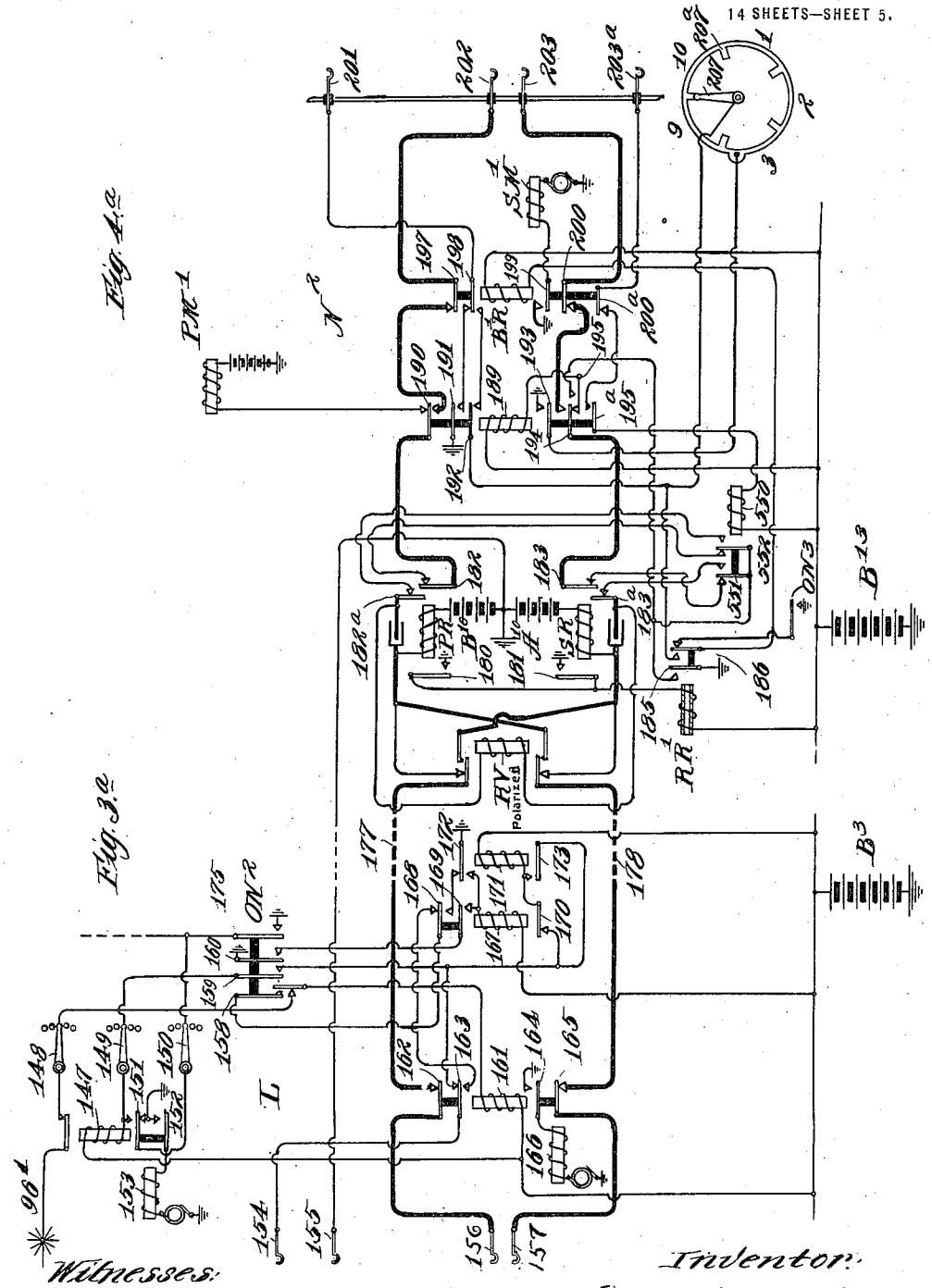

Witnesses:

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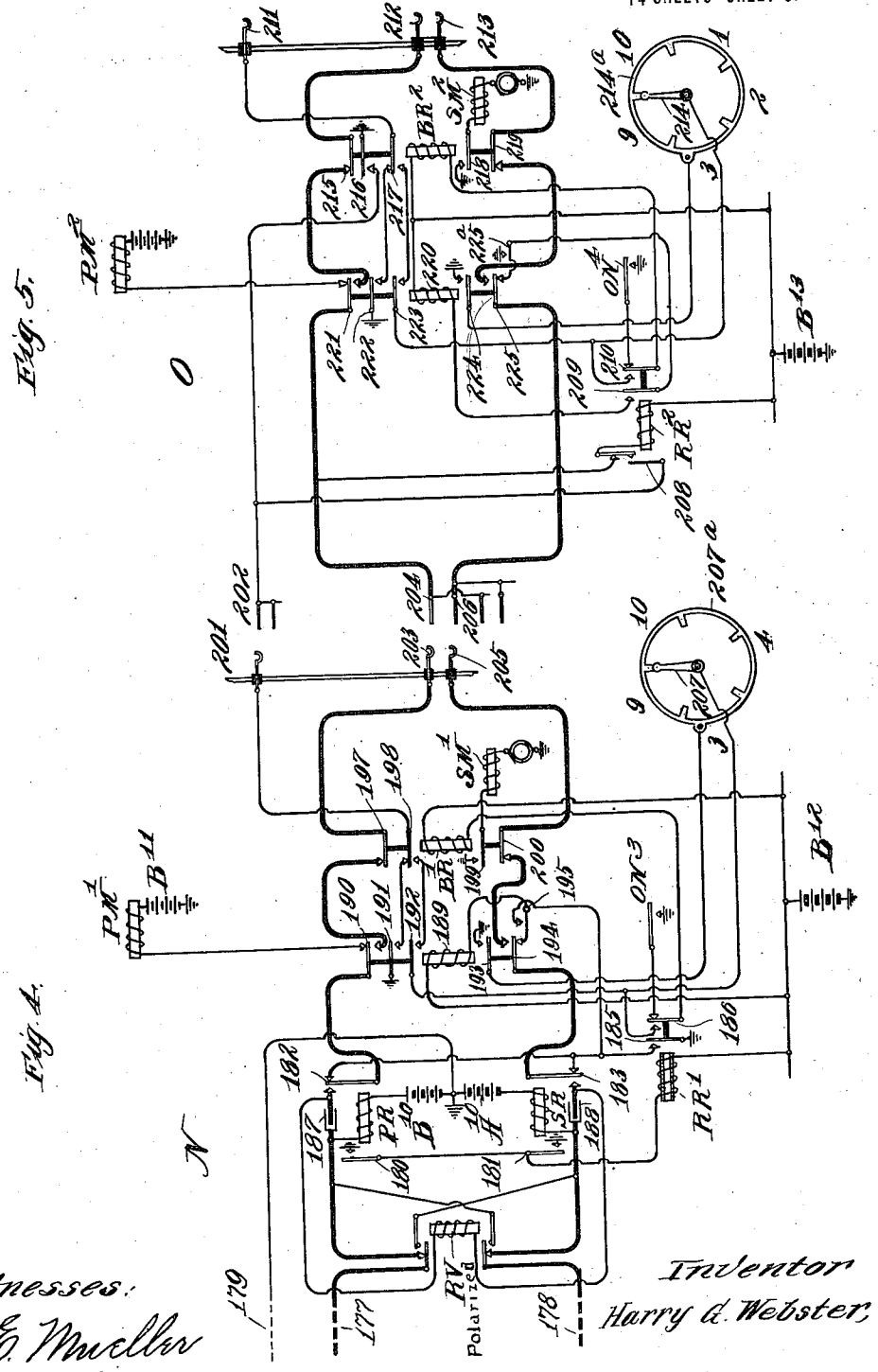

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14 SHEETS—SHEET 7.

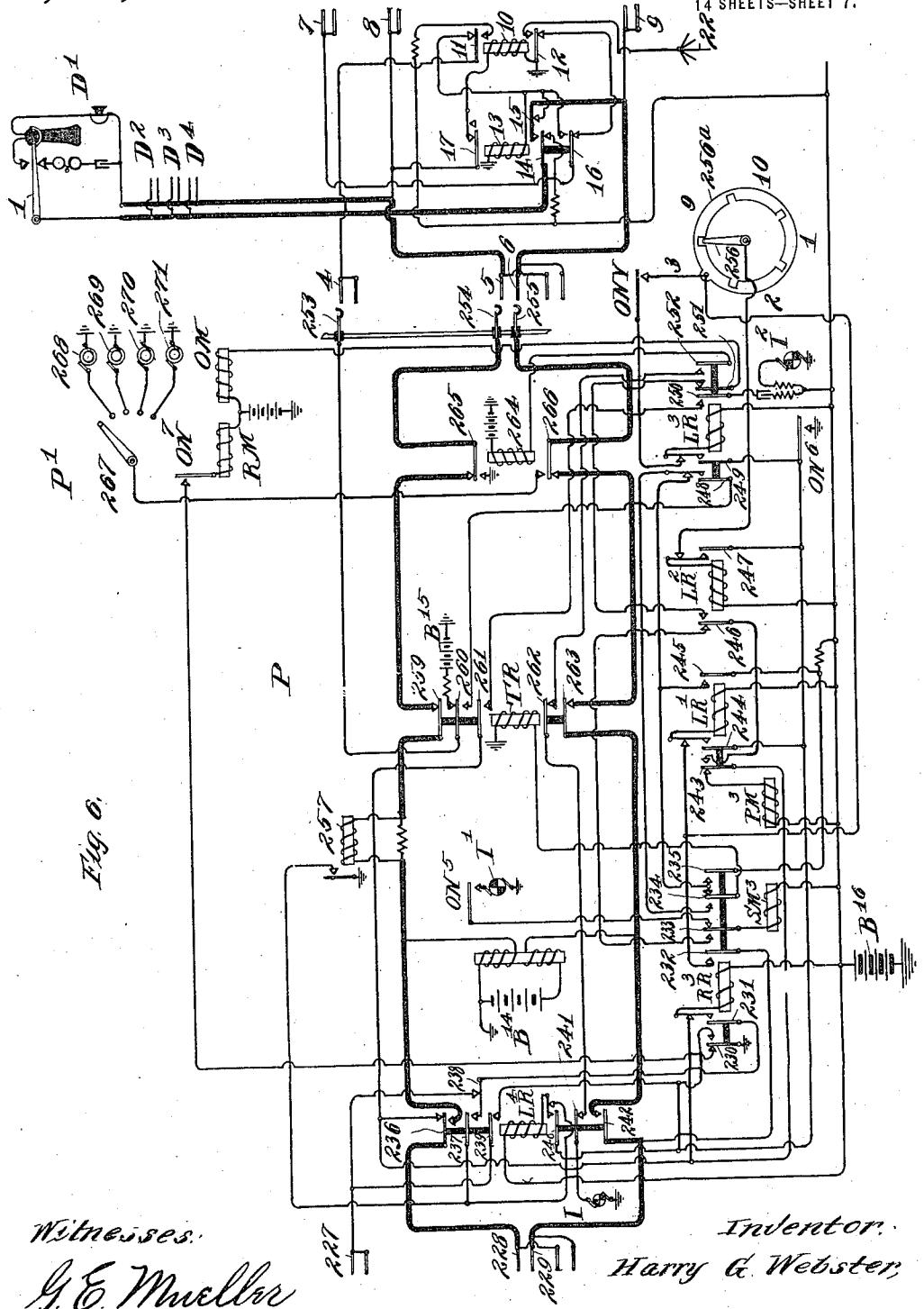

Fig. 6.

Witnesses:

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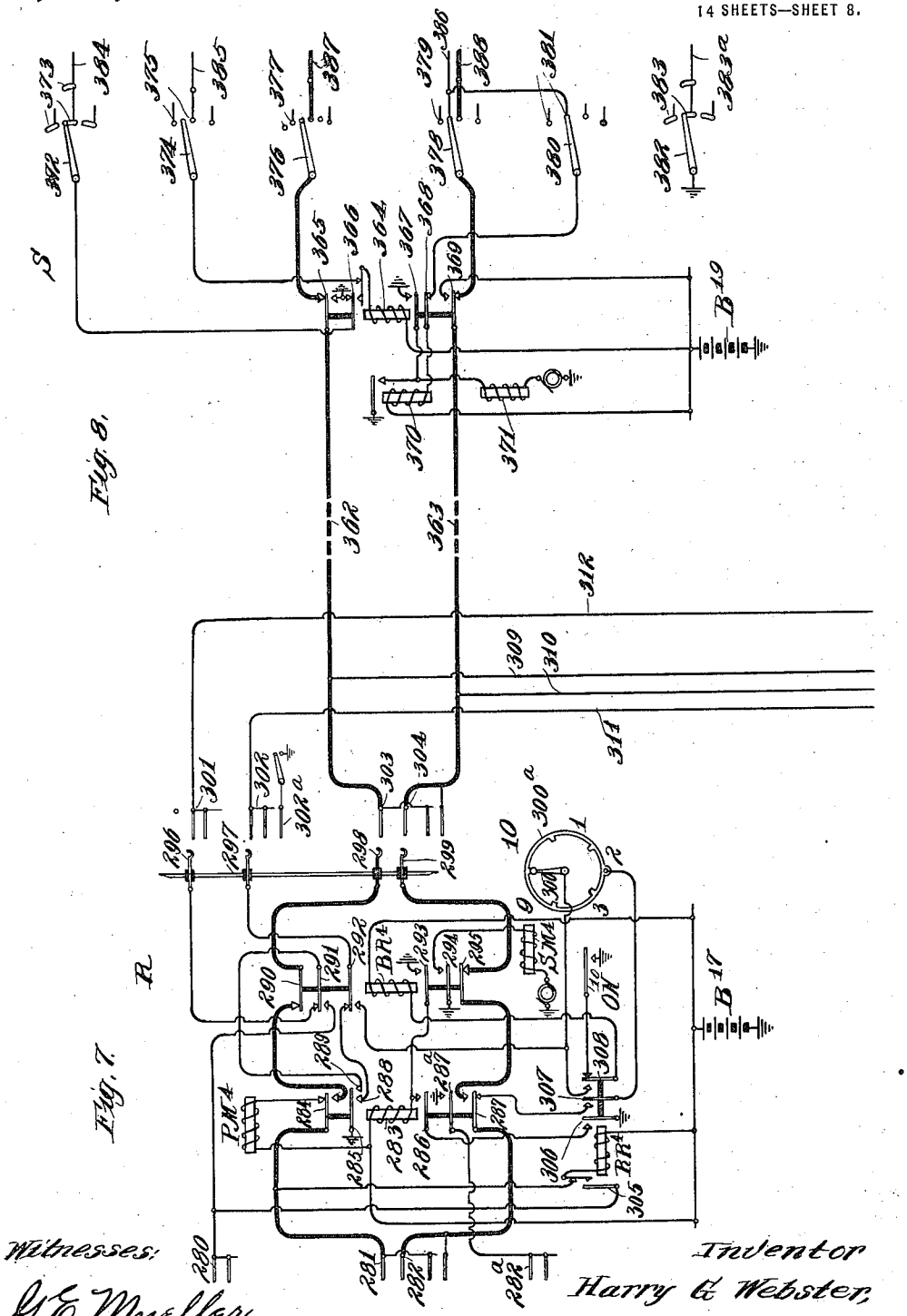
14 SHEETS—SHEET 8.



Witnesses:

G. E. Mueller

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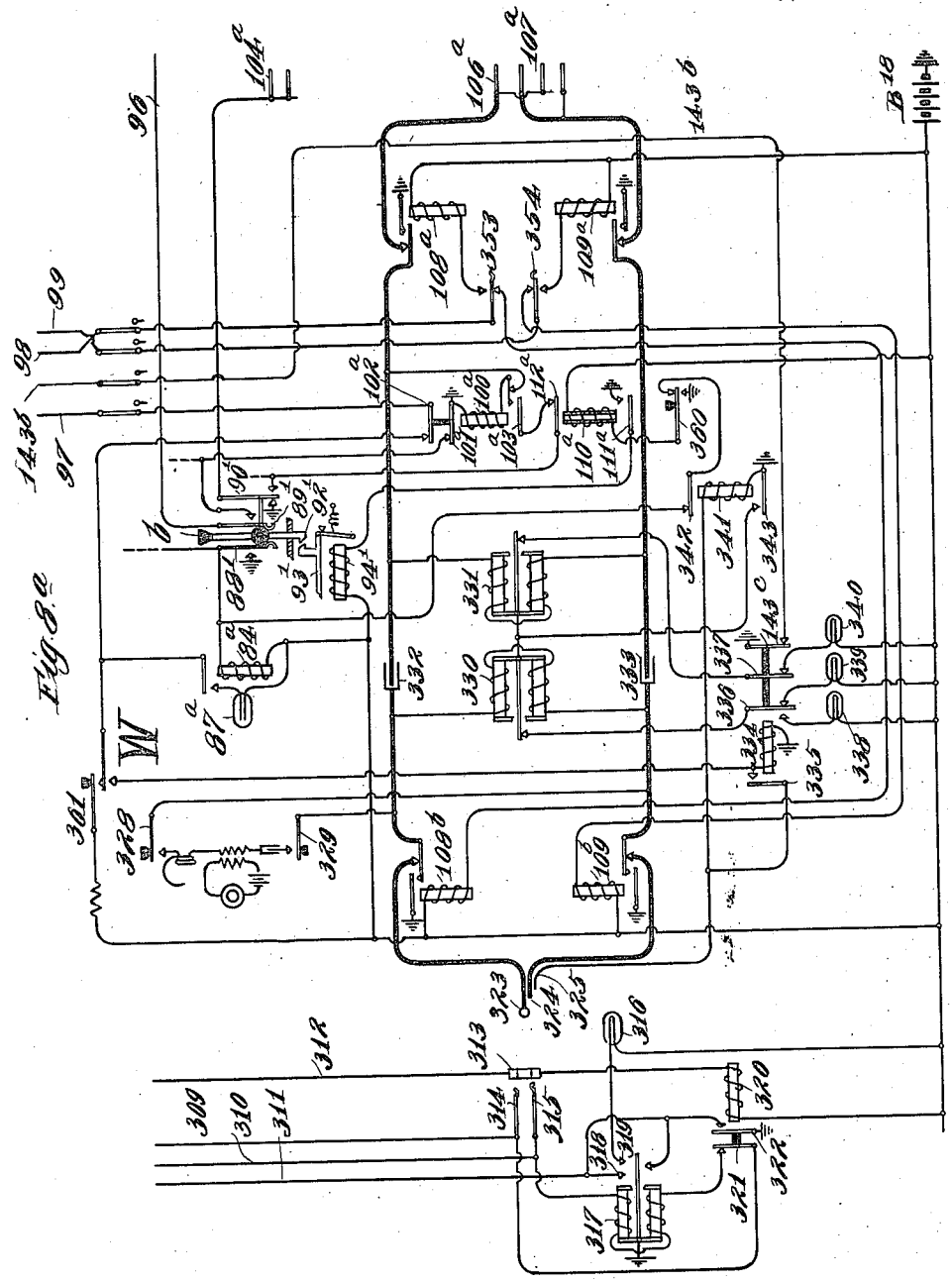

Fig. 8e.

Witnesses:
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14 SHEETS—SHEET 10.

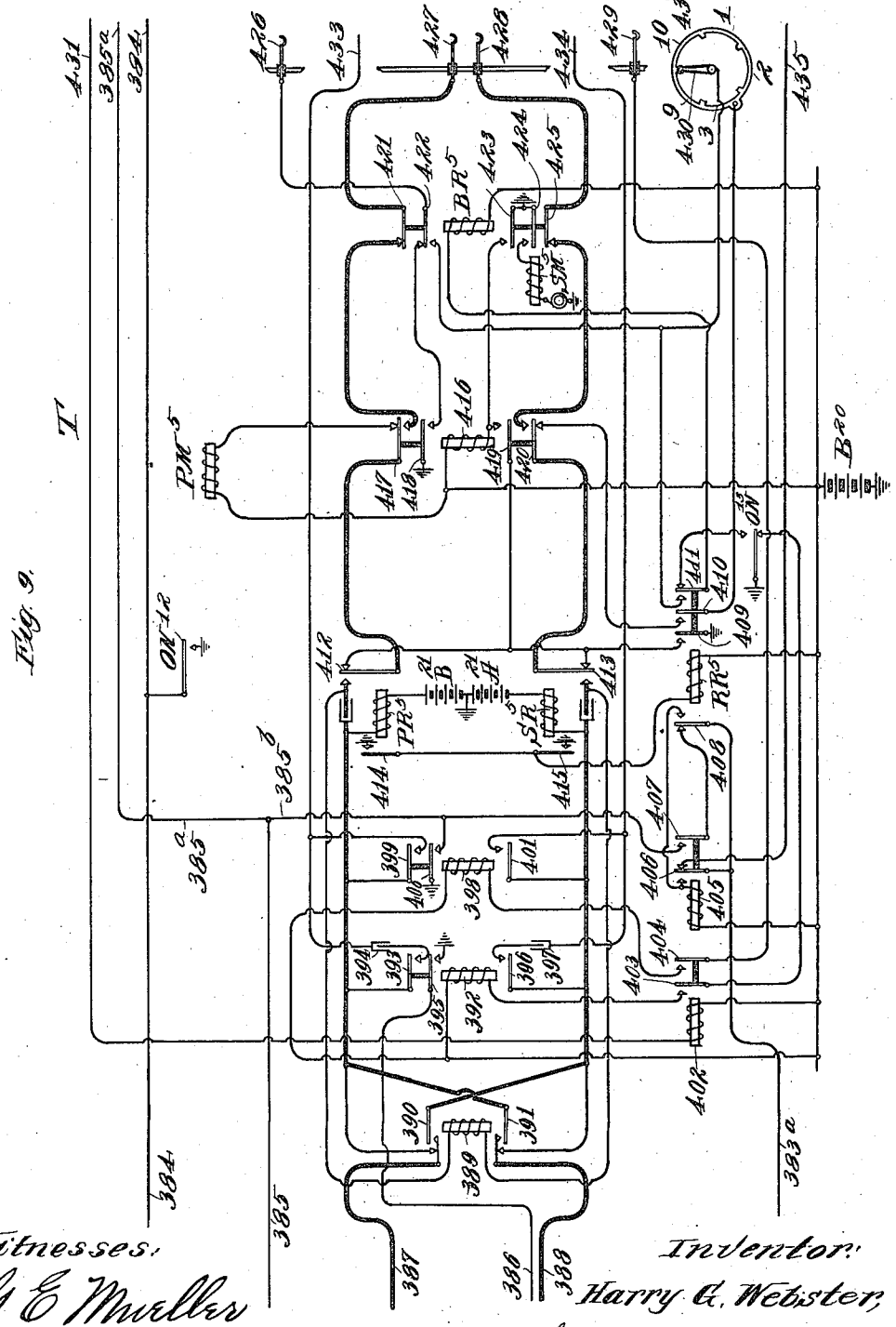

Fig. 9.

Witnesses:

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14 SHEETS—SHEET 11.

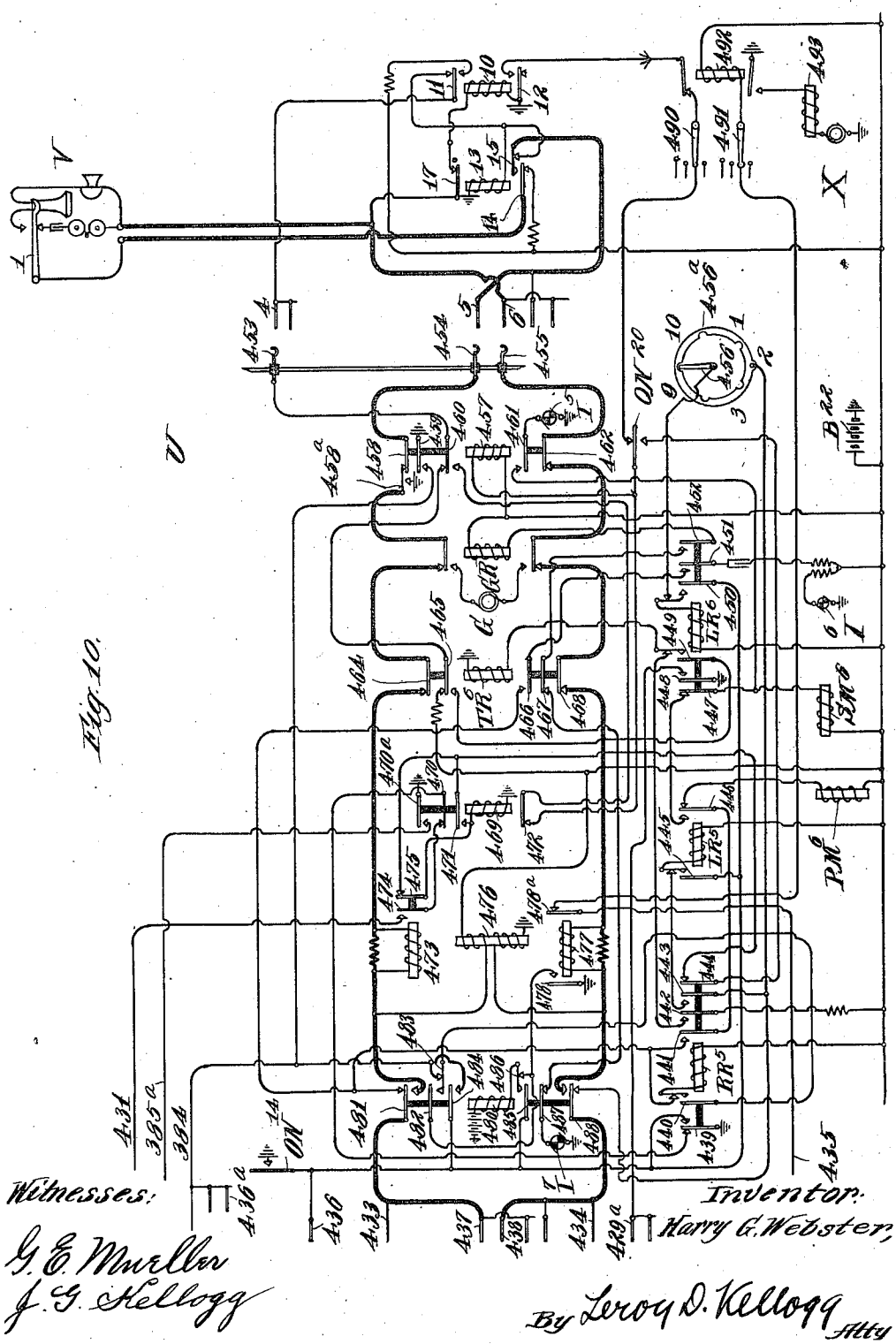

Fig. 10.

Witnesses:

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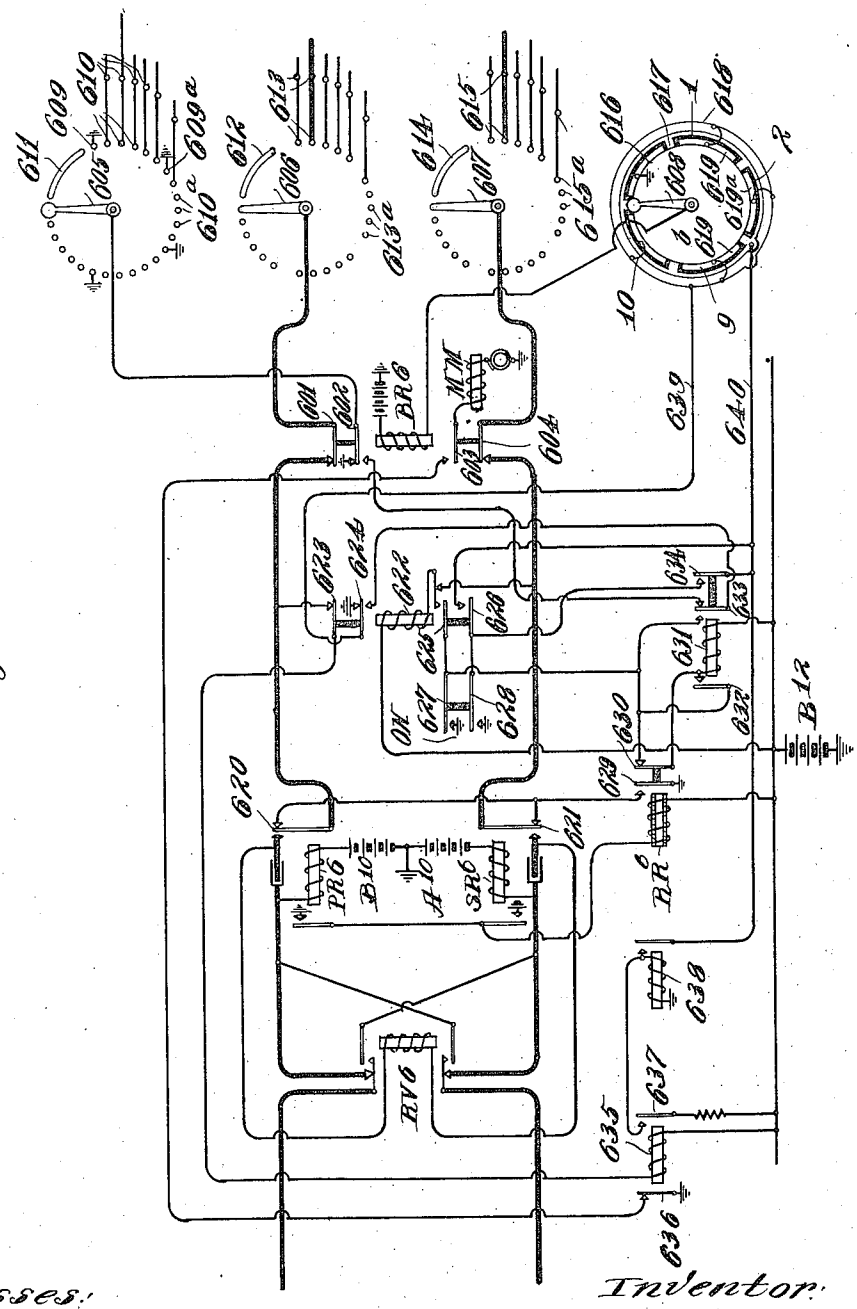

Fig. 11.

Witnesses:

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TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED MAR. 9, 1908.

1,425,728. Patented Aug. 15, 1922.

14 SHEETS—SHEET 13.

Fig. 12.

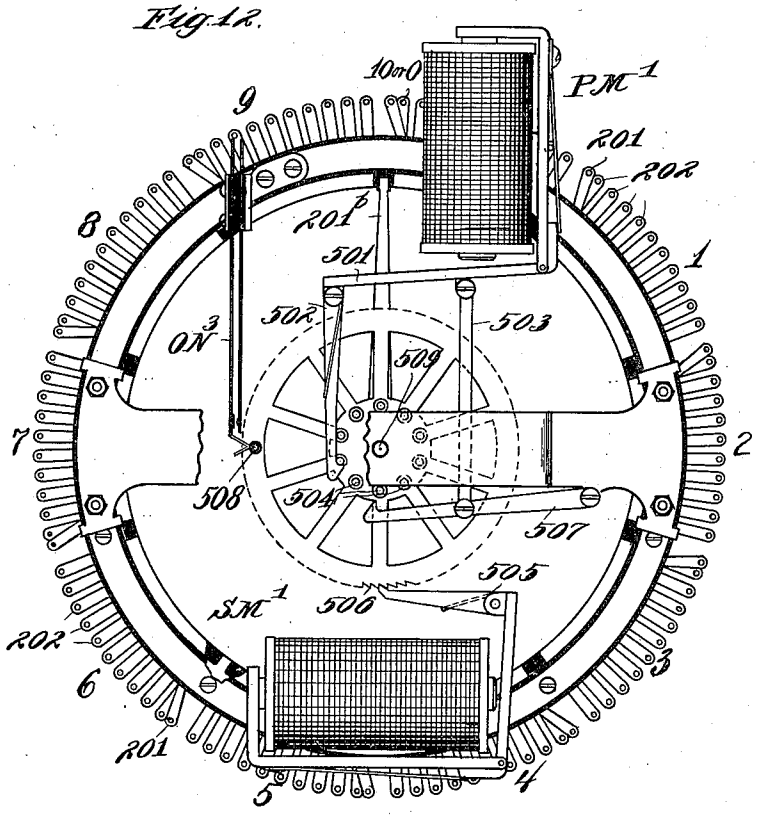
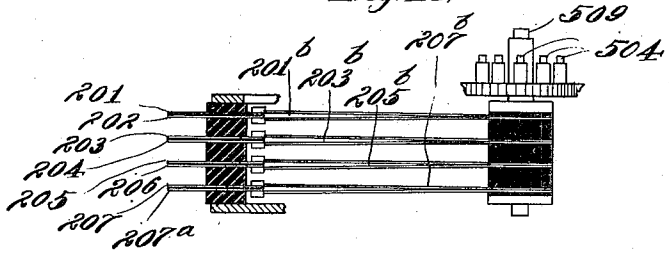


Fig. 13.



Witnesses:

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14 SHEETS—SHEET 14.

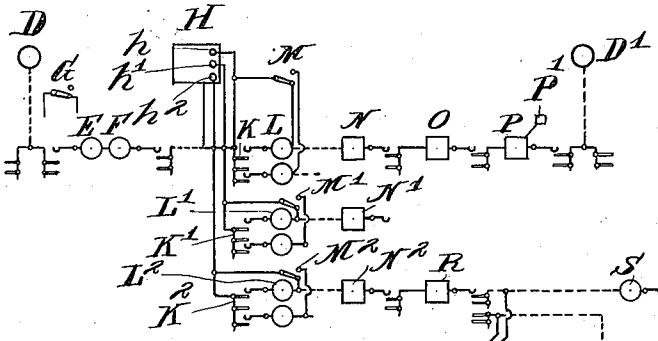


Fig. 19.

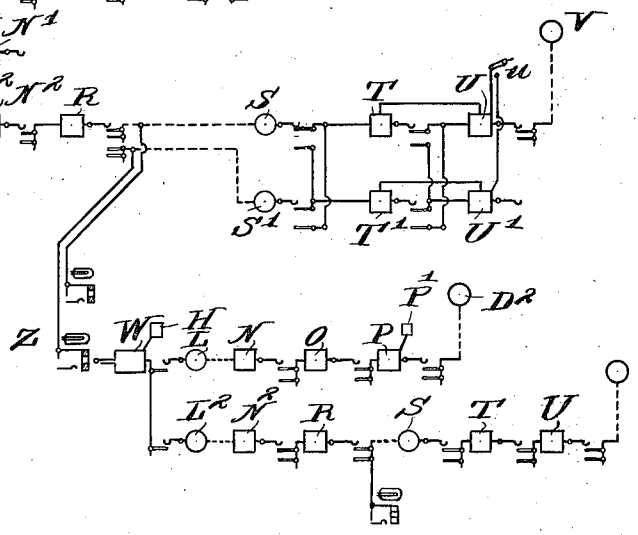


Fig. 14.

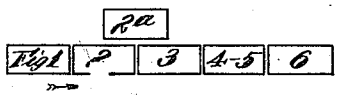


Fig. 15.

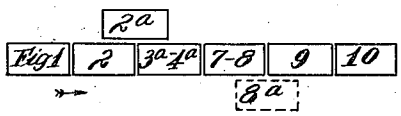


Fig. 16.

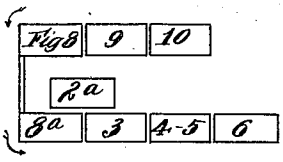


Fig. 20.

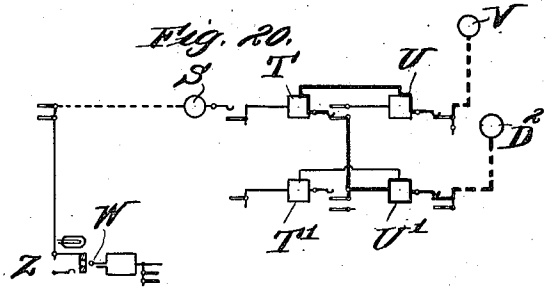


Fig. 17.

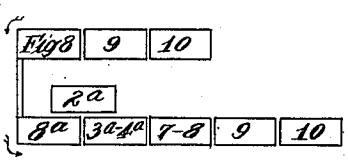
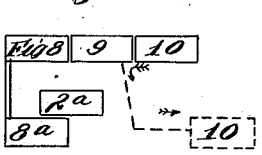


Fig. 18.



Witnesses:

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UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

TELEPHONE-EXCHANGE SYSTEM.

1,425,728. Specification of Letters Patent. Patented Aug. 15, 1922.

Application filed March 9, 1908. Serial No. 419,981.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, residing in Chicago, in the county of Cook and State of Illinois, have invented new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification.

My invention relates to systems in which selective switches are employed in building up the connections from the calling subscribers' lines to the called subscribers' lines, and I employ, in organizing the system of my invention, selective switches divided into two general classes. First, what may be called automatic switches which, when traveling, stop when engaging conductors of pre-determined electrical characters, no directive impulses being employed for their operation; while switches of the second class have the conductors associated with them arranged in different groups and are operated in response to directive impulses to select a group of conductors, whereafter they are automatically controlled to select contacts forming terminals of idle conductors.

Generally stated the object of my invention is to provide a telephone exchange system in which connections are built up with the aid of operators at one central office who, by suitable calling devices, control the directive switches to complete the desired connections, and in such system to provide an organization of co-operating automatic and directive switches of such character as to provide a relatively small number of switches and conductors.

A further object of my invention is to provide means whereby subscribers, whose lines terminate in exchanges at a distance from the exchange wherein the operators are located, may, by means of two-wire trunks extending from their exchanges to the operator's exchange, manifest calls at the operators' positions; and the operators working out over the same trunks over which the calls came in may adjust directive switches at the branch exchanges to connect the calling lines with any desired called lines and thereafter free the trunk lines for further use, thus securing a desirable economy in the use of the trunk lines.

Other objects of the invention are to secure certain more specific improvements in the mechanism of the various switches employed and in the circuits by which their adjustment is secured, together with certain improvements to be more particularly pointed out in the specific description and in the claims.

In describing my invention, I shall assume a telephone system embracing several different exchanges located, it may be, in different sections of a large city, the exchanges being divided into two classes. First, a class of main exchanges to which I shall refer as "A" exchanges, each such exchange embracing a large number of subscribers' lines. In the system as drawn out, the mechanism for each such "A" exchange is adapted for a maximum of 10,000 lines per exchange. Secondly, exchanges of a class which I shall designate "B" exchanges which may be branch exchanges having a relatively small number of subscribers each, the system as drawn out being arranged for a maximum of 1,000 subscribers per "B" exchange.

The various A and B exchanges being part of the same system, it is obvious that each A subscriber must be enabled to secure connections to the subscribers of his own main or A exchange and to the subscribers of each other main exchange and also to the subscribers of each branch or B exchange. Similarly, the B exchange subscribers must have facilities for securing connections to the subscribers of each A exchange and each B exchange including subscribers of that B exchange in which their lines terminate.

In large telephone exchange systems of the character which I have indicated, it has been found that a relatively small number of calls from any exchange are for subscribers of the same exchange; in fact, in large cities, the percentage of trunking calls to the total number of calls handled will amount to eighty per cent and will sometimes run as high as ninety per cent. In these systems, with the ordinary methods of operation, each trunking call requires the services of two operators, one in the originating exchange and one in the exchange in which the called subscriber's line terminates. It is apparent that in the operation of such an exchange, the employment of two operators for eighty or ninety per cent of the calls produces a very high charge for operators' wages and will also render the completion of connections relatively slow and, as has been demonstrated, much more sub-

ject to error than in systems where but one operator is employed to complete each connection. From these considerations, I have deemed it advisable, in organizing the system of my invention, to arrange the structure so that each call, whether from the subscriber of an A exchange, or from the subscriber of a B exchange, will be extended to one main exchange office, wherein all the operators for the entire system will be located, each operator being enabled, without the assistance of any other operator, to complete each call received by her, irrespective of the exchange in which the called subscriber's line terminates. This arrangement will obviously result in a material saving of operators' wages and the concentration of the entire operating force in one building will result in the elimination of certain load expenses occasioned by the present system of maintaining a widely scattered corps of workers.

As will hereafter more fully appear, the trunk lines, which are employed between exchanges, are in each case composed of but two wires each, whether they be employed as incoming trunk lines or as outgoing trunk lines, and this is also true of the trunk lines extending from the B exchanges, each of which is capable of use as an incoming trunk line or as an out-going trunk line, as required.

Referring to the drawing, I show diagrammatically in Fig. 1 an A subscriber's substation connected with its line circuit at the exchange, together with circuits of an A line selector which makes connection with the line as a calling line, and the circuits of an A link selector which is joined to the line selector and seeks out and makes connection with a two-wire trunk leading to the operator's exchange. The incoming trunks I have called "A link trunks," and Fig. 2 illustrates the circuits of one of these, Fig. 2[a] showing the circuit arrangements of an impulse transmitting device for use by the operator, while Fig. 2[b] is a plan view of the keyboard of the same. In Fig. 3 I have illustrated the circuits of a pair of A link connectors which are automatic switches connected in parallel to an outgoing trunk line and serve, at the proper time, to connect a first selector, by means of an associated two-wire trunk comprising conductors 177 and 178, with the out-going terminals of the A link trunk at the operator's position. In Fig. 3[a] is shown an A link connector connected to a B first selector. In Fig. 4, is illustrated an A first selector which is operated responsive to directive impulses transmitted from an operator's position to select a group of trunks assigned for connection to the thousand lines among which the called line is included, and then an idle trunk from a group, said A first selector corresponding to a certain extent to the first selectors known in purely automatic telephone systems. Fig. 4[a] illustrates a B first selector. Fig. 5 illustrates an A second selector adapted for operation after the adjustment of the A first selector to select a group and then an idle trunk therefrom assigned for connections to the hundred out of the previously selected thousand among which the called subscriber's line is located. In Fig. 6, are illustrated circuits of a connector for selecting the tens and units of the called subscriber's number, said circuits also comprising a party line switch for selectively ringing the stations of a poly-station line. Fig. 7 illustrates a B second selector for use in selecting B link trunks—that is, out-going trunks to the B exchanges; Fig. 8 illustrating the circuits of one of said trunks. Fig. 8[a] shows an operator's link-circuit which I have designated the "B cord trunk," together with the circuits controlling a call signal for indicating in-coming calls from the B exchange subscribers, said B cord trunk being employed for receiving and completing the calls from B subscribers. In Fig. 9 I have illustrated the circuits of a B third selector located at a B exchange; and in Fig. 10 I have illustrated the circuits of a B line connector, also located at a B exchange. In Fig. 11 I have illustrated the modification of the circuits of an A first selector; Fig. 12 shows mechanism that may be employed for the selective switches, said figure being a top view thereof; and Fig. 13 is a detailed view showing the arrangement of the switch wipers upon the switch shaft. Fig. 14 shows the manner in which the figures are to be arranged for considering the operation of a connection from an A subscriber to an A subscriber; Fig. 15, the arrangement in which the figures are to be arranged in considering the connection from an A subscriber to a B subscriber; Fig. 16, the arrangement of the figures for connecting a B subscriber to an A subscriber; Fig. 17, the arrangement for connecting a calling B subscriber in one B exchange to a called B subscriber in another B exchange; and Fig. 18, the arrangement for connecting a calling B subscriber in a certain B exchange with a B called subscriber in the same exchange. Fig. 19 is a skeleton view showing the general organization of the various mechanisms arranged in accordance with the invention, and Fig. 20 a similar view of a connection from a B subscriber to another B subscriber in the same exchange.

In organizing the system I have had in mind to reduce the operator's work to a minimum in order that each operator may handle a maximum number of calls and the item of operators hire be correspondingly reduced. Thus the operators who receive calls from A exchange subscribers are re-

quired only to ascertain the number of the subscriber desired and to thereupon press down a number of buttons of a keyboard associated with the A link trunk upon which the call is manifested, the depression of the buttons counting out the number of the called-for subscriber. Thereafter the operator has nothing to do with the connection. The operation of adjusting the various switches to make connection with the called line, the ringing of the called subscriber, the transmission of the busy signal back to the calling subscriber if the called line be busy, and the restoration of the entire mechanism used in the connection being automatically controlled without requiring any attention whatever from the operator.

In the case of the operators who handle calls originating in the B exchanges, the operator is required to insert a plug within a spring-jack of the B link trunk employed and then operate the proper buttons to count out the called subscriber's number, and the operator is also required, at the proper time, to withdraw the answering plug she used.

Referring first to Fig. 19, the structural relation of the various switches will be more specifically referred to. At D I have indicated a calling subscriber's station and line, said line being provided with passive multiple called terminals at the left and passive multiple calling terminals at the right, said called terminals being preferably grouped together with those of ninety-nine other lines before the wipers of a suitable number of connectors, and said calling terminals being grouped together with those of ninety-nine other lines before the wipers of a suitable number of A line selectors, which may number ten for each hundred lines. One of these I have indicated at E, and at G I have indicated a master-switch which is effective, when a call is initiated over any line of the one hundred line group, to start an idle A line selector E to seek out the multiple calling terminals of the calling line and to rest in connection with them. The A line selector E has its A link selector F individual to it, said A link selector being started simultaneously with the starting of the A line selector to seek out multiple terminals of an idle A link trunk leading to the operator's exchange.

It may be stated that, in Fig. 19, the automatic switches have been indicated by circles with the conventional wiper symbol attached, while the directively operated switches have been indicated by squares with the wipers symbols. In the said Fig. 19, the trunk lines for which two conductors only are required have been indicated by dotted lines.

The A link selector F may have before it the multiple contacts of one hundred A link trunks, which may extend to a number of operators' positions at the exchange. For instance, the first ten encountered by the switch F when leaving its normal position may extend to a first operator's position, the next ten to a second operator's position, the next ten to a third operator's position, and so on, so that each operator's position may be rendered busy by having all of its trunk lines engaged before the next operator's position begins to receive calls. Thus on the removal of the receiver at substation D, the A line selector, E, selects its line and the A link selector, F, selects a link circuit extending to an idle operator's position; and when this connection is completed, a lamp associated with the A link trunk is displayed, and the operator inquires the number of the wanted subscriber. Each A link trunk preferably has its individual impulse transmitting device which may consist of six rows of buttons, each row consisting of ten buttons, one for each of the numbers from 1 to 9, and a button for the zero which is represented by ten impulses. The operator depresses one button in each of the first five rows to count out the called-for subscriber's number and then depresses a button in the sixth row which determines the exchange to which the A link trunk shall be extended and causes it to be connected over a two-wire trunk of that exchange, whereafter the five previously depressed buttons control means for counting out the number of the called-for subscriber by sets of current impulses which adjust selective switches at the distant exchange to complete the required connection.

Each out-going A trunk is connected at its out-going end with an A first selector N and at its answering end with an A link connector L, which latter has before it multiple terminals of one hundred A link trunks. Each A link trunk has multiple terminals K before a number of A link connectors L connected to trunks extending to one distant exchange, a master-switch M being provided for the A link connectors L for one particular exchange, said master-switch serving to start an idle A link connector to select multiple terminals of the A link trunk over which a call is being extended. The A link trunk shown in Fig. 19 has, in addition to the multiple terminals K′ which are selectable by a number of A link connectors L′ connected to A first selectors N′ of a second exchange, a master-switch M′ being arranged to start an idle one of said A link connectors L′. The said A link trunk also has multiple terminals K^2, appearing before and selectable by a number of A link connectors L^2 connected to B first selectors N^2 for selecting second selectors R arranged for connections to B exchanges. The A link connectors L^2 are controlled as to their starting by a master-switch mechanism M^2 and, when started,

said A link connectors L^2 will automatically seek out and connect with the terminals K^2 of the A link trunk over which the call is being completed.

It is thus apparent that each A link trunk has a number of groups of multiple terminals K, K', K^2, etc., and it will have as many such groups as there are different exchanges. All of the said multiple terminals are normally unselectable by the A link connectors L, L' and L^2 respectively, having access to them, and the operator is enabled to render any group K or K' or K^2 selectable by its A link connectors, while leaving the other groups unselectable. For instance, to render the group K selectable, the operator may depress the button indicated at h, the depression of said button also operating the master-switch mechanism M to start an idle A link connector L to connect its trunk to the terminals K, now rendered selectable, of the A link trunk. The depression of key h, however, has no effect upon the terminals K' and K^2 and they remain unselectable to their respective A link connectors. On the other hand, if the operator learns that the calling subscriber D desires to be connected with the line of a B exchange, she will depress the button h^2 and this will render the multiple contacts K^2 selectable and will influence the master-switch mechanism M^2, associated with the switches L^2, to start one of them which will seek out and connect with the terminal K^2, the A link trunk being thus connected with a B first selector N^2 assigned for connection to the B exchanges. It is thus apparent that if the operator have ten buttons h', h^2, h^3, h^4, etc., she may have access to ten groups of A link connectors by means of their respective ten master-switches and may control distributively the selectable condition of ten groups of multiple terminals all belonging to the same A link trunk. It will of course be understood that the master-switch mechanism M is not individual to a particular A link trunk, but that it is connected with branch wires to the buttons h of one hundred A link trunks appearing before different operators—that is, to as many A link trunks as have multiple terminals before the master-switch's group of A link connectors.

Assuming that the calling subscriber D desires to be connected to subscriber D'—namely, to a subscriber at a distant A exchange—the operator will depress the buttons as described, corresponding to the digits of the called number, the depression of button h thereafter causing a switch L to connect with its set of contacts K, whereafter the transmission of the impulses will first adjust the A first selector N to select the thousand, the next set will adjust the second selector O to select the hundreds, the next set of impulses the connector P to select the tens, and the next set the same switch P to select the units, whereafter the fifth set of impulses adjust the party line switch P' to select the frequency of generator current to ring the called subscriber's bell, whereafter the busy signal will be transmitted to substation D if the called line be busy, or the bell of D' rung if the called line be idle. Assuming the first to be the case, subscriber D hearing the busy signal, replaces his receiver and his line and switches E, F, L, N, O, P, P', are all restored to normal. Assuming, however, that the called subscriber's line is idle and that he answers the call, upon such answer the power to restore the switches P and P' is taken from the calling subscriber and turned to the called subscriber so that when, at the conclusion of conversation, subscriber D' replaces his receiver, the switches P and P' will be restored, the other switches being restored when the calling subscriber hangs up.

Assuming, however, that the calling subscriber D desires to be connected with a subscriber in the B exchange, the operator would have depressed the button h^2, thus causing a switch L^2 to select the terminals K^2, whereafter the first set of impulses would adjust the B first selector N^2, which may have before it ten groups of multiple contacts of B second selectors R, the B second selectors of each group being assigned for connection to a different group of ten B exchanges. Thus the B first selector N^2 is common for connection to a group of one hundred B exchanges and is operated directively to select a group of ten and then an idle second selector R out of the group of ten. The second selector R is adjusted by the second set of impulses to select one of ten groups of multiple terminals of B link trunks, those of each group extending to a different B exchange, and then an idle B link trunk out of the selected group so that the connection is extended over an idle B link trunk to the wanted B exchange. At the B exchange, each trunk terminates in a switch S which I have termed a "B trunk controller" and which serves merely to maintain its B link trunk in connection with an idle switch pair comprising a B third selector T and a B line connector U, the said switches T and U at the branch exchanges being arranged in pairs, to the end to be hereinafter described.

It should be stated at this point that each third set of current impulses transmitted comprises one extra impulse—that is, one impulse more than there are units in the digit to be transmitted. This extra impulse is for the purpose of operating the B trunk controller S, and the A line connection P is arranged to take care of this additional impulse, without producing a wrong selection, by its wipers being set back so that two im-

pulses are required before the said A line connector P selects its first group of contacts.

The extra impulse reaching the B trunk controller, S, steps it one step forward but not out of engagement with the terminals of the switch pair T, U, which it is engaging, to bring the said switch pair into relation such that each of the succeeding impulses operates upon the mechanism of the B third selector T to select a group of contacts forming terminals of B line connectors U, assigned for connection to the hundred corresponding to the wanted number. The fourth and fifth sets of impulses adjust the B line connector U to engagement with the multiple terminals of the called-for line, whereafter the busy signal to the calling subscriber, if the called line be busy, the ringing of the called-for subscriber, and the release of the mechanism, occur as in the previous case. It is therefore seen that when the connection is being extended to an A called subscriber, the fifth or final set of impulses is used to adjust a party-line generator selecting switch, whereas when connection is extended to a B called subscriber, the fifth set is employed to adjust the connector itself. This is believed to be a novel feature.

As before stated, the B exchanges are preferably arranged each for one thousand lines, and the switches thereat include two classes of directively operable switches, namely, B third selectors T, T′, in Fig. 19, and B line connectors U, U′. The switches at the B exchange also include two classes of automatically operated switches—namely, B trunk controllers S, S′, and a number of master-switches *u*.

At the B exchanges the lines are arranged, by having their multiple terminals grouped together, in groups of one hundred, according to their numerical values, and each group of lines may have ten or more B line connectors U, each of which will be capable of making connection with multiple terminals of any line of its appropriate group. There would thus be for one thousand lines ten groups of lines of one hundred each and ten groups of ten or more line connectors, one for each group of lines. The said line connectors are arranged for a double use. They may be either directively operated responsive to current impulses transmitted over B link trunks, of they may be automatically operated responsive to the removal of a receiver at a B exchange substation to connect a B link trunk with a calling B exchange subsriber's line. For starting the B line connectors, U, to connect with calling lines, the master-switch, *u*, one for each group of lines, is so arranged that upon the removal of the receiver, it will only start a B line connector, U, whose paired B third selector, T, is at that time engaged by the B trunk controller, S, of an idle link trunk. When the B line connector has selected a calling B exchange line, the connection over the B link trunk exists by way of a link permanently uniting its B third selector, T, with the B line connector, U, through the B trunk controller S then engaging the terminals of switch, T, and over the trunk to the B cord trunk operator's position, where a signal is displayed and the operator answers by means of a cord connector. As soon as a B line connector is started in its automatic search of a calling line, the multiple terminals of the B link trunk, whose B trunk controller S is engaging the switch pair whose switch, U, has started, are made busy at the B second selectors R at the operator's exchange so that the trunk is instantly guarded from seizure at the B second selectors. The call being extended to the B operator's exchange, the oprator thereat may find that the calling subscriber desires his line to be connected with an A exchange subscriber. Assuming this to be the case, the operator at the B cord trunk position actuates buttons of her calling device for that cord to cause an A link selector L for the appropriate exchange to select multiple terminals of the B cord trunk W with which she answered, and the call is extended via the switch, L, the A first selector, N, the second selector, O, the connector, P, and the party line switch, P′, just as before. The B cord trunk is provided with two supervisory signals, one controlled by the calling party and one controlled by the called party. When the called subscriber D^2 replaces his receiver, the switches P and P′ will be restored; and when the calling B exchange subscriber V replaces his receiver, the B trunk controller S is moved off the switch T and the answering supervisory lamp is displayed. Both lamps being now displayed, the operator withdraws the plug. The switches L, N and O are all restored to normal.

In Fig. 20, it is asumed that a calling subscriber V in a B exchange has removed his receiver, whereon the B line connector U selected the multipled terminal of the line and the call was extended over the permanent link, associating switch U with switch T, to the B link trunk having the controller S then engaging switch T, and that the operator at the B cord trunk W answered the call and ascertained that the called subscriber belonged to the same B exchange to which the calling subscriber belonged. The operator at W thereupon connected her calling mechanism operatively with the answering end of her cord trunk and actuated keys corresponding to the last three digits of the called subscriber's number. She then depresses a special starting

key for her calling device and impulses are transmitted back over the same B link trunk over which the call is received, to the B third selector T, causing the said selector to select the group and then an idle connector U' from those assigned for connection to the hundreds group corresponding to the first digit transmitted. The second and third digit sets transmitted by the operator at W are now effective to adjust the selected B line connector U' to select the tens and units of the called subscriber's number, when the called subscriber D^2 will be automatically rung or the busy signal extended. Immediately following the last impulse adjusting the B line connector U', the B trunk controller S of the B link trunk which was used, is moved off the terminals of the B third selector T and sweeps over its contacts, coming to rest engaging terminals of a B third selector T of an idle switch pair T, U, the B link trunk being then ready to be used for calls from or to subscribers of its B exchange. In Fig. 20 the talking circuit established from the calling subscriber, V is shown by the heavily marked conductors extending through the switch, U, over its by-path to the switch, T, thence to a multiple contact forming a terminal of the connector, U', and thence to the called subscriber, D^2. When this connection is established, it is seen that the switch, T', of the pair, T', U', is not employed in the connection at all. Neither can it be selected by a B link trunk controller, S. Moreover, if at the time the switch T attempted to select the switch U', a controller S was resting on a terminal of the switch T', said switch T would be automatically moved away from the terminal thereof in search of an unconnected idle switch pair T, U. Thus for a connection of this character, the trunk to the operator's exchange is used for a short time only—namely, only long enough for the operator to receive the order and to transmit the directive impulses back over the trunk. The two subscribers V and D^2, on replacing their receivers, cause the switches, U, T, and U' to be restored to normal, and the switch pairs may then be selected by a B trunk controller, S.

It is apparent that in order to get the full use out of the trunks, a sufficient number of switch pairs, T, U, must be provided so that each trunk controller S, when moved off terminals of a busy switch pair, may find terminals of an idle switch pair so that it may come to rest engaging them and so be available for use. The switch pairs T, U, will therefore exceed in number the number of B link trunks for the exchange. It will also be understood as being within the scope of the invention that switches of the general character of the B line connector, U, may be provided without any individually associated selectors, T. In this case, such B line connectors would not be capable of employment to connect with calling lines, but would only be employed to connect with called-for lines and would have their stationary contacts multiply connected at the banks of the B third selectors, T.

In developing the system, I have arranged for the use of rotary switches exclusively for both the automatic and directive switches, the wipers or movable contacts being designed to make a complete circular revolution from a normal point around to the same normal point when restoration is to be made, the rotary movement being thus always in the same direction. For the automatic switches, short steps of the wipers only are employed. Thus, assuming switches having one hundred contact sets arranged in a circle, the switch would comprise wipers mounted upon a rotary shaft, said shaft carrying a ratchet provided with one hundred and one teeth and a magnet controlling an actuating pawl for driving the ratchet, shaft and wipers. In such case, one hundred ratchet teeth would be employed for adjusting the wipers to engage one hundred contact sets included in the switch, and the additional ratchet teeth above the one hundred would be for the purpose of bringing the wipers into the additional normal position, said position being one between the first contact set of the switch and the one hundredth contact set.

In the case of the directively operated switches, which are designed to permit of the selection of ten groups of contact sets, each group comprising ten contact sets, the contacts are arranged circularly, and the wipers are mounted upon a rotary shaft as before, the so-called primary movements of the wipers to select the group wanted being effected by long steps, each long step causing the wipers to advance a distance corresponding to eleven short steps, the wipers for each long step thus wiping over ten sets of contacts to a position between the set wiped over and the succeeding set. To select an individual idle contact set out of a selected group, the wipers are caused to make short steps, each such step being one-eleventh as long as the group-selecting steps, and each such short step moves the wipers from one contact set of a group to the next contact set, moving continually until an idle set is selected.

For producing the long or group-selecting steps, one magnet is used, while for producing the short steps another magnet is employed. Both of these magnets are true driving magnets, and in no part of its operation is the switch actuated by a stored power controlled by escapements, although such method would be within the scope of the invention. For the first selectors, second se-

lectors and connectors, four wipers are employed for each switch, two being the customary talking wipers connected to the talking conductors of the switches, a third being the well-known so-called private wiper, and a fourth being what may be called a sub-normal wiper, its function being in the case of the first and second selectors to complete a circuit at the conclusion of each long step, by means of which the short step travel of the switch may be initiated. When the switch has wipers resting in one of the sub-normal positions, of which there will be one for each group of contacts, the sub-normal wiper is on closed circuit; and upon the first contact-selecting or short step of the switch, it moves to a position such that it is on open circuit. In the A line connector and B line connector, the sub-normal wiper has a circuit relation converse to that which it has in the first and second selectors. That is to say, when in the sub-normal positions the said wiper is open circuit, and when in the intermediate positions it is in closed circuit relation for the purposes hereinafter described.

Referring to Figs. 12 and 13, the mechanism there shown is more specifically that of an A first selector. Ten groups of contact sets 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 or 0 are shown in Fig. 12, the wiper 201^b being shown in its normal position, resting between the groups 9 and 10. A first long step produced by an actuation of magnet PM′, whose armature 501 will operate the pawl 502 to engage one of the pins 504 to move shaft 509, upon which the switch wipers are mounted, will move the wipers so that they will be between the groups of contacts 10 and 1. A second long step will move them so that they will rest between the groups of contacts 1 and 2 and so on for each long step. On the actuation of magnet PM′, its attracted armature, in addition to actuating pawl 502, lifts the arm 503 to which the pawl 507 is attached, so that the hook on the end thereof will be raised to engage one of the pins upon ratchet wheel 506 when the full long step has been completed, thus accurately determining the extent to which the wipers can be rotated on each long step. It is apparent that upon the retraction of armature 501, the pawl 502 will come back to a position where it will engage an adjacent pin upon the ratchet wheel 506, successive steps by successive actuations of magnet PM′, being thus rendered possible. Upon the ratchet 506, the stud 508 is provided adapted, upon the first movement of the ratchet and shaft, to free the off-normal spring ON^3 so that it moves to engage its associated contact to produce circuit changes hereafter described in connection with the circuit drawings.

Referring to Fig. 13, it will be noted that each group of contacts 202 and 204, which are the stationary contacts, is provided with an associated common strip 201 and 203, respectively, and that similarly the stationary private contacts 206 are provided with a common strip 205. Likewise the sub-normal contact piece 207^a has a common strip 207. The common strips 201, 203, 205 and 207 are the true terminals of the circuits of the first selector, the wipers indicated mechanically in Fig. 13 at 201^b, 203^b, 205^b and 207^b being insulatingly mounted upon the shaft and having in themselves no circuit connections, but serve only to cross the respective common strips 201, 203 and 205 to successive individual contacts 202, 204 and 206, when the said wipers are moved step-by-step upon the short step travel. The strip 207 is a terminal for the sub-normal conductor of the switch, and the strip 207^a is of the shape indicated in Fig. 4, being cut away so that at all times, except when the wiper 207^b (Fig. 13) and the other wipers are in positions between contact groups, the said wiper 207^b fails to close circuit from 207 and 207^a but will close the circuit when the wipers are in the between-group positions. For driving the switch wipers upon their short step travel, the secondary magnet SM′ is provided, whose armature-actuated pawl 505 on each energization of the magnet drives the ratchet wheel 506 a short step, said pawl 505 on each retraction engaging a tooth of the ratchet adjacent to that previously engaged. Assuming that the magnet PM′ has been actuated a number of times to cause the wipers to rest in a between-group position adjacent to the desired group of contacts, and that thereafter the secondary magnet SM′ has been actuated to select the idle contacts out of the selected group, and that the switch is thereafter to be restored to its normal position, such restoration is effected by the secondary magnet SM′, the travel from the selected position around to normal being thus effected exclusively by short steps of the switch.

The switch above described with the obvious changes indicated by the circuit drawings may be employed for the circuits of Figs. 4, 4^a, 5, 6, 7, 9 and 10. It may also be employed with the arrangements of wipers and contact arrangements indicated by the circuit drawings for the circuits of Figs. 1, 3, 3^a, 8, 11 and the various master-switch arrangements, the latter, of course, requiring no off-normal contacts.

Assuming that the A subscriber, whose substation is indicated at D in Fig. 1, desires his line to be connected with that of another A subscriber, say the one whose line is indicated at D′ in Fig. 6, a diagram embracing the circuit connections, required for completing the desired conversational circuit, will be produced by placing Figs. 1 to 6 and Fig. 2^a in the relationship shown in Fig. 14.

To describe in detail the circuit connections involved, the operations involved in completing the connection will be traced. To indicate that he desires to make a call, the subscriber D (Fig. 1) removes his receiver, whereon the A line selector, E, starts automatic travel of its wipers 27, 28, 29, to select the multiple calling terminals 7, 8, and 9 of the line of D, while the A link selector F simultaneously starts to select the multiple terminals 70, 71 and 72 of the two-wire A link trunk whose conductors 75, 76 extend from the exchange of subscriber D to the operator's exchange.

The removal of the receiver at D closes circuit from battery B through normal contact 14 through the raised hook lever, returning through normal contact 17, line relay 10 to ground, which relay energizes, attracting armature 12 to remove ground from the multiple private calling contacts 7 at the A line selectors, said armature engaging its alternate contact to place ground upon the common conductor 22 which has branches, one to each line relay 10 of the one hundred lines which the A line selectors, controlled by the master-switch wipers 23, 24, of switch G serve. Armature 11 places battery from B upon the multiple called contacts 4 at the A line connectors, rendering the line of A busy against incoming calls.

Current now flows from ground, through alternate contact 12, conductor 22, normal contact 19, contact 23, 25, (wiper 23 normally resting and engaging contact 25 of an idle switch pair E, as hereafter described), over conductor 40, normal contact 52, part of the current then flowing through normal contact 43 and through the private relay 30 of the A line selector E to battery B. The said relay 30 now energizes and, by armature 34, closes a generator circuit through the stepping magnet 36 which, by a suitable armature-controlled pawl, advances the wipers 27, 28, 29 step-by-step in a rotary direction, said wipers for each step engaging a successive set of multiple contacts 7, 8 and 9 of a different subscriber's line. On the first step of the switch wipers 27, 28 and 29, the off-normal contacts 41, 42 and 43 are shifted upward to their alternate positions, the shifting of 43 freeing relay 30 from the influence of the starting conductor 40, so that the said relay now depends for its continual energization on successive locking circuits established via normal contact 51, alternate contact 33 to wiper 27 and to ground over successively engaged multiple contact 7 of lines which are not calling and of lines which have been selected either by an A line selector or an A line connector. If a line is idle because in its normal condition, its multiple contacts 7 will be grounded through normal contact 12. If a line is busy either because its contacts 7 have been selected by an A line selector, or its contacts 4 have been selected by an A line connector, then its multiple contacts 7 will be connected to ground through alternate contact 16 and its cut-off relay 13, because in both of these cases the said cut-off relay will be energized as hereafter described. Thus until the wipers 27, 28 and 29 have progressed so far that the wiper 27 engages the multiple contact 7 of a line such as D, at whose substation the receiver has been taken down to initiate a call, the relay 30 will continue locked over successive circuits, holding contact 34 closed, whereby magnet 36 causes continued travel of the wipers 27, 28 and 29. As soon, however, as wiper 27 engages the multiple contact 7 of the calling line, no circuit for continuing relay 30 energized will exist, because the said contact 7 will be on open circuit at attracted armature 12, whereon relay 30 de-energizes, armature 34 opening the circuit of operating magnet 36, whereby wipers 27, 28 and 29 rest engaging the multiple contacts 7, 8 and 9 of the calling line.

As soon as relay 30 was energized in the first place, the closing of alternate contacts 37 and 38, which operate on the "make-before-break" principle both on attractions and retractions of the armatures 35 and 31, established a closed circuit extending from battery B through the lower winding of relay 54, normal contact 61, alternate contact 37, alternate contact 38, normal contact 59, upper winding of relay 54 to ground, whereby relay 54 was energized (not to be de-energized until the calling subscriber replaced his receiver), the energization of said relay attracting its armature to prevent the premature operation of release relay RR which would otherwise occur when the off-normal, ON, contact 42 was shifted on the first step of the A line selector.

The current flowing over conductor 40, caused by attracted armature 12, after passing through contact 52, branched, a portion thereof flowing through normal contact 68, the private relay 44 of the A link selector to battery B, which relay energizes and by armature 47 closes generator circuit through the operating magnet 62 of the A link selector, F, which magnet thereupon moves the wipers 63, 64, and 65 to engage the first set of contacts 70, 71, and 72 of the first A link trunk. On this first step of the A link selector, the off-normal ON' contacts 66, 67, 68, controlled by it, are shifted upward to their alternate positions, 68 opening the initial energizing circuit of relay 44 which now depends for its continued energization upon successive locking circuits extending from battery through said relay 44, normal contact 50, attracted armature 46, wiper 63 and to ground through successive private multi-

ple contacts 70 of busy A link trunks, the multiple contacts 70 of such busy A link trunks being grounded through wipers 63 and normal contacts 46 of such A link selectors as may have previously occupied their multiple terminals. Thus relay 44 will continue energized and magnet 62 receive successive impulses, advancing wipers 63, 64, 65 step by step until wiper 63 engages a multiple contact 70 of an unoccupied or idle A link trunk, at which time, there being no ground connection to the said contact 70, relay 44 will be de-energized and its armatures retracted, armature 47 opening the circuit of magnet 62, whereby wipers 63, 64, 65 come to rest engaging the multiple contacts 70, 71, 72 of the selected A link trunk, assumed to be that shown in Fig. 2.

Returning now to the selection of the calling line by the A line selector, as soon as this occurs and armatures 31, 35 are retracted to restore contacts 37, 38 to normal, circuit is closed from battery B, through lower winding of relay 54, normal contact 61, contacts 37—35, 29—9, normal contact at 15, cut-off relay 13 to ground, which relay becomes energized, its armature 17 opening the circuit of line relay 10, whose armatures thereon fell back to normal. Attracted armature 14 of relay 13 opens the initial energizing circuit of the relay and the said relay locks over a circuit extending through alternate contact 16, contact 7—27, normal contact 33, to battery B, through resistance *rr* and through normal contact 53, contact 26—24 of the master-switch, its relay 18, to said battery B. The path through resistance *rr* is a continuing one. The other path is immediately opened on the energization of relay 18 whose armatures are attracted, armature 20 closing the circuit of magnet 21 which rotates wipers 23, 24 step-by-step over the contacts 25, 26, respectively, of the switch pairs which said wipers control, in search of contacts of an idle pair. The contacts 26 of busy switch pairs will be grounded, either through the circuit previously described including normal contact 53, if the line selector E of a switch pair is engaging a calling line, or through alternate contact 53 if the switch is releasing, relay RR being then energized. Thus until the master-switch wipers 23, 24 reach contacts of an idle switch pair, relay 18 will have successive locking circuits established, but when contacts of an idle pair are reached, its contact 26 will be on open circuit at the wiper 27, and connected to active battery through *rr*, relay 18 will de-energize, and the retraction of its armatures, by opening the circuit of magnet 21, will allow the wipers to rest engaging the contacts of such idle switch pair.

The described operation and locking of cut-off relay 13, in addition to effecting the travel of the master-switch, establishes a new circuit for the relay 54 without the opening of the circuit including the lower winding of relay 54 and relay 13 causing de-energization of the former, the new circuit extending through contact 14—15, over line limb 3, through raised hook-lever 1, returning over line limb 2, contact 8—28, contacts 31—38, 59, upper winding of relay 54 to ground. It is thus apparent that the relay 54 is first energized through alternate contacts 38, 37, that its circuit is thereafter shifted to include the cut-off relay 15, and thereafter again shifted to include the line limbs of the calling substation, without the relay at any time becoming de-energized.

The calling line D has now been connected through to the A link trunk shown in Fig. 2, it being understood that throughout the circuit diagrams the talking conductors are indicated by heavily marked lines. As soon as the A link selector and A line selector completed their selections, a circuit was established as follows: from ground at Fig. 2, through the inductive resistance 123, through normal contact 121, over trunk wire 76, contacts 72—65, 48, through the polarized relay 57 in such direction as to tend to throw its armature upward, through contact 32, contacts 45, 64—71, trunk wire 75, normal contact 116, relay 80 to battery B^2. Relay 80 attracts its armatures and by armature 81 lights the call signal lamp 83 whereby the operator is advised that a calling subscriber's line has been connected to that A link trunk to which the signal corresponds. The operator will now actuate the levers 73—74 of her listening key and inquire of the calling subscriber the number of the wanted subscriber, whose number will be assumed to be 23233^b, the letter designating the main exchange of A subscribers in which the called subscriber's line terminates.

To cause the connection to be completed, the operator now actuates the push buttons of her keyboard corresponding to the selected A link trunk (each A link trunk being preferably provided with an individual keyboard) to count out the number of the called subscriber. In Fig. 2^a are shown five sets of springs, the first set comprising springs l', l^2, etc., the second set m', m^2, etc., the third set n', n^2, the fourth o', o^2, etc., and the fifth p', p^2, etc. Each spring is provided with an actuating button, although the top springs in the illustration are alone shown provided with their actuating buttons. The buttons of each vertical row of springs are interrelated in such manner that when one is depressed, it will remain in its depressed position, causing its associated spring to engage its contact until another button of the same row is depressed, at which time any previously depressed button of the row will be automatically freed and rise to its normal position. This interrelation is the same as

that used for party line indicating ringing keys, such structure being well known in publications and practice of the art. The buttons *a*, *b*, although shown on a separate sheet from Fig. 2ª, would in practice be placed to the right of the buttons for springs p', p^2, etc. For convenience of reference, I have indicated the number of impulses to be transmitted by each of the springs *l*, *m*, *n*, *o*, and *p*, by the exponent given to its letter. Thus the operator will actuate the buttons of springs l^2, m^3, n^2, o^3, p^3 and the button *b*, the buttons being depressed in the order named.

The actuation of the button *b* sets in train of operation mechanism by which the multiple contacts 104, 106 and 107 of the selected A link trunk will be automatically picked up by an A link connector connected to a two-wire trunk line extending to the exchange in which the called subscriber's line has terminals. After such selection is completed, the depressed buttons *l*, *m*, *n*, *o* and *p* will be effective, by the aid of the mechanism shown in Fig. 2ª, to transmit selective impulses to the switches at the called subscriber's main exchange to complete the desired connection.

As indicated in Fig. 2, the multiple contacts 104, 106 and 107 are connected in the banks of A link connectors such as shown in Fig. 3 which A link connectors are connected to trunks for the *b* main exchange, this being indicated by the fact that the private multiple contacts 104 are connected to the switch lever 90′ of the button *b*. The multiple contacts 104′ which are connected to the switch lever 90 of the button *a* would appear along with additional multiples 106, 107 of the same A link trunk in the banks of A link connectors connected to trunk lines extending to the exchange whose subscribers would be indicated in the directory by the suffix *a*, this multiple arrangement having been heretofore described more at length in connection with the Fig. 19. The wire 96, connected to the spring 89′ of the button *b*, leads to the master-switch of the A link connector shown at the left in Fig. 3, before whose wipers 154, 156 and 157 the multiple contacts 104, 106 and 107 are located. At this point it may be stated that the conductor 179, to which is connected the wiper 155 of the A link connector, which wiper is adapted to engage the multiple contact 105 associated with the mechanism of the A link trunk of Fig. 2, is a common return and may be used or not, according as the earth potential at the different exchanges is or is not such as to render the operating relays of the first selectors unreliable.

When button *b* was depressed, spring 88′ engaged its contact and closed circuit through the relay 84 whose armature 86 put out the call signal lamp 83 while armature 85 closed circuit from battery B^2 through lamp 87, through normal contact 102, over conductor 97, through relay 139 of the impulse transmitting mechanism to ground, which relay 139 attracted its armature, closing the circuit through magnet 125 which is energized and moves the impulse transmitter shaft one step so that the off-normal stud 138 disengages the spring 137 which spring then engages its alternate contact, whereby the constantly rotating interrupter 133 will be operatively connected in circuit with the magnet 125 to cause successive impulses of current through said magnet to rotate the ratchet 126 for impulse transmitting purposes as soon as the relay 139 is hereafter de-energized. The lamp 87 before the operator is displayed as a guard lamp until the A link trunk has been selected by an A link connector and the impulse transmitting mechanism started on its full operation as hereafter described. The actuation of button *b* also caused spring 90′ to move to engage its alternate contact, whereby the normal ground was removed from the multiple contacts 104 at the A link connectors of the *b* exchange trunks so that any started A link connector of such a trunk will be able to select the contacts of the A link trunk of Fig. 2. The shifting of contact 89′ to engage its contact closed a circuit extending from ground at armature 101, through contact 89′, over conductor 96, through upper armature of relay 147, wiper 148 (the wipers 148, 149 and 150 normally engaging the contacts of an idle A link connector), through the contact engaged by the wiper 148, through normal contact at 158 and through the operating relay 161 of the A link connector to battery B^3. The energization of this relay closes the generator circuit for magnet 166 which now steps the wipers 154, 155, 156, 157, a rotary step to engage the first multiple contact set of an A link trunk. With this first step, the off-normal, ON^2, contact springs 158, 159, 160 and 175 are shifted to the right, the shifting of 158 connecting the winding of relay 161 through normal contact 168 and attracted armature 163 to the private wiper 154, so that the relay 161 will now be held energized over successive locking circuits until the wiper 154 engages a contact 104 which has no ground connection. The relay 161 thus will continue energized, holding its armatures attracted, and magnet 166 will advance the wipers step-by-step until an ungrounded contact 104 is encountered. Contacts 104 of idle A link trunks will be grounded at their respective normal contacts 90′, while contacts 104 of A link trunks which have already been selected by

an A link connector will be grounded through the relays 100 of such A link trunks as will be hereafter explained.

Thus the A link connector, L, to the left of Fig. 3 will continue its travel until it engages the multiple contacts of the A link trunk of Fig. 2, at which time the relay 161 will be de-energized because contacts 104 are on open circuit at 103. Consequently, the armatures of relay 161 will be simultaneously retracted to the position shown, whereby further actuations of magnet 166 are prevented. By the retraction of armature 162, a circuit is now completed from positive battery B^{10} in Fig. 4, through relay PR, over trunk wire 177, contact 162, contact 156—106, through upper normal contact of relay 108, through normal contact at 103 to ground through relay 100, which relay immediately energizes and, by its attracted armature 103, connects its winding via contact 112 and contact 90′ to the multiple contact 104, thence via wiper 154, normal contact 163, normal contact 170 and relay 171 to battery, said relay 171 thereon energizing and by armature 173 locking itself to ground in series through relay 100. Armature 172 energizes the relay 167 which by armature 169 locks itself to ground at off-normal spring 160.

The ground from relay 100 is also connected via shifted contact 159, the wiper 149 and relay 147 to battery B^3, whereby relay 147 is energized and, by armature 152, connects generator through magnet 153 to ground, whereupon the master-switch wipers 148, 149 and 150 move step by step over the contacts of the different A link connectors controlled by the master-switch in search of contacts of an A link connector whose trunk line is idle.

As shown in Fig. 3, I have connected two A link connectors to a single trunk line 177, 178, said connectors being arranged in parallel, the corresponding parts of the connector at the right of Fig. 3 being indicated by the same numbers as corresponding parts of the connector at the left of said figure with the suffix *a* added to each number. Two A link connectors may be provided for a single trunk line if circumstances so require. For instance, in the present system I have adopted, for automatic switches, mechanism having one hundred sets of contact points and thus each A link connector can reach at most one hundred A link trunks. If, however, it should be desired that each trunk line 177, 178 should be capable of being connected to, say, two hundred A link trunks, it would either be necessary to provide an A link connector with two hundred contact sets before its wipers, which would not be the standard adopted, or to provide two A link connectors, as I have done, for such trunks, and divide the multiple terminals of the two hundred A link trunks evenly between the two switches. In such case certain operators would have multiple contacts of their A link trunks before one of these A link connectors, and others would have the terminals of their A link trunks before the others of these A link connectors. The A link connectors having access to one particular hundred of A link trunks would be controlled by one master-switch, and the A link connectors having access to the other one hundred A link trunks would be controlled by another master-switch. The conductor 96 shown in Fig. 3 would have branches to the *b* keys of each operator who had A link trunks having multiple terminals before the A link connectors of the group controlled by the master-switch M of Fig. 3, while the conductor 96^a would have branches extending to the *b* exchange buttons of the operators who had A link trunks with multiple terminals before the A link connectors controlled by the master-switch M^a at the right of Fig. 3. Thus any operator of either group, by depressing a *b* exchange button, would render the multiple terminals of the A link trunk, whose *b* button was depressed, selectable at the A link connectors capable of selecting that trunk and would actuate the starting wire of the master-switch of that group. However, it will be seen that two A link connectors connected to one trunk shall not be allowed to simultaneously operate, for otherwise it is obvious that each might select a different A link trunk whose multiple terminals had been rendered selectable, and two A link trunks each connected to a calling subcriber's line would be improperly connected together. I therefore arrange the master-switch circuits so that the two master-switches are incapacitated from having their wipers come to rest engaging terminal contacts of A link connectors of the same trunk line 177, 178. It is obvious of course that when the master-switch at the left of Fig. 3 was started as before described, its wiper 149 would continue passing over contacts of A link connectors of its own group which had selected A link trunks, the contacts engaged by wiper 149 of such A link connectors being grounded through the relay 100 of such selected A link trunks. The relay 147 was also connected through alternate contact 151 with wiper 150. This wiper 150 has before it a contact for each associated trunk line 177, 178, which contact is connected by a wire 176 with the off-normal contacts 175 and 175^a of the A link connectors of its respective trunk so that when the relay 147 is once energized, it must not only find an open circuit through its wiper 149 before it can be de-energized, but must find one through the wiper 150 also and such open circuit will not exist when the wipers 148, 149 and 150

engage contacts of any trunk line, either of whose A link connectors is off normal. Moreover, in addition to these two requirements, for the relay 147 to become de-energized, its wiper 150 must engage a contact upon whose multiple the wiper 150^a of the other master-switch is not resting, because if such wiper 150^a rests upon the associated contact of an A link connector, the contact engaged by said wiper will be grounded through normal contact 151^a. It is thus seen that the wire 176 pertaining to a trunk line 177, 178, is, when multiple A link connectors are connected to such trunk line, multipled before the wipers 150 and 150^a of the two master-switches and also multipled to the off-normal contacts 175, 175^a, and that by this multipling, all interference between a pair of A link connectors connected in parallel to one trunk line is prevented.

This arrangement, by which two selector switches are connected to one trunk line whereby the trunk line is given access to double the number of connections to which it could otherwise be connected and without interference between the two switches, is believed to be novel and hitherto unknown.

Returning now to that point in the operation of the system whereat the relay 100 was energized, the attraction of armature 101 of said relay removes ground from the common conductor 96 while the attraction of armature 102 puts out the lamp 87 and opens the circuit of wire 97, whereby relay 139 is de-energized and interrupter 133 caused to effect the rotation of ratchet 126 by the armature driven pawl of magnet 125. The going out of lamp 87 informs the operator that the A link trunk had been properly selected by the A link connector and that the transmitting mechanism of Fig. 2^a is performing its function. The operator's impulse-transmitting mechanism comprises a rotary shaft 124 upon which are mounted the wipers 146 and 140, the ratchet 126 and a disk in which are cut the notches 127, 128, 129, 130 and 131, which disk also carries the off-normal stud 138. It is apparent that when relay 139 has been energized to effect a single step of the shaft, ratchet, disk and wipers, and the armature of the said relay 139 is thereafter released, magnet 125 will be successively actuated until one complete revolution of the shaft has been effected and stud 138 thus brought clear around the circle to again engage the spring 137 and raise it free of its associated contact, when magnet 125 will cease being actuated and the operator's impulse transmitter will be at rest. The transmitter, as specifically illustrated in Fig. 2^a, is adapted to transmit, at the most, four sets of directive impulses of a maximum of five impulses per set, and a fifth set of impulses of a maximum of four impulses per set. It will be understood, however, that in practice each set of impulses would consist of a maximum of ten impulses and that the operator's impulse transmitter would, in an obvious manner, be arranged accordingly. As the shaft 124 is turned, the wiper 140 rotates from left to right and passes first over the contacts 141 of the associated ring and will begin transmitting impulses from ground through armature 135 as soon as the said armature is attracted. The attraction of said armature will occur as soon as the wiper 146, in passing over the contacts lettered l, reaches the one which has been grounded at one of the springs lettered l', l^2, etc. In the present case, this will occur as soon as its fourth contact is engaged, said fourth contact being connected to the spring lettered l^2, whereon current will pass from the grounded spring lettered l^2 through wiper 146 and relay 134 to battery. Relay 134 locks itself by armature 136 to ground at normal contact 132. At this time wiper 140 will be engaging its fourth contact 141 and an impulse will be transmitted from ground through said fourth contact, through attracted armature 135 and conductor 98, through relay 108 to battery B^2, and a second impulse will be transmitted when the wiper 140 engages its fifth contact 141 with the continued rotation of the shaft 124. When the wiper 140 passes the last contact 141, the disk of shaft 124 will have traveled so far that immediately thereafter spring 132 will engage notch 127, said spring then opening the locking circuit of 134 which relay de-energizes, whereon spring 132 transmits a current impulse from ground over conductor 99 and through relay 109 to battery, energizing and de-energizing said relay. As shaft 124 continues to rotate, spring 132 rides up on the periphery of the disk and opens the circuit of conductor 99, again closing the ground to armature 136 so that when wiper 146, in passing over contacts m, engages a grounded one, relay 134 will again be energized and locked and wiper 140 will commence transmitting impulses from ground through its contacts 142, energizing and de-energizing the relay 108. When wiper 140 passes beyond the last contact 142, spring 132 will drop into the notch 128 and unlock relay 134, thereon transmitting a single impulse over conductor 99. From the preceding description the manner in which the buttons n' n^2, etc., to o', o^2, etc., p', p^2, etc., control the numbers of impulses transmitted over conductor 98 is apparent, and it is apparent also that each set of impulses thus transmitted will be followed by a de-energization of the relay 134 and the transmission of an impulse over conductor 99. As before indicated, it is required by the organization of the present system that the third set of impulses

establishing a talking circuit to wipers 203 and 205, armature 198 placing ground on the multiple contacts of the selected second selector and wiper 199 opening the circuit of secondary magnet SM′ so that the wipers of the first selector remain engaging the contacts of the idle second selector. It is obvious that with the first secondary step of the A first selector, the wiper 207 disengages the contact of the ring 207^a located between the first and second groups so that the relay BR′ is no longer influenced by the ground at armature 193.

The second set of de-energizations of relay PR, consisting of three de-energizations, transmit three impulses of current from ground through armature 185, normal contact 182, alternate contact 190, contacts 197, 203—204, the current thereon dividing a portion flowing through release relay RR^2 to battery B^{13}, energizing said relay RR^2 which thereon locks itself by armature 208 to the private contact 202, grounded at contact 191. The remainder of the current impulse flows through normal contact 221 and primary magnet PM^2 to battery, causing three actuations of said primary magnet which advances wipers 211, 212, 213 and 214 three long steps in a clockwise direction until wipers 211, 212 and 213 rest between the second and third contact groups, wiper 214 engaging the contact of ring 214^a between said second and third groups. The single de-energization of relay SR, following the three de-energizations of relay PR, causes a current impulse to flow from ground through attracted armature 185, retracted armature 183, alternate contact 194, contacts 200, 205—206, normal contact 225, attracted armature 209, relay 220 to battery B^{13}. Relay 220 locks itself through attracted armature 209, alternate contact 225^a to ground. Armature 224 closes circuit from ground through ring 214^a, its contact between the second and third groups, through wiper 214, attracted armature 210, busy relay BR^2 to battery, which relay is energized and, by armatures 215 and 219, places the talking wipers 212 and 213 on open circuit. Armature 218 completes the generator circuit for secondary magnet SM^2 which now causes short steps of the wipers 211, 212, 213 and 214, wipers 211, 212 and 213 engaging successive contacts forming terminals of A line connectors assigned for connection to the third hundred of the second thousand of the *b* exchange. On the first short step, wiper 214 disengages the contact of ring 214^a so that relay BR^2 is freed from the influence of ground at armature 224. The armature 217 connects battery B^{13} through the winding of relay BR^2 via alternate contact 210, and attracted armature 223 to wiper 211, and the relay BR^2 will continue energized, causing successive actuations of magnet SM^2 until wiper 211 engages a multiple contact 227 of an idle A line connector, the multiple contacts 227 of busy A line connectors being grounded through wipers 211, normal contacts 217 and attracted armatures 222 of A second selectors which have already occupied them. When an idle A line connector has been reached, its multiple contacts 227 are on open circuit, as is apparent from an inspection of Fig. 6, relay BR^2 therefore becomes de-energized, and its armatures 215 and 219 re-establish the talking circuit to wipers 212 and 213, armature 217 places ground at attracted armature 222 upon wiper 211 and the multiple contacts 227 of the selected A line connector, rendering it busy, and armature 218 opening the circuit of the secondary magnet SM^2 so that wipers 211, 212 and 213 rest engaging the multiple contacts 227, 228 and 229 of the selected A line connector.

The next set of de-energizations of relay PR will be three in number to transmit three impulses of current from ground through attracted armature 185 over the before-traced path, the current now passing through alternate contact 221, contacts 215, 212—228, normal contact 236, and through relay RR^3 to battery B^{16}, a portion of the current also flowing through primary magnet PM^3. Thus the first impulse energizes and de-energizes magnet PM^3 and also energizes relay RR^3 which latter, by armature 231, locks itself to ground through normal contact 238 and contact 227—211. By the opening of normal contact at 231, the relay RR^3 is disconnected from the contact 228 so that the second impulse transmitted by the de-energization of relay PR passes only through the primary magnet PM^3. Each actuation of magnet PM^3 moves the wipers 253, 254, 255 and 256 a long step so that, at the conclusion of the third impulse, the said wipers will be between the first and second groups of contacts, ready to be moved over the contacts of the second group of lines when the short step travel of the A line connector is produced. Each long step moves wiper 256 entirely across one of the contact segments of the ring 256^a so that at the conclusion of each long step the said wiper rests in one of the open spaces and out of contact with ring 256^a. As indicated in Fig. 6 by the wiper 256, the normal positions of the A line connector wipers are two long steps back from the 1 group of contacts.

It may be stated at this time that in the circuit diagrams of selectors and connectors, but five groups of contacts are indicated by the various contact rings, namely, groups 1, 2 and 3, and groups 9 and 10, it being

shall include one more impulse than would ordinarily be required in consequence of the B trunk controller connected in one of the circuits. Therefore, in the group of contacts engaged by wiper 140 comprising the contacts 143 which operate in conjunction with the contacts n, there is a sixth contact 143^a connected to ground over the wire 143^b so that if the relay 134 is energized by wiper 146 engaging the contact connected to button n^3, there will be four impulses transmitted from the contacts 143 and 143^a.

Having described the operation of the impulse transmitter, its effect upon the directively operated switches will next be explained, this effect being communicated by means of the relays 108 and 109. Going back for a moment, when the A link connector of the trunk line 177, 178 selected the A link trunk, current flowed from negative battery at A^{10} through secondary relay SR, over trunk wire 178, through contact 157—107, normal contact of relay 109, upper winding of the polarized relay 118 in such direction as not to cause said relay to close its contacts, through normal contact 114, normal contact of relay 108, contact 106—156, trunk wire 177 and through primary relay PR to positive battery at B^{10}, whereby relays PR and SR were energized simultaneously with relay 100 and their armatures attached. The attraction of armatures 180 and 181 closed circuit through the release relay RR′ which relay is energized to remain energized until the calling subscriber replaces his receiver. Each time relay 108 is energized with the operation of the impuplse transmitter, its armature first closes a maintaining circuit for relay SR to ground and thereafter opens the circuit of relay PR which is de-energized while relay SR remains energized. If there are three impulses in a set transmitted by the impulse transmitter, three energizations and de-energizations of relay 108 will obviously produce three successive de-energizations of relay PR. When at the conclusion of the set of impulses over wire 98, an impulse passes over wire 99, energizing and de-energizing relay 109, the attraction of said relay's armature will first close a maintaining circuit for relay PR and then open the circuit of relay SR, de-energizing the same. The armatures of the relays 108, 109 are shown connected to the common return multiples 105, adapted for engagement by the A link connector wiper 155 connected to the common return 179, it being assumed that there is such difference of earth potential between the exchange wherein the apparatus of Fig. 2 is included and that wherein the apparatus of Fig. 4 is included, that the use of a ground local to the exchange of Fig. 2 would not be such as to properly furnish a maintaining circuit for the relays PR and SR. Such conditions would of course be unusual and ordinarily a local ground, as indicated in dotted lines in Fig. 2, would be adequate for the purposes referred to.

It is now apparent that the revolution of the impulse transmitter of Fig. 2^a will first cause two de-energizations of relay PR followed by one of relay SR. Armature 182 being released and then attracted twice, two current impulses are caused to flow from ground through attracted armature 185, relay RR′ being energized, normal contact 182, primary magnet PM′ to battery B^{11}. The said primary magnet will now effect two long steps of wipers 201, 203, 205 and 207, moving the rotary shaft of the switch so that the wipers, moving clockwise, will rest between the first and second groups of multiple contact sets, wiper 207 having been moved from its normal position shown engaging a contact piece of ring 207^a to a position where it engages the second contact piece of said ring to the right. When the contacts are in this position, short travel steps of the wipers will move them over individual contacts of second selectors, Fig. 5, assigned for connections to the second thousand of the called exchange. When relay SR is now de-energized, an impulse of current flows from ground through contact 185, contact 183, normal contact 194, relay 189 to battery B^{12}, energizing said relay which, on the attraction of armature 194, locks itself to ground through alternate contact 195 and contact 185. Armature 193 places ground through ring 207^a and wiper 207, alternate contact 186, to one terminal of relay BR′, the other terminal being connected to battery B^{12} so that the said relay is energized and by armatures 197 and 200 places wipers 203 and 205 on open circuit, and by armature 199 completes the generator circuit for secondary magnet SM′ which produces the short steps of the switch wipers. By armature 198, the winding of relay BR′ is, via attracted armature 192, connected to the private wiper 201 of the first selector and the relay BR′ will continue energized, causing successive steps of the switch under the influence of magnet SM′ until wiper 201 engages a contact 202 of an idle second selector of the group assigned for connection to the second thousand of the exchange. The multiple contacts 202 of busy second selectors will be grounded through wipers 201, normal contacts 198 and attracted armatures 191 of other A first selectors which have previously occupied them. When, however, contacts 202, 204 and 206 of an idle second selector are reached the private contacts 202 will be on open circuit, relay BR′ will be de-energized, its armatures retracted, armatures 197 and 200

understood that in practice the groups 4, 5, 6, 7 and 8 would be interposed between the groups 3 and 9, as illustrated.

The groups of contacts now selected by the A line connector (Fig. 6) are terminals of lines numbered from 2321 to 2329 inclusive, followed by the terminals of line 2320, the naught being represented by ten impulses.

A single de-energization of relay SR, following the three described de-energizations of relay PR, by retracted armature 183, transmits a current impulse over the before traced path, through alternate contact 225, contacts 219, 213—229, through attracted armature 232 and locking relay LR′ to battery, actuating the said relay to lock itself by armature 244 to ground at the off-normal contact ON^6, said contact having been shifted on the first long step of the switch.

The next set of de-energizations of relay PR, consisting of three de-energizations, transmits three impulses of current over the before-traced path through normal contact 236, through alternate contact 243, normal contact 246, alternate contact 233 and secondary magnet SM^3 to battery, said secondary magnet being actuated three times to produce three short steps of the connector's wipers whereby wipers 253, 254 and 255 will come to rest engaging terminals of line number 2323, wiper 256 being then moved part way along the contact segment 2 of the ring 256^a. An ensuing de-energization of relay SR transmits a current impulse over the before-traced path which passes now through contact 213—229, attracted armature 232, to the ring 256^a, thence over wiper 256 through locking relay LR^2 to battery, which relay now locks itself by armature 247 to the off-normal contact ON^6. Armature 246 now disconnects secondary magnet SM^3 from contact 228 and, by engaging its alternate contact, connects operating magnet OM of the generator switch P′ with the said contact 228. The generator switch P′ may be of the well-known mechanical construction comprising a rotary shaft carrying a ratchet adapted to be rotated by magnet OM, and a wiper 267 adapted to be moved step by step to engagement with any one of the contacts connected with the frequency generators 268, 269, 270 and 271. The shaft preferably has a restoring spring and a retaining pawl to hold it against back movement, the release magnet RM being arranged to withdraw the retaining pawl on its energization and so allow the spring to move the wiper 267 back to normal when the switch is to be released. The line of subscriber D′ may have connected to it three other substations, multiple taps for such substations being indicated at D^2, D^3 and D^4, and the bells of these substations may in the well known manner be attuned to respond only to the frequency of a particular one of the four generators associated with the switch P′. In the present case, it is assumed that the third generator 270 is of the frequency to ring the bell of subscriber D′ so that it is now necessary to adjust the wiper 267 to engage the contact of generator 270 preparatory to selectively ringing the bell of subscriber D′. The last set of de-energizations of relay PR—three in number—accomplish this by transmitting three current impulses through contact 212—228, normal contact 236, alternate contact 243, alternate contact 246, normal contact 251, and through magnet OM to battery, actuating the said magnet three times, which moves wiper 267 to rest engaging the contact of the frequency generator 270. The off-normal contact ON^7 and also the off-normal contact ONY, which will be found below the wiper 255, are shifted on the off-normal step of the generator switch P′.

The next operation is the testing of the called-for line in order to determine whether the selected generator shall be applied to the called-for line to ring the called substation, or whether the busy signal shall be transmitted back to the calling subscriber. The testing is accomplished by means of a test relay TR. This relay was energized at the time the first impulse was transmitted over contact 212—228, which impulse, it will be remembered, energized the release relay RR^3, whereby a circuit was established from ground through relay TR, through alternate contact 234, through the normal contact at 248, through alternate contact 235 to battery B^{16}. The said relay TR has continued energized up to this time and the relay LR^3 will now be energized to connect the said test relay TR with the test wiper 253 to test the called-for line. A de-energization of relay SR, following the adjustment of wiper 267, causes an impulse from ground through contact 213—229, alternate contact 232, to ring 256^a, thence through the off-normal contact ONY and locking relay LR^3 which, by armature 249, locks itself to ground at contact ON^6. Circuit may now be traced from ground through relay TR, alternate contact 234, alternate contact 248, through attracted armature 260 of relay TR and to wiper 253. Assuming first that the called line, that of D′, is idle, the private multiple contacts 4 will, as indicated in Fig. 6, be connected only to ground via normal contact 11 and cut-off relay 13. Both terminals of relay TR being therefore grounded, the relay will become de-energized and its armatures retracted, the retraction of armature 260 connecting battery B^{15} through contact 253—4, normal contact 11 and cut-off relay 13 to ground, whereby said relay is energized and by armature 14 connects one limb of the line D′ with its associated contact 6. The

mulitiple contacts 4 are now busy because they are connected to battery B^{15}, and the multiple contacts 7 at the A line selectors are busy because the attraction of armature 16 has connected to them ground through cut-off relay 13. Armature 259 and 263 have now re-established the talking circuit of the connector at their respective back contacts, the wipers 254 and 255 having been on open circuit during their adjustment.

On the de-energization of relay TR, the interrupter I alternately makes and breaks the following circuit. From ground through said interrupter, contact 241, contact 262, contact 252, and the ringing relay 264 to battery, which relay alternately attracts and releases its armatures 265, 266, periodically connecting and disconnecting generator 270 with and from the called-for line to ring the substation bell thereat. When the called subscriber removes his receiver and the armatures of relay 264 are retracted, the relay 257 will be energized to cause the ringing generator, then disconnected, to continue disconnected from the called line. At this point it should be stated that the interrupter I is preferably connected to the same shaft with the generator 270 or operated from a suitable source of power, so as to be so related thereto that the armatures of relay 264 will always be retracted just as the current from the alternating current generator 270 reaches a point in its variation where the called-for line is substantially discharged of current. By this means, any improper operation of the relay 257 by capacity discharges from the line is effectually prevented.

The removal of the receiver at substation D′ causes current to flow from battery B^{14} through relay 257 and its non-inductive shunt, normal contacts 259, 265, contact 254—5, through the transmitter and receiver and raised hook switch 1, returning through contact 14—15, contact 6—255, contacts 266, 263, and through the impedance shown to the active side of battery B^{14}. This flow of current also supplies the called line transmitter with talking battery from B^{14} through its associated inductive resistances. The attracted armature of relay 257 closes circuit via normal contact at 240 to locking relay LR^4, which relay attracts its armatures, armature 240 locking the said relay to ground at contact ON^6. Armatures 236 and 242 complete the talking circuit at the connector, Fig. 6, armature 241 disconnects interrupter I so that relay 264 continues inert, and generator 270 remains disconnected from the called line. Armature 237, by engaging and moving the contact 238, disconnects the locking circuit of release relay RR^3 from the private contact 227 and extends the said locking circuit to the armature of relay 257, whereby the continued energization of release relay RR^3 is placed under the control of the called-for subscriber. Armature 239 connects off-normal contact ON^6 with the multiple contacts 227 at the second selectors and, since the relay LR^4 has locked to ground at the off-normal contact, it will continue energized until the A line connector is completely restored to normal, whereby the contacts 227, 228 and 229 are protected from occupancy by any other second selector during the restoration of the A line connector, Fig. 6.

On the energization of relay LR^4, the battery B^{14} has its circuit completed to the left through alternate contact 236, over the upper talking conductor to alternate contact 182 in Fig. 4, through the polarized reversing relay RV, alternate contact 183 and over the lower talking conductor, through alternate contact 242 at Fig. 6, to the positive side of said battery B^{14}, whereby relay RV is energized and attracts its armatures which, by their "make-before-break" arrangements, reverse the connections of batteries B^{10} and A^{10} to the conductors 177 and 178. Current of a polarity opposite to that previously flowing therethrough now passes over conductor 177, through contact 156—106, through normal contact 114 of Fig. 2, through the upper winding of the polarized relay 118, returning through contact 107—157 to battery B^{10}, whereby the polarized relay 118 is actuated to attract its armatures. It will be observed that up to this time, positive battery from B^2 has been connected via relay 80 and contact 116 to trunk conductor 75 and over a circuit including the polarized relay 57 at Fig. 1 and the trunk conductor 76 to ground through impedance 123. By the attraction of armatures 119 and 121, however, negative battery from A′ is connected to conductor 75 and positive battery from B′ is, through the lower winding of relay 113 and alternate contact 121, connected to the trunk conductor 76. The direction of current flow through polarized relay 57 is thus reversed and its armature is actuated in a downward direction to reverse the connections of battery B extending through the inductive windings of relay 54 to the limbs of the calling subscriber's line. This reversal of current in the calling subscriber's line, produced when the called subscriber answers the call, may be employed to actuate a register device employed at the substation or at the exchange, or to actuate coin controlling mechanism, any of the polarized structures of the art being available in this connection. The polarized relay 118, when actuated, by armature 120, locked itself to ground at contact 88′; and as the restoration of button *b* rests exclusively with the calling subscriber, the polarized relay 118 will continue its armatures actuated until the called subscriber replaces his receiver, thus pre-

venting any possible re-operation of the polarized counting or coin-actuating mechanism.

Relay 113 is energized, its armature 114 short-circuiting the condenser 122, while armature 115 opens the circuit of the relay 110 so that it will not prematurely energize when relay 80 retracts its armature on its de-energization, occurring at the attraction of armature 116. Armature 117 completes the last contact to be closed in the established talking circuit and the two subscribers are now in a position to converse, the talking circuit extending from substation D, whose transmitter is supplied by current through the windings of relay 54, over the heavily marked conductors through Fig. 1, trunk wires 75, 76, to the operator's exchange, then to Fig. 2, Fig. 3, trunk wires 177, 178 at Fig. 4 and through Figs. 5 and 6 to the called substation D'.

When the called subscriber D' replaces his receiver, the A line connector and the generator switch Y, Fig. 6, are restored to normal, but the other apparatus used in the connection remains unrestored until the calling subscriber replaces his receiver.

When the receiver is replaced at substation D', circuit is opened through relay 257 whose retracted armature opens the circuit including contact 237—238 and the winding of release relay RR^3 so that the said relay is de-energized. Its armature 230 energizes release magnet RM of switch P', the circuit including the shifted off-normal contact ON^7, and the switch P' has its retaining pawl withdrawn and wiper 267 springs back to normal. The armature 234 causes the energization of test relay TR over a circuit extending through the normal contact of said armature 234, attracted armature 245 to battery, so that while the A line connector is restoring, the talking wipers 254, 255 may be on open circuit. The retracted armature 233 connects constantly rotating interrupter I' via the shifted off-normal contact ON^5 with secondary magnet SM^3 which now drives the wipers 253, 254, 255 and 256 in a rotary direction by short steps until they have completed an entire revolution, at which time the off-normal contacts ON^5 and ON^6 will be opened. The opening of ON^5 obviously prevents further actuation of magnet SM^3 so that the switch wipers come to rest in their normal positions. The shifting of contact ON^6 to normal opens the locking circuits of relays LR', LR^2 and LR^3, and all other armatures are returned to normal, the return of armature 245 opening the circuit of relay TR. If the A second selector Fig. 5 has, prior to the time the A line connector reaches normal, moved its wiper off the contacts 227, 228, 229, the opening of contact ON^6, Fig. 6, will also de-energize locking relay LR^4 and the A line connector Fig. 6 will be in its fully restored condition.

If, however, the A second selector Fig. 5, still engages the contacts 227, 228 and 229, relay LR^4 will continue locked via alternate contact 240 and attracted armature 239 and over the private contact 227 to ground at the A second selector until the said second selector starts to restore to normal. When the calling subscriber D replaces his receiver, the release of the various mechanisms is effected in the following manner. The opening of circuit at substation D de-energizes the relay 54 whose retracted armature energizes release relay RR over a circuit extending through off-normal contact 42 at the A line selector and a circuit extending through off-normal contact 67 at the A link selector to battery B, whereby relay RR, by its locking armature 49, will remain energized until both these switches have been fully restored and their offnormal contacts ON and ON' shifted to normal. Attracted armature 50 closes circuit from ground at shifted contact 66, through relay 44 to battery, which relay opens the circuits of wipers 64 and 65 and completes the generator circuit of magnet 62. Since relay RR remains energized at least until contact 67 is opened, and as relay 44 remains energized until contact 66 is opened, it is obvious that magnet 62 will receive generator impulses until the wipers 63, 64, 65 have completed a revolution around to their normal point at which time the off-normal ON' contacts are all shifted. Armature 51 of relay RR energizes relay 30 of the A line selector by current passing to ground through said attracted armature 51 and off-normal contact 41, whereon relay 30 opens the circuits of line wipers 28, 29, and its armature 34 completes the generator circuit of operating magnet 36, which now steps the wipers 27, 28, 29, around until the normal point of the A line selector is reached, when the off-normal contacts ON will be shifted and relay 30 de-energized by the shifting of contact 41 and the switch wipers stopped. It is obvious that when both the A line selector and the A link selector have reached normal, relay RR will be de-energized because of the opening of contacts 42 and 67. When the A line selector reaches normal, the relay 54, which was energized again as soon as relay 30 operated, will be de-energized by the retraction of armatures 31 and 35 and all mechanism shown in Fig. 1 will be at normal, including the line circuit of subscriber D whose cut-off relay 13 was of course de-energized when the release of the A line selector started.

As soon as relay 44 in Fig. 1 operated, circuit through conductors 75 and 76 of Fig. 2 was opened and the relay 113 consequently

de-energized. The operative effect of the retraction of armature 115 is to energize the relay 110 by current passing through back contact of armature 82 and to ground through the shifted spring 88′. Attracted armature 111 actuates magnet 94 whose armature moves the multiple retaining pawl arm 93 to the left whereby the hook 92′ of button *b*, which from the time said button was depressed was engaged by the associated pawl of arm 93, is disengaged therefrom and the button *b* is automatically raised to its normal position, whereby its springs are restored, the restoration of spring 90′ again grounding the multiple contacts 104 of the A link trunk to render them unselectable. The opening of contact 88′ then de-energizes the relay 110 so that magnet 94 has its circuit opened and its armature falls back, allowing arm 93 to be restored. The shifting of spring 89′ at button *b* to disengage its contact prevents starting wire 96 from being again grounded on the de-energization of relay 100.

On the energization of relay 110 as before described, armature 112 opens the locking circuit including serially the relay 100, its attracted armature 103, contact 90′, contact 104—154, normal contact 163, attracted armature 173, relay 171 and battery B^3, so that relays 100 and 171 are deenergized. By the de-energization of relay 171, circuit is closed from ground through normal contact 172, alternate contact 168, alternate off-normal contact 158, and the operating relay 161, which closes the generator circuit for magnet 166. As relay 167 is locked through off-normal contact 160, relay 161 will continue energized and magnet 166 receives successive actuations until the A link connector, Fig. 3, is restored to normal, when the shifting of the off-normal contact 160 de-energizes relays 167 and 161, stopping the switch, the shifting of contact 175 of course making the contacts pertaining to the trunk lines 177, 178 open and thus selectable at the wipers 150 and 150^a. The opening of contact 88′, as before described, also de-energized polarized relay 118 so that the A link trunk was at normal.

The opening of contacts 162, 165, de-energized the two relays PR and SR so that their armatures 180 and 181 are both retracted and the release relay RR′ is de-energized. The opening of contact 185 de-energizes the relay 189, and the closing of normal contact 186 closes circuit from ground through spring ON^3, relay BR′ to battery B^{12}, whereby relay BR′ is energized and will obviously so continue until the A first selector Fig. 4 reaches normal under the influence of short steps produced by secondary magnet SM′ whose circuit will be closed by attracted armature 199, the wipers 203, 205 being in the meantime on open circuit at armatures 197 and 200. When normal is reached, contact ON^3 opens, relay BR′ de-energizes, and magnet SM′ ceases its actuations, the switch coming to rest with all its apparatus in its normal condition.

As soon as the relay 189 became de-energized and relay BR′ became energized as just described, the ground was removed from the private contact 201 so that the locking circuit for release relay RR^2 was opened and the said relay became de-energized. Its retracted armature 209 opened the circuit of relay 220 and the retracted armature 210 closed circuit from off-normal contact ON^4 through relay BR^2. This relay will continue energized until contact ON^4 is opened which will occur when the switch, under the influence of magnet SM^2, has taken sufficient short steps to bring its wipers around to normal, at which time relay BR^2 will retract its armatures and magnet SM^2 ceases operating, the switch remaining in its normal condition. It is apparent that as soon as relay BR^2 is energized, ground is removed from the private contact 211 so that locking relay LR^4 is de-energized and the A line connector Fig. 6 is fully at normal.

Let it now be assumed that the called line was busy at the time test relay TR of the A line connector Fig. 6 had its winding, on the actuation of locking relay LR^3, connected to the private or test wiper 253. In such case the private multiple contact 4 engaged by said wiper would be connected to battery in one of three possible ways. First, if the subscriber at D′, or another subscriber on his line, has removed his receiver to initiate a call, the multiple contact 4 would be connected to battery through alternate contact 11 of the line circuit. In case a line selector had already selected the multiple calling contacts 7, 8, and 9 of the wanted line, the cut-off relay 13 would be operated over a circuit extending from ground through said relay, alternate contact 16, and through multiple contact 7 and engaging wiper 27 of some other line selector (see Fig. 1), its normal contact 33 and to battery through a resistance *rr*, battery from this circuit being connected with the multiple contacts 4 over a branch including the normal contact 11. If the wanted line of D′ were busy because another A line connector had already occupied multiple terminals thereof, its multiple contacts 4 would be connected to battery B^{15} via a wiper 253 of such other A line connector. In any of these cases, it is obvious that the battery connection existing to multiple contacts 4, engaged by wiper 253 of the testing A line connector Fig. 6, will find its way via alternate contact 260 of the testing A line connector, its alternate contact 248, its alternate contact 234 and through relay TR to ground, thus maintaining the said relay TR energized. Since said relay remains

energized, circuit for the ringing relay 264 continues open at contact 262. The busy signal is now transmitted from interrupter I^2 (Fig. 6) through attracted armature 250 attracted armature 261, normal contact 236, over the talking circuit to the left, via condensers 187, 122 and 55, to the calling subscriber's substation, producing the customary busy signal in his receiver, returning over the lower talking conductor to battery through the lower winding of relay 54.

The calling subscriber being thus signalled that the called line is busy, replaces his receiver and the mechanisms of Figs. 1, 2, 3, 4 and 5 are restored to normal substantially in the manner before described, except that the restoring relay 110 of Fig. 2 receives its energizing current in a different way. Since the circuit over the called line was not completed, the relays 118 and 113 in Fig. 2 remained de-energized and relay 80 therefore continued energized by current through contact 116 over conductor 75. When conductor 75 was opened at contact 45 of Fig. 1, relay 80 de-energized and caused energization of the restoring relay 110 by current through contacts 115, 82 and 88'. Since relay TR has continued energized, relay 257 remains inert and relay LR^4 therefore has failed to operate. Under these circumstances, the release relay RR^3 of the A line connector has continued locked via alternate contact 231, normal contact 238, contact 227—211, to ground at the A second selector Fig. 5, via normal contact 217 and attracted armature 222 until, in the release operation, relay 220 is de-energized. When this occurs, the locking circuit of relay RR^3 in Fig. 6 is of course opened and the relay de-energized, said relay, by the retraction of its armatures, causing the restoration of the A line connector and the generator switch P' in the manner before described.

It will be observed that the A second selector Fig. 5, while restoring, by armature 216, maintains ground on its multiple contacts 202 so that until the A second selector has reached normal, it cannot be selected by any other A first selector.

I will now explain the method of operation when a calling subscriber in an A exchange, as subscriber D, desires his line to be connected with that of the subscriber whose line terminates in one of the B exchanges. For the consideration of this, the sheets of drawing are to be arranged as indicated in Fig. 15.

In the present description, it will be assumed that the called subscriber's number is $12—323^a$.

The system contemplates that there may be a hundred or more B exchanges which may be private branch exchanges or smaller exchanges at outlying points. Such exchanges would be grouped by hundreds and each 100 exchange would have, at the operators controlling the A link trunks, a lettered button and groups of multiple terminals controlled, as to their selectable character by such a button, in the banks of A link connectors assigned for use to the group of 100 exchanges, a master-switch being provided and also controlled by the lettered button for the group of exchanges to start an idle one of its proper A link connectors to make connection with multiple terminals of the A link trunk whose button for that group of exchanges may have been depressed.

In the present case, it will be assumed that the button lettered *a* in Fig. 2 is the button for a group of one hundred B sub-exchanges including that in which the called subscriber's line terminates. By the number 12, forming the first part of the called subscriber's number, is indicated the fact that his line terminates in the twelfth exchange of the *a* 100 exchange group and that a trunk line extending to that exchange must accordingly be selected.

When now the subscriber D removes his receiver to initiate the second call, the A line selector and the A link selector of Fig. 1 will operate in the precise manner before described to extend the calling line to an operator's position, and it will be assumed that the A link trunk shown in Fig. 2 is the one selected. The operator having learned the called subscriber's number, will depress buttons l', m^2, n^3, o^2, p^3 of her operator's calling device, Fig. 2^a, and will thereafter actuate the button *a* which will be depressed and, by its piece 92, will be locked by its corresponding pawl of the arm 93. The conductor 96', shown in Fig. 2, extends to a master-switch shown in Fig. 3^a identical in arrangement with that shown at the upper left portion of Fig. 3, but which controls the starting of a group of A link connectors, one being shown in Fig. 3^a, identical in circuit arrangement with those shown in Fig. 3, but which instead of having before them multiple terminals 104 controlled by the *b* button, as in the previous case, will have before them multiple terminals 104' of a different group controlled by the *a* button. These A link connectors will each be connected by trunk wires 177 and 178, which in the present case will be local conductors and not conductors extending to a distant exchange to a B first selector assigned for connections to the *a* group of one hundred sub or B exchanges. These first selectors, one being shown in Fig. 4^a, will be very similar in circuit arrangement to that shown in Fig. 4.

By the depression of the button as described, the master-switch connected to conductor 96' will automatically start an idle A link connector which will operate to se-

let the multiple terminals 104', 106, 107, thus connecting a B first selector for the *a* exchanges to the A link trunk of Fig. 2. Before the wipers of this B first selector, will be ten groups of ten sets each of multiple contacts 280, 281, 282 and 282ª, the contacts of the first group being terminals of B second selectors for connection to sub-exchanges 11 to 19 inclusive, and sub-exchange 10, the second group being common for connections to sub-exchanges 21 to 29 inclusive, and sub-exchange 20, and so on for the third, fourth and other groups of contacts. When the operator's impulse transmitter of Fig. 2ª starts operation following the selection of the A link trunk as before described, the operation of the spring lettered *l'* will cause one operation of relay 108 and one de-energization and energization of relay PR of Fig. 4ª which will thereon transmit an impulse to magnet PM', causing the wipers of the B first selector, Fig. 4ª, to select its first group of contact terminals of B second selectors. A de-energization of relay SR following as before, the B first selector Fig. 4ª will thereon automatically proceed to pick out an idle B second selector of the first group and render the same busy in the same manner in which the A first selector, as previously described, picked out an idle A second selector. The impulse transmitted by relay PR to the magnet PM' traverses normal contact 552, while that transmitted by relay SR to relay BR' traverses normal contact 551.

The B second selector, Fig. 7, whose multiple terminals 280, 281, 282, 282ª are those selected by wipers 201, 202, 203, 203ª of the B first selector, Fig. 4ª, will have before it multiple terminals 301, 302, 303, 304, of B link trunks, arranged in ten groups, the ten contact sets of the first group being terminals of B link trunks extending to the B exchange 11; the second group of ten sets will be terminals of B link trunks extending to B exchange 12; the third group to B exchange 13, and so on up to 19, when the tenth group will be terminals connected to B link trunks extending to B exchange 10 or 0, all of these B exchanges of course belonging to the *a* group.

As the operator's transmitter continues its operation, two de-energizations of relay PR will be produced and two impulses of current transmitted from ground through contacts 185, 552, normal contact 182, alternate contact 190, normal contact 197, contact 202—281, contact 284 and primary magnet PM^4 to battery B^{17}, whereby the wipers of the B second selector will be moved two long steps to select their second group of ten multiple contact sets, the same being terminals of B link trunks to the number 12 *a* exchange. The first impulse passed in part through release relay RR^4 and said relay, by its armature 305, locked itself to ground through contact 280—201. A de-energization of relay SR, following the two de-energizations of relay PR, transmits an impulse from ground through contacts 185, 551, normal contact 183, alternate contact 194, contacts 200, 203—282, 287, 307, the contact of ring 300ª between groups 1 and 2, wiper 300, alternate contact 308 and busy relay BR^4 to battery, energizing the said busy relay, whose attracted armatures 290 and 295 hold talking wipers 298 and 299 on open circuit while the switch is making its short steps. Armature 293 energizes relay 283 which, by armature 286, locks to ground at contact 306. Armature 294 of relay BR^4 completes the generator circuit of secondary magnet SM^4 so that the said magnet begins to effect the short step travel of the switch. Circuit may now be traced from battery B^{17} through busy relay BR^4, alternate contact 308, attracted armature 292 to the private wiper 297 which passes over multiple contacts 302 of busy B link trunks, relay BR^4 continuing energized in the usual way until wiper 297 finds a set of contacts 302, 303, 304, whose contact 302 is ungrounded, such ungrounded contact being that of an idle B link trunk. When this ungrounded contact is reached, relay BR^4 is de-energized and the B second selector Fig. 7 comes to rest. When armature 292 engages its back contact, ground at armature 285 will be connected via contact 288 with wiper 297, thus grounding the multiple terminals 302 to render them busy. A circuit is also completed from ground at armature 285 through contact 289, normal contact 291, contact 296—301, over wire 312, through cut-off relay 320 at the B cord trunk operator's position, energizing said cut-off relay, whereby the signal relay 317 is rendered inoperable.

The B first selector of Fig. 4ª, as shown, is provided with an extra wiper 203ª which moves over the multiple contacts 282ª of the B second selectors associated with the B first selector so that contact 203ª—282ª has now been closed. When the secondary impulse was transmitted by relay SR, resulting in the energization of relay BR^4, and consequently of relay 283, the armature 287ª of the latter relay was actuated to close a circuit from ground through contact 282ª—203ª, normal contact 200ª, closed contact 195ª and the relay 550 to battery B^{13}, which relay 550 energizes and by armatures 551—552 shifts the ground at closed contact 185 from the normal contacts of armatures 182 and 183 to the normal contacts of springs 182ª and 183ª. This change is produced for the reason that the de-energizations of relay PR in the operation of this part of the system (after the B second selector has com-

pleted its selection as just described), are to produce openings of the circuit of the upper talking conductor while holding a ground upon the lower talking conductor; similarly, the de-energizations of relay SR are hereafter to produce openings in the circuit of the lower talking conductor while maintaining a ground upon the upper talking conductor. Thus, each time relay PR is de-energized, after relay 550 is energized, armature 182 will be retracted and spring 182^a will follow said armature in its retraction until normal contact 182^a is closed, whereby ground from attracted armature 552 will, via the winding of polarized reversing relay RV, be connected to the lower talking conductor through closed contact 183^a—183. Immediately after the closing of normal contact 182^a, the further retraction of armature 182 opens the upper talking conductor. When relay SR is de-energized, the closing of normal contact 183^a, resulting on the release of armature 183, places ground via alternate contact 551, normal contact 183^a, closed contact 182^a—182 upon the upper talking conductor, and as armature 183 continues its back motion, the circuit of the lower talking conductor is opened.

It is thus seen that the relays PR and SR are capable of controlling selective switches after two different methods of operation at different stages of connection, the first method being by causing energizations of magnets by grounding their circuits; the second, or substituted method, being by causing the de-energization of electromagnets by opening their circuits. This shifting the methods of control of switch adjusting relays is believed to be broadly novel and will be claimed in broad terms.

It will be remembered that although the n^3 button was depressed, four impulses will be transmitted from the operator's transmitter and four de-energizations of relay PR will now be produced. The first of these is a preliminary impulse and is employed to shift the wipers of the B trunk controller of the selected B link trunk of Fig. 8 a single step to connecting position with the conductors of the switch pair comprising a B third selector and B line connector, which said wipers have theretofore selected.

As above mentioned, the de-energization of relay PR now opens the upper talking conductor and grounds the lower talking conductor. The grounding of the latter closes a circuit from battery B^{19} through the relay 370 of the B trunk controller, contact 368, contact 380—381, conductor 386 and wiper 378, normal contact 369 over the trunk wire 363, contacts 304—299, 295, alternate contact 287, contacts 282—203, 200, alternate contact 194, contact 183—183^a, polarized relay RV, in a direction not to actuate said relay, normal contact 182^a, alternate contact 552 to ground through attracted armature 185. Relay 370 is thereby energized and its armature closes generator circuit for magnet 371 which magnet receives an impulse and steps the wipers of the B trunk controller one step, whereby wiper 372 continues in engaging the broad contact 373, wiper 374 moves to engage contact 375, wiper 376 to engage conductor 387, wiper 378 to engage conductor 388, the movement of said wiper opening the energizing circuit of relay 370 whereby but the single actuation of magnet 371 is permitted, wiper 380 moves to open circuit and wiper 382 moves a step but continues to engage broad contact 383.

The connection has now been extended from the calling subscriber's line through to the B third selector and the succeeding three impulses of the third group will adjust the B third selector (Fig. 9) to select the group of B line connectors assigned for connections to the hundred lines including that of the called subscriber; and the fourth and fifth sets of impulses transmitted will adjust the B line connector to select the particular line out of the hundred.

Before describing in detail the sequence of operation now occurring, I will briefly refer to the more important peculiarities of a switch pair such as the B third selector and the B line connector shown in Figs. 9 and 10.

Each B line connector is capable of operating either as an automatic switch to seek out and connect with any line of its group as a calling line, directively operated to pick out and connect with and test any line of its group as a called-for line. When operating as an automatic switch, it is controlled as to its starting by the master-switch mechanism X. When it is to be operated under directive control to connect with a called-for line, the B line connector must first have been picked out by some B third selector, which may be the B third selector in permanent association with the particular B line connector or it may be by some other B third selector linked with its respective B line connector. Each B line connector (Fig. 10) has multiple contacts 437—438 appearing in the banks of the B third selectors in the appropriate groups there and also has multiple private contacts 436^a appearing in the banks of the B third selectors other than the one especially associated with the particular B line connector. At such associated B third selector a non-multiple private contact 436 is provided and this non-multiple contact will of course be associated with talking contacts 437—438. The set including the non-multiple contact 436 will be the first contact set in the per-

manently associated B third selector of the group of B line connector contacts pertaining to the line group which the particular B line connector serves but it will be the only contact set of that group, there being the usual nine other contact sets provided.

It is immaterial whether the B third selector, which is placed in connection with the B second selector as before described, has, or has not permanently associated with it a B line connector for the called line group to which connection is to be finally completed. If, however, it should happen that the B third selector already has linked with it a B line connector for that group, the wipers 426, 427, 428, 429 of the B third selector would be adjusted to the proper group position and then would make but a single short step engaging the non-multiple private contact 436 and the line contacts 437—438. It is to be noted that this first private contact 436 will usually be idle as respects its associated B third selector because were the B line connector in use, its being in this condition would have prevented the selection and operation of the associated B third selector as will hereafter appear. However, if a B line connector has connected to a calling line and the called line were in the same hundred in the same B exchange, then the B third selector would pass over the non-multiple contact 436 and select an idle multiple contact 436^a.

The B line connector is, as will be understood from the preceding, to a large extent independent of the B third selector with which it is permanently associated inasmuch as it is capable of being selected by some other B third selector and rendered busy and is also capable of being started from a calling subscriber's line and operating independently of its B third selector.

Similarly, the permanently associated B third selector of a B line connector, is, to a certain extent, an independent switch and can select a group and then an idle switch out of a plurality of groups in the usual manner.

The linking together of the B line connector and B third selector is accomplished by the by-path talking wires 433—434 and by the wires 431, 385^a, 384 and 435.

Since a switch pair can be placed in use from either end, that is, in response to an in-coming call or out-going call, it is necessary that where one of the switches of a pair is rendered busy, the avenues of approach to the other switch of the pair shall be closed. This is accomplished by placing guarding electrical conditions upon the various contacts by which the switch may be in any way influenced from an external point.

As before indicated, the B line connector may normally be rendered busy by a calling line causing it to start in operation to seek out such line. It may also be rendered busy by being selected by some other B third selector. In the first of these cases, the effect is produced by closing circuit through the wiper 490 of the master-switch mechanism X and in the second of these cases, a selection is effected by some other B third selector of the multiple contacts 436^a, 437, 438.

In the present case, therefore, namely that in which a call has come in over the B third selector (Fig. 9) via the B second selector (Fig. 7), it is necessary to at once render the multiple private contacts 436^a busy and to render contacts at wipers 490 and 491 of master-switch X of such electrical character that the master-switch wipers, if already engaging them, will be moved off from them and also such that the said wipers will be incapable of coming to rest engaging them until the switch pair have been fully restored to normal. As soon as the B trunk controller was caused to make its single step, relays PR^5 and SR^5 were immediately energized by current from positive battery B^{21}, through relay PR^5 to the left over the upper talking conductor, through contact $182—182^a$, through polarized relay RV in a direction not to actuate said relay, through closed contact $183—183^a$ and to the right over the lower talking conductor and through relay SR^5 to battery A^{21}. Attracted armatures 414—415 operated release relay RR^5 whose armature 408 energized relay 405 from ground at wiper 382, said relay 405 by armature 406 then locking itself to said ground. Armature 406 disengaging its normal contact opened a circuit which had previously existed traceable from ground at wiper 382 over conductor 435, contact 478^a, and to the contact of the switch pair (Figs. 9–10) at the master-switch X. Assuming that the wipers 490—491 of the said master-switch are at this time resting engaging the contacts of the switch pair (Figs. 9 and 10), its operating relay 492 will have been energized by current from battery B^{22} to ground over conductor 435 and, the armatures of said relay 492 being attracted, the generator circuit for magnet 493 will have been held open and the common wire extending to the alternate contacts of armatures 12 of line relays 10 will have been held connected to the starting wiper 490. The opening of normal contact 406 de-energizes relay 492, wiper 490 is placed on open circuit and the generator circuit for magnet 493 is closed, the master-switch X then initiating travel of its wipers in search of contacts of a switch pair whose contact associated with wiper 491 is on closed circuit to ground which condition will mean that neither the B third selector or B line connector of that pair is in use and that a B trunk controller has connected its B link to the switch pair when the master-switch will, of course, stop, the re-

lay 492 being energized in consequence of the said ground.

We have seen that the primary impulses of the third set transmitted from the operator's impulse transmitter caused one step of the wiper of the B trunk controller with the results indicated. The immediately following three de-energizations of relay PR at Fig. 4[a] will cause three de-energizations of relay PR^5 while holding relay SR^5 energized. Each de-energization of relay PR^5 transmits a current impulse from ground through attracted armature 409 through normal contact 412, contact 417, magnet PM^5 to battery B^{20}, and said magnet PM^5 is actuated three times to produce three long steps of wipers 426, 427, 428, 429 and 430 to select the third group of multiple contacts associated with them, said group being terminals of B line connectors for the three hundreds group of the a^{12} branch exchange. With the first step, off-normal contacts ON^{12} and ON^{13} were shifted, the shifting of contact ON^{12} placing a ground over conductor 384 upon the multiple private contacts 436^a of the B line connector so that no other B third selector can, after the first step of the switch in Fig. 9, select the said B line connector until the B third selector has reached its normal position. It will be seen that the multiple contacts 436^a of the B line connector were already grounded by the conductor 384 by wiper 372 at the B trunk controller and normal contact 366; therefore, a B line connector will be busy with respect to B third selectors (other than the one paired with it) whenever a B trunk controller is engaging contacts of the switch pair, and in addition as long as the paired B third selector is off-normal.

A de-energization of relay SR, Fig. 4[a], de-energizes the relay SR^5, Fig. 9, while holding the relay PR^5 energized. The de-energization of relay SR^5 causes an impulse of current to flow from ground through attracted armature 409, normal contact 413, normal contact 420, attracted armature 410 through the contact of ring 430^a between groups 2 and 3, over wiper 430, alternate contact 411, busy relay BR^5 to battery B^{20}.

It will first be assumed that the B line connector (Fig. 10) paired with the B third selector (Fig. 9) is assigned for connection with the third hundreds group of subscribers of the a^{12} exchange. In such case, on the energization of relay BR^5, circuit will be closed through magnet SM^5 by armature 424 and a short step of wipers 426, 427, 428, 429, 430 will be made, the said wipers as before indicated, then coming to engage respectively the non-multiple contact 436 and multiple contacts 437, 438, 429^a of the B line connector (Fig. 10). The movement of wiper 430 opens the initial energizing circuit of relay BR^5 which thereon depends, for its further energization, upon a circuit extending from battery B^{20} through said relay BR^5, alternate contact 411, alternate contact 422, to wiper 426 and a contact engaged thereby. Since the B line connector Fig. 10 is at normal, contact 436 is ungrounded, no locking circuit for relay BR^5 exists and the relay de-energizes, a single step of the switch wipers only being produced.

As soon as relay BR^5 energized as before described, its armature 423 energized the relay 416 whose armatures were attracted, armature 419 locking said relay to ground at contact 409. A circuit has now been established through to a B line connector of the appropriate group and further operations of relays PR^5 and SR^5 of Fig. 9 will be effective to adjust said line connector to connection with the called-for line.

Before proceeding with the description of the operation of the B line connector, we may consider the features of operation arising when it is assumed that the B line connector, Fig. 10, paired with the B third selector, Fig. 9, is not assigned for connection to the group including the line of the called subscriber. In such case, of course, the B third selector will have to select some set of multiple contacts 436^a, 437, 438 among its third group. In such case, the third group will not include the non-multiple contact 436 and associated contacts 437, 438, 439^a, as in the previous case, but the said third group will comprise ten sets of multiple contacts 436^a, 437, 438.

Under these circumstances, succeeding locking circuits for relay BR^5 will be established via wiper 426 and successive engaged multiple contacts 436^a until a private multiple contact 436^a of a B line connector is selected which B line connector pertains to an idle switch pair. A switch pair whose B line connector will be capable of selection in this manner must be one disconnected from a B link trunk for otherwise the multiple contacts 436^a will be grounded over conductor 384 via wiper 372, and normal contact 366 of the B trunk controller. Further, such selectable B line connector must be one whose associated B third selector is at normal, otherwise the multiple contacts will be grounded at off-normal contact ON^{12} of its B third selector. It must be one not already selected by another B third selector or the multiple contacts 436^a will be grounded via wiper 426 of such other B third selector, its normal contact 422 and its alternate contact 418. Such B line connector must not have been placed in use owing to a call initiated from one of its lines having caused it to operate as an automatic switch or the multiple contacts 436^a will be grounded either at alternate contact 459 if the switch is traveling or via alternate contact 484 of relay 480 and off-normal contact ON^{14} if the

B line connector has already connected the calling line. As soon, however, as the B third selector engages, by its wipers, multiple contacts of a B line connector not rendered busy by having its multiple contact 436^a grounded in one of these several ways, the relay BR^5 will be de-energized and, by its retracted armature 422, will place ground via attracted armature 418, upon the multiple contacts 436^a rendering the switch pair, whose B line connector has been selected, busy.

At this point it may be stated that the placing of ground upon contact 436^a pertaining to an idle switch pair as just described, renders the said switch pair which was previously selectable by any B trunk controller that might have engaged terminals thereof, busy, with respect to the B trunk controllers, by grounding the multiple contact 373 at the various B trunk controllers so that any such controllers engaging multiple contacts of the switch pair to which the selected B line selector belongs will find the said switch pair unselectable on account of this ground. Since, as before made manifest, the master-switch mechanism X is only capable of selecting and stopping its wipers in engagement with contacts of a switch pair which are in connection with a B trunk controller, the wipers of said master-switch were not in engagement with the contacts of the switch pair whose B line connector has been selected at the time the selection occurred; nor will they be enabled to stop upon the contacts of that switch pair should they thereafter engage them, since no B trunk controller can be engaging its contact of such switch pair as just indicated.

Having now indicated the two manners in which the B third selector of Fig. 9 can secure a B line connector of the appropriate group, the operation of the B line connector will be described, it being understood that it is the same without regard to the manner in which it has come to be selected.

As the operator's transmitter continues in its revolution, a fourth set of impulses consisting of two impulses will be transmitted which will result in two deenergizations of relay PR and two de-energizations of relay PR^5. Thereby, two impulses of current will be transmitted from ground at armature 409 (Fig. 9) through normal contact 412, alternate contact 417, normal contact 421, contact 427—437, and normal contact 481; this first impulse passes through normal contact 440 and through release relay RR^5 to battery B^{22}, said relay RR^5 energizing and locking itself via armature 440, contact at 483 and over the grounded conductor 384. Armature 441 will be attracted before the first impulse ceases and said impulse will then traverse said attracted armature 441, normal contact 446, private magnet PM^6 to battery, the actuation of said magnet causing a long step of the wipers 453, 454, 455 and 456. The second impulse will pass through magnet PM^6 only since armature 440 is attracted, and said magnet PM^6 will cause a second long step of the wipers of the B line connector and bring them adjacent to the second group of line contacts including those of lines numbered 12—321^a to 12—329^a followed by contacts of line 12—320^a. An ensuing energization of relay SR will de-energize relay SR^5 and a current impulse will flow from ground through armature 409, normal contact 413, alternate contact 420, normal contact 425, contact 428—438, normal contact 488, via attracted armature 443, and locking relay LR^5 to battery B^{22}, energizing the relay LR^5 which, by armature 445, locks itself to ground at alternate contact 439 and by armature 446 disconnects primary magnet PM^6 from normal contact 481 and connects secondary magnet SM^6 thereto.

By the operation of the impulse transmitter, a fifth set of impulses comprising three will de-energize relay PR^5 three times and three impulses of current will be transmitted from ground through attracted armature 409 over the before traced path to the B line connector, through contact 441, alternate contact 446, normal contact 447 and secondary magnet SM^6 to battery. Said secondary magnet now produces, in response to these impulses, three short steps of the switch wipers and they will come to rest engaging the multiple contacts 4—5—6 of the third line of the selected group being the lines of subscriber 12—323^a whose substation V is indicated at the right of Fig. 10.

Obviously, the next step in the operation of the system is the testing of the called subscriber's line. Going back for a moment, it will be seen that the test relay TR^6 was energized when relay RR^5 attracted its armature on the first primary impulse transmitted to the B line connector, the circuit of said relay TR^6 including normal contact 449, and attracted armature 442. A final de-energization of relay SR^5 transmits a current impulse over the before traced path through normal contact 488, through the ring 456^a, the wiper 456 now engaging said ring, normal contact at 450 and through locking relay LR^6 to battery, said relay LR^6 then locking itself via armature 450 to ground at alternate contact 439. Attracted armature 449 disconnects the test relay TR^6 from its previous battery connection and connects the winding of said relay via alternate contact 465 of relay TR^6 and normal contact 460 to the test wiper 453. If the called line be busy, the multiple contact 4 now engaged by wiper 453, will be connected to battery and relay TR^6 will continue energized whereby the busy signal from interrupter I^6 will be transmitted to the calling substation

via attracted armature 451, attracted armature 466, normal contact 481 to the left over the upper talking conductor to the calling substation, making the usual noise in the receiver whereon the calling subscriber will replace his receiver upon the switch hook and all apparatus will be restored, as hereinafter explained.

It will at present be assumed, that the called line is idle, in which case the multiple contacts 4 will be connected to ground only, via normal contact 11 and cutoff relay 13. Test relay TR^6 will thus have both terminals of its winding connected to points of equal potential; said relay will be de-energized and its armature will be retracted. When this occurs, battery B^{22} is connected via normal contact 465, normal contact 460, contact 453—4, normal contact 11 and cut-off relay 13 to earth whereby the cut-off relay 13 is energized and attracts its armatures to complete the talking circuit and to cut-off line relay 10.

Battery having thus been placed upon the private multiple contacts 4, the called line is protected from seizure by any other B line connector operating as a directively controlled switch; and as the said contact is also connected to ground through the cut-off relay, no B line connector, operating as an automatic switch, can make connection with the called-for line, as will hereafter appear.

Retracted armature 467 of test relay TR^6 has now connected interrupter I^7 via attracted armature 452 of relay LR^6 with generator relay GR and battery, said relay being alternately energized and de-energized, including and excluding generator G from the circuit of the called line, to periodically ring the bell at the substation in the well known manner. When the called subscriber removes his receiver, the hook lever *l* closes a conductive circuit through the substation, and as soon as the armatures of relay GR are retracted, current will find its way from battery B^{22} through the upper winding of inductance 476, through relay 473 and its non-inductive shunt, normal contact 464, upper armature of relay GR, normal contact 458, contacts 454—5, 15—14, through the substation, returning through contact 6—455, normal contact 462, lower armature of relay GR, contact 468, through relay 477 and its non-inductive shunt and through the lower winding of inductance 476 to ground. This current flow energizes the called substation transmitter for talking and results in the energizations of relays 473 and 477. The attracted armature 478 energizes the relay 480 which, by armature 485, locks itself to ground at off-normal contact ON^{14}; armature 487 opens the interrupter circuit, preventing further actuation of relay GR, so that ringing current ceases to be applied to the called line. Armatures 481 and 488 engage their alternate contacts, completing the talking circuit at the B line connector. Armature 482 shifts the locking circuit of release relay RR^5 from the private conductor 384 and connects it through to ground at attracted armature 478 so that the control of release relay RR^5 no longer depends upon the private conductor, but is directly controlled by the called subscriber by his control of relay 477 and the release of the B line connector is so turned to the called subscriber. The armatures of relay 473, although attracted, have no operative effects upon the mechanisms of the switch pair under the present conditions of operation.

With the attractions of armatures 481 and 488, the battery B^{22} was bridged across the talking conductors of the B third selector, Fig. 9, and as the reversing relay 389 is in bridge of said conductors, the said relay is operated and reverses the connections of batteries B^{21} and A^{21} to conductors 387 and 388 and so to the conductors 362 and 363 of the B link trunk. The reversed current will now find its way to the left over the talking conductors through the B second selector and the polarized reversing relay RV of the B first selector, said reversing relay then attracting its armatures to in turn reverse the connections of batteries B^{10} and A^{10} to the trunk wires 177 and 178, the reversed current then flowing over the talking conductor to the left and through the polarized relay 118 at the A link trunk, causing its armatures to be actuated. The operation of the relay 118 causes, just as described in connection with the first circuit diagram, results in the energization of relay 113 and the actuation of the polarized battery reversing relay 57 at the A line selector, whereby the direction of current flow in the calling subscriber's line is reversed as before described. As in the previous instance, the transmitter of the calling substation is supplied by current from battery B, finding its way through the lower winding of relay 54, to the left over the lower talking conductor, through the substation, returning over the upper talking conductor and to ground through the upper winding of relay 54. The two subscribers are now in conversation, the talking circuit being traced throughout the exchange by the heavily marked conductors.

When the subscribers finish their conversation, they replace their receivers. This act on the part of the calling subscriber D causes the restoration to normal of the switches of Fig. 1, the mechanism of the A link trunk Fig. 2, the A link connector Fig. 3^a, the B first selector Fig. 4^a, the B second selector Fig. 7, the B trunk controller Fig. 8, and the B third selector Fig. 9. The restoration of the B line connector is controlled solely by the called-for subscriber, and if he

first replaces his receiver, he will also cause to be restored to normal the B third selector and the B trunk controller. The other mechanism, however, in this latter case will remain for the calling subscriber to restore. It is thus seen that the calling subscriber restores the apparatus up to and including Fig. 7 and may restore the apparatus of Fig. 8 and Fig. 9; and the called subscriber restores the apparatus of Fig. 10 and may restore the apparatus of Figs. 8 and 9.

It will be assumed that the calling subscriber first replaces his receiver, whereon the A line selector, the A link selector, the A link trunk mechanism, and the A link connector will be restored as in the previous case. As soon as, in this process of operation, relays PR and SR are de-energized, the retraction of their armatures 180 and 181 de-energizes release relay RR′, and its retracted armature 186 closes circuit from battery B^{13}, through busy relay BR′, normal contact 186 to ground through the off-normal contact ON^{3}. Relay BR′ thereon attracts its armatures, 199 closing the generator circuit of secondary magnet SM′, and the said magnet now steps the switch around to normal, when contact ON^{3} will be opened, relay BR′ de-energized, and the circuit of magnet SM′ opened. Armature 200^{a} de-energizes relay 550.

The retraction of armature 185 opened the circuit of relay 189 so that as soon as armature 198 of relay BR′ was attracted, ground was removed from the private wiper 201. Consequently, release relay RR^{4} of Fig. 7 was de-energized and its armature 308, falling back, closed the circuit from ground at off-normal contact ON^{10}, through relay BR^{4} to battery B^{17}, said relay then energizing and, by armature 294, closing the circuit of secondary magnet SM^{4} which now steps the B second selector around to normal, when the opening of contact ON^{10} stops the switch by de-energizing relay BR^{4}.

As soon as the circuits of the talking conductors at the B first selector were opened on the de-energization of relay RR′, the relays PR^{5} and SR^{5} at the B third selector, Fig. 9, were de-energized and their retracted armatures 414—415 de-energized the release relay RR^{5}, whereon the retracted armature 411 closed circuit from ground through alternate contact ON^{13}, relay BR^{5} to battery, which relay then attracted its armatures, whereof 424 closed the generator circuit for magnet SM^{5} which steps the wipers around to normal, when contact ON^{13} is restored, de-energizing relay BR^{5} and preventing further actuation of magnet SM^{5}. Contact ON^{12} is also shifted to normal, and the mechanism of Fig. 9 is then in its normal condition. Retracted armature 408 closed circuit from ground at wiper 382 via contacts, 383, 408, alternate contact 407, wires 385^{b}, 385, contact 375—374 and relay 364, which by armature 367 closes generator circuit for magnet 371 which steps the B trunk controller in search of an idle switch pair, relay 364 by armature 366 being energized by successive locking circuits via wiper 372 until the idle switch pair is reached.

When now the called-for subscriber replaces his receiver, the relays 473 and 477 are de-energized, the opening of contact 478 de-energizing the release relay RR^{5} by whose de-energization the restoration of the B line connector is set in train of progress by the closing of circuit as follows: from battery B^{22}, through the relay 457, through the alternate contact ON^{20}, normal contact 444 of relay RR^{5}, through normal contact 475 and relay 469 to ground, energizing the relays 469 and 457. Relay 469, by armature 471, locks itself in series with relay 457 so that, on the energization of the latter, the closing of alternate contact at 458, which will cause relay 473 to be again energized, does not affect the circuit of relays 457 and 469. Attracted armature 461 of relay 457 connects interrupter I^{5} through magnet SM^{6} with battery, so that the magnet steps the wipers of the B line connector around to normal, when the opening of alternate contact ON^{20} will de-energize relays 457 and 469, preventing further actuation of magnet SM^{6}, the switch then coming to rest. When the B line connector reaches normal, the opening of contact ON^{14} will unlock and de-energize the following relays: 480, LR^{5} and LR^{6}, when the mechanism of the B line connector will be in its normal condition. As soon as relay 457 was energized as before described, the circuit through the cut-off relay 13 of the called line was opened and the line circuit was thereon restored to its normal condition.

If it has not already been released by the calling subscriber, the restoration of the B trunk controller Fig. 8 was initiated as soon as relay 469 became energized, armature 470^{a} then closing circuit over a conductor 385^{a}, conductor 385, wiper 374, relay 364 to battery B^{19}, whereon said relay attracted its armatures, armature 367 closing the generator circuit of operating magnet 371, whereon the travel of a B link controller is initiated and continues until the relay 364 now connected, by its attracted armature 366 with a private wiper 372 of the B trunk controller, is by said wiper, placed in circuit with a contact 373 of a switch pair connected with a conductor 384 which is ungrounded. Such conductor will be found when the wiper 372 engages a contact 373 belonging to a switch pair whose B third selector and B line connector are both in their normal positions and one such that its multiple contact 373 has not already been selected by a B trunk controller. The relay 364 will then

be de-energized and its armatures retracted, armature 366 grounding the multiple contact 373 and rendering the switch pair selected busy to the other B trunk controllers. At such time the apparatus will of course be in the condition shown in Figs. 8, 9 and 10 and a ground connection will exist from the grounded wiper 382 through the contact 383 of the switch pair found idle, its conductor 383ª, its normal contact 406, over conductor 435, contact 478ª and to the contact pertaining to the switch pair before wiper 491 of the master switch mechanism X, so that when the master-switch has its wipers brought to engage the contacts of that switch pair, it will have its relay 492 energized and will stop in connection therewith, ready to start the B line connector of the selected pair in response to the initiation of a call from one of the lines.

If it be assumed that the called-for subscriber has replaced his receiver in advance of the calling subscriber, the release of the B line connector and the B trunk controller would proceed just as before described; and as soon as relay 364 of Fig. 8 was energized, causing the wipers 376 and 378 to disengage conductors 377 and 388, relays PR^5 and SR^5 of the B third selector would be de-energized and the restoration of that switch be effected as before described.

If instead of the called line being found idle, the said line had been found busy, the calling subscriber in response to the busy signal would have replaced his receiver and the apparatus would have been restored in the manner generally similar to that before described. In this case, however, the B line connector and the B trunk controller would have been restored, responsive to the act of the calling subscriber. Since the called subscriber had not answered the call, the relay 480 would have remained inert and the release relay RR^5 of the B line connector would have been locked by its armature 440 through normal contact 483 to ground over the private wire 384. When in the course of these release operations which would proceed to include the B third selector as before, the said B third selector, Fig. 9, has its relays PR^5 and SR^5 de-energized, the release of armature 408 of relay RR^5 closes circuit from the grounded wiper 382, Fig. 8, normal contact 408, attracted armature 407, wires 385ᵇ, 385, wiper 374, and through relay 364 of Fig. 8 to battery, whereon the B trunk controller starts its travel, coming to rest engaging an idle switch pair as before described. When the B third selector now reaches normal, off-normal contact ON^{12} is shifted and the locking circuit of relay RR^5 is opened, since wiper 372 of the B trunk controller has left contact 373. On the resulting de-energization of relay RR^5, the B line connector, Fig. 10, restores to normal, as before described. This is the method of release when the called subscriber's line happens to be in the group which the B line connector, paired with the B third selector, which was selected by the B second selector, serves, the B third selector thus having selected by its wipers its own paired B line connector. If, however, the B third selector had picked out a B line connector, not the one paired with it, the release of such B line connector, in the case where the called subscriber does not answer, would occur as soon as relay BR^5 of the B third selector was energized, this alone being sufficient to open the locking circuit of release relay RR^5.

The multiples of the contacts 373, 375, 377, 379, 381 and 383 of the switch pairs before the wipers of the B trunk controllers may be divided after any approved fashion. If it be assumed that the branch exchange has a full one thousand lines, it may be assumed that a maximum of ten per cent or one hundred lines will be calling lines at one time. It may further be assumed that more than one-half of the calls from the branch exchange will be for lines terminating in the same exchange and that a maximum of, say, thirty-five or forty lines of this branch exchange will have to be connected at one time either as calling lines or called-for lines with lines outside of its own branch exchange. In such case, fifty B link trunks for the branch exchange would be adequate, allowing, say, thirty-five or forty trunk lines for outside calls and from ten to fifteen trunk lines in excess of these, which would be available for emergencies and for the method of operation wherein a B link trunk is employed only for transmitting directive impulses back to switches of its local exchange, the B link trunk being thereafter immediately freed.

Inasmuch as to get the full use out of the B link trunks, enough switch pairs should be provided so that when a B trunk controller was started into operation it would never fail to quickly find an idle switch pair so as to soon become again available for use, there should be provided a greater number of switch pairs than there are B link trunks with their B trunk controllers. One hundred switch pairs would prima facie give the usual ten per cent trunking basis, but because, as previously stated, a connection between two local branch exchange lines will, if the two lines be in different hundreds, require a B line connector of one group, a B third selector paired therewith, and another B line connector of another group to make connection with the called line, there will be for each such connection a B third selector rendered busy and yet not actively employed or adjusted in the connection. Thus for some of the connections, four switches will be employed and a considerable percentage of calls will be ex-

pected to be of this character—to say nothing of those for distant B exchanges—and one hundred switch pairs or two hundred switches will result in a considerably less than ten per cent trunking facilities. It may therefore be desirable to provide not less than two hundred switch pairs for one thousand lines, this of course depending upon traffic requirements in every case. As each B trunk controller requires a two step space for each switch pair, the switch pairs are preferably divided into groups of not more than fifty pairs per group, and each such group would have its pro rata of B link trunks of that exchange individual to it. Thus if two hundred switch pairs were provided, they may be divided into four groups of fifty pairs each, and the multiple contacts, at the B trunk controllers, of the switches of each group would be multiplied at one-fourth of the B trunk controllers provided; or the switch pairs might be divided into still smaller groups and the B trunk controllers divided into a corresponding number of groups. Thus each two hundred or three hundred lines of a B exchange might have its switch pairs included in one group and these lines would then be capable of reaching other exchanges and of being reached from other exchanges over certain ones of the B link trunks only. The arrangement of multiples will in any case be such as the particular requirements of the case may demand, an important feature to be borne in mind in organizing such a system being that at all times there should be an idle switch pair for each group of lines having a B link trunk resting in connection with it so that each group will have facilities enabling any calling line of the group to be promptly extended to the central office and its call there indicated.

Assuming that the subscriber V of the B exchange desires his line to be connected for conversation with that of a subscriber of an A exchange, the sheets are to be arranged in the order indicated in Fig. 16, circuit No. 3.

When the calling subscriber V removes his receiver, a conductive circuit is closed through the substation, permitting the flow of current from battery B^{22}, through normal contact 14, over the line limbs to normal contact 17 and relay 10 to ground, energizing the said relay which, by armature 11, places battery from B^{22} upon the multiple contacts 4, at the same time removing ground from the multiple contacts 4 renders them selectable by any B line connector traveling as an automatic switch and renders them busy against any B line connector testing them as a directively operated switch. Attracted armature 12 of relay 10 closes circuit through the common conductor extending to master-switch X, current flowing through the wiper 490, and the contact of the idle switch pair then engaged by the master-switch X, through normal contact ON^{20} at the B line connector of the pair and through its relay 457 to battery B^{22}. The energization of relay 457 closes circuit from interrupter I^5, through attracted armature 461, secondary magnet SM^6 to battery, so that as long as relay 457 remains energized, magnet SM^6 will move wipers 453, 454, 455, 456, successive short steps in search of multiple contacts 4 of an unselected calling line. Armature 460 of relay 457 connects the relay's winding with the private wiper 453, while contact ON^{20} opens the original energizing circuit of relay 457. Selected calling lines, selected called lines, and normal non-calling lines will all have a ground connection on their multiple contacts 4 through their respective cut-off relays 13, so that relay 457 will continue energized over successive locking paths established through wiper 453 and successive contacts 4 until the calling line contacts are reached, at which time the relay 457 will have both terminals connected to battery and the relay will therefore de-energize, leaving the wipers of the B line connector in engagement with the contacts of the called line V. As soon as relay 457 energized, alternate contact at 458^a was closed, resulting in the immediate operation of relay 473, when circuit may be traced from ground, through normal contact 439 of relay RR^5 through normal contact 470, attracted armature 474, over wire 431, relay 402, to battery, energizing the relay 402, whereon the relay 392 is operated by current through attracted armature 403, normal contact ON^{13} to ground. The attracted armatures 393 and 396 of this relay complete paths capable of transmitting voice currents from armatures 481 and 488 of the operating B line connector, over wires 433 and 434, to the talking conductors of the B third selector. Armature 395 of relay 392 grounds conductor 386 so that the B trunk controller wipers make a single step to connecting position with the B third selector. As soon as this occurs batteries B^{21} and A^{21} are bridged across the trunk wires 362, 363, and the wires 309 and 310 extending to the B cord trunk, Fig. 8^a, whereby current passes through the signal relay 317 in a direction to tilt its armature upward whereby the call signal lamp 316 is at once displayed. The armature of relay 317 also grounds contact 318, whereby the multiple contacts 302 at the B second selector are protected against selection. It will be remembered that the just described operations all occur immediately on the energizations of relay 457 and without waiting for the selection of the calling line, so that the call lamp is displayed and the B line trunk rendered

busy without any appreciable interval after the removal of the receiver at the substation. With the energizations of relays PR^5 and SR^5 occuring when the B trunk controller makes its single step, relays RR^5 and 405 are at once energized, the energization of the latter opening the circuit through the relay 492 at master-switch mechanism X, the circuit for said relay having previously existed by way of conductors 435 and 383ª. The master-switch mechanism X now starts its travel over the contacts of its associated switch pairs in search of a pair which is idle and which has an idle B link trunk in connection with it, in the manner before described. As soon as this occurs, the master-switch mechanism X will of course be available for use by any other calling subscriber of its group.

When the B line connector, Fig. 10, reaches the contacts of the calling line, the de-energization of relay 457, by armature 458, which engages contact 458ª before said contact 458ª disengages its associated contact, completes a substitute circuit for the relay 473, extending through contact 458ª—458, contact 454—5, normal contact 15 and cut-off relay 13 to ground, whereon said cut-off relay energizes and, by armature 17, opens the circuit of line relay 10, whose de-energization closes contact 11 in time to close a maintaining circuit for cut-off relay 13, including said contact 11, contact 4—453, normal contacts 460 and 465 to battery B^{22}. With the actuation of the cut-off relay 13, relays 473 and 477 have their circuits closed over the limbs of the telephone line and the relays are both energized. The attracted armature 478 now actuates the relay 480, which, by armature 485, locks itself on to the off-normal contact ON^{14} shifted on the first step of the B line connector, whereby ground, via contact 484, is placed upon the multiple contacts 436ª, said contacts having been pro ected during the operation of the B line connector by ground at attracted armature 459. Attracted armatures 481 and 488 complete the talking circuit through to the contacts 314, 315 of the spring-jack in Fig. 8ª. The calling subscriber is now supplied with talking current in a manner similar to that in which supply was given when his line was called, and the talking circuit extends via contacts 481, 488 of relay 480, over conductors 433, 434, to Fig. 9, through contacts 393, 396, normal contacts at 390 and 391, over trunk wires 362, 363 and the conductors 309, 310.

The operator may plug in before or after the calling line has been selected. When she does so, the cut-off relay 320 is actuated, de-energizing line relay 317, whereby lamp 316 is extinguished. Armature 322 places a substitute protecting ground upon the conductor 311 and the private contacts 302 of Fig. 7. The insertion of the plug, by closing contact 325—313, in addition to energizing relay 320, also actuates the cord relay 341, which places ground by armature 343 upon the armatures of the two polarized supervisory relays 330 and 331. The closing of contacts 314—323 and 315—324 continue the relays PR^5 and SR^5 energized by establishing a conductive bridge across contacts 314 and 315, said contacts including the winding of the polarized relay 330, and current passes therethrough in a direction to lift its armature so that the answering supervisory lamp signal 339 is not lighted.

The operator, depressing the keys 328, 329, connects her telephone in circuit with the calling line and ascertains the number of the wanted subscriber, which will be assumed to be the same A exchange subscriber who was previously called, namely, subscriber 23233—*b*.

Each B cord trunk may have its individual operator's impulse transmitter like the one shown in Fig. 2ª, although I have indicated in Fig. 8ª, by manually operable switches connected to conductors 97, 143ᵇ, 98 and 99, that the impulse transmitter may be arranged to be shifted from one cord trunk to another. The out-going end—that at the right of Fig. 8ª—of each B cord trunk has groupwise disposed multiples which may be arranged in the same manner as the arrangement hereinbefore described for the A link trunks, there being as many starting buttons as there are A exchanges and B exchange groups to be reached, although for convenience I have only shown a single set of multiples in Fig. 8ª. The multiple contacts 106ª—107ª would appear in the A link connectors of all the groups, while the contacts 104ª would be arranged in different groups, each group being controllable by a starting button, one of which I have indicated at *b* in Fig. 8ª.

Having thrown levers 353, 354 to their alternate positions, the operator will now depress buttons on her calling device associated with the B cord trunk, Fig. 8ª, as before, and will finally depress the button *b* for the *b* main exchange. The circuit connections associated with the right-hand or calling end of the B cord trunk are generally the same as those associated with the right-hand end of the A link trunk, Fig. 2, and corresponding parts have similar reference numbers with the letter *a* added. The depression of button *b* actuates relay 84ª to display the cord lamp 87ª and also grounds conductor 96 to start an A link connector Fig. 3 to select the multiple contacts 104ª, 106ª, 107ª of the B cord trunk, the contact 104ª having been ungrounded as before by the actuation of the lever 90′. The selection of the B cord trunk is performed in a manner similar to that in which

the A link trunk was selected, the relay 100[a] being operated, as was the relay 100, to put out the cord lamp 87[a] and to cause the starting of the operator's impulse transmitter Fig. 2[a]. From this point on, the operation of the A first selector, the A second selector, and the A line connector is performed in the same manner as before described. The relay 331, which, after the selection of the B cord trunk, is included in circuit with batteries B[10] and A[10], will, until the called subscriber answers, receive current in a direction tending to throw its armature downward, so that the called supervisory lamp 340 will remain lighted until the called subscriber answers. When this occurs, the consequent reversal of current flow caused by relay RV of Fig. 4 will throw the armature of relay 331 upward and the operator will know that the called subscriber has answered. The subscribers V and D are now in conversation through the condensers 332 and 333 in Fig. 8[a] and the condensers associated with armatures 393 and 396 in Fig. 9.

When at the conclusion of conversation the subscriber V replaces his receiver, the consequent de-energization of relay 473 closes the release circuit including relays 469 and 457, which are the same relays that were brought into play when the B line connector was employed as a directively operated switch, and the said switch restores to normal, ground being held on the multiple contacts 436[a] at armature 459 of relay 457 during restoration. When the B line connector reaches normal, the opening of contact ON[20] de-energizes relays 457 and 469, and the opening of contact ON[14] de-energizes the relay 480, at which time the B line connector will be at normal.

As soon as relay 469 operated, its armature 470[a] closed circuit over conductors 385[a] and 385 and through relay 364 at the B trunk controller Fig. 8, which relay causes the said B trunk controller to commence its travel, said controller stopping as soon as it reaches contacts of an idle switch pair in the customary way. As soon as wipers 376, 378 disengage conductors 387, 388, relays PR[5] and SR[5] of the B third selector are de-energized and consequently the relay RR[5]. The opening of contact 382—383, Fig. 8, opens the locking circuit of relay 405, while the opening of conductor 431 at contact 470 in Fig. 10 has de-energized the relay 402 of Fig. 9, so that when the B line connector reaches normal, the switch pair will be capable of selection by a B trunk controller when one engages the said switch pair.

As soon as relay 364 of Fig. 8 is operated, the direction of current flow through relay 330 in Fig. 8[a] is reversed and the relay throws the armature down to close circuit to light the answering supervisory lamp 339; and when the B trunk controller reaches an idle switch pair, the circuit through relay 330 is opened and the lamp 339 will remain lit until the operator plugs out.

When the called subscriber replaces his receiver, the generator switch and the A line connector P are restored to normal, and, on restoration of the latter, relay LR[4] is de-energized so that the circuit is opened through the polarized reversing relay RV of Fig. 4, whose retracted armatures reverse current through the calling supervisory relay 331 whose armature is then thrown downward to close circuit through the called supervisory lamp 340. The two lamps being displayed, the operator withdraws the plug of the B cord trunk, thus de-energizing relays 320 and 341, the de-energization of the former removing the busy ground from multiple contacts 302 of the B link trunk, Fig. 8. The de-energization of relay 341 closes circuit from contact 88′, through contact 342, contact 360 and the relay 110[a] to battery, whereon the relay 110[a] energizes and, by armature 111[a], operates magnet 94′ and causes restoration to normal of the button *b*. Armature 112[a] of relay 110[a] opens the circuit extending from ground through relay 100[a], alternate contact 103[a], and over contact 104[a]—154, attracted armature 173 and relay 171 to battery. The relay 110[a] is preferably made slow-acting in releasing its armature, as for instance by a copper shell, to insure a sufficient duration of opening for this circuit. Relay 171 being de-energized, circuit is closed as before from ground through normal contact 172, alternate contacts 168, 158, relay 161 to battery; and on the energization of this relay, the A link connector and the A first selector and second selector are restored to normal. The restoration of button *b* having restored the mechanism of the B cord trunk to its original position, all apparatus is now at normal.

It will now be assumed that a B exchange subscriber desires a connection with a subscriber in another B exchange. In such case, the circuit will be completed through the diagram as indicated in Fig. 17, the calling of the A cord trunk operator occurring as described in connection with Fig. 16, while the connection to the called-for B exchange subscriber's line will be performed in the manner similar to that in which connection was extended from an A link trunk to the called B exchange subscriber's line in connection with circuit No. 2, Fig. 15. From what has gone before, the control of supervisory signaling in the case of this connection, and the manner of release at the end of the connection, will be obvious and a detailed description is therefore superfluous.

When, however, a B exchange subscriber desires his line to be connected with the line of a subscriber terminating in the same B exchange as his own line, the method of oper-

ation in extending the call from the B cord trunk position to the called subscriber's line is quite different. This is illustrated by the diagrams of Figs. 18 and 20.

The operator in this case will be signalled in the manner before described and on receiving the called-for subscriber's number will, from the position of the lamp by which the call was manifested, know that the line of the called subscriber terminates in the same B exchange as that of the calling subscriber. In this case, the operator will actuate buttons of her calling device to transmit the three last digits of the called subscriber's number only and will thereupon actuate the special starting button 361, depressing and releasing it. On the depression of the said button, the relay 334 is actuated and locks itself on to sleeve contact 325 of the plug then engaging the sleeve 313 of the spring-jack. Armatures 336 and 337 of this relay open the circuits of the supervisory lamps 339 and 340, armature 336 also connecting in the automatic release signal lamp 338, which will remain lighted by current through attracted armature 336 until the two subscribers have been connected and the trunk has been released, as hereafter more fully explained. On the actuation of key 361, circuit was also closed over conductor 97 and relay 139 of the operator's impulse transmitter so that the said transmitter began its operation at once. As soon as wiper 140 reaches the group of contacts 143, the first set of impulses will be transmitted. There will, however, not be the extra impulse sent in the present case because of the attraction of armature 143^c of relay, 334 which has removed ground from the contact 143^a. Thus where an operator's impulse transmitter is used for a B cord trunk, the conductor 143^b is led through a relay switch, whereas when the transmitter is used as an A link trunk, the said conductor 143^b may be permanently grounded.

It will be assumed in this connection that the called subscriber's number was 12—233^a. The first set of impulses transmitted by the calling device will therefore be two in number and will pass over wire 98 through normal contact 353 and relay 108^b, producing two openings of the tip strand of the cord, while maintaining the sleeve strand grounded through the relay 330. Relay PR^5 at Fig. 9 will therefore be twice de-energized, relay SR^5 remaining energized. Each retraction of armature 412 produces an actuation of magnet PM^5 to cause a long step of the B third selector so that it will come to rest with wiper 430 engaging the contact piece of ring 430^a between groups 1 and 2. On the first step, contact ON^{13} is shifted to its alternate contact so that the relay 392 is de-energized, whereby the calling subscriber has his line temporarily disconnected from the talking strand of the B third selector and does not hear the succeeding impulses.

Following the two de-energizations of relay 108^b, the operators impulse transmitter energizes relay 109^b a single time to open the sleeve conductor of the cord, first grounding the tip conductor. Thereby relay SR^5 is de-energized while relay PR^5 is maintained energized. The de-energization of relay SR^5 results in the operation of relay BR^5, and the B third selector, Fig. 9, now proceeds to pick out multiple contacts 436^a, 437, 438, 429^a, of an idle B line connector of the second group, it being remembered that the called subscriber's number is assumed to be in a different hundred from that of the calling subscriber.

The next set of three impulses will adjust the selected idle B line connector to a position adjacent to the group of contacts including those of lines 231 to 239, followed by those of line 230, and the secondary impulse will shift the connection of the upper talking strand from the primary magnet PM^6 to the secondary magnet SM^6.

The next set of three impulses transmitted by the operator's calling device will result in three de-energizations of relay PR^5 and three short steps of the B line connector to select the contacts 4, 5, 6, individual to the called-for line. The ensuing secondary impulse de-energizes relay SR^5 and its de-energization now causes the transmission of an impulse of current from ground through alternate contact 420, contact 425, contact 428 of the B third selector paired with the B line connector in connection with the calling subscriber's line, through contact 438 of the B line connector which has been selected by said B third selector, (which B line connector is now engaging the contacts of the called-for subscriber's line), through normal contact 488, through segment 3 of ring 456^a, wiper 456 and relay LR^6 to battery, actuating said relay which energizes and, by armature 450, locks itself to ground at off-normal contact ON^{14}. Armature 448 of relay LR^6 now closes circuit through contact 429^a—429, attracted armature 404, relay 398 to battery, whereby the energized relay 398 connects conductors 433 and 434 to the upper and lower talking conductors of the B third selector, respectively, by armatures 399, 401.

As soon as the relay 398 operates, its armature 400 places ground over conductors 385^b and 385 and wiper 374 to one terminal of the relay 364, and the B trunk controller, Fig. 8, has its wipers automatically moved off the switch pair whose B line connector is in connection with the calling subscriber's line and proceeds in search of an idle

switch pair. On the attraction of the armatures of relay 364, the polarized supervisory relay 330 at Fig. 8ª has current closed through it to shift its armature down, whereon the automatic release lamp 338 is displayed to advise the operator that the call has been completed, whereupon she will withdraw the plug terminal of her cord and the apparatus will be at normal.

It being assumed first that the called-for line is idle, the line will be tested and the bell of the called-for substation rung in the usual manner; and when the called-for subscriber answers, the relays 473 and 477 of the B line connector which has been placed in connection with the called-for subscriber's line will be energized. The relay 480 of this B line connector will be operated by the attraction of armature 478 and the conversation may then proceed, the talking circuit being traced from the calling subscriber's line V, through the mechanism of the B line connector which selected his line, over its attracted armatures 481 and 488, etc., conductors 433, 434, to the B third selector mated with the B line connector which selected the calling subscriber's line, through attracted armatures 399 and 401 thereat, to the right through the condensers in the talking strands thereof, through wipers 427, 428, engaging another B line connector which said wipers selected as before described, through attracted armatures 481, 488 at said B line connector, through its talking wipers 454, 455, and to the contacts of the called subscriber's line and over the said line. During conversation, the relay PR^5 is held energized by current passing from battery B^{21}, through the armature 399, conductors 433 and over the calling line, to ground through the lower winding of impedance 476 while relay SR^5 is energized by current over conductor 434 to ground through 476. The current supplying battery to the calling substation is mainly supplied by proper proportioning of resistances from battery B^{22} through the windings of the impedance coil 476 at the B line connector which selected the calling line.

When at the conclusion of conversation the called-for subscriber replaces his receiver, the relays 473 and 477 of the B line connector connected to his line are de-energized, de-energization of relay 477, by armature 478, opening the locking circuit for the release relay RR^5 of the B line connector in connection with his line, whereafter a circuit may be traced from ground through relay 469, normal contact 475, normal contact 444, off-normal contact ON^{20} and through the relay 457 to battery, the release of the B line connector then proceeding in the same manner as described in connecting with the second circuit diagram.

When the calling subscriber replaces his receiver, the resulting de-energization of relay 473 completes a release circuit including the relays 469 and 457 of the B line connector which selected the calling line and that switch is restored to normal, at which time the armatures of the relay 480 will be released on account of the opening of off-normal contact ON^{14}. As soon as armatures 481 and 488 disengage their alternate contacts, the relays PR^5 and SR^5 will be both de-energized at one time, it being noted that relay SR^5 may be held operated, while the B line connector is being restored, by current through the lower winding of impedance 476; and on the de-energization of these relays, PR^5 and SR^5, release relay RR^5 releases its armatures, closing the before described release circuit of the B third selector through the relay BR^5 and normal contact 411 and the shifted contact ON^{13}, whereupon the B third selector is restored to normal. The locking relay LR^6 is of course de-energized as soon as the contact ON^{14} of the B line connector in connection with the calling subscriber's line was opened.

As has before been indicated, the B third selector, which was paired with the B line connector which was placed in connection with the called-for subscriber's line, took no part in the connection and its apparatus remained at normal.

Let it now be assumed that the called-for line was busy. In such case, test relay TR^6 will of course remain operated and the busy signal from interrupter I^6 will be transmitted through alternate contact 451, attracted armature 466, normal contact 481, contact 437—427 to the B third selector used in the connection, through its contact 421, alternate contact 417, attracted armature 412, the condenser, thence through attracted armature 399, over conductor 433 to the B line connector in connection with the calling subscriber's line, through its attracted armature 481 and over the upper talking strand to the calling subscriber's line, giving in the receiver the customary busy signal, whereon the calling subscriber replaces his receiver and the B line connector in connection with the calling line is restored, as previously described. When this reaches normal, the B third selector will start its restoration as before described; and as soon as relay BR^5 is energized, the locking circuit for the relay RR^5 of the B line connector in connection with the called-for subscriber's line will be de-energized, since this relay will be depending upon normal contact 483, conductor 384, a multiple contact 436^a engaged by wiper 426 of the B third selector, and the ground upon said wiper. The retracted armature 444 of relay RR^5 will close the release circuit as usual, and the B

line connector in connection with the called-for subscriber's line will be restored after the usual manner.

It may be here pointed out that the operation just described, and indicated by the diagram of Fig. 20, is the same, even though the called line be in the same sub-group as the calling line.

In Figs. 7 and 8 is shown a feature which, as far as I am aware, is entirely novel in a selective switch system. The contact 302^a is provided having a manual switch for the purpose of connecting it to ground, if desired. Contact 302^a is located between two groups of contacts 302, in a manner similar to the inter-group grounded contacts co-operating with wiper 605 in Fig. 11. It is apparent that should contact 302 be connected to ground, the wiper 297, assuming that it found all ten contacts of a previously selected group busy, would pass on to engage contact 302^a and finding this contact grounded, would continue on to select idle contacts out of what would ordinarily be the next group. By means of the contact 302^a and its associated switch, it is thus apparent that in the employment of switches such as I have illustrated, the number of groups of contacts may be varied with practically no change in the apparatus. For instance, if multiples of twenty trunk lines 362, 363 were desired at the banks of a B second selector R, such trunk lines could be connected to the successive contacts in two groups and the switch of contact 302^a thrown to connecting position. It is, of course, obvious that when this is done, directory numbers must be omitted at the R switches which would otherwise be represented by the second group of contacts. It is evident that the use of a contact between two groups employed for the purpose of throwing two groups into one, may be employed at any desired part of the system according as practical conditions require and the system is, consequently in this respect, more flexible than a system not affording facilities of this character.

In Fig. 11, I have shown a modified A first selector which may, if desired, be substituted for that shown in Fig. 4. When the circuit arrangement of Fig. 11 is used, there are ten groups of multiple contacts forming terminals of B second selectors before the wipers 605, 606, 607, and upon the same shaft carrying the said wipers is an auxiliary wiper 608 having before it eleven contact segments, only four of which are shown so as to bring the drawing within reasonable bounds. Between the tenth and first contact groups, a space, which may be equal to the space occupied by one contact group, is left, the dead contacts 611, 612, 614 being provided to guide the talking and private wipers, while before the auxiliary wiper 608 a permanently grounded segment 616 is provided.

For the circuit of Fig. 11, a switch similar to that shown in Fig. 12 may be employed, except that the long step magnet is not used, it being understood that all travel of the switch used in connection with Fig. 11 is short step travel. The switch of Fig. 12 will, of course, be provided with the contact arrangement indicated diagrammatically in Fig. 11. The mechanism associated with the auxiliary wiper 608, in addition to the contact segment 616, includes contact segments 619, 619^a, 619^b, etc., one being provided for each contact group and insulated from the contact ring 617. A common conductor 618 is provided with which the segments 619, 619^a, etc., are connected, and this common conductor is connected by a wire 639 with the contact 624 of relay 622 to the end hereafter referred to. When the auxiliary wiper 608 is at normal, it engages the contact ring 617, and in each between-group position it engages the said ring and is disconnected from the contact segments. A first step from normal will cause it to engage the segment 616, and a first step from any between-group position will cause it to engage the contact segment for the next group of contacts 610, 613, 615, forming terminals of second selectors.

The operation of the circuit of Fig. 11 is as follows; it being assumed that an operator's A link trunk has been connected by an A link connector with the circuit of Fig. 11 and that the relays PR^6 and SR^6 have consequently been energized in an obvious manner. It is assumed that some idle contact set 610, 613, 615, of the second group is to be selected. The operator's impulse transmitter will therefore cause relay PR^6 to be de-energized twice and thereafter relay SR^6 to be de-energized once. The relay RR^6 having become energized upon the energizations of relays PR^6 and SR^6, the first de-energization of relay PR^6 will transmit a current impulse from ground through the closed contact 629, normal contact 620, contact 623, relay 635 to battery B^{12}, whereon armature 637 energizes relay 638 which, by its armature, locks itself over a circuit extending through the ring contact 617, the wiper 608 in its normal position, and through the busy relay BR^6 to battery. The energization of the latter places the talking wipers 606, 607 on open circuit and, by armature 603, closes a break in the generator circuit of the short step motor magnet MM. Until, however, the relay PR^6 is again energized at the cessation of the break in its circuit, magnet MM does not begin its operation, since its circuit is open at contact 636. As soon, however, as relay 635 is de-energized upon the energization of relay PR^6, magnet MM will begin its actuations, its circuit including closed contacts 603 and 636, and it will continue its operations until the wiper 608

passes off the permanently grounded contact segment 616, the relay BR^6 being continued energized during the travel of the switch to select the first group of contacts by current through said wiper 608 to ground. As soon as the wiper 608 reaches a position adjacent to the segment 619 of the first group of contacts, said wiper 608 disengages segment 616 and engages ring 617, whereby relay BR^6 is de-energized since contact 637 is now open, and the actuations of magnet MM cease for the moment. The second de-energization of relay PR^6, which now occurs, again operates relay 635 which, by armature 637, operates again the relay 638 which latter was de-energized as soon as, on the first step of wiper 608, it disengaged ring 617. On this second energization of relay 638, current will flow therethrough from ground, through its closed armature contact, through ring 617, through wiper 608 and relay BR^6 to battery, the two relays 638 and BR^6 remaining energized until relay PR^6 is re-energized by the closure of its circuit; and the closing of contact 636, resulting therefrom, causes further short-step travel of the switch. On the first step, relay 638 will be de-energized by wiper 608 disengaging ring 617, and relay BR^6 will continue operated by current through said wiper 608 to the common conductor 618 over conductor 639 and to ground through normal contact 624. Relay BR^6 will thus continue energized and the generator circuit through magnet MM closed until the wipers have come to a position between the first and second groups of contacts when wiper 608 will leave the segment 619 and again engage ring 617. When now the relay SR^6 is de-energized, a current impulse flows from ground through attracted armature 629, normal contact 621, normal contact at 625 and the relay 622 to battery, which relay, by armature 625, immediately locks to ground at the shifted off-normal contact 627; said contact, along with contact 628, having been shifted on the first step of the switch. Current now finds its way from ground through contacts 628, 626, 617, 608, and through the busy relay BR^6 to battery, which relay energizes and, on the first step of the switch, is placed in a circuit extending through wiper 608, contact 619^a, common conductor 618, over conductor 639, through alternate contact 624, normal contact 633, and alternate contact 602 and to connection with the private wiper 605. Successive locking circuits will be established to ground via multiple contacts 610 of busy second selectors in the usual manner, and the relay BR^6 will continue energized, holding closed the circuit of magnet MM until the wipers 605, 606, 607 have reached contacts of a second selector whose private contact 610 is ungrounded and the second selector therefore idle. When this occurs, relay BR^6 de-energizes and the travel of the switch, Fig. 11, ceases, armatures 601 and 604 re-establishing the talking circuit, while armature 602, by engaging its normal contact, places ground upon the private contact 610 of the selected second selector to render it busy. It will be seen that the auxiliary wiper 608 does not control in any way the continued energization of relay BR^6 after the relay 622 has been operated by the secondary impulse as just described, since the common conductor 618 has had its ground removed by the attraction of armature 624.

When the switch of Fig. 11 is to be released, the relays PR^6 and SR^6 will be de-energized by the opening of their circuits, as were the relays PR and SR of the first selector in Fig. 4. When their armatures are retracted, release relay RR^6 de-energizes and the closing of its contact 630 energizes the relay 631 by current to ground at contact 627, said relay 631 then locking itself to ground at said contact. Armature 633 places ground upon the common conductor 618 via conductor 639 and alternate contact 624, and the relay BR^6 energizes, closing the generator circuit for magnet MM which will continue its actuations until the wipers of the switch reach normal, the said relay BR^6 being maintained energized when the wipers are in the between-group positions by the grounds at contacts 609, 609^a, etc. encountered by the private wiper 605. When the wipers reach normal, contacts 627 and 628 are opened and relays 622 and 631 are de-energized, as is also relay BR^6, and the switch rests at normal.

It is of course necessary in the operation of the first selector of Fig. 11 that the time elements between the operations of the impulse transmitter and the actuations required of magnet MM be properly gauged. It will be observed that the actuations of magnet MM only begin when the relay PR^6 has been de-energized and again energized, so that no interference with proper selection, because of a long de-energization of relay PR^6, can result.

While I have shown a plurality of batteries in the various figures, it will be understood that the battery symbols of the same polarity for one exchange are preferably a single source of current, and also that the various generator symbols shown for one exchange are preferably the same source of alternating current.

Obviously many modifications may be made in carrying out the principles of the invention and it is not to be limited to the structure more specifically shown but what I claim as my invention is:—

1. A telephone system comprising tele-

phone lines terminating in a plurality of exchanges, a switchboard having operators' positions, two-wire trunks, each having a maximum of two conductors at one point at least in its length, automatic means at said plurality of exchanges for extending calling lines over such two-wire trunks to said switchboard and displaying signals thereat, operators' impulse controlling means at said switchboard, and selective switches operable responsive to said means in completing connections from calling lines to called lines, said connections including two-wire trunks for interconnecting telephone lines of the different exchanges.

2. A telephone system comprising telephone lines extending to a plurality of exchanges, an operator's exchange, trunk lines for use in interconnecting lines terminating in the same and different exchanges, said trunk lines including two-wire trunk lines connecting with the operator's exchange, each of said two-wire trunk lines having a maximum of two conductors at one point at least in its length, means under a calling party's control for extending a call over a two-wire trunk line to the operator, and means under operator control for automatically linking together trunk lines to interconnect any line of any exchange with any line of any other exchange.

3. A telephone system comprising telephone lines extending to a plurality of exchanges, an operator's exchange, two-wire trunk lines extending from said operator's exchange to each of said plurality of exchanges, each of said two-wire trunk lines having a maximum of two conductors at one point at least in its length, means under subscriber control for extending a call over a two-wire trunk line to the operator, and means under the control of the operator for automatically connecting any line of any exchange with any line of the same or any other exchange.

4. A telephone system comprising telephone lines having their terminals divided among a plurality of exchanges, an operator's exchange, two-wire trunk lines extending from each of said plurality of exchanges to said operator's exchange, automatic means at each of said exchanges for extending calling lines of the respective exchanges over said trunk lines, means for displaying an operator's signal at said operator's exchange to indicate the extension of a calling line thereto, two-wire trunk lines for interconnecting lines of the various exchanges, and means under the control of the operator for automatically determining the connections of said trunk lines to connect any calling line of any exchange with any called line of the same or any other exchange.

5. In a telephone exchange system, a telephone line, multiple terminals therefor, a selective switch adapted to connect with said terminals, means for adjusting said switch directively to engage said terminals when said line is a called line, means for automatically adjusting said switch to engage said terminals when said line is a calling line, a test wiper for said switch, a pair of test relays for said switch, and means for connecting the one or the other of said relays to said test wiper according as the switch is employed in one capacity or the other.

6. In a telephone system, the combination with a selective switch of circuits adapted to be tested thereby, means for employing said switch in two capacities, a test conductor for said switch adapted to be placed in connection with a circuit to be tested, a pair of electrical test devices for said switch, and means for connecting the one or the other of said devices to said conductor according to the capacity in which said switch is employed.

7. In a telephone system, the combination with a telephone line of a test terminal therefor, a link-circuit provided with a test contact for testing said terminal, a pair of test responsive devices for said link-circuit, means for connecting the one or the other with said test contact according to the purpose of the test to be made, the means for connecting one of said devices being controlled over said telephone line.

8. A telephone system including telephone lines, a selective switch, terminals for said lines at said switch arranged in groups, means for directively adjusting said switch to select a group of terminals and then a particular terminal of the group, and means for employing said switch in an alternate capacity to automatically seek out the terminals of any line that may be calling and unselected.

9. A telephone system including telephone lines, terminals therefor at the exchange, a selective switch for selecting said terminals, means for adjusting said switch to connection with terminals of a line, a test responsive device energized while said adjustment is taking place, and means for operatively connecting said device, while energized, with a terminal of a connected line after adjustment is completed.

10. A telephone exchange system including a selective switch, multiple terminals therefor, a selector and means for controlling said selector to select said terminals, a release controlling electromagnet for said selective switch, means for holding said magnet energized while said switch is in use, means for de-energizing said magnet to effect release of said switch, and means con-

trolled by said de-energization to place a busy potential upon said terminals to render them guarded during restoration.

11. In a telephone system, the combination with a selective switch of a release controlling magnet therefor, a source of current, a private multiple contact for said switch, means for maintaining said magnet energized during conversation over a circuit extending to one terminal of said source, means for disconnecting said contact from said terminal to de-energize said magnet whereby said switch is caused to be restored, and means controlled by said magnet on its de-energization to re-connect said contact to said terminal.

12. In a telephone system, the combination with a selective switch, of a release relay therefor, a test contact for said switch, means effective on initial operation of said switch to energize and lock said relay over a circuit including said test contact, means for altering the electrical condition of said contact to de-energize said relay to restore said switch, and means effective on the de-energization of said relay to restore its prior electrical condition to said contact pending release.

13. The combination with a trunk line of a pair of selective switches connected in parallel thereto, contacts adapted to be connected with said trunk line and divided into two groups, one group being assigned to each switch, and means for operating the one or the other of said switches according as the contact to be selected is in one or the other group.

14. The combination with a trunk line of two selective switches individual thereto, means independent of the trunk-circuit and normally capable of actuation to cause travel of either of said switches, and means effective on initiation of travel of either switch to disable the means for initiating travel of the other.

15. The combination with a pair of selective switches of a separate starting wire for each switch, and means effective when one of said switches leaves normal to disable the starting wire of the other switch and maintain it disabled until the first switch reaches normal.

16. The combination with a pair of selective switches at a control station, of means for adjusting either switch from said station, and connections effective by the adjustment of one switch to render the other incapable of adjustment till the first reaches normal.

17. A telephone exchange system including telephone lines, selective switches for adjustment in completing connections to called ones of said lines, trunk lines adapted to be interchangeably connected with said switches, and means whereby each trunk line is normally connected to an idle switch.

18. A telephone system including telephone lines, selective switches operable responsive to directive currents for use in extending connections toward called lines, link-circuits adapted to be interchangeably connected with said switches, means whereby each link-circuit is normally connected to an idle switch, and mechanism for shifting a link-circuit from connection with one switch to connection with another.

19. In a telephone system, the combination with a selective switch, of contacts associated therewith arranged in groups, means for adjusting said switch to select a group, means for transmitting a current impulse to initiate travel of said switch to select contacts of a group, a control magnet having a winding traversed by said impulse, and a contact for locking said magnet on its energization, and holding it energized during conversation.

20. In a telephone system, the combination with a selective switch, of contacts associated therewith arranged in groups, means for adjusting said switch to select a group, means for transmitting a current impulse to initiate travel of said switch to select contacts of a group, a control magnet having a winding traversed by said impulse, and restoring means for said switch controlling the subsequent de-energization of said magnet.

21. In a telephone system, the combination with a selective switch, of contacts associated therewith arranged in groups, means for adjusting said switch to select a group, means for transmitting a current impulse to initiate travel of said switch to select contacts of a group, a control magnet having a winding traversed by said impulse, a contact for locking said magnet on its energization, and restoring means for said switch controlling the subsequent de-energization of said magnet.

22. In a telephone system, the combination with a selective switch of contacts associated therewith arranged in groups, means for transmitting currents to adjust said switch to select a group, a control magnet having a winding traversed by the first of said currents, means for locking said magnet during the further adjustment of said switch, and restoring means for said switch controlling the subsequent de-energization of said magnet.

23. In a telephone system, the combination with a selective switch of contacts associated therewith arranged in groups, means for transmitting currents to adjust said switch to select a group, a control magnet having a winding traversed by the first of

said currents, talking conductors having their continuity controlled by said magnet, and restoring means for said switch controlling the subsequent de-energization of said magnet.

24. In a telephone system, the combination with a selective switch of contacts associated therewith arranged in groups, means for transmitting currents to adjust said switch to select a group, a control magnet having a winding traversed by the first of said currents, means for locking said magnet during the further adjustment of said switch, means for transmitting current to render possible adjustment of said switch to select particular contacts of a group, an electromagnet having a winding traversed by said current, means for locking said magnet on its energization, and release circuit connections associated with said switch controlling the subsequent de-energization of said magnets after conversation is over.

25. A telephone system including telephone lines, an operator's position, trunk lines including two-wire trunk lines, each having a maximum of two conductors at one point at least in its length, automatic mechanism for connecting a line over an idle two-wire trunk line with, and signaling said operator's position, operators means for working back over said two-wire trunk line and selectively connecting said line with another wanted line, and means for freeing said trunk line for further use when the connection is established.

26. A telephone system including telephone lines, an operator's position, trunk lines including two-wire trunk lines, each having a maximum of two conductors at one point at least in its length, automatic mechanism for connecting a line over an idle two-wire trunk line with, and signaling said operator's position, operators' means for working back over said two-wire trunk line and selectively connecting said line with another wanted line, and an operator's signal displayed to indicate the establishment of the connection.

27. A telephone system including telephone lines, an operator's position, trunk lines including two-wire trunk lines, each having a maximum of two conductors at one point at least in its length, automatic mechanism for connecting a line over an idle two-wire trunk line with, and signaling said operator's position, operators' means for working back over said two-wire trunk line and selectively connecting said line with another wanted line, an operator's signal displayed to indicate the establishment of the connection, and means for freeing said trunk line for further use when the connection is established.

28. A telephone system including an operator's position, directively operable switches associated therewith, a link-circuit, operators' current controlling means including connections for transmitting impulses over said link-circuit, said means including mechanism whereby the operator may set up a desired number, mechanism associated with said means for causing one of said directively operable switches to be placed in operative connection with said link-circuit, and apparatus automatically effective by the establishment of said connection to initiate the transmission of impulses representing the number set up.

29. A telephone system including a trunk line, an operator's calling device, an automatic switch for connecting said trunk line operatively with said device, means whereby the operator may set up a number on said device, and apparatus automatically responsive to the connection of said trunk line with said device to render the latter active.

30. A telephone system including a trunk line, an operator's device, an automatic switch for connecting said trunk line operatively with said device, means whereby the operator may set up a number on said device, apparatus automatically responsive to the connection of said trunk line with said device to render the latter active, directively operable selective switches associated with said trunk line for operation in extending connections, and means effective on disconnection to automatically complete restoration of said device to normal.

31. A telephone system including telephone lines divided into groups, an operator's position including impulse controlling mechanism, a link-circuit having conductors whose electrical conditions are controllable by said mechanism, trunk lines, divided into a plurality of groups, the lines of each group being common for connections to a different group of telephone lines, an automatic switch at the answering end of each trunk line, multiple terminals of said link-circuit, a set being provided at each of said switches, operator's means for discriminatively rendering the terminals at the switches of a predetermined group of trunk lines selectable, while leaving the terminals at the switches of other groups unselectable whereby an automatic switch of a particular group connects its trunk line with said link-circuit, and directively operable switches associated with the calling ends of said trunk lines adapted to be connected with said link-circuit thereover.

32. A telephone system including telephone lines divided into groups, an operator's position including impulse controlling mechanism, a link-circuit having conductors

whose electrical conditions are controllable by said mechanism, trunk lines, divided into a plurality of groups, the lines of each group being common for connections to a different group of telephone lines, an automatic switch at the answering end of each trunk line, multiple terminals of said link-circuit, a set being provided at each of said switches, operator's means for discriminatively rendering the terminals at the switches of a predetermined group of trunk lines selectable, while leaving the terminals at the switches of other groups unselectable whereby an automatic switch of a particular group connects its trunk line with said link-circuit, directively operable switches associated with the calling ends of said trunk lines adapted to be connected with said link-circuit thereover, means whereby the operator may set up a desired number on said impulse controlling mechanism, and connections automatically effective on connection of a directively operable switch with said link-circuit to render said mechanism active.

33. A telephone system including telephone lines divided into groups, an operator's position including impulse controlling mechanism, a link-circuit having conductors whose electrical conditions are controllable by said mechanism, trunk lines, divided into a plurality of groups, the lines of each group being common for connections to a different group of telephone lines, an automatic switch at the answering end of each trunk line, multiple terminals of said link-circuit, a set being provided at each of said switches, operator's means for discriminatively rendering the terminals at the switches of a predetermined group of trunk lines selectable, while leaving the terminals at the switches of other groups unselectable whereby an automatic switch of a particular group connects its trunk line with said link-circuit, directively operable switches associated with the calling ends of said trunk lines adapted to be connected with said link-circuit thereover, means whereby the operator may set up a desired number on said impulse controlling mechanism, connections automatically effective on connection of a directively operable switch with said link-circuit to render said mechanism active, and means for restoring said link-circuit to normal.

34. A telephone system including telephone lines divided into groups, an operator's position including impulse controlling mechanism, a link-circuit having conductors whose electrical conditions are controllable by said mechanism, trunk lines, divided into a plurality of groups, the lines of each group being common for connections to a different group of telephone lines, an automatic switch at the answering end of each trunk line, multiple terminals of said link-circuit, a set being provided at each of said switches, operator's means for discriminatively rendering the terminals at the switches of a predetermined group of trunk lines selectable, while leaving the terminals at the switches of other groups unselectable whereby an automatic switch of a particular group connects its trunk line with said link-circuit, directively operable switches associated with the calling ends of said trunk lines adapted to be connected with said link-circuit thereover, means whereby the operator may set up a desired number on said impulse controlling mechanism, connections automatically effective on connection of a directively operable switch with said link-circuit to render said mechanism active, an operator's signal controlled thereby to indicate said condition, and means for restoring said link-circuit to normal.

35. A telephone system including telephone lines, a link-circuit, automatic mechanism operable responsive to initiated calls to interchangeably connect calling lines with said link-circuit, an operator's calling device and means whereby the operator may set up a called number thereon, a trunk line having automatic mechanism at the answering end thereof and directively operable switches associated with the calling end thereof, operator's means for causing said automatic mechanism to connect with said link-circuit, whereby one of said switches may be operatively connected with said circuit, and means effective on the connection of a switch to render said calling device active.

36. A telephone system including telephone lines provided with contacts at the exchange, connector switches for connecting directly with the contacts of said lines, selector switches associated with said connector switches each said selector switch having a connector permanently paired with it, movable contacts for said selector capable of adjustment to select the connector paired with it or another connector in completing connection to said lines as called lines, connections rendering said connectors available for extending said lines as either calling or called lines, and means effective when a connector is employed to extend a calling line to extend a talking circuit from said calling line through the mechanism of the selector paired with such connector.

37. A telephone system including telephone lines, selective switches for selecting said lines as calling lines, trunk lines adapted to be interchangeably connected with said selective switches, and means rendering a switch disconnected from a trunk line incapable of operation to select a calling line.

38. A telephone system including telephone lines, selective switches for selecting

said lines as calling lines, link-circuits, selective means for interchangeably connecting said link-circuits with said switches, starting circuits for initiating travel of said switches responsive to calls initiated over said lines, and means for rendering the starting circuit of any switch disconnected from a link-circuit inoperable.

39. A telephone system including a plurality of selective devices, a controller switch therefor and a link-circuit connected thereto, multiple contacts of said devices at said switch, the contacts of each device occupying a two step space thereat, means for arresting travel of said switch at a preliminary position when it engages a contact of an idle device, and apparatus effective when a device is to be placed in use to cause said switch to assume its final or connecting position.

40. A telephone system comprising subscribers' lines arranged in groups, directively operable selective switches for connecting with desired called lines, auxiliary party line switches for part of said selective switches adapted to be used for selecting a particular character of ringing current, apparatus for transmitting several sets of current impulses in completing desired connections, and means whereby the last set will effect the adjustment of a party line switch in one case and the final adjustment of a selective switch in the other case, according to the group in which the called line is included.

41. A telephone system comprising circuits having their terminals arranged in groups, a selective switch, means for causing long steps of said switch to select a group, means for causing short steps of said switch to select contacts of a group, said short step travel being in the same direction as the long step travel, and means for continuing said short step travel to a normal point to restore said switch.

42. A telephone system including telephone lines, selectors of plurality of classes for use in extending connections, a conductor at the exchange adapted to serve as the medium of transmission of currents to adjust a plurality of selectors in succession, a relay controlling the operative electrical connections of said conductor, means for employing said relay to intermittently ground said conductor in adjusting a selector of one class, and means for causing said relay to intermittently open the circuit of said conductor in adjusting a selector of another class.

43. In a telephone system, the combination with a plurality of selectors, of a single conductor adapted to be successively operatively connected with a plurality of selectors to control their adjustments, a relay for said conductor, armature means controlled thereby to adjust one selector by causing said conductor to be grounded, and means effective when another selector is to be adjusted to alter said means of said relay to render it effective to adjust said other selector by opening the circuit of said conductor.

44. A telephone system including a telephone line, a varying source of current at the exchange for charging and discharging said line, means for disconnecting said source from said line, and mechanism for preventing the disconnection thereof except when said line is substantially discharged.

45. A telephone system including a telephone line, apparatus for charging and discharging said line to signal thereover, a switch for disconnecting said apparatus from said line, and means co-ordinating the operation of said apparatus and said switch, whereby said disconnection occurs at a time when said line is discharged.

46. A telephone system including a telephone line extending from a substation to the exchange, a condenser at said substation, a source of alternating current at the exchange adapted to be connected with said line to charge and discharge said condenser to signal said substation, and a switch co-ordinated temporally with the alternations of said source to periodically disconnect said source from said line at times when an alternation has discharged said condenser.

47. A telephone system including a telephone line extending from a substation to the exchange, a condenser at said substation, a source of alternating current at the exchange adapted to be connected with said line to charge and discharge said condenser to signal said substation, a switch co-ordinated temporally with the alternations of said source to periodically disconnect said source from said line at times when an alternation has discharged said condenser, and an electromagnet at the exchange adapted to be connected with said line upon disconnection of said source therefrom.

48. A telephone system including a telephone line extending from a substation to the exchange, a condenser at said substation, a source of alternating current at the exchange adapted to be connected with said line to charge and discharge said condenser to signal said substation, a switch co-ordinated temporally with the alternations of said source to periodically disconnect said source from said line at times when an alternation has discharged said condenser, an electromagnet at the exchange adapted to be connected with said line upon disconnection of said source therefrom, and means responsive to currents over said line to control said magnet to maintain said source excluded.

49. A telephone system including a tele-

phone line, a current source connected with and alternately charging and discharging said line, a switch temporally co-ordinated with the variations of current in said line to disconnect said source from said line at a time when said line is discharged, and means for causing a flow of steady current over said line to maintain said source disconnected.

50. In a telephone system, the combination with a selective mechanism having groups of contacts, and an adjustable member adapted to select a group and then a contact of a group, of means for throwing two groups of contacts into one group, whereby the number of contacts in a group selectable by said member may be doubled.

51. In a telephone system, the combination with a selective switch, of circuits adapted to be tested thereby, a test conductor for said switch adapted to be associated with a circuit to be tested, means for employing said switch in two capacities, and test means associated with said conductor adapted to make tests of two characters, the character of the test being determined by the capacity in which said switch is employed.

52. A telephone system including multiple terminals, selective switches for selecting said terminals, a starting conductor and means controlled thereover for distributively starting said switches, a normally energized electromagnet associated with said conductor, and means for de-energizing said magnet to alter the connections of said conductor.

53. A telephone system including a plurality of selective switches for use in extending connections, a master-switch having a starting conductor for initiating travel of said switches, a normally energized electromagnet for said master-switch, and means for de-energizing said magnet to initiate travel of said switch to select an idle selective switch.

54. A telephone system comprising telephone lines, an operator's position, two two-wire trunk lines, each having a maximum of two conductors at one point at least in its length, selective switches associated therewith for extending calling lines to said position, operator's means for working back over the first of said two-wire trunk lines to selectively interconnect one of the calling lines with a called line and thereon free said trunk, other trunk lines and operator's means to connect the second of said two-wire trunk lines with one of said other trunk lines and complete the connection between the other calling line and a called line by working back over the connected other trunk line.

55. In a telephone system including telephone lines, the combination with a calling subscriber's station of a selective switch at the exchange, a talking circuit interconnecting said switch and said station, means for transmitting directive currents to said switch to adjust the same in connecting said line to a called line, circuit connections effective on transmission of the first impulse to alter the connections of said line to said switch whereby the succeeding impulses are not audible at the calling substation, and means automatically operated when connection is made to the called line to establish a conversational circuit from the calling line through said switch.

56. A telephone system including telephone lines, selective switches adapted to be used in interconnecting lines, trunk lines and automatic switches whereby said trunk lines are normally connected with idle selective switches, means for establishing conversational circuits including trunk lines and the respective automatic and selective switches connected with them, and means effective when a conversational circuit is destroyed to initiate travel of the automatic switch, associated with the trunk line used, to select an idle selective switch.

57. A telephone system including telephone lines, selective mechanism for use in interconnecting lines, a trunk line having an automatic switch normally engaging an idle selective mechanism, means for electrically adjusting said mechanism while said trunk line remains connected therewith and establishing a talking circuit including said trunk line and said switch, and means for shifting said trunk line to connection with a different mechanism at the conclusion of each conversation.

58. A telephone system including telephone lines, a trunk line for interconnecting different lines, selective switching mechanism at both ends of said trunk line whereby it may be selectively connected with a calling line at either end, a third terminal for said trunk line and a signal associated therewith, means for displaying said signal when said trunk line is connected with a calling line at one end, and means for preventing the display of said signal when said trunk line is connected with a calling line at the other end.

59. A telephone system including telephone lines, a trunk line for interconnecting different lines, selective switching mechanism at both ends of said trunk line whereby it may be selectively connected with a calling line at either end, an answering terminal connected intermediate of the ends of said trunk, and a call signal operated responsive to calls originating at one end of said trunk line only.

60. In a telephone system the combination with fixed contacts arranged in groups, of a set of adjustable contacts, means under operator control for advancing said adjust-

able contacts to select a group of fixed contacts and then a contact in said group, and means under subscriber control operating alternatively to said operator's means to cause said adjustable contacts to select a fixed contact independently of group selection.

61. A telephone system including impulse transmitting mechanism adapted to send a plurality of sets of directive impulses, trunk lines of a plurality of classes adapted to be connected with said mechanism, means for including an extra impulse in one of the sets transmitted, a directively operable switch, a trunk switch connected thereto, normally preventing the transmission of directive impulses to said first mentioned switch, a trunk line of one class connected to said trunk switch, said trunk switch being arranged to receive said extra impulse and be operated thereby to render said directively operable switch sensitive to the other impulses, and means for preventing wrong selection in consequence of said extra impulse when a trunk line of another class is employed.

62. A telephone system including a pair of connected telephone lines, a connector in connection with the called line, a plurality of selectors intermediate of said connector and the calling line through which the talking circuit extends, a release electromagnet for said connector held energized during conversation over a circuit extending to a selector adjacent thereto, a release electromagnet for the said selector held energized during conversation over a circuit extending to another selector adjacent to it, a contact at said other selector for opening the said circuit to de-energize the release electromagnet to restore said first-mentioned selector, and a contact at said first-mentioned selector for opening the circuit of the release electromagnet of said connector to restore the same.

63. A telephone system including a pair of connected telephone lines, a connector in connection with the called line, a plurality of selectors intermediate of said connector and the calling line through which the talking circuit extends, a release electromagnet for said connector held energized during conversation over a circuit extending to a selector adjacent thereto, a release electromagnet for the said selector held energized during conversation over a circuit extending to another selector adjacent to it, and means for successively de-energizing said electromagnets when restoration is desired.

64. A telephone system including a telephone line, a plurality of selective switches through which the conversational circuit extends, trunk release circuits extending from switch to switch, said release circuits being separate from the talking circuit, means for holding said circuits energized during conversation, and means for successively de-energizing said circuits when disconnection is desired.

65. A telephone system including a selective switch, contacts at said switch arranged in groups, a magnet for causing travel of said switch to select a group and to select contacts of a group, a relay controlling the actuations of said magnet, a directive impulse controlling relay for said switch, means controlled thereby for energizing said first-mentioned relay to initiate actuations of said magnet, circuit connections for maintaining said first-mentioned relay energized while said magnet adjusts said switch from one group to the next, and additional means for rendering said relay sensitive to the conditions of encountered contacts of a selected group.

66. A telephone system including a selective switch, contacts at said switch arranged in groups, a magnet for stepping said switch from contact to contact, a relay controlling the actuations of said magnet, group contacts for said groups, a directive impulse controlling electromagnets, switching apparatus controlled thereby for actuation to effect connection between said relay and a group contact, said group contact then holding said relay energized while said switch passes its group, and an auxiliary electromagnet controlling means for altering the electrical condition of the group contact of a selected group whereby said relay is operative to cause said switch to select idle contacts of a group.

67. In a selective switch, the combination with a magnet controlling the travel thereof, of a relay, switching means controlled by the de-energization of said relay to close a contact in the circuit of said magnet, and switching means controlled by the subsequent re-energization of said relay to close a second contact in the circuit of said magnet whereby said magnet becomes active.

68. A telephone system including telephone lines, an operator's position, trunk lines including two-wire trunk lines each having a maximum of two conductors at one point at least in its length, automatic mechanism for connecting a line over an idle two-wire trunk line with, and signaling said operator's position, and means whereby the operator may work back over said two-wire trunk line and selectively connect said line with another wanted line.

69. The combination with a trunk line, of two selective switches individual thereto, a control station, means controlled from said station to cause travel of either of said switches, and means effective on initiation of travel of either switch to disable the means for initiating travel of the other.

70. The combination with a trunk line, of two selective switches located at one end

of said trunk line and individual thereto, means normally capable of actuation to cause travel of either of said switches, means effective on initiation of travel of either switch to disable the means for initiating travel of the other, and switching means at the other end of said link-circuit.

71. A telephone exchange system comprising a plurality of groups of subscribers' lines, a group of automatic switches and associated talking trunks for each group of said lines operative to establish conversational circuits between calling and called ones of said lines in its group, an operator's position, two-wire talking trunks extending from said position to each group of switches and operative therewith to establish conversational circuits through said position between calling and called ones of said lines in different groups, each two-wire talking trunk having a maximum of two conductors at one point at least in its length, and means for controlling certain of the switches of each group over a two-wire talking trunk extending to that group.

72. A telephone exchange system comprising a plurality of subscribers' lines, automatic switches and associated trunks operative to establish conversational circuits between calling and called ones of said lines, a two-wire control trunk extending to an operator's position, said trunk having only two conductors at one point in its length, and an operator's equipment at said position comprising means for controlling certain of said switches over said control trunk in establishing each such conversational circuit.

73. A telephone exchange system comprising a plurality of subscribers' lines, automatic switches and associated trunks for interconnecting said lines, means for restoring said switches and trunks to normal, an operator's equipment comprising means for controlling certain of said switches, a two-wire control trunk extending from said equipment to said certain switches, said control trunk having only two conductors at one point in its length, and means for freeing said operator's trunk and equipment for further use before operating said restoring means.

74. A telephone exchange system comprising a plurality of subscribers' lines, automatic switches and associated trunks for interconnecting said lines, means for restoring said switches and trunks to normal, an operator's equipment comprising means for directively controlling the operation of certain of the said switches used in putting through each connection, a two-wire control trunk extending from said equipment to said certain switches, said control trunk having only two conductors at one point in its length, and means for freeing said operator's trunk and equipment for further use as soon as the operator in each instance has completed said directive control.

75. A telephone exchange system comprising a plurality of subscribers' lines, automatic switches and associated trunks for interconnecting said lines, means for restoring said switches and trunks to normal, an operator's equipment comprising means for directively controlling the operation of certain of said switches used in putting through each connection, a two-wire control trunk extending from said equipment to said certain switches, said control trunk having only two conductors at one point in its length, and means for freeing said operator's trunk for further use in each instance after the operator has completed said directive control and before operating said restoring means.

76. A telephone exchange system comprising subscribers' lines, talking trunks, automatic switches for uniting said lines and talking trunks into conversational circuits, a two-wire control trunk extending to an operator's position and having only two conductors at one point in its length, means whereby an operator at said position may directively control the operation of certain of said switches over said control trunk, and means for freeing said control trunk for further use as soon as said directive control has been exercised.

77. A telephone exchange system comprising subscribers' lines, talking trunks, automatic switches for uniting said lines and trunks into conversational circuits, means for restoring said switches and trunks to normal, a two-wire control trunk extending to an operator's position and having only two conductors at one point in its length, means whereby an operator at said position may directively control the operation of certain of said switches over said control trunk, and means for freeing said control trunk for further use prior to the operation of said restoring means.

78. A telephone exchange system comprising subscribers' lines, talking trunks, automatic switches for uniting said lines and talking trunks into conversational circuits, means for restoring said switches and trunks to normal, a two-wire control trunk extending to an operator's position and having a maximum of two conductors at one point in its length, means whereby an operator at said position may directively control the operation of certain of said switches over said control trunk, and means for freeing said control trunk for further use after the exercise of said directive control and before the operation of said restoring means.

79. A telephone exchange system comprising subscribers' lines, talking trunks, automatic switches for uniting said lines and

talking trunks into conversational circuits, a two-wire control trunk having a maximum of two conductors at one point in its length, means whereby a calling subscriber may communicate his order to an operator over said control trunk, and means whereby an operator may directively control the operation of certain of said switches over said control trunk.

80. A telephone exchange system comprising subscribers' lines, talking trunks, automatic switches for uniting said lines and talking trunks into conversational circuits, a two-wire control trunk having a maximum of two conductors at one point in its length, means whereby a calling subscriber may communicate his order to an operator over said control trunk, means whereby an operator may directively control the operation of certain of said switches over said control trunk, and means for freeing said control trunk for further use as soon as said directive control has been exercised.

81. A telephone exchange system comprising subscribers' lines, talking trunks, automatic switches for uniting said lines and talking trunks into conversational circuits, means for restoring said switches and trunks to normal, a two-wire control trunk having a maximum of two conductors at one point in its length, means whereby a calling subscriber may communicate his order to an operator over said control trunk, means whereby an operator may directively control the operation of certain of said switches over said control trunk, and means for freeing said trunk for further use prior to the operation of said restoring means.

82. A telephone exchange system comprising subscribers' lines, talking trunks, automatic switches for uniting said lines and talking trunks into conversational circuits, means for restoring said switches and trunks to normal, a two-wire control trunk having a maximum of two conductors at one point in its length, means whereby a calling subscriber may communicate his order to an operator over said control trunk, means whereby an operator may directively control the operation of certain of said switches over said control trunk, and means for freeing said control trunk for further use after the exercise of said directive control and before the operation of said restoring means.

83. A telephone exchange system comprising subscribers' lines, automatic switches and trunks for extending the circuits of said lines, an operator's equipment including an impulse sending device for controlling certain of said switches in extending such circuits, means including a two-wire trunk having a maximum of two conductors at one point in its length for automatically establishing connection between said equipment and any busy one of certain of said trunks, and means for automatically freeing said device for further use as soon as said control has been exercised.

84. A telephone exchange system comprising subscribers' lines, automatic switches and trunks for extending the circuits of said lines, an operator's equipment including an impulse sending device for controlling certain of said switches in extending such circuits, means for restoring said switches and trunks to normal, means including a two-wire trunk having a maximum of two conductors at one point in its length for automatically establishing connection between said equipment and any busy one of certain of said trunks, and means for automatically freeing said device for further use prior to the operation of said restoring means.

85. A telephone exchange system comprising subscribers' lines, automatic switches and trunks for extending the circuits of said lines, an operator's equipment including an impulse sending device for controlling certain of said switches in extending such circuits, means for restoring said switches and trunks to normal, means including a two-wire trunk having a maximum of two conductors at one point in its lengthfor automatically establishing connection between said equipment and any busy one of certain of said trunks, and means for automatically freeing said device for further use after the exercise of said control and before the operation of said restoring means.

86. A semi-automatic telephone system including telephone lines, an operator's two-wire trunk circuit having a maximum of two conductors at one point in its length, selective switching mechanism at the calling end of said circuit, operator's means for transmitting directive currents to said switching mechanism to extend the calling end of said circuit to desired lines, a calling telephone line, and a pair of electrically connected switches between said line and the answering end of said circuit, one of said switches serving on initiation of the call to connect with said calling line and the other to connect with said operator's trunk circuit, and means controlled by connected subscribers for restoring all exchange mechanisms used in a connection to normal.

87. A telephone system including telephone lines, trunk-circuits having selective switching mechanisms at the ends thereof, an operator's two-wire trunk circuit having a maximum of two conductors at one point at least in its length, operator's means for transmitting directive currents over said trunk circuits independently of the two conductors of said two-wire trunk circuit to said switching mechanisms to extend said

trunk circuits to desired lines, operator's signals, link-circuits having selective switches at both their ends intermediate of said signals and said lines, multiple terminals pertaining to said lines at the answering ends of said link-circuits, multiple terminals pertaining to said signals at the other ends of said link-circuits, means effective on initiation of a call to start travel of the switches of an idle link-circuit, means for stopping travel of one of said switches when engaging contacts of the calling line, and means for stopping travel of the other of said switches when engaging contacts of an idle signal.

88. A telephone system including telephone lines, trunk-circuits having selective switching mechanisms at the ends thereof, operators' signals, operators' two-wire trunks each having a maximum of two conductors at one point in its length, link-circuits having selective switches at both their ends intermediate of said two-wire trunks and said lines, multiple terminals pertaining to said lines at the answering ends of said link-circuits, multiple terminals pertaining to said two-wire trunks and signals at the other ends of said link-circuits, means effective on initiation of a call to start travel of the switches of an idle link-circuit, means for stopping travel of one of said switches when engaging contacts of the calling line, means for stopping travel of the other of said switches when engaging contacts of an idle two-wire trunk and associated signal, and apparatus for electrically adjusting selective switching mechanism associated with a trunk-circuit to connect said idle link-circuit with a called line through said two-wire trunk.

89. A telephone system including telephone lines, trunk-circuits having selective switching mechanisms at the ends thereof, operators' signals, operators' two-wire trunks each having a maximum of two conductors at one point in its length, link-circuits having selective switches at both their ends intermediate of said two-wire trunks and said lines, multiple terminals pertaining to said lines at the answering ends of said link-circuits, multiple terminals pertaining to said two-wire trunks and signals at the other ends of said link-circuits, means effective on initiation of a call to start travel of the switches of an idle link-circuit, means for stopping travel of one of said switches when engaging contacts of the calling line, means for stopping travel of the other of said switches when engaging contacts of an idle two-wire trunk and associated signal, apparatus for electrically adjusting selective switching mechanism associated with a trunk-circuit to connect said idle link-circuit with a called line through said two-wire trunk, and mechanism for automatically applying ringing current to the called line.

90. In a telephone exchange system, the combination with a plurality of exchanges, of a plurality of subscribers' lines connected with each of said exchanges, each of said exchanges comprising two-way automatic switches for effecting connections between subscribers' lines, talking trunks extending between said exchanges, and operators' equipments comprising means for controlling said automatic switches and grouped at an office separate from said exchanges.

91. In a telephone exchange system, the combination with subscribers' lines, and connecting trunks, of a plurality of two-way automatic switches, an operator's equipment comprising means for directively controlling said switches over said trunks to extend desired circuits, and means for operating said switches at other times to extend calls over said trunks to said operator's equipment.

92. In a telephone exchange system, the combination with a plurality of subscribers' lines and cooperating connecting trunks, of an operator's equipment circuit, antomatic mechanism for connecting a calling line to an idle equipment circuit, finder switches for extending the calling party's circuit, and means under operator control for starting an idle finder switch and causing it to stop in circuit with a busy equipment circuit.

93. In a telephone exchange system, the combination with a plurality of exchanges, of a plurality of subscribers' lines connected with each of said exchanges, automatic selector and connector switches and talking trunks at each of said exchanges, talking trunks extending between said exchanges, a plurality of operators' equipments, each comprising means for operating said selector and connector switches equipment, finder switches for connecting the operators' equipments to selectors in different exchanges, and means under operator control for at will starting a finder switch to connect with a desired exchange.

94. A semi-automatic telephone system including telephone lines, a main exchange in which a portion of said lines terminate, a branch exchange in which a portion of said lines terminate, two-wire trunk lines interconnecting said exchanges, each of said trunk lines having a maximum of two conductors at one point at least in its length, means for automatically connecting a calling line of said branch exchange over an idle one of said trunks with said main exchange, and impulse controlling mechanism at said main exchange for transmitting directive currents back over said same trunk to link the calling line to the called line.

95. A semi-automatic telephone system including telephone lines, a main exchange in which a portion of said lines terminate, a branch exchange in which a portion of said

lines terminate, two-wire trunk lines interconnecting said exchanges, each of said trunk lines having a maximum of two conductors at one point at least in its length, means for automatically connecting a calling line of said branch exchange over an idle one of said trunks with said main exchange, impulse controlling mechanism at said main exchange for transmitting directive currents back over said same trunk to link the calling line to the called line, and means for thereon freeing the trunk while leaving the connection of subscribers continuing.

96. A semi-automatic telephone system including telephone lines, a main exchange in which a portion of said lines terminate, a branch exchange in which a portion of said lines terminate, two-wire trunk lines interconnecting said exchanges, each of said trunk lines having a maximum of two conductors at one point at least in its length, means for automatically connecting a calling line of said branch exchange over an idle one of said trunks with said main exchange, impulse controlling mechanism at said main exchange for transmitting directive currents back over said same trunk to link the calling line to the called line, and switches at the substations of lines so connected for rendering them idle when disconnection is desired.

97. A semi-automatic telephone system including telephone lines, a main exchange in which a portion of said lines terminate, a branch exchange in which a portion of said lines terminate, two-wire trunk lines interconnecting said exchanges, each of said trunk lines having a maximum of two conductors at one point at least in its length, means for automatically connecting a calling line of said branch exchange over an idle one of said trunks with said main exchange, impulse controlling mechanism at said main exchange for transmitting directive currents back over said same trunk to link the calling line to the called line, means for thereon freeing the trunk while leaving the connection of subscribers continuing, and switches at the substations of lines so connected for rendering them idle when disconnection is desired.

98. A telephone system including telephone lines, two telephone exchanges, terminals of part of said lines at each exchange, two-wire trunk lines interconnecting said exchanges, each of said trunk lines having a maximum of two conductors at one point at least in its length, means for automatically extending a call initiated at one exchange to the other exchange over an idle trunk, and mechanism controlled by an operator at said other exchange for working back over the same trunk to complete the connection from terminals of the calling line to terminals of the called line.

99. A telephone system including telephone lines, two telephone exchanges, terminals of part of said lines at each exchange, two-wire trunk lines interconnecting said exchanges, each of said trunk lines having a maximum of two conductors at one point at least in its length, means for automatically extending a call initiated at one exchange to the other exchange over an idle trunk, and mechanism controlled by an operator at said other exchange for working back over the same trunk to complete the connection from terminals of the calling line to terminals of the called line with means for freeing the trunk.

100. A telephone system including a calling subscriber's line, terminals therefor at an exchange, a central office link-circuit, adapted to be automatically connected with said line on initiation of a call, an operator's position, a two-wire trunk line leading thereto, said trunk line having a maximum of two conductors at one point at least in its length, a signal for said trunk line, an electrically controlled selective switch at the exchange, means for initiating travel thereof to connect said link-circuit and trunk line in response to the operation of said selective switch, a called subscriber's line, terminals therefor at the exchange, operator's means for transmitting directive currents to establish a connection from the terminals of the calling line to terminals of the called line by way of said two-wire trunk, with means for thereon freeing said trunk line.

101. A telephone system including a calling subscriber's line, terminals therefor at an exchange, a central office link-circuit, an automatic switch at the exchange operable responsive to initiation of a call over said line to connect said link-circuit and line, an operator's position, a signal thereat, a two-wire trunk line leading thereto, said trunk line having a maximum of two conductors at one point at least in its length, automatic switching means for interconnecting said link-circuit and trunk line whereby said signal is displayed to indicate the call, a called subscriber's line, terminals therefor at the exchange, directively operable selective switches associated with said link-circuit, operator's means for electrically controlling adjustment of said selective switches to complete a connection from terminals of the calling line to terminals of the called line, the circuit by which said lines are connected including said trunk line and said link-circuit, and means for disconnecting said trunk line from said link-circuit when said telephone lines have been disconnected.

102. A telephone system including a call-

ing subscriber's line, terminals therefor at an exchange, a central office link-circuit, adapted to be automatically connected with said line on initiation of a call, an operator's position, a two-wire trunk line leading thereto, said trunk line having a maximum of two conductors at one point at least in its length, an electrically controlled selective switch at the exchange, means for initiating travel thereof to connect said link-circuit and trunk line in response to the operation of said selective switch, a called subscriber's line, terminals therefor at the exchange, operator's means for transmitting directive currents to establish a connection from the terminals of the calling line to terminals of the called line by way of said two-wire trunk, with means for thereon freeing part of said operator's means.

103. A telephone system including a calling subscriber's line, terminals therefor at an exchange, a central office link-circuit, adapted to be automatically connected with said line on initiation of a call, an operator's position, a two-wire trunk line leading thereto, said trunk line having a maximum of two conductors at one point at least in its length, an electrically controlled selective switch at the exchange, means for initiating travel thereof to connect said link-circuit and trunk line in response to the operation of said selective switch, a called subscriber's line, terminals therefor at the exchange, directively operable selective switches associated with said link-circuit, operator's means for electrically controlling adjustment of said selective switches to complete a connection from terminals of the calling line to terminals of the called line, the circuit by which said lines are connected including said trunk line and said link-circuit, and means for disconnecting said trunk line from said link-circuit when said telephone lines have been disconnected.

104. A telephone system including a main exchange and a sub-exchange, telephone lines terminating in said exchanges, two-wire trunk lines connecting said exchanges adapted to be employed for connecting together a telephone line terminating in the main exchange and one terminating in the sub-exchange, each of said trunk lines having a maximum of two conductors at one point at least in its length, means for using said trunk line as an impulse transmitting medium to cause automatic connection of two lines terminating in said sub-exchange, with means for freeing said trunk line for further use when employed as said medium as soon as connection is established.

105. A telephone system including telephone lines, identical automatic selecting mechanisms at outlying points capable of operating in different capacities for interconnecting said lines, a central station having operators' positions, means responsive to initiation of a call for operating one of said mechanisms to connect with the calling line, means for thereon displaying a signal at an operator's position, operators' apparatus for transmitting directive impulses to another of said mechanisms in connecting the calling line with a called line, and a switch for disconnecting said apparatus from said last-mentioned mechanism after its operation.

106. In a telephone exchange system, the combination with an exchange, of a plurality of subscribers' lines connected thereto, said exchange comprising a plurality of talking trunks, means for connecting a calling subscriber with an idle one of said talking trunks, and selector switches associated with said trunks, a master switch for controlling said selector switches, and operators' equipments comprising means for controlling said selector switches through said master switch.

107. In a telephone exchange system, the combination with an exchange, of a plurality of subscribers' lines connected thereto, said exchange comprising talking trunks for connecting subscribers' lines, automatic switches, and a master switch for controlling said automatic switches, operators' equipments comprising means for controlling said automatic switches through said master switch, and means located at said exchange for automatically selecting an idle operator's equipment.

108. In a telephone exchange system, the combination with a plurality of exchanges, of a plurality of subscribers' lines connected to each of said exchanges, each of said exchanges comprising a plurality of talking trunks, means for connecting a calling subscriber with an idle talking trunk and the bank contacts of selector switches, and operators' equipments comprising means for controlling said selector switches.

109. A semi-automatic telephone system including a plurality of exchanges, having telephone lines, trunk lines interconnecting said exchanges, operators' positions at one of said exchanges, impulse senders at said positions, special impulse trunks extending from each exchange to said operators' positions, impulse trunk finders and selective switches directively operable responsive to currents over said impulse trunks to extend calling circuits to called lines, automatic means for connecting calling lines with said impulse trunks, and automatic means for freeing an impulse sender as soon as a connection between a calling and a called line is established.

110. A semi-automatic telephone system including a plurality of exchanges, having telephone lines, trunk lines interconnecting said exchanges, operators' switchboards at some of said exchanges, impulse senders at said switchboards, special impulse trunks extending from each exchange to an oper-

ator's switchboard, impulse trunk finders and selective switches directively operable responsive to currents over said impulse trunks to extend calling circuits to called lines, automatic means for connecting calling lines with said impulse trunks, automatic means for freeing an impulse sender as soon as a connection between a calling and a called line is established, and signals at said switchboard operated by said connecting means.

111. In a telephone exchange system, a plurality of subscribers' lines, a number of two-wire trunks less in number than the number of lines, each of said trunks having a maximum of two conductors at one point at least in its length, an operator's circuit including a telephone set and an impulse sending device, means for automatically connecting a calling line with any one of said trunks, thereby rendering the said trunk busy, a trunk finder started by the operator and then operating to automatically connect with said busy trunk and means for automatically connecting said trunk finder with a wanted line.

112. In a telephone exchange system, a number of subscribers' lines, a number of trunks less than the number of lines for interconnecting said lines, an operator's impulse sending device associated with said trunks and means associated with said sending device and started by the operator for automatically connecting with any busy trunk, together with restoring means for said connecting means.

113. In a telephone exchange system, a number of subscribers' lines, a number of trunks less than the number of lines for interconnecting said lines, two-wire trunks for extending the circuits of said trunks, each of said two-wire trunks having a maximum of two conductors at one point at least in its length, an operator's impulse sending device associated with said two-wire trunks, means associated with said operator's sending device and becoming active when a trunk is connected to a calling line for automatically connecting the operator's sending device through a two-wire-trunk with said connected trunk, and means for restoring said connecting means.

114. In a telephone exchange system, subscribers' lines, a number of trunks less than the number of lines, an operator's impulse sending device, means for automatically connecting a calling line with a trunk, means thereupon becoming active for automatically connecting the operator's sending device with the busy trunk, and a trunk finder and other automatic switches for completing the connection to a wanted subscriber, said finder being started by the operator and said other switches being controlled by impulses from the operator's sending device.

115. In a telephone exchange system, subscribers' lines, trunk circuits for interconnecting said lines less in number than the number of lines, an operator's impulse sending device associated with said trunks, an automatic finder switch associated with said operator's sending device for connecting said sending device with any of said trunks, operator's means for starting said finder switch, automatic means for extending the circuit of connected trunks, and means for thereupon restoring said impulse sending device to render it available for extending circuits of other trunks of the group.

116. A telephone exchange system including a number of subscribers' lines, a number of trunks, each trunk terminating at its opposite end in selected switches, an operator's equipment, a two-wire trunk extending from said equipment to said trunks, said two-wire trunk having a maximum of two conductors at one point at least in its length, and automatic switch mechanism for connecting said two-wire trunk to said other trunks.

117. A telephone exchange system including a number of subscriber's lines, a number of trunks, each trunk terminating at one end in a line selector and at the other end in a trunk selector, an operator's equipment, two-wire trunks extending from said equipment to said trunks, each two-wire trunk having a maximum of two conductors at one point at least in its length, automatic switches associated with said two-wire trunks, driving means for the line selectors controlled by the calling subscribers, and driving means for said automatic switches controlled by the line selectors.

118. A telephone exchange system including a number of subscribers' lines, a number of trunks, each trunk terminating at one end in a line selector and at the other end in a trunk selector, an operator's equipment, two-wire trunks extending from said equipment to said trunks, each two-wire trunk having a maximum of two conductors at one point at least in its length, automatic switches associated with said two-wire trunks, driving means and release or restoring means for said line selectors controlled by the calling subscribers, and driving means for said automatic switches controlled in the use of the line selector trunks.

119. A telephone exchange system including a number of subscribers' lines, a number of trunks, each trunk terminating at one end in a line selector and at the other end in a trunk selector, an operator's equipment, two-wire trunks extending from said equipment to said trunks, each two-wire trunk having a maximum of two conductors at one point at least in its length, automatic switches associated with said two-wire trunks, driving means and release or restor-

ing means for the said line selectors controlled by the calling subscribers, and driving means and release or restoring means for said automatic switches controlled in the use of the line selector trunks.

120. A telephone exchange system including a number of subscribers' lines, a number of trunks, each trunk terminating at one end in a line selector and at the other end in a trunk selector, an operator's equipment, two-wire trunks extending from said equipment to said trunks, each two-wire trunk having a maximum of two conductors at one point at least in its length, automatic switches associated with said two-wire trunks, driving means and release or restoring means for said line selectors controlled by the calling subscribers, driving means and release or restoring means for said automatic switches controlled in the use of the line selector trunks, and driving means for the forward or calling trunk selectors controlled by the operator.

121. A telephone exchange system including a number of subscribers' lines, a number of trunks, each trunk terminating at one end in a line selector and at the other end in a trunk selector, an operator's equipment, two-wire trunks extending from said equipment to said trunks, each two-wire trunk having a maximum of two conductors at one point at least in its length, automatic switches associated with said two-wire trunks, driving means and release or restoring means for said line selectors controlled by the calling subscribers, driving means and release or restoring means for said automatic switches controlled in the use of the line selector trunks, driving means for the forward or calling trunk selectors controlled by the operator, and release or restoring means for the said forward or calling trunk selectors controlled over the lines connected.

122. In a telephone exchange system, subscribers' lines, trunk circuits for interconnecting said lines in number less than the number of lines, two-wire trunks associated with said trunk circuits, each two-wire trunk having a maximum of two conductors at one point at least in its length, an operator's impulse sending device associated with said two-wire trunks, automatic switching means associated with said two-wire trunks and operator's sending device for connecting said sending device by said two-wire trunks with any of said trunk circuits, automatic means for completing a talking connection, and means for thereupon restoring said automatic switching means and for rendering it available for effecting the connection of the operator's sending device with another trunk circuit of the group.

123. In a telephone system the combination with fixed contacts arranged in groups, of a set of cooperating adjustable contacts, means under a control exercised from one point to advance said adjustable contacts by group and individual selection to individual fixed contacts, and means under a control exercised from another point to advance said adjustable contacts by individual selection only to individual fixed contacts.

124. In a telephone system the combination with fixed contacts arranged in groups, of a set of cooperating adjustable contacts, means under a control exercised from one point to advance said adjustable contacts by group and individual selection to individual fixed contacts, means under a control exercised from another point to advance said adjustable contacts by individual selection only to individual fixed contacts, and means for advancing said adjustable contacts to a normal position.

125. In a telephone system, a switch adapted to serve in different capacities, said switch having grouped fixed contacts and a cooperating movable contact, means for causing said switch to advance its movable contact to a fixed contact by group and individual selection when serving in one capacity, and means for causing said switch to advance its movable contact to a fixed contact by individual selection only, when serving in another capacity.

126. A telephone system including telephone lines, a plurality of permanently mated switch pairs at the exchange, each pair including a line selector provided with active contacts to select the calling line, the other switch of each pair being a first selector, connectors for connecting directly with called lines, link-circuits operatively associating said connectors with switch pairs, multiple terminals for said switch pairs, two-wire trunk lines leading to an operator's position, each two-wire trunk line having a maximum of two conductors at one point at least in its length, trunk selectors therefor having contact wipers to select said multiple terminals, means responsive to initiation of a call at a station of said line serving to control operation of a line selector and a trunk selector to extend the call to and manifest it at said operator's position, operator's means for transmitting directive currents over a two-wire trunk line in connection with a switch pair to electrically adjust a first selector and a connector to effect a connection from the calling line to the called line, and means for freeing said trunk line while leaving the completed connection existing.

127. A telephone system including telephone lines, a plurality of permanently mated switch pairs at the exchange, each pair including a line selector provided with active contacts to select the calling line, the other switch of each pair being a first se-

lector, connectors for connecting directly with called lines, link-circuits operatively associating said connectors with switch pairs, multiple terminals for said switch pairs, two-wire trunk lines leading to an operator's position, each two-wire trunk line having a maximum of two conductors at one point at least in its length, trunk selectors therefor having contact wipers to select said multiple terminals, means responsive to initiation of a call at a station of said line serving to control operation of a line selector and a trunk selector to extend the call to and manifest it at said operator's position, operator's means for transmitting directive currents over a two-wire trunk line in connection with a switch pair to electrically adjust a first selector and a connector to effect a connection from the calling line to the called line, and release mechanism associated with said trunk selector operable to free said trunk line from terminals of a switch pair while leaving said pair in adjusted position.

128. A telephone system including telephone lines, a plurality of permanently mated switch pairs at the exchange, each pair including a line selector provided with active contacts to select the calling line, the other switch of each pair being a first selector, connectors for connecting directly with called lines, link circuits operatively associating said connectors with switch pairs, multiple terminals for said switch pairs, two-wire trunk lines leading to an operator's position, each two-wire trunk line having a maximum of two conductors at one point at least in its length, trunk selectors therefor having contact wipers to select said multiple terminals, means responsive to initiation of a call at a station of said line serving to control operation of a line selector and a trunk selector to extend the call to and manifest it at said operator's position, and operator's means for transmitting directive currents over a two-wire trunk line in connection with a switch pair to electrically adjust a first selector and a connector to effect a connection from the calling line to the called line.

129. A telephone system including selective switches, telephone lines adapted to be interconnected for conversations by said switches, operator's impulse transmitters for adjusting said switches, two-wire trunk lines extending between points adjacent to said switches and points adjacent to said transmitters, each said trunk line having a maximum of two conductors at one point at least in its length, and automatic means for interchangeably connecting said trunk lines and impulse transmitters over said two-wire trunk lines.

130. A telephone system including selective switches, telephone lines adapted to be interconnected for conversations by said switches, operators' impulse transmitters for adjusting said switches, two-wire trunk lines extending between points adjacent to said switches and points adjacent to said transmitters, each said trunk line having a maximum of two conductors at one point at least in its length, automatic means for interchangeably connecting said trunk lines and impulse transmitters over said two-wire trunk lines and means automatically controlled at said transmitters for disconnecting said two-wire trunk lines and switches.

131. A telephone system including a plurality of telephone lines, selective switches capable of uniting said line into a plurality of conversational circuits, operators' impulse transmitters less in number than said switches for directively adjusting the same, two-wire trunk lines for use in conveying the impulse from said transmitters to said switches, said trunk lines each having a maximum of two conductors at one point at least in its length, automatic means for interconnecting switches and said two-wire trunk lines, and circuit connections controlled at said switches for operating said means.

132. A telephone system including a plurality of selective switches, operators' impulse transmitters less in number than said switches for directively adjusting the same, two-wire trunk lines for use in conveying the impulse from said transmitters to said switches, said trunk lines each having a maximum of two conductors at one point at least in its length, automatic means for interconnecting switches and said two-wire trunk lines, circuit connections controlled at said switches for operating said means, and apparatus controlled at said transmitters for restoring said means to a normal condition.

133. A telephone system including a plurality of selective switches, operators' impulse transmitters less in number than said switches for directively adjusting the same, two-wire trunk lines for use in conveying the impulse from said transmitters to said switches, said trunk lines each having a maximum of two conductors at one point at least in its length, automatic means for interconnecting switches and said two-wire trunk lines, circuit connections controlled at said switches for operating said means, apparatus controlled at said transmitters for restoring said means, and signals one for each trunk line for display responsive to connection of a switch with the corresponding trunk line.

134. A telephone system including telephone lines, directively operable selective switches including first selectors for connecting said lines in pairs for conversation, operators' impulse transmitters for adjust-

ing said switches, two-wire trunk lines for individual use with said transmitters, each said line having a maximum of two conductors at one point at least in its length, extending to points adjacent to said selectors, a signal for each said trunk line, and automatic means intermediate of said trunk lines and selectors for interchangeably connecting the same.

135. A telephone system including telephone lines, directively operable selective switches including first selectors for connecting said lines in pairs for conversation, operators' impulse transmitters for adjusting said switches, two-wire trunk lines for individual use with said transmitters, each said line having a maximum of two conductors at one point at least in its length, extending to points adjacent to said selectors, a signal for each said trunk line, automatic means intermediate of said trunk lines and selectors for interchangeably connecting the same, and selective apparatus for connecting said selectors with calling lines, the connection of a selector with a calling line being effective to actuate said automatic means.

136. A telephone system including telephones lines, directively operable selective switches including first selectors for connecting said lines in pairs for conversation, operators' impulse transmitters for adjusting said switches, two-wire trunk lines for individual use with said transmitters, each said line having a maximum of two conductors at one point at least in its length, extending to points adjacent to said selectors, a signal for each said trunk line, automatic means intermediate of said trunk lines and selectors for interchangeably connecting the same, selective apparatus for connecting said selectors with calling lines, the connection of a selector with a calling line being effective to actuate said automatic means, and circuit changers at said transmitters.

137. In a telephone system, a switch adapted to serve in different capacities, said switch having grouped fixed contacts and a cooperating movable contact, means for causing said switch to advance its movable contact to a fixed contact by group and individual selection when serving in one capacity, means for causing said switch to advance its movable contact to a fixed contact by individual selection only when serving in another capacity, and means for advancing said movable contact to a normal position.

138. In a telephone system, an automatic switch serving as a line finder under certain conditions and as a connector under other conditions comprising fixed and movable contacts, and means for advancing the movable contact to a fixed contact by long and short steps when said switch is serving as a connector and by short steps only when said switch is serving as a line finder.

139. In a telephone system, an automatic switch serving as a line finder under certain conditions and as a connector under other conditions comprising fixed and movable contacts, means for advancing the movable contact to a fixed contact by long and short steps when said switch is serving as a connector and by short steps only when said switch is serving as a line finder, and means for restoring said switch to normal by short advance steps.

140. A telephone system including selective switches in different groups, telephone lines adapted to be interconnected for conversation by said switches, an operator's impulse transmitter for adjusting said switches, manual means for determining the group of switches in which said adjustment shall take place, and means for freeing said impulse transmitter for further use when the switches of a particular connection have been adjusted.

141. In a telephone system, the combination with a calling line, of a plurality of line selectors having access to said line, a master switch for controlling the starting of said line selectors, other switches connected to said line selectors and operative to extend calling line circuits therefrom, and means whereby said latter switches control said master switch in determining the next selector to be operated.

142. In a telephone system the combination with a calling line, of a plurality of line selectors having access to said line, selective starting circuits for said line selectors, other switches for extending calling line circuits beyond said selectors, and means whereby said other switches control said starting circuits to determine the next line selector to be operated.

In witness whereof, I hereunto subscribe my name this 4th day of March, 1908.

HARRY G. WEBSTER.

Witnesses:
G. E. MUELLER,
CAROLYN WEBER.