F. R. McBERTY.

SEMI-AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED SEPT. 13, 1912.

1,284,996.

Patented Nov. 19, 1918.

8 SHEETS—SHEET 1.

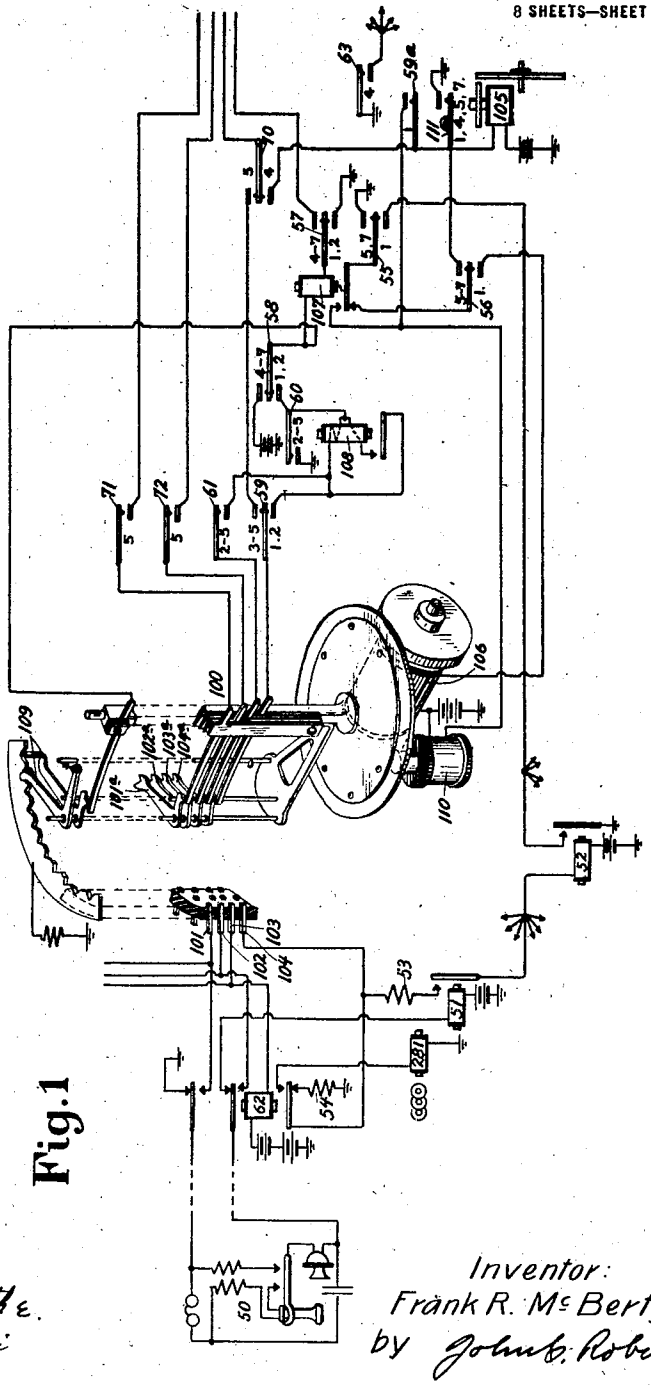

Fig. 1

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M. R. Rossi

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8 SHEETS—SHEET 2.

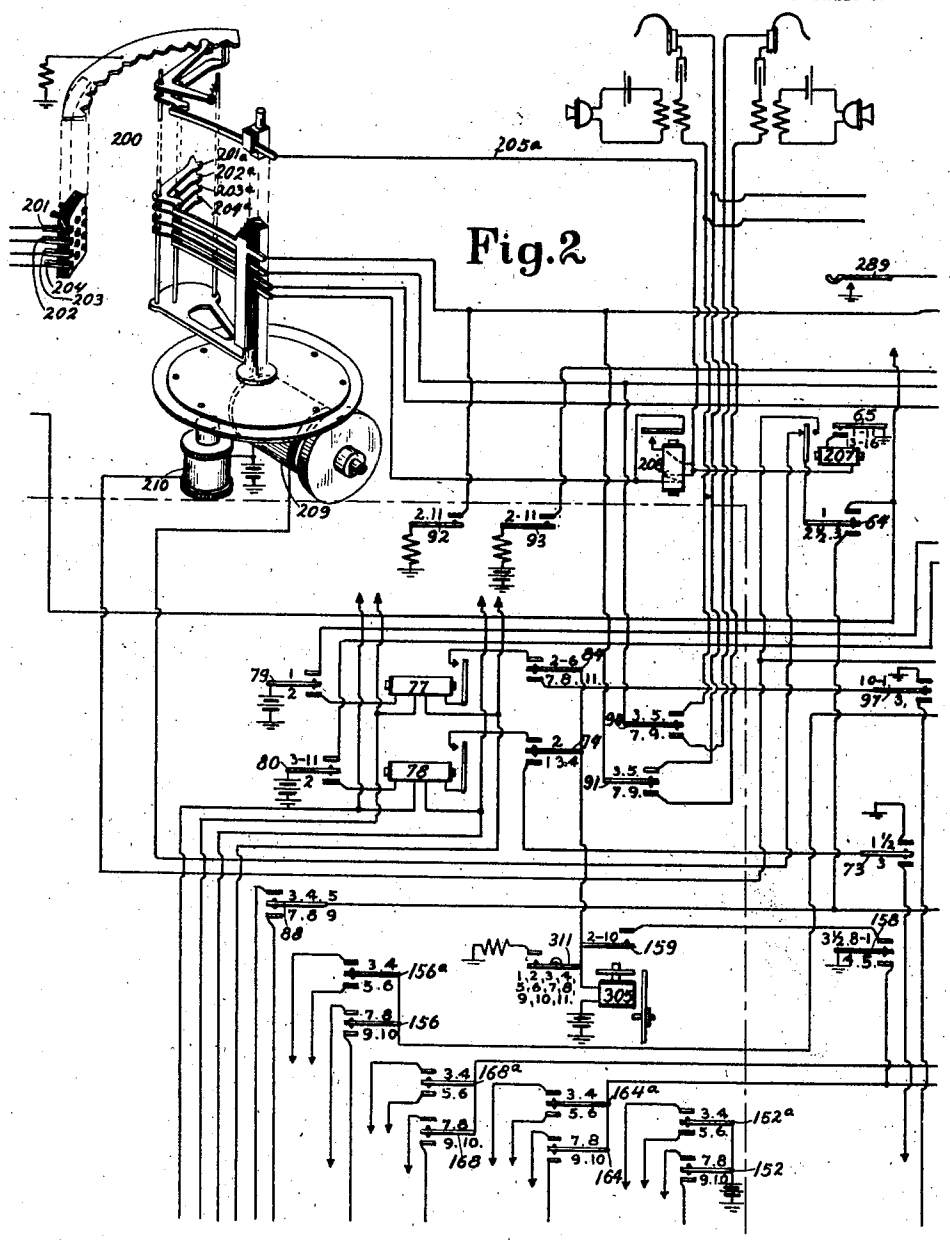

Fig.2

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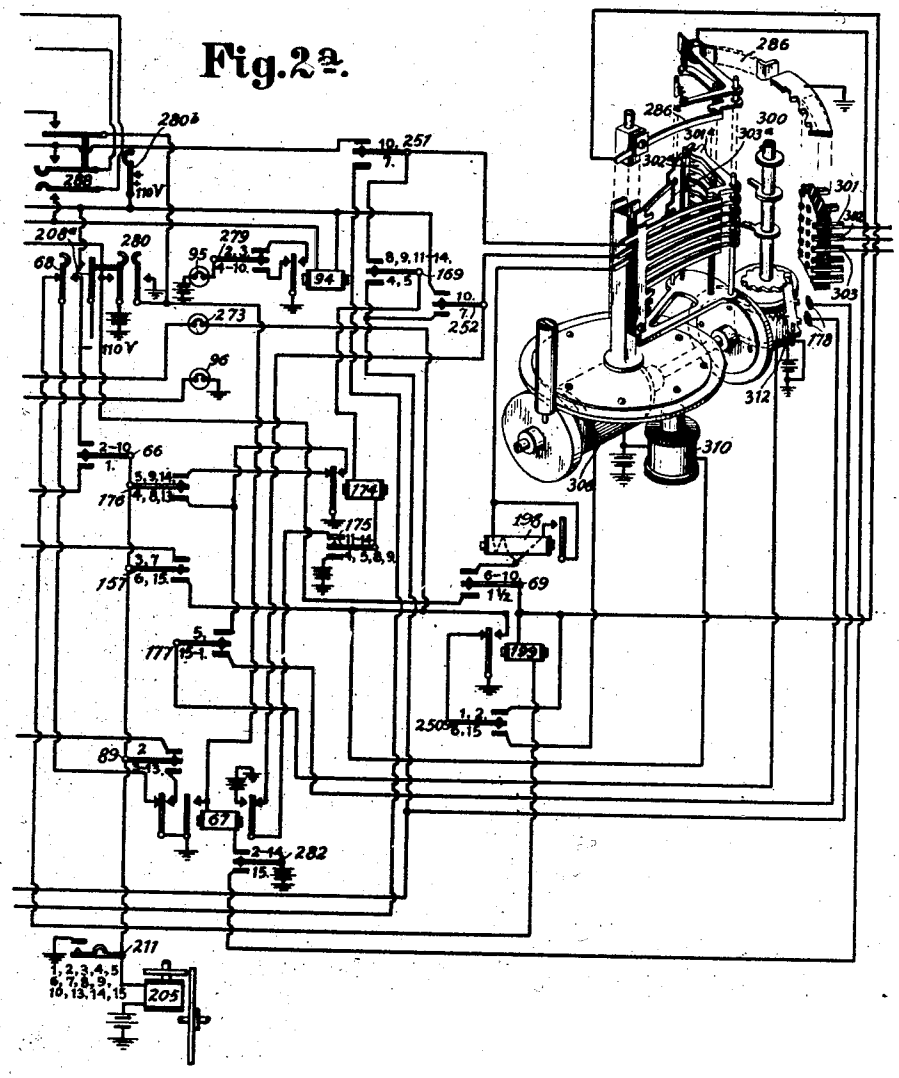
8 SHEETS—SHEET 3.

Fig. 2a.



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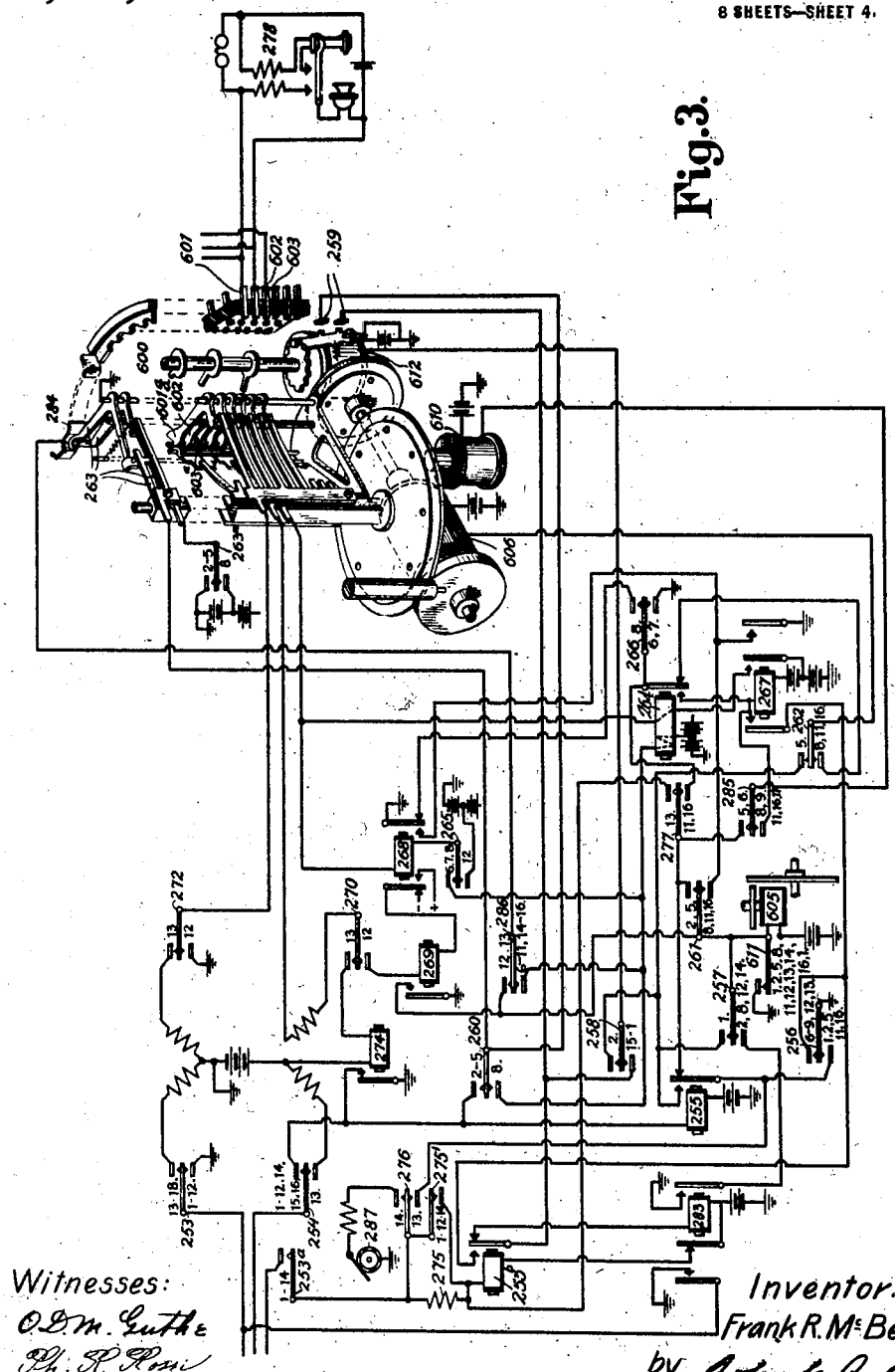
8 SHEETS—SHEET 4.

Fig. 3.



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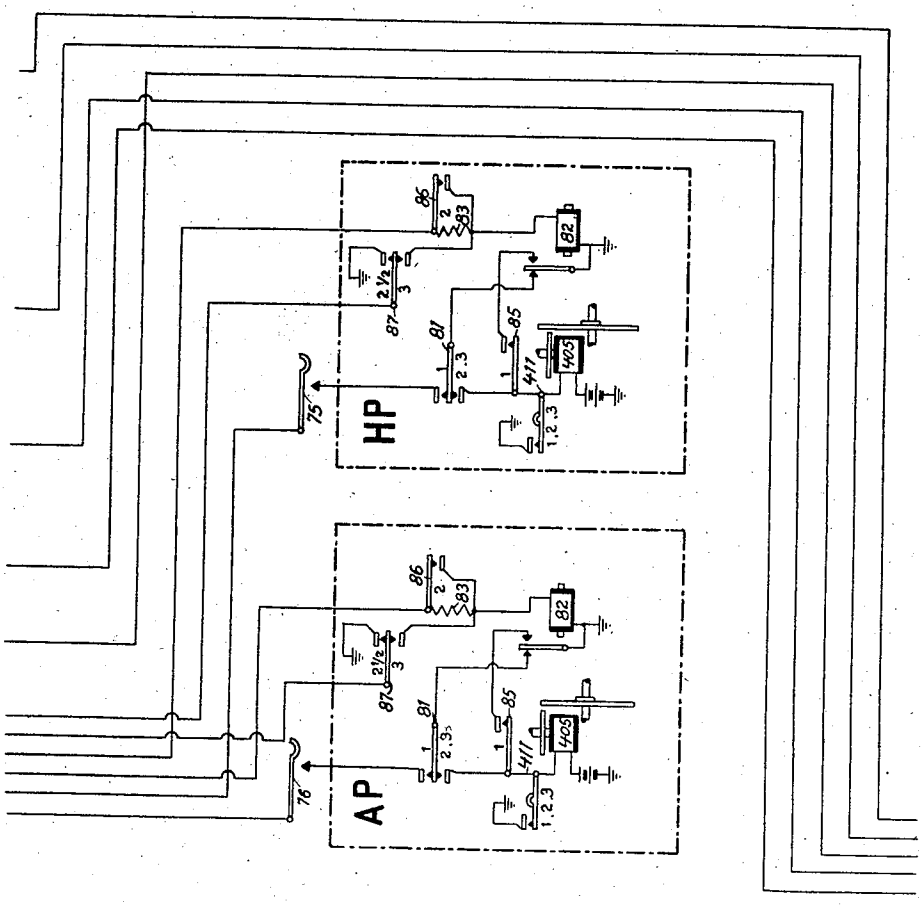
8 SHEETS—SHEET 5.

Fig. 4



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8 SHEETS—SHEET 6.

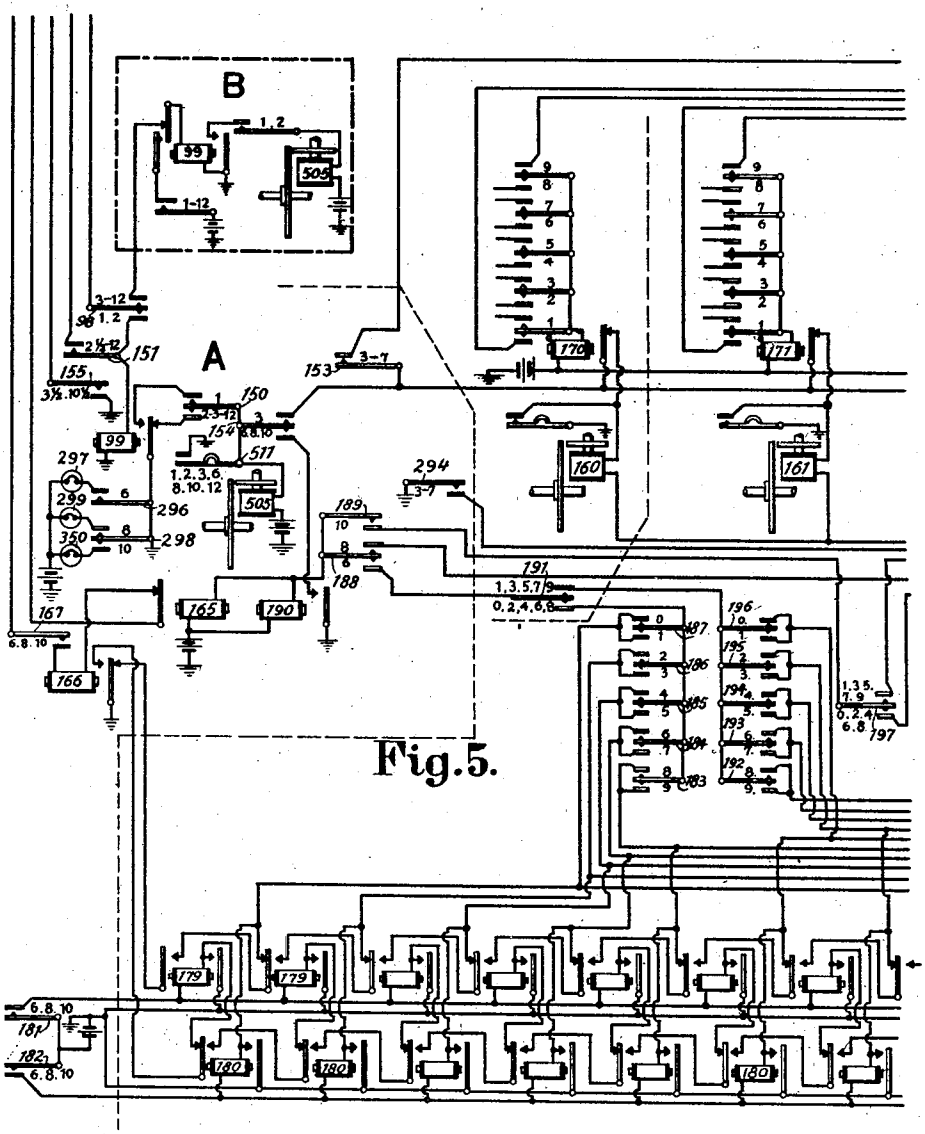

Fig.5.

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APPLICATION FILED SEPT. 13, 1912.

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8 SHEETS—SHEET 7.

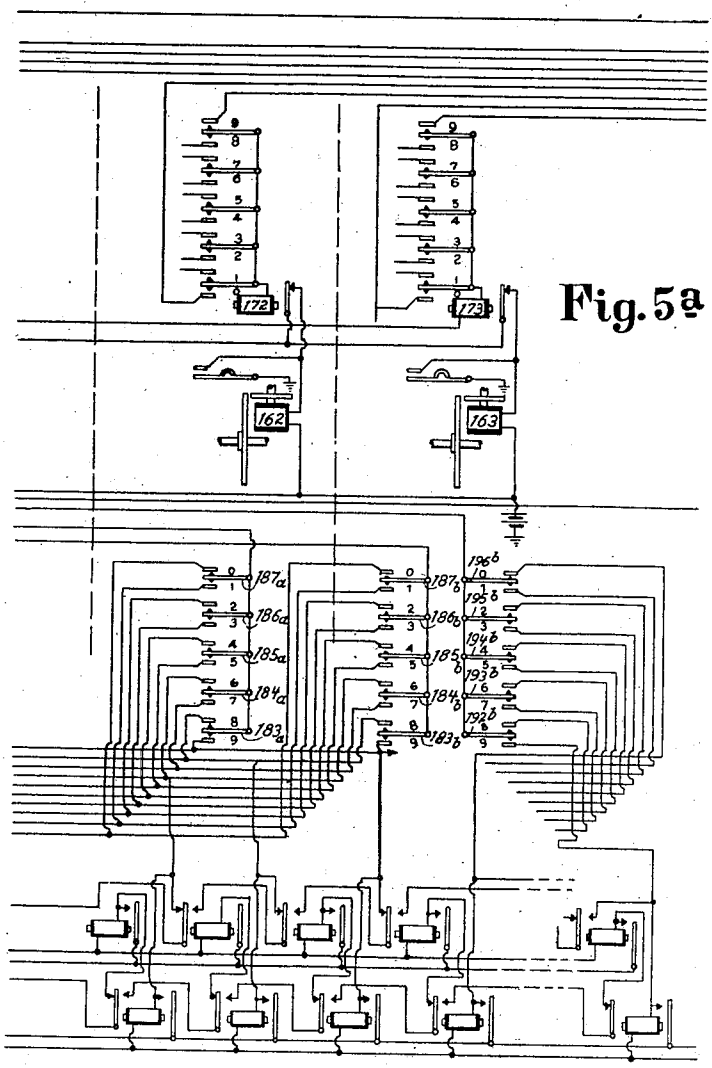

Fig. 5a

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SEMI-AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED SEPT. 13, 1912.

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8 SHEETS—SHEET 8.

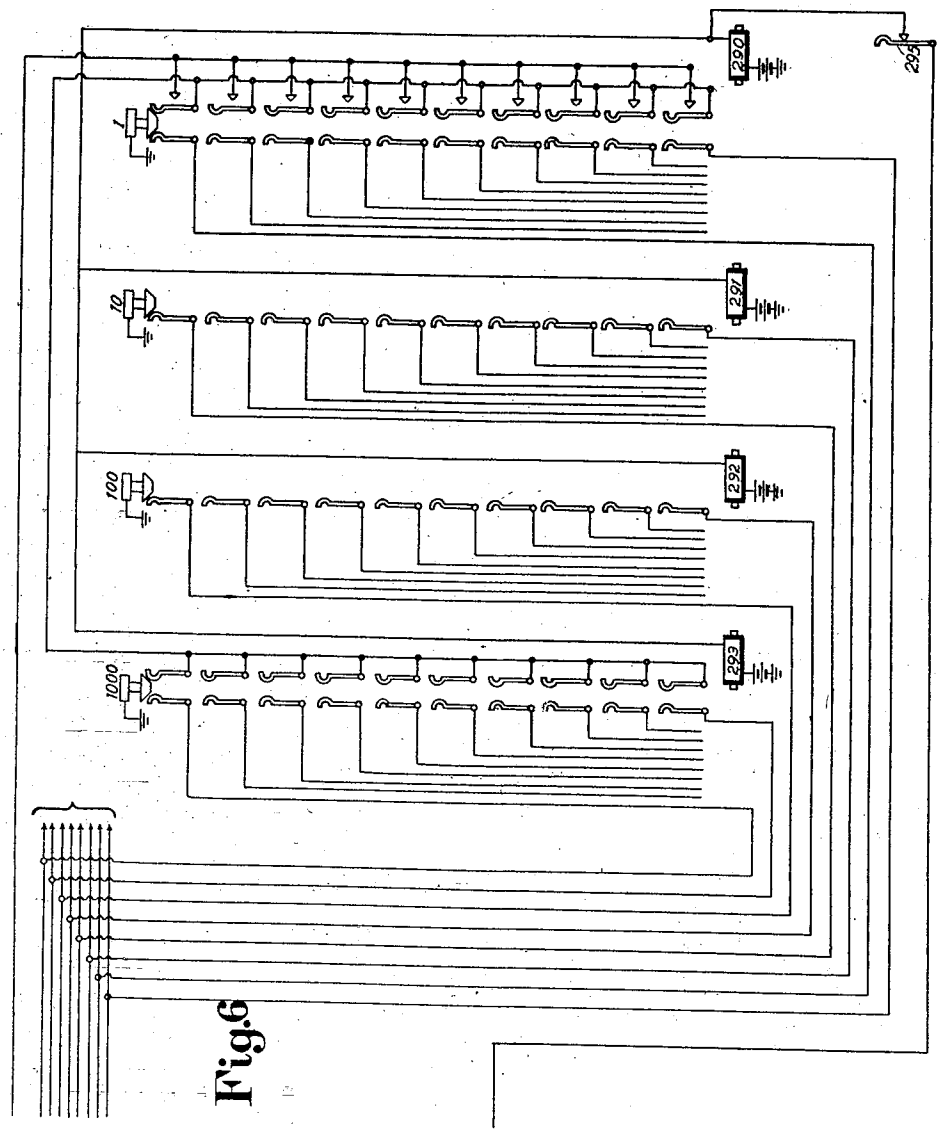

Fig. 6

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UNITED STATES PATENT OFFICE.

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SEMI-AUTOMATIC TELEPHONE-EXCHANGE SYSTEM.

1,284,996. Specification of Letters Patent. Patented Nov. 19, 1918.

Application filed September 13, 1912. Serial No. 720,169.

To all whom it may concern:

Be it known that I, FRANK R. McBERTY, a citizen of the United States, and a resident of Antwerp, in the Province of Antwerp and Kingdom of Belgium, have invented new and useful Improvements in Semi-Automatic Telephone-Exchange Systems, of which the following is a specification.

This invention relates in general to improvements in telephone exchange systems for the interconnection of telephone lines, and has to do more particularly with systems in which the extension of the desired connection from a calling line to a called line is accomplished by automatic selector switches, under the control of an operator at the central or switching station. Certain features to be described, however, are not restricted to systems of this character, being also applicable, as will be apparent to those skilled in the art, to systems of widely varying character, as, for example, to full automatic telephone exchange systems and, particularly those features relating to the connection of a calling line with an operator, to manual telephone exchange systems.

One of the principal features of the invention has to do with the association of an operator with a connection to be extended for the purpose of receiving the instructions from the party calling, in accordance with which she will then act to produce the desired connection. To produce the best results in a system of this character, it is necessary that more than one operator should be able to control the establishment of any desired connection. For this purpose the invention involves the distribution of calls to home or alternate operators, it being possible for either a home or alternate operator to control the establishment of any desired connection. In this system of distribution, the home operator—that is, the operator in whose position the circuit to be extended is located—will automatically be associated with such circuit when calling, if idle, in preference to an alternate operator. However, if such home operator is busy at the time, and an alternate operator is idle, and prepared to receive a call and establish the desired connection, such circuit to be extended will be associated with such alternate operator. The invention, therefore, may be said to contemplate the automatic association of a circuit to be extended to any idle one of a plurality of operators, the preference being given to a particular operator, if idle, but if such operator is not idle, being automatically associated with some other operator.

A further feature of the invention relates to the automatic distribution of calls, that is, of circuits to be extended, not only to operators but also to one of a plurality of controlling equipments individual to such operator. A call coming in causes first the automatic selection of an idle operator, and then the automatic selection of an idle controlling equipment of such operator, such selection causing the association with the circuit to be extended on which such call has come in, of the equipment for controlling the establishment of the desired connection.

Another feature of the invention provides means whereby every call coming into a semi-automatic exchange, in which calling lines are automatically connected to an operator's position and are connectible to such operator if idle, will be indicated before such operator by a visual signal, such visual signal, although located on one operator's position, being observable by a plurality of operators, any one of which may obtain access to the circuit to which the signal is individual, for the purpose of controlling the extension of the desired connection. Furthermore, the invention provides that all calls in the exchange connected to any operator's position, and still unattended to, are simultaneously indicated, each by its own visual signal, so that at all times the number of calls awaiting attention will be apparent to each operator, and to the other operators to whom the circuits on which such calls have been received are accessible.

A further feature of the invention provides that a circuit to be extended, having caused the selection of an idle operator and of an idle equipment of such operator, will be connected to the telephone of such operator and to such controlling equipment by separate and independent leads. By such arrangement it is possible that, as soon as the operator has received the necessary instructions from the calling party, and has

established the necessary controlling condition in such controlling equipment, her telephone may be disconnected from the particular circuit, and is immediately prepared to be connected to some other circuit, whereas, the controlling equipment will remain associated with the circuit to be extended until the controlling operations are complete. Furthermore, this arrangement contemplates that the operator shall control, one after another, different controlling equipments in accordance with the instructions received from calling subscribers without the necessity of awaiting the completion of the operation of the one of her controlling equipments used, her telephone being automatically connectible to a calling line, together with an alternate equipment, as soon as it becomes idle.

In the invention another feature provides not only the automatic connection of an operator's controlling equipment to a circuit to be extended for the purpose of controlling the extension of such circuit to the desired line over automatic selector switches, but also provides for the automatic disconnection of such controlling equipment from such circuit at the very earliest stage in the connection at which such disconnection can properly take place. That is to say, one of the features of the invention relates to the automatic disconnection of the controlling equipment immediately upon the selection in the final selector switch, of the set of terminals in correspondence with the numerical designation of which the controlling equipment has been operated, such automatic disconnection taking place before the testing of the line associated with such terminals, before the ringing of the line—if such line is idle—and before the response of the called subscriber. In accordance with this feature of the invention, the time of use of a controlling equipment in connection with any selecting operation is materially shortened, the circuits for testing, ringing, and the establishment of the talking connection in response to the reply of the called subscriber being purely local, and in no way requiring the assistance, or direction, of the controlling equipment.

According to the invention, furthermore, although each connection is established over automatic selector switches, and also preferably over automatic line finder or distributing switches, the operator, to whose position the connecting circuit over which the call has been extended is individual, has at all times access and complete control over the connection established, or being established. For this purpose, the invention provides that each connecting circuit shall appear before the operator in a requisite number of signal lamps and controlling keys, whereby the operator may supervise the connection at any time, and in any way desirable.

Another feature of the invention, and relating particularly to semi-automatic systems, in which supervision of the call established or being established is always possible, relates to the fact that the establishment of the call—that is to say, the receipt of the necessary instructions from the calling party, the bringing about of the necessary controlling condition in an operator's controlling equipment, and the ensuing selection-controlling operation by such equipment to establish the call, all may take place at one operator's position, whereas, the supervision of the call established or being established may reside in another operator's position, so that, briefly speaking, it may be said that the establishment of the call is produced by one operator, and the call is supervised by another operator.

Another feature of the invention relating to systems in which the call is established over automatic selector switches, but having been established is supervised by an operator at the central office, provides that the complete disconnection of an established call, involving the restoration to normal condition of all of the apparatus forming part of such connection is controlled by manually operable means before the supervising operator, and in the particular form shown herein resides in a single manually operable key individual to the connecting circuit over which such call is established.

It sometimes occurs that it is desirable that a connection, being established or fully established should be maintained, while at the same time it is desirable that the line so connected should be free to call and be called in the normal manner. A feature of the invention, therefore, relates to holding the switches in the position to which they have been brought for inspection or other purposes, while, at the same time, causing the subscriber's line, or subscribers' lines attached to such connection, to be freed entirely at the line finder or final selector, the brushes of which rest upon the terminals thereof, so that such line or lines may call or be called in the normal manner. As shown the means for accomplishing this holding condition, may comprise relays under the control of manually operated means before the supervising operator, which relays in turn control the apparatus associated with the switches forming the extremes of the connection.

Other features of the invention have to do with the circuits and operation of the line finder switches by which the idle connecting circuit is brought into connection with a calling line. One of these features provides a pilot relay under the control of any line of a group, whereby all the idle line finders in which such group of lines terminate will

immediately start to search for a calling line. The circuit by which the pilot relay is energized also forms one of the features of the invention. This circuit, controlled by a single contact device, provides when closed, not only the energizing circuit for the pilot relay itself, but by means of a branch therefrom, places a selectable potential upon the test terminal of the calling line in all the finder switches in which such line appears. From another standpoint this circuit may be considered as, in part, a common circuit, in which part the pilot relay common to a group of lines is located, and in part comprising an individual circuit for each of the lines of such group, the establishment of a calling condition at any one of such lines closing common circuit and individual circuit of such line to energize such pilot relay, and also such branch circuit individual to such line leading to the test terminals of the line upon the line finder switches, to place a selectable potential upon such terminals. One of the features of the invention, therefore, has to do with the apportionment of the resistances in the portions of the established circuit individual to a line in such a manner that the proper potential will exist upon the test terminal of such line when calling, until such line has been seized by a line finder switch, at which time the potential upon such test terminals will be so changed that no other one of the line finder switches in which such line appears will be able to seize such line, and furthermore, that the potential or changed potential upon the test terminal of one line will have no effect upon the potential, lack of potential or change of potential on the test terminals of another line of such group, even though the source of potential for such test terminals is in the common portion of such circuit.

Another feature of the invention involves the use in line finder switches, of means whereby immediately upon the brushes of a line finder switch coming in contact with the terminals of a calling line a test guard will be placed upon the test terminals of such line, in all other line finder switches in which it appears, to prevent its seizure by any other of such line finders, whereas, the motion of the seizing line finder will not be arrested until the brushes thereof are properly centered upon the terminals of the line. This is accomplished by locating in the test circuit two relays, one of them operating immediately upon the brushes coming in contact with the terminals of the calling line to place the test guard thereon, and the other operating subsequently, upon the opening of a local interrupter device carried by the line finder switch, to arrest the motion of such finder switch. Another feature relates to the subsequent transference of the test relays located in such test circuit—one to an alternative test circuit and the other to a controlling circuit whereby the restoration of the line finder apparatus to normal may be controlled as desired.

Another feature of the invention, relating particularly to systems in which a calling line is connected to an idle connecting circuit through a plurality of line finder switches, provides that when a calling line has been seized, and connected to by a first line finder switch, all of the idle second line finder switches in which appears the circuit individual to the first line finder switch to which the line is now connected, will start in motion to hunt, and one of them seize such circuit, whereby the calling line will be extended to the connecting circuit individual to the seizing second line finder switch. Related to this feature is another feature of this invention, according to which the control of the starting in motion of such idle second line finders resides in a sequence switch (steering switch) individual to the first line finder, whereby the seizure of the calling line by the first line finder immediately initiates the operation of such sequence switch, resulting in the starting in motion of the idle second line finders in which such first line finder is accessible.

Another feature of the invention, and relating particularly to systems in which a calling line is connected to an idle connecting circuit by line finder switches is embodied in the provision of line finder switches the brushes of which have no normal position and move in one direction only. Upon the seizure of a calling line by one of a plurality of moving line finder switches, all of such switches will, provided no other line is at that time calling, immediately stop in whatever position they may respectively be in, and having stopped, will remain in such position until the establishment in some other line of the group of lines terminating in such switches, of a calling condition, at which time they will again start in motion and continue therein until such line is found.

A related feature of the invention provides that when the brushes of a line finder switch rest upon the terminals of a line in which a calling condition is established, such line finder switch will immediately seize such line without any movement of its brushes, and prevent the seizure of such line by any other line finder switch.

Another feature of the invention relating to systems in which a calling line is connected to an idle connecting circuit through a plurality of line finder switches provides that the restoration of the first finder switch through which a connection has been established is dependent on the condition of the second finder switch which has formed a

part of the same connection. It further provides that upon the initiation of the restoring operation in such connection the apparatus of the first finder switch will be so operated that the subscriber's line to which it is connected will be immediately freed to call or be called in the normal manner, but the apparatus of such first finder switch will be maintained in an "off-normal" position, to prevent the use of such first finder switch in a subsequent connection, until the apparatus of the second finder switch connected with it, and its connecting circuit, have been restored to their normal condition.

Other features of the invention have to do with the use, location, and operation of sequence switches (steering switches) in various portions of a telephone exchange system, for controlling various portions of the apparatus and the controlling and extension of the various circuits. For example, one of the features of the invention relates to the use of a sequence switch for controlling the first line finder.

Another feature relates to the use of a sequence switch common to and controlling both the second line finder switch and the group selector. Another feature relates to the use of a sequence switch to determine the selection by a calling line of an idle operator of a plurality of operators to any one of which such calling line may be connected. A further feature relates to the use of the same sequence switch for controlling not only the selection of an idle operator but also the selection of an idle controlling equipment of the operator selected.

Still another feature of the invention relates to the use of a plurality of electromechanisms (herein shown as sequence switches) to accomplish the selection and extension of a circuit to a particular one of a plurality of circuits, in such selection the circuit extending mechanism (group sequence switch) maintaining the first said circuit open, but closing such circuit when the desired selection has been accomplished by the circuit choosing mechanism (position sequence switch).

Other novel and important features of the invention will sufficiently appear from the detailed description thereof, and it will be understood that while, for the sake of clearness, specific descriptive language must be used in describing the embodiment of the invention shown herein, such language is not to be construed as in any way limiting the invention, since the various features thereof may appear in widely varying and dissimilar forms when used in other systems than the specific one herein described.

A system embodying the invention is diagrammatically illustrated in the accompanying drawings in which—

Figure 1 shows the calling substation and line circuit, and the circuit of the first line finder.

Figs. 2 and 2ª show a connecting circuit and the second finder switch and group selector associated therewith.

Fig. 3 shows the line or final selector and the substation circuit of the called line.

Fig. 4 shows the circuits of two operators' sequence switches.

Figs. 5 and 5ª show the circuit of one of the controlling equipments apportioned to the operator on whose position the connecting circuit in Fig. 2 appears.

Fig. 6 shows the circuit of the operator's key-board.

For the purpose of viewing the system as a whole, Fig. 2 should be placed to the right of Fig. 1, Fig. 2ª to the right of Fig. 2, Fig. 3 to the right of Fig. 2ª, Fig. 4 under Fig. 2, Fig. 5 under Fig. 4, Fig. 5ª to the right of Fig. 5, and Fig. 6 to the right of Fig. 5.

The ground and final selectors are of the multiple brush type, described in the British Patent No. 20841/09, in which the brush carriage is driven by constantly supplied power coupled thereto when needed through a magnetic clutch and carries brushes held free of the terminals by latches any one of which may be withdrawn to allow its set of brushes to make contact successively with the sets of terminals individual thereto.

The set of brushes is chosen by a tripping spindle according to the different angular positions thereof, which is driven by the same constantly supplied power as the brush-carriage with which it is associated, through a magnetic clutch.

The line finder switches shown at 100 and 200 are somewhat similar in construction to the selectors, the principal differences residing in that they each have but a single set of brushes mounted on the brush-carriage, and such brushes are normally in position to make contact with the sets of contact terminals over which they pass. Furthermore, the line finder switches have no normal position and, having been moved in hunting a calling line, remain in such position until subsequently again taken from use.

In both the line finder switches and the selectors the top of the brush-carriage carries an interrupter which inter-acts with a toothed rack upon the frame of its switch in such a way that a circuit is established to maintain the brush-carriage in motion whenever the brushes are passing from one set of terminals to the next. When the brushes are properly centered upon a set of terminals, however, this circuit is open and the movement of the brush-carriage will stop with the brushes squarely in contact with a set of contact terminals.

The system shown also utilizes electromagnetic switching devices known as se-

quence switches. Devices of this character are disclosed in the British Patent No. 20840 of 1909.

In the drawings, the switch springs of the sequence switches are not shown in their actual arrangement, but are so located as to give a clear arrangement of the circuits. The positions of the rotary elements of each sequence switch in which any of its contacts (except the contacts corresponding to 111 of the line finder sequence switch) are closed, are indicated by numbers placed adjacent to such contacts, each contact being open in all positions except those indicated by such reference numerals. For example, contact 58 top is closed in the fourth and from such position through the seventh position of the line finder sequence switch of which it forms a part as indicated by the numbers 4—7 adjacent thereto, and the alternate or bottom contact is closed in the first and second positions, as indicated by the figures 1, 2, adjacent to such alternate contact, said contact being open in all positions except those so indicated. In the case of the special contacts such as 111, the numbers are placed on the opposite side of the switch lever from its contact point and indicate positions in which the contact is opened, such contact being closed continuously while the rotary element of sequence switch is in transit between positions indicated. It will therefore be understood that the special contact 111 of the sequence switch 105 is closed continuously betwen positions 1 and 4, 4 and 5, 5 and 7, and 7 and 1, but is opened when the sequence switch is either resting in or passing through any one of these positions.

In the system herein disclosed, the operator receives the number from the subscriber and then manipulates keys which serve to set in operation mechanism adapted to extend the connection automatically to the desired line and these keys are divided into four sets of ten each for the thousands, hundreds, tens and units respectively. These keys are shown diagrammatically in Fig. 6. The operator having received the number of the desired line presses a key of each set corresponding to digits of the number desired. The keys are electromagnetically locked down when depressed, and remain in such condition until the magnets are deënergized.

There are provided at each operator's position two duplicate senders, A and B, each controlled by a sequence switch 505, and each comprising twenty pairs of counting relays 179, 180 and four registers whose power magnets are designated 160, 161, 162, and 163, and belong to the thousands, hundreds, tens and units registers respectively. In general, the register is a sequence switch having the usual power magnet and the usual contacts operated by cams, located on the sequence switch shaft. The only difference is that the register has no normal position, but remains in any operated position until a new controlling condition is established by the operator's keys when associated with the equipment of which any particular register forms a part, when it may assume a new position.

The thousands register 160 has five springs shown above its magnet, the coöperating contacts of which are connected with the thousands keys. It has in addition a spring 191 shown below.

The hundreds register 161 has in addition to the five springs shown above its power magnet, the coöperating contacts of which are connected with the springs of the hundreds keys, five springs numbered 183, 187, and five springs numbered from 192–196; also spring 197.

The tens register, has in addition to the five springs, the contacts of which are connected to the tens keys, five springs numbered 183^a–187^a.

The units register has in addition to the five springs, the contacts of which are connected to the units keys, five springs numbered 192^b—196^b.

In general it may be stated that when the register power magnets are energized, they revolve their shafts, and when the upper contacts on the registers corresponding to the keys depressed by the operator are reached, circuits are closed through the stop relays 170—173 which cut off the power from the register and stop it revolving with the upper contact closed in each corresponding to the depressed key. The lower springs of the registers are closed or open as indicated by the position numbers adjacent thereto according to the set position of the register as determined by the upper springs and such lower springs control the operation of the counting relays which themselves determine the number of steps that the various selectors are to take in their operation to extend the connection to the desired line.

The operator is provided with the usual telephone set (not shown) which is connected to the conductors leading from the lower contacts of sequence switch springs 90—91 (Fig. 2). The upper contacts of the same sequence switch springs lead to the telephone set of the operator located to the left; who may assist the home operator. This operator will be referred to as an alternate operator. The operator's telephone set is also connected to the conductors leading from the springs of the listening key 288, but these connections are also omitted for the sake of clearness. This key is to permit the operator to communicate with a subscriber after her telephone set has been automatically disconnected in the normal operation of the system. The operator is also

provided with a set of progress lamps 297, 299 and 350 for each controlling equipment, serving to indicate the progress of the extension of the connection.

The telephone set of the operator located to the right of the home operator is not shown, nor the means for permitting her to assist the home operator, this being merely a duplication of the means for connecting the left hand operator's set.

The subscriber's set is of the kind usually provided in common battery manual telephone exchanges. The lines are connected to multipled terminals in the banks of each of a group of first line finder switches. They also appear in multipled terminals of the proper final selectors. There may be provided a smaller number of line finders than subscribers, and a still smaller number of second line finders (200) may be provided, and operate substantially in the same way as the first line finder, each second line finder being connected with a group switch 300.

It will be understood that the sequence switch springs in Fig. 2 surrounded by the dot and dash lines are associated with the position sequence switch 305, whereas all those outside of the dot and dash lines are associated with the group sequence switch 205, which latter controls the line finder switch and group selector.

The system shown is best described by an explanation of the operation thereof.

Assume that the subscriber whose substation is shown at 50 on Fig. 1 desires connection with the subscriber, the numerical designation of whose line is 1149, and further assume that such subscriber is the one whose substation is shown at 278 on Fig. 3. When the subscriber at 50 removes the telephone from its hook, the line relay 51 (Fig. 1) is energized, and closes a circuit to energize the pilot relay 52. This circuit also, by means of a branch leading off between the resistance 53 and the resistance 54, placed a selectable potential on the terminal 104 of the line finder 100, and of all the other line finders of the group in which this line appears. This pilot relay 52 is common to such group of line finders, and when energized, causes the brush-carriage of all of the idle finders in the group to rotate, over circuits including springs 55 bottom, and 56 bottom, and brush-carriage power magnet 106. A group of idle first finder switches is now hunting for the calling line, the brushes traversing the line terminals 101, 102, 103, 104, and when the first arriving line finder is fully centered upon the calling line whose test terminal 104 has been connected to battery, this finder will stop rotating due to the closure of the circuit through relay 107 which includes spring 58 bottom, upper (high resistance) winding of test relay 108, spring 59 bottom, brush 104^a, terminal 104, resistance 53 and relay 52. The resistance of the shunt circuit from resistance 53 through resistance 54 to ground is so proportioned that sufficient current will flow through relay 108 to actuate it. Relay 108 is energized before relay 107 due to the shunt about the latter closed by the interrupter 109 whenever the brushes are not squarely centered on the terminals, and in responding closes at its front contact a path of low resistance through its lower winding, so reducing the potential of the test terminal 104 and its multiples that no other relays 108 and 107 can be energized thereby, and therefore causing the line to appear non-calling to all other line finder switches. If two line finders should reach the terminal 104 of a calling line at the same time, the circuit from the battery placed on terminal 104 by the calling line would be closed through two circuits in parallel, each of which would contain relays 108 and 107. The two relays 108 would consequently be simultaneously energized and generally one of the two would close its armature contact first, by virtue of which the circuit containing this relay, due to its decreased resistance, would draw the major part of the current of the parallel circuit and the second relay 108 would therefore receive insufficient current to attract its armature. However, if both relays 108 of the parallel circuit should close the low resistance shunt winding simultaneously, then the resistance of this parallel circuit would be so reduced that the potential difference at the terminals of the relays would be so small that the current traversing the coils of the relays would be insufficient to hold up the armatures of both relays and one or the other would drop back.

When relay 107 is energized, it opens the circuit of the power magnet 106 and closes a circuit to energize the holding magnet 110 through spring 55 bottom. At the same time relay 107 energizes the sequence switch power magnet 105 over spring 59^a and it moves from position 1 to position 4, moving through positions 2 and 3 by reason of the closure of contact 111 in those positions. As the sequence switch moves through position 2 a circuit is closed over spring 61 and the third brush 103^a of the line finder to operate the cut-off relay 62 which circuit by reducing the potential on the terminal 103, makes the seized line test busy in all the final selectors in which it appears. The operation of the cut-off relay also connects the line conductors to the terminals 101, 102 of the finder at the upper front contacts of relay 62, and, unless some other line of the group is calling, and has not as yet been seized by a line finder, opens the circuit of the pilot relay 52 to arrest the movement of any other line finders which may have been

seeking this line. At position 4 of the sequence switch 105 a circuit is closed over spring 63 to a local wire leading to a group of second line finder switches 200, in which the conductors connected to the first line finder switch 100 appear, causing the idle finders of such group to hunt for the first line finder now connected to the calling line.

The sequence switch 105 (Fig. 1) at position 4 has prepared at springs 58 top and 57 top a circuit leading to the 4th terminal 204 of this line which will be closed when a second line finder switch reaches said terminal and will cause, by the energization of the relay 208, the inclusion in this circuit of a low resistance path to reduce the potential of the terminal 204 to render it non-selectable to other second line finder switches, and when the brushes have been squarely centered on terminals leading to the calling first line finder switch the brush-carriage is stopped. Potential being present therefore upon test terminal 204, upon the test brush 204^a arriving thereat, the relay 208 to ground is immediately energized and a moment later when the ground at the interrupter is removed, the relay 207 is also energized opening the driving circuit of the brush carriage and closing the circuit for the holding magnet. It has also closed over spring 66 bottom and spring 63 (Fig. 1) a circuit for the group sequence switch 205. This sequence switch 205 therefore moves into position 2, in which movement an impulse is transmitted to the first finder sequence switch 105, over left back contact of relay 67, normal contact of locking key 68, relay 199, spring 69 bottom, and spring 70 bottom. This sequence switch is moved into position 5 in which position the calling subscriber's line wires are connected through to the second line finder over spring 71 bottom and spring 72 bottom. The circuit of relay 107 of the first finder remains closed at springs 57 and 58 top (Fig. 1) and 65 bottom (Fig. 2) and consequently relays 208 and 207 (Fig. 2) and 107 (Fig. 1) remain energized. This is a locking circuit and remains closed until the operator clears out the connection.

As the group sequence switch moves from position 1 into position 2, an impulse is also transmitted to the position sequence switch 305 over spring 73 top and spring 74 bottom, causing such sequence switch to move from position 1 into position 2, in which position the test is made for an idle operator.

In Fig. 4 are shown two operators' sequence switches, one of which is associated with the home operator's position HP and the other with the alternate operator's position AP, which alternate operator's position only comes into service when the home position HP is busy.

When the operators are on duty the hand switches 75 and 76 at their respective positions are closed.

When the position sequence switch 305 advanced into position 2, circuits to the position test relays 77 and 78 were closed at spring 79 bottom and spring 80 bottom respectively, to the home operator's position and to the alternate operator's position, through the respective hand switches 75 and 76 and the spring 81 top of the sequence switches of such operator's positions and over the back contacts of the relays 82 to earth. When, and only when, an operator is idle the spring 81 is closed at the top. If both the operators should be idle at the moment when the position sequence switch 305 reaches position 2, both the home and the alternate relays 77 and 78 will be energized. These relays establish holding circuits from the power magnet 305 over their front contacts, their right hand windings and the windings of the respective relays 82 to earth. It will be first assumed that the home position HP was idle, and that the alternate position was either engaged or that its hand switch was not closed.

With the group sequence switch 205 in position 2, the position sequence switch 305 in position 2, and the home operator's sequence switch 405 in position 1, relay 77 will be energized by a circuit over spring 79 bottom, hand switch 75, spring 81 top, and back contact of relay 82, whereupon it closes an energizing circuit for relay 82, including position sequence switch power magnet 305, spring 84 top, front contact of relay 77, right hand winding of relay 77, resistance 83, (Fig. 4) and relay 82. The relay 82 at its front contact closes a circuit by way of spring 85 for the home operator's sequence switch, whereupon it moves to position 2, in which position the resistance 83 is short circuited by the closure of spring 86 bottom, with the result that power magnet 305 of the position sequence switch will receive enough current to rotate the sequence switch to position 3. Inasmuch as it was assumed that the relay 77 became energized, the position sequence switch will move to position 7 since the circuit established remains closed until the position sequence switch 305 has rotated beyond position 6, when it will be opened at spring 84 top. When this occurs the relay 82 (Fig. 4) is deënergized, and a circuit is closed over spring 81 bottom, to energize the magnet 405 which thereupon moves the home position sequence switch into position 3.

With the group sequence switch 205 in position 2, and the position sequence switch 305 in position 7, the home operator's sequence switch 405, as it starts to move from position 2 to position 3, will transmit an impulse over spring 87 top (Fig. 4) and spring 89 top to the group sequence switch

205 to move it into position 3. Before the group operator's sequence switch fully arrives in position 3 thereof, an energizing circuit for relay 82 is closed through magnet 210 of the 2nd finder, front contact of relay 207, spring 64 bottom, spring 88 bottom, and spring 87 bottom. This relay 82 is therefore energized to maintain the home operator's sequence switch in position 3 and remains energized until the operator has recorded the call.

It should be here observed that if the relay 78 had been energized simultaneously with the relay 77 in the second position of the position sequence switch, which would have occurred if the alternate operator had been idle and her switch 76 had been closed, the energizing of such relay would have initiated a cycle of operations in the alternate operator's sequence switch AP, but since the position sequence switch, when it moved from its second position, was driven directly into its seventh position, no holding or checking circuit would be established or maintained for the alternate operator's sequence switch and it would return immediately to its normal position.

On the other hand, assuming that the home operator is busy when the position sequence switch arrives in position 2, the relay 77 will not be energized as the circuit for it is open at contact 81 of the home operator's sequence switch. If at this time the alternate operator is also busy, and, consequently, no circuit is established for the relay 78, the position sequence switch will remain in position 2 until a circuit for one or the other relays 77 or 78 is closed. If the relay 77 is the first one energized the circuit operation will be as has been described; if, however, the relay 78 is the first to be energized, or if the relay 78 was the only one energized when the position sequence switch came into position 2 the position sequence switch in response to the operation of the alternate operator's sequence switch, will move into position 3 where the same operation will take place to drive the group sequence switch into position 3 in response to the operation of the alternate operator's sequence switch as have been described as taking place in position 7 under the control of the home operator's sequence switch. Also the alternate operator's sequence switch will be held in position 3 in precisely the same manner that the home operator's sequence switch was held in the same position.

Furthermore, it will be apparent that if when the position sequence switch comes in to position 2 the switches 75 and 76 were both open, the operation of the sequence switches will be held up just as though both operators were busy and upon the closure of one of such switches, the operation of such sequence switches will forthwith proceed to extend the connecting circuit to the operator whose switch is closed. While, however, the position sequence switch stands in position 2 the lamp 95 will be continuously lighted indicating to both the home operator and the alternate operator that a call is awaiting attention, so that at all times all of the operators having access to any given connecting circuit and to which they are automatically connectible as described, will be able to observe just how many calling lines are awaiting attention.

Returning, however, to the case assumed the group sequence switch 205 is now in position 3, the home operator's sequence switch 405 is in position 3 and the position sequence switch 305 is in position 7. The home operator's telephone set was connected across the line by the closure of springs 90 and 91 bottom when the position sequence switch moved into position 7, current for talking purposes being supplied through springs 92 and 93 closed in this position. It will be noted that the calling and supervisory relay 94 is included in this circuit and that these springs are closed when the position switch arrives at position 2, thus lighting the lamp 95 in positions 2 and 3 of the second finder sequence switch for the purposes described. Furthermore, there is a circuit closed through the progress lamp 96 at spring 80 top, this lamp remaining lighted until the called subscriber has answered; that is, during the entire progress of the connection, and is an indication to the operator that a call is going through on this trunk.

The operator noting the lighting of the calling lamp inquires the number desired by the subscriber. In the meantime a selection-controlling equipment (Fig. 5) has been selected and seized in the following manner:

With the connecting circuit, therefore, connected to the home operator, a test circuit is established to pick up the idle one of the two selection-controlling equipments of the home position as follows:—battery, through position sequence switch 305, spring 84 bottom, spring 97 bottom (Fig. 2), spring 98 bottom or top (Fig. 5), to relay 99 of equipment A or B to earth. If equipment A is idle, spring 98 bottom will be closed. If on the other hand, equipment A is busy, spring 98 will be closed at the top, thereby connecting this circuit to the second equipment B. If it is assumed that equipment A is idle and spring 98 bottom is closed, the circuit above referred to is continued to relay 99, which is energized and establishes a circuit over spring 150 top, for first equipment sequence switch 505 and moves it into position 2. The circuit through the relay 99 and the position sequence switch 305 remains closed until interrupted at spring 84 bottom in position 9, hence position sequence

switch 305 assumes position 9, and the relay 99 at the controlling equipment becomes deenergized closing a circuit over spring 150 bottom, to drive the equipment sequence switch (505) into position 3.

As the equipment sequence switch moves from position 2 into position 3, an energizing circuit for the relay 99 is closed by way of spring 151 top (Fig. 5) and spring 152 bottom (Fig. 2). This is a locking circuit for the relay 99 and remains closed until the controlling equipment has established the desired connection, or until the operator at some earlier period clears out the circuit.

It was assumed that equipment A was idle. If equipment A had been busy and spring 98 top had been closed, the circuit through sequence switch 305 and relay 99 of the B equipment would have been opened immediately at left back contact of relay 99, and hence the position sequence switch 305 would have remained at position 7.

It should be here observed that if the connecting circuit had been in connection with the alternate operator, that is, with the position sequence switch in position 3 instead of position 7, a similar testing of the controlling equipments of such alternate operator would have taken place over spring 74 bottom and spring 73 bottom. In that case, if the A equipment had been idle, the position sequence switch would have been driven to position 5 and such A equipment placed in coöperative relation to the connecting circuit, whereas, if the A equipment had been busy, the position sequence switch would have remained in position 3 and the B equipment so associated. From this point on the operation is precisely the same whichever operator the connecting circuit is connected with, and whichever equipment of such operator is in controlling relation therewith. In all cases when the designation of the desired line has been completely recorded on the operator's keys (Fig. 6) the position sequence switch will be advanced one position, to open the connection to the operator's telephone and upon the completion of the selection-controlling operation the position sequence switch will be operated (through the group sequence switch) to move into its eleventh position,—all of which will be hereinafter described,—such operation taking place regardless of the position the position sequence switch may be in at that time, that is to say, regardless of which of the various equipments may have been connected with the connecting circuit by such position sequence switch to control selection.

The apparatus is now ready for the registration of the designation of the desired line, and, in accordance therewith, to control the movement of the various switches to connect with the terminals of the required subscriber's line. The operator having received the number desired depresses the corresponding keys of the sets of keys shown in Fig. 6.

There is arranged a key for each digit, there being ten units keys, ten tens keys, ten hundreds keys and ten thousands keys. It may be noted that each row of keys is provided with a holding magnet 290, 291, 292, 293, each arranged to hold depressed the depressed key of its row. The circuit of these magnets is closed by way of the spring 294 (Fig. 5) when the equipment sequence switch is in positions 3 to 7, a special releasing key 295 being included in the circuit of the holding magnets to release the keys if, before the designation of the desired line is completely recorded, the operator should observe that she had depressed a wrong key. In depressing the digit keys, the operator depresses the units key last. When the units key is depressed an energizing circuit for the equipment sequence switch 505 is closed to move it into position 6, such circuit including the contact on the units key, spring 153 top and spring 154 top. As the sequence switch moves from position 3 into position 4, an impulse is transmitted to the group sequence switch 205 over a circuit through spring 155 (Fig. 5), spring 156 bottom (Fig. 2), and spring 157 top (Fig. 2) to move it into position 4. As it moves from position 3, an impulse is sent to the position sequence switch 305, over spring 158 top and spring 159, driving it out of the 9th or operator's listening position and into position 10. In this position the A equipment of the home position is still connected to the circuit, but the operator's telephone set is disconnected from the circuit at spring 90 bottom and spring 91 bottom, and also the holding circuit of the relay 82 of the home operator (Fig. 4) is opened at spring 88 bottom (Fig. 2). The relay 82 of the home operator's sequence switch becomes deënergized, closing a circuit over spring 81 bottom, to drive the home operator's sequence switch to its normal position and render it free to be connected to other lines to which calling subscribers may be connected.

The selection controlling equipment is now ready to control the establishment of the connection.

As the units key of the keyboard was depressed, the same circuit which resulted in the movement of the equipment sequence switch formed a part of circuits established for the various power magnets 160, 161, 162 and 163 of the 1000's, 100's, 10's and units registers respectively in parallel by way of spring 153 and the contact on the units key to earth as above described. These registers rotate until the position corresponding to the depressed key of its associated set of

keys is reached, where the circuits through their power magnets are broken by their respective test relays 170, 171, 172, 173. For example, if the number four, the fifth, tens key has been depressed the tens register will be driven by the energization of its power magnet 162 until it comes into its position 4 when a circuit will be closed through the number four tens key through the register spring, of the upper set of five springs of such register, adjacent to which the number 4 is placed, and test relay 172. The energization of the test relay by this circuit opens the circuit of the power magnet 162 and brings the tens register to a stop in its number four position, independent of whether the other registers are still in motion, or where they may stop. It should be noted that for the sake of clearness the ten positions of the registers are numbered from zero to nine to agree with the designation of the keys by which they are controlled. That is to say, when the zero key has been depressed, the corresponding register will move into its zero position, and all of the switch springs of such register designed to be closed in its zero position, that is, all that have the figure zero placed adjacent thereto, will be closed and remain closed until for the control of a subsequent connection the register is again moved. In this manner, therefore, all of the registers are simultaneously set to register or record the designation of the desired line as recorded by the operator on her set of keys, and such keys may then be released to control registration in the B equipment of the same operator such release taking place when the equipment sequence switch moves out of its seventh position.

With the group sequence switch 205 in position 4 the position sequence switch 305 in position 10, the equipment sequence switch 505 in position 6, the fundamental or selecting circuit from the A equipment (Fig. 5) to the group selector 300 (Fig. 2) is completed, this selecting circuit being as follows:—earth, spring 158 bottom of the group sequence switch, spring 164 bottom of the position sequence switch, back contact of relay 165 (Fig. 5), winding of selecting relay 166, spring 167 of the equipment sequence switch, spring 168 bottom of the position sequence switch, spring 169 bottom of the group sequence switch, line relay 174, spring 175 bottom to battery. Relays 166 of the selection-controlling equipment, and line relay 174 of the group selector are thereupon energized. Relay 174 closes a circuit over spring 176 bottom, which drives the group sequence switch from position 4 into position 5, in which position the fundamental circuit remains unchanged and a circuit is closed over spring 177 top to the power magnet 312 of the brush chooser of the group selector, which thereupon causes its shaft to rotate. For each step or advancing stage of the brush choosing mechanism the interrupter 178 closes a low resistance path to ground which shunts out the selecting-relay 166 (Fig. 5) but maintains energized the line relay 174 of the group selector.

The armature of the selecting relay 166 of the sender circuit therefore falls back and is attracted once for each step taken by the brush choosing device. Referring to Fig. 5, as the relay 166 is energized, for each closing of its front contact, a relay 179 of the upper counting relays is energized by way of the left back contact of the corresponding lower counting relay 180 and spring 181, whereas for each time relay 166 closes its back contact, one of the lower counting relays 180 is energized by way of the front contact of the corresponding upper counting relay 179 and spring 182. These counting relays, when once energized, lock themselves over their own right front contacts and springs 181 and 182 respectively, and the circuits for the second and subsequent relays of both the relays 179 and 180 will be established over such of the relays as have been locked up, as will be plainly apparent from an examination of Fig. 5.

One counting relay after another is energized, first a relay 179, then a relay 180, then a relay 179, and so on until that pair of counting relays is energized corresponding to the closed register switch springs of the hundreds and thousands registers (as determined by the depressed keys in the keyboard).

The selectors used in this system are 200-line selectors so that it is necessary to translate from a decimal system to a system that is non-decimal, corresponding to the grouping of the lines in the switches. The operator, when registering the call, depresses keys corresponding to the 1000's, 100's, 10's, and units digits of the desired line, that is, on a decimal basis.

Inasmuch as 200 lines are connected to the final selectors in each group, it follows that each level of terminals in the group selector gives access to a group of 200 lines. The first level gives access to lines numbered 0–199, the second level 200–399, the third level 400–599, and so on. If it be assumed that the required number is 1149, the trunks leading to the final selectors containing this particular line, are wired to the sixth level on the group switches. Consequently, the group selector brush-chooser must move six steps or stages to select the proper set of brushes, which movement will result in the energization and deënergization of the stepping relay 166 six times.

In response to the action of the operator in depressing keys in the respective sets to

set up the number 1149, the registers have been so set that the following contacts are closed in the registers:—1000's register spring 191 top (position 1), the springs 187 and 196 of the 100's register will each be closed at the bottom, and the spring 197 of the 100's register will be closed at the top (position 1). The 10's register will have its spring 185^a closed at the top (position 4) while the units register will have its springs 183^b and 192^b each closed at the bottom (position 9).

When the sixth shunting of the stepping relay 166 is caused by the brush-chooser of the group selector, the sixth lower counting relay 180 was energized, and a circuit was closed, over right hand front contact of the sixth counting relay 180, contact spring 196 bottom of the 100's register, contact spring 191 top of the thousands register, spring 188 bottom of the equipment sequence switch, and through relays 190 and 165. Relay 190 energized closes a circuit to the power magnet 505 over spring 154 bottom, and the equipment sequence switch moves into position 8, in passing through position 7, opening springs 181 and 182, allowing the locked counting relays to be deënergized. As it leaves its seventh position it opened the springs 153 and 294, the spring 294 opening the circuit of the holding magnets 290, 291, 292, and 293, of the several sets of keys and the depressed key in each set resumes its normal position. Spring 153 opens the circuit over which the power magnets 160, 161, 162, and 163, of the registers were put in motion and renders it impossible for the operation of the keys to affect the positions of the registers shown on Fig. 5 so long as the selection-controlling operation is going on. It will thus be seen that though the set of keys may now be associated with the equipment B of the operator by springs performing precisely the functions of the springs 153 and 294 and, as indicated by the multiple conductors shown on Fig. 6, so be used to control the selection-controlling operations of such equipment B in connection with some other call, no operation of these keys can in any way interfere with the selection-controlling operations now going on in the equipment A.

With the sender sequence switch in position 8, the selecting circuit is again closed at the controlling equipment for governing selection according to the 10's digit of the wanted line.

When at position 6 of the equipment sequence switch, the relay 165 was energized it immediately opened the fundamental circuit to the group selector including the line relay 174 (Fig. 2), which relay, when the brush-chooser has finished its sixth step or stage and the shunt to earth is opened, will be deënergized, opening the power circuit to the brush-chooser, causing it to stop in its sixth position and also closes a circuit to the group sequence switch 205 over spring 176 top, so that such switch moves into position 6. This is the trunk hunting position for the group selector 300. The third or test brush 303^a of the group selector is connected through left hand (high resistance) winding of the test relay 198, spring 69 top, test relay 199, normally closed contact of locking key 68, left hand back contact of relay 67 to earth. The brushes of the group selector are rotated due to the closure of a circuit from brush-carriage power magnet 306, over spring 250 bottom, and back contact of relay 199. As the test brush 303^a touches a test terminal 303 of a trunk line of an idle final selector, upon which terminal there is present the full potential of the battery connected over spring 253^a, spring 275', relay 253^b, and back contact of relay 283, the test relay 198 will be energized, placing its low resistance right hand winding parallel to its high resistance left hand winding, thereby closing a low resistance path to the third terminal of the trunk and making it busy by lowering its potential. As soon as the brushes have been accurately centered upon the trunk, the shunt through the interrupter device 286 is removed and relay 199 is also energized, which opens the circuit of the power magnet 306, and closes the circuit to the holding magnet 310, causing the brush-carriage instantly to stop rotating. The energization of relay 199 also by a circuit over spring 157 bottom drives the sequence switch 205 into position 7.

In this position the fundamental or selecting circuit is again closed, this time to the brushes 301^a, 302^a, at spring 251 bottom and spring 252 bottom, and thence to the final selector 600 by spring 253 bottom to earth on the one hand, and spring 254 top through the line relay 255 to battery on the other. Relay 255 (Fig. 3) and relay 166 (Fig. 5) are thereupon energized, and the former closes an energizing circuit for the final sequence switch 605 over springs 257 top and 256 bottom to move it into position 2, in which position the apparatus is in condition to select the set of brushes in the final selector according to the tens digit of the number of the desired line. As the sequence switch moves into position 2 a circuit for the brush-choosing power magnet is closed through spring 256 bottom, front contact of relay 255, and spring 258 top. For each step taken by the brush-choosing mechanism the interrupter 259 closes a low resistance path to earth over spring 260 top in shunt of the selecting relay 166 to cause the intermittent deënergization thereof. The relay 255 (Fig. 3), however, remains continuously energized.

The intermittent energization and deën-

ergization of the selecting relay 166 causes it to lock up the counting relays, as has been described in connection with the selection of the desired level in the group selector. Since we have assumed that the required number was 1149, the contact 185[a] top of the 10's register is closed and the fifth lower counting relay, upon being energized, closes a circuit over its right armature, register spring 185[a] top of the 10's register, sequence switch spring 188 top, and relays 190 and 165. The energization of the relay 190 by this circuit causes the equipment sequence switch 505 to advance to position 10 and the energization of the relay 165 opens the selecting circuit, as explained above. As the equipment sequence switch passes through position 9, it unlocks the counting relays allowing them to assume their normal positions. When the fundamental circuit is opened at this time the relay 255 (Fig. 3) becomes dependent for its energization on the connection to ground through the interrupter 259 and when the brush-chooser completes its fifth step or stage of movement, this connection being open, the relay 255 is deënergized and closes a circuit over spring 256 bottom, and spring 261 top, for the final sequence switch, moving it into the fifth position. In this position and with the equipment sequence switch in the tenth position the fundamental circuit is complete as before for controlling the final selection at the line switch 600. When the equipment sequence switch closes the fundamental circuit at position 10, the final selector line relay 255 (Fig. 3) is again energized, closing a circuit over spring 256 bottom, and spring 262 top for brush-carriage power magnet 606. As the brush-carriage passes the tripping spindle of the brush-chooser, the selected set of brushes having access to the desired level (containing those having the tens digit of the wanted line) is tripped, and for each set of terminals in this level a low resistance path to ground is closed at the interrupter 263 to the battery side of the fundamental circuit over spring 263[a] top, contact springs actuated by arms 263, and spring 260 top. As in the selection of the tens level, the selecting relay 166 (Fig. 5) is alternately energized and deënergized, with the consequent locking up of the counting relays, the line relay 255 remaining continuously energized. The final selectors are 200-line machines, having 10 levels of 20 lines each. The first ten sets of terminals of each level correspond to the even hundreds of each group, while the second ten sets of terminals correspond to the odd hundreds of the group. The particular line we are considering is 1149 and since the lowest level is occupied by numbers whose tens digit is zero, the line we are considering lies in the fifth level. The particular units digit of this line appears in the second set of ten in this level, inasmuch as its 100's digit is odd. The spring 197 of the 100's register is closed at the top and will consequently connect into circuit the units register springs 192[b], 193[b], 194[b], 195[b], 196[b], keeping open at 197 bottom the circuits of the units register springs 183[b], 185[b], 186[b], 187[b]. Consequently, not until the twentieth counting relay has been energized, will the circuit be closed over right armature and front contact of the twentieth relay 180, units register spring 192[b] bottom, 100's register spring 197 top, equipment sequence switch spring 189 and relays 190 and 165. Relay 165 opens the fundamental circuit, and causes the relay 255 (Fig. 3), when the brushes are properly centered and the shunt through the interrupter 263 is opened, to be deënergized. This relay on deënergizing opens the power circuit for the brush-carriage and closes the circuit for the holding magnet 610 over the spring 285. It also closes a circuit through springs 261 top and 256 bottom for the final selector sequence switch 605 to move it out of its position 5, and such sequence switch will move until it reaches its position 11, position 8 thereof being used only for hunting private branch exchange trunk lines.

As the equipment sequence switch 505 (Fig. 5) which was started by the energization of the relay 190 moves from position 10 through position 11, an impulse is transmitted to the group sequence switch 205 over spring 155 (Fig. 5), spring 156 bottom (Fig. 2), and spring 157 top (Fig. 2). This moves the group sequence switch into position 8, in which movement a circuit is closed to the position sequence switch 305 over spring 158 top and switch spring 159, sending the position sequence switch into position 11. The position sequence switch in position 11 opens the holding circuit to relay 99 (Fig. 5) at its spring 152 bottom and relay 99 (Fig. 5) becomes deënergized, closing a circuit over spring 150 bottom, to drive the equipment sequence switch to its normal position and entirely freeing the registering and controlling equipment A so that it may be used to control selection in setting up another connection.

It may be noted that the equipment sequence switch 505 closes in position 6 over spring 296 a circuit for the progress lamp 297, this lighting of the lamp indicating that the first selection, that is, the selection in the group selector, is taking place properly. Similarly in the positions 8 and 10 of the equipment sequence switch, circuits for the progress lamps 299 and 350 are closed over spring 298 top and bottom respectively, these lamps indicating that the tens and final selections are occurring.

As the position sequence switch 305 moves into position 11, springs 156, 168, 164, and

152, are all opened, thus disconnecting the position sequence switch from the conductors leading to the controlling equipment, and until this sequence switch starts in a new cycle of operations, that is, again leaves its normal position, it is entirely free from any of the operator's apparatus.

As the group sequence switch 205 is moved into position 8, an energizing circuit for relay 174 (Fig. 2) is closed through spring 175 bottom, spring 169 top, brush 301[a] of the group switch 300, terminal 301, and spring 253 bottom (Fig. 3), such relay energized closing a circuit through spring 176 bottom to move the group sequence switch into position 9 in which position it will remain until the called party answers.

When the final selector sequence switch started in motion at the end of the final selecting operation, in passing through positions 6 and 7 it established a test circuit whereby the busy or idle condition of the selected line is determined. This test circuit extends from the third or test brush 603[a] of the released set of brushes through the polarized relay 268, spring 265 top, left (high resistance) winding of the test relay 264 to the middle point of the battery. The cut-off relay of the line under test (see cut-off relay 62 of the calling line; Fig. 1) is connected to full battery potential, and therefore, provided the line is not busy, the potential of half of the battery will cause the relay 264 to be energized in such positions, 6 and 7. Assuming first that the selected line is not busy, relay 264, at position 6 or 7, being energized, closes a circuit over spring 266 bottom for relay 267, which relay locks itself up over a circuit leading through spring 256 top, in positions 6 to 9 of the sequence switch 605. In the normal operation of the system this relay will now be maintained locked up over front contact of relay 253[b] and off-normal contact of interrupter 259 in positions 9 to 12, and over spring 256 top again in positions 12 and 13 of the sequence switch. Relay 267 at its middle front contact closes circuit to the test brush through the right hand lower resistance winding of relay 264, which circuit so reduces the potential on the test terminal of the selected line that the line will test busy to all other final selectors.

On coming into position 8 the sequence switch will find closed by the relay 267 a circuit through spring 261 bottom which will cause it to continue in motion until it reaches its eleventh position. In position 11, relays 267 and 264 will still be energized, and a circuit will be closed to move the final sequence switch to position 12, such circuit like the one found in position 8 being over the outer right armature of relay 267, and spring 261 bottom. This twelfth position is the ringing position, ringing current being supplied to the line over front or back contact of polarized relay 268, depending on the direction of current flow in the test circuit, the circuit for such ringing current including the ringing cut-off relay 269 and springs 270 bottom and 272 bottom. Whether the ringing current is to be supplied over the front or back contact of the relay 268 relates solely to party line ringing, which, however, since it forms no part of the particular invention herein disclosed, need not be discussed further than to say that since the line selected is assumed to be an ordinary subscriber's line the current flow through the polarized relay 268 is of such direction that the relay will be energized and attract its armatures so long as it is connected in the test circuit with the test terminal of the line. This is of importance when considering the attempted connection with a busy line.

So long as the direct current circuit at the called substation remains open the ringing current will be insufficient to energize the relay 269, but when the subscriber answers by removing his receiver from its hook, the amount of current will be so increased by the closure of the substation circuit that the relay 269 will be energized and will close a circuit to move the sequence switch 605 into position 13, in which movement the circuit for relay 174 (Fig. 2[a]) leading through spring 253 bottom is opened and the relay 174 (Fig. 2[a]) thereupon becomes inert, closing a circuit to the group sequence switch 205 over spring 176 top, which now moves into position 10. This is the through or talking position of the group sequence switch. As this sequence switch moved into position 10, a circuit is closed to restore the position sequence switch to normal, this circuit leading through spring 97 top of the group sequence switch and sequence switch spring 84 bottom of position sequence switch magnet 305 to battery. The group sequence switch 205 moving into position 10 has closed the talking circuit from the subscriber's line to the final selector at sequence switch spring 251 top and sequence switch spring 252 top. The position sequence switch 305 moving from position 11 into position 1 opens the circuit of the progress lamp 96 at sequence switch spring 80 top, the extinguishing of such lamp 96 indicating to the operator that the connection has been established. This sequence switch, on moving into position 1, closes a circuit to the supervisory lamp 273, by way of spring 79 top and front contact of the relay 199. The final selector sequence switch is arrested in position 13 due to the opening of the circuit through relay 269 at spring 270 bottom. This position is the through or talking position. In this move-

ment into position 13 it includes in the subscriber's line circuit the supervisory relay 274 which is thereupon energized, and at its front contact closes a circuit for relay 255 which removes the short-circuit about the resistance 275, which short-circuit would otherwise be established in position 13, by way of spring 277 top and spring 276 bottom. This short-circuit is a substitute circuit around the resistance 275 for the short-circuit maintained in the positions 1 to 12 and in position 14 by the spring 275'. The inclusion of this resistance in the circuit of relay 199 (circuit Fig. 2) causes its deenergization without affecting the energized condition of the relay 198. Upon the deenergization of relay 199 it opens the circuit of the supervisory lamp 273 so that such lamp will not be lighted. So long therefore as the receiver of the called subscriber if off its hook, the relay 199 will remain deënergized and the lamp 273 unlighted. With the line finder sequence switch 105 (Fig. 1) at position 5, group sequence switch 205 at position 10, and the final selector sequence switch 605 in position 13, the complete talking circuit is established from the calling subscriber's station to the called subscriber's station, such circuit including the usual source of current for supplying both of such stations and also the usual repeating coil (Fig. 3).

Disconnection.

Upon the conclusion of conversation, when the calling subscriber 50 restores his receiver to its switch hook, it opens the circuit of the supervisory relay 94 (Fig. 2[a]), which thereupon becomes deënergized closing the circuit of the supervisory lamp 95 over spring 279 bottom, and when the called subscriber 278 restores his receiver to its switch-hook, relay 274 (Fig. 3) becomes deenergized, opening the circuit of relay 255, which now closes the short circuit around resistance 275, and the relay 199 is energized, thereby closing the circuit of and lighting the supervisory lamp 273 (Fig. 2[a]). The mere restoration, therefore, of the receivers at the respective calling and called substations causes the two supervisory lamps 95 and 273 to be lighted to indicate to the operator that the conversation has been concluded. The operator thereupon presses the register and disconnect key 280, closing a circuit over brush 203[a] and terminal 203 of the second line finder switch, spring 70 top (Fig. 1), spring 59 top, brush 104[a] and terminal 104 of the line finder switch 100, lower armature of the relay 62, through the message register 281, thereby operating such message register and charging the call thereon.

The substation 50 may be provided with a toll device of a type well known to those skilled in the art having a polarized magnet which is connected with one of the line conductors, the other terminal being connected over a contact operated on initiating a call to earth. In this type of toll device the polarized magnet is arranged either to charge the call or to rebate the call, depending upon whether the desired connection was or was not established. This toll device may be either a coin collector or a message register. The operation of the magnet of the device is controlled by the operator, who, by means of suitable keys, connects positive or negative current of about 100 volts to the line. The key 280[b] is the rebate key which when actuated connects positive current to the line conductor causing the polarized magnet of the toll device to attract its armature in such a direction that the call is rebated.

No separate charging key is employed; an extra contact 208[a] located on the register and disconnect key 280 being provided which upon the operation of the key connects negative potential to the line conductor. In the case of an established connection, the operator presses the key 280, by which single operation she not only initiates disconnection and operates the message register 281, but also charges the call in the substation toll device—in case the line should be provided with such device and a message register. The depression of the key 280 closes a circuit over spring 282 top, for the relay 67 which relay on energizing closes a circuit over spring 89 bottom, for the group sequence switch 205 to drive it into position 14. Relay 67 also opens the circuit through relays 198 and 199 to the terminal 303 of the group selector causing not only the deenergization of these relays but also the deenergization of the relay 253[b], (Fig. 3) which by deënergizing closes a circuit for relay 283, this relay remaining energized until its circuit is opened by the restoration of the final selector brush chooser to its normal position. The relay 283 on the attraction of its middle armature removes battery from relay 253[b] and at its left front contact closes a circuit through the terminal 301 of the trunk circuit to energize the relay 174 (Fig. 2[a]), such circuit being over terminal 301 and brush 301[a] of the group selector spring 169 top, spring 175 top, and contact of relay 67. Relay 174 becomes energized before the group sequence switch has reached position 14 and will remain energized to prevent its restoration until the final selector has been restored to normal.

Another circuit for energizing the relay 174 and which will maintain it energized after the deënergization of the relay 283 which may occur before the brush carriage of the final selector has reached its normal position extends from the terminal 301 of the group

selector through final selector spring 253 top and one winding of the repeating coil to ground. This latter circuit will not be opened until the final selector sequence switch is coming into its normal position. As the group sequence switch 205 moves from position 10 to position 14, the circuit to the first finder over spring 65 bottom is opened at position 12, resulting in the deenergization of relay 107 (Fig. 1) which thereupon closes over springs 55 and 56 top a circuit to move the first finder sequence switch to position 7 in which position the circuit of the cut-off relay 62 of the calling line is opened at spring 61 bottom, and, such relay releasing its armature, the subscriber's line circuit is immediately freed.

With the final selector sequence switch (605) at position 16, to which position it moved when relay 283 was energized by a circuit established through the fourteenth position through spring 257 bottom, and with relay 255 deënergized, a circuit is closed to the brush carriage power magnet 606 over spring 256 bottom, spring 277, back contact of relay 264, and spring 262 bottom, whereupon the brush carriage is started on its restoring movement. As it passes the brush restoring bar shown, the released brushes are forced back and held by the corresponding latch in their normal retracted position. When the carriage reaches its normal position the earthed spring of the interrupter 263 comes into contact with the segment 284, insulated from the frame, closing the circuit of relay 264 over spring 286 bottom. Relay 264 energizing opens the circuit of power magnet 606 and closes a circuit to relay 267, also closing the circuit to holding magnet 610 through spring 285 bottom, to instantly arrest the rotation of the brush carriage. Relay 267 on energizing closes a circuit to the sequence switch 605 over spring 261 bottom, and returns it to normal. From positions 15 to 1 of this sequence switch, a circuit to the brush choosing power magnet 612 was closed at spring 258 bottom, and the off-normal contact of the brush chooser and drives the tripping spindle thereof to its normal position. As the sequence switch of the final selector moves from its last position into its normal position, the circuit to the group selector over the terminal 301, is opened at spring 253 top, and hence, the relay 283 being already deënergized, the relay 174 (Fig. 2) becomes deënergized, and closes over spring 176 top a circuit for the group sequence switch 205 which moves it into position 15. At position 15, a circuit is closed to the motor magnet 306, of the brush carriage over back contact of relay 199 and spring 250 bottom to restore the carriage to its normal position. In passing the brush restoring roller the released brushes are latched back in normal position. As the brush carriage comes into its normal position, the interrupter brush makes contact with insulated segment 286 and closes a circuit to relay 199 over spring 282 bottom, normal contact of the key 68 and left back contact of relay 67. Relay 199 energized, breaks the circuit through magnet 306 and closes the circuit through the holding magnet 310, causing the brush carriage to stop rotating instantly. Relay 199 also closes a circuit over spring 157 bottom to move the group sequence switch 205 into its normal position, in which movement the circuit to the line finder is opened at spring 65 bottom sufficiently long to allow relay 107 (Fig. 1) to be deënergized, which relay thereupon closes a circuit over spring 55 top, spring 56 top, to advance the line finder sequence switch 105 to its normal position.

All the sequence switches and both the group selector and final selector are now returned to normal position and are ready to establish a new connection. The brush carriages of the first and second line finder switches have not been moved from the position in which the connection was established as they have no normal position, but they are nevertheless, since their associated apparatus is at normal, also ready for a new connection.

Attempted calling of a busy line.

With the group sequence switch 205 in position 9, when the final selector sequence switch 605 passes through positions 6 and 7, relays 264 and 267 will not be energized if the called line is busy, as, owing to the reduced potential present on the test terminal of such line, there will be insufficient current in the test circuit to energize relay 264. Sufficient current, however, will be present to energize the relay 268, and since the line selected is an ordinary line, the flow of current will be in the direction to cause the attraction of the armature of such relay 268.

This busy condition, that is, reduced potential upon the test terminal, will exist if the line tested is in use either as a calling or a called line. In either case there will be a connection to ground from the test conductor connected to the test terminal 603, either through a low resistance winding of a relay 264 of some other final selector if the line is in use as a called line, or through a test terminal 103, relay 108, and springs 61 and 60 of a first line finder switch if the line is in use as a calling line.

When, therefore, the line tested being busy the final selector reaches its eighth position the relay 267 will not be energized, and the circuit for the sequence switch 605 over the left front contact of such relay 267 will not be closed. However, as the line under test

is an ordinary line, the polarized relay 268 will be energized, and a circuit will be closed over its right front contact and spring 261 bottom that will drive the sequence switch 605 out of its eighth position, and it will come to rest in its eleventh position as the circuit for driving it out of such position is open due to the fact that the relay 267 is not energized.

In the eleventh position of this sequence switch a circuit is established for the brush-carriage power magnet over spring 256 bottom, back contact of relay 255, spring 277 bottom, back contact of relay 264, and spring 262 bottom, and the brush-carriage will rotate until it reaches its normal position.

When, however, the earthed brush of the interrupter 263 reaches the segment 284, a circuit over spring 286 bottom to energize relay 264 will be closed, which when energized, opens the circuit to power magnet 606 and closes a circuit to holding magnet 610 over spring 285 bottom, causing the immediate stopping of the brush carriage. Relay 264 at the same time closes a circuit for relay 267, which in turn closes a circuit over its outer right front contact, spring 261 bottom, to sequence switch 605, causing it to be moved into position 12, in which position the brush carriage interrupter arm being in contact with the block 284, a circuit is closed over spring 286 top to sequence switch 605 driving it without stop into position 14. As this sequence switch leaves position 12, the circuit to terminal 301 is interrupted at spring 253 bottom, and relay 174 (Fig. 2) is deënergized. Relay 174 thereupon closes a circuit over spring 176 top, to the group sequence switch which moves to position 10. In this position a circuit is closed over spring 97 top, spring 84 bottom to position sequence switch 305 returning it to position 1, where it closes a circuit for lamp 273 including spring 79 top and front contact of relay 199. With the final selector sequence switch in position 14 and group sequence switch 205 in position 10, and the position sequence switch at normal, the lamp 273 will flash repeatedly, denoting to an operator that the called line is busy. The intermittent flashing of the lamp 273 is caused by the intermittent energization and deënergization of the relay 199 produced by the interrupter 287 at the final selector. When in the fourteenth position of the final selector sequence switch the circuit through the interrupter is open, the relay 199 will be energized over the circuit hereinbefore traced, the spring 275 being closed in this position. When, however, the interrupter 287 has rotated so that it closes a circuit to ground through the spring 276 top, the relay 199 will be shunted and will allow its armature to retract. The continued operation of the interrupter will, therefore, produce before the operator a distinctive signal to indicate that the desired line is busy. It should here be noted that the resistance in the interrupter circuit is not sufficiently low to cause the deënergization of the relay 198. The operator will now press the trunk key 288 and notify the waiting calling subscriber that the party he desired is busy. When this subscriber restores his receiver to the switch-hook, thereby lighting the supervisory lamp 95, the operator will press the master wipe-out key 289 while the listening key 288 is still depressed. This will energize the relay 67 and the clearing out process, without, however, the operation of the message register, will be initiated. The operation of the message register will not take place in this clearing out operation, for the reason that, as the key 280 has not been operated, no registering potential has been applied to the conductor leading to the message register, since the call has not been a successful one. The clearing out which has been thus initiated will take place precisely as did the clearing out after a complete connection as hereinbefore described, except that the final selector sequence switch, being in its fourteenth position, and the final selector brush-carriage being already in its normal position, the restoration of the final selector apparatus will begin from the fourteenth position of the final selector sequence switch, and such sequence switch will not have to wait in its sixteenth position for the restoration of the brush-carriage.

Disconnecting at any period of the connection.

The calling subscriber can at any time, by moving his receiver switch-hook, flash his supervisory lamp 95, thereby attracting the attention of the operator, and if for any reason the operator desires to disestablish the connection, either while it is being established, or after it has been established, she can do so by actuating the trunk listening key 288 and the master wipe-out key 289. This will, at any time, energize the relay 67, which relay will remain energized through position 14 of the group sequence switch. This will move the sequence switch to position 14 over spring 89 bottom. Whether or not it passes to position 15, depends upon the relay 174 which will be energized if a final selector has been seized, and, if so, will remain energized until such a final selector has been restored to normal, when it is rendered inert, as hereinbefore described, and closes a circuit to move the group sequence switch to position 15. If a final selector had been seized when the relay 67 is energized the consequent energization of the relay 283, in the manner hereinbefore described, will close a circuit through its right hand front contact and spring 257

bottom to drive the final selector sequence switch directly into its eleventh position. From this position, the relay 267, being deenergized, since its circuit is open at the front contact of relay 253[b], the restoration of the final selector apparatus will take place as has been fully described.

In position 15 of the group sequence switch, spring 282 top is opened to deënergize relay 67 and closed at its bottom or alternate contact to energize the relay 199 when the group selector brush-carriage reaches normal. The relay 199 then closes a circuit to move the group sequence switch to normal position. When the operator clears out, as explained above, springs 158 and 97 will close circuits to restore to normal the position sequence switch 305, and the position sequence switch returning to normal will open the telephone circuit to any operator who may be connected thereto, and also open the operator's controlling equipment circuits, as has been explained above. The group sequence switch at position 12, and in leaving position 16, will at spring 65 cause the restoration to normal of the first finder switch apparatus, as has been described.

Locking.

If for any reason the operator wishes to lock into position the various switches used in building up a connection, as for instance, to allow a fault to be located, she can do so at any time during the progress of a connection by actuating the locking key 68 to close a circuit to the group sequence switch 205, over left back contact of relay 67, and spring 66 top. This will move the group sequence switch directly into position 13. The group sequence switch moving into position 13 will immediately return to normal the position sequence switch 305, so that the operator's controlling equipment and the operator's sequence switch, which may be connected to the connecting circuit shown, and which equipment and switch are common to a plurality of connecting circuits, will be disconnected and rendered free to be used in establishing a connection over some other connecting circuit.

In throwing the key 68, earth is removed from the group selector test circuit connected to the third wire leading to the final selector and the relay 253[b] (Fig. 3) will become deënergized, closing the circuit of relay 283. When the group sequence switch moves into position 11, the relay 174 is bridged across the connecting circuit, as the relay 67 has not been energized. The circuit is as follows:—brush 301[a], spring 169 top, winding of relay 174, spring 175 top, right back contact of relay 67 to the brush 302[a]. Hence, as the final selector sequence switch 605 is moved out of its position 8, due to the energization of the relay 283, relay 174 will become energized over left front contact of relay 283, spring 254 top (Fig. 3), and relay 255. If the locking-up occurred previous to position 8 of the final selector sequence switch, then as this sequence switch moves into position 11, the circuit of the relays 264 and 267 will be opened, inasmuch as relay 253 is deënergized. Consequently, there will be no ground or battery connection to the test terminal of the subscriber's line, and such line will test free to other final selectors seeking a connection, or be free to initiate a call. The final selector sequence switch will remain in position 11 as long as relay 255 remains locked, since the clearing out circuit in position 11 is over the back contact of relay 255, hence the brush-carriage will remain on the terminals of the line upon which it last stood, but all of the leads to the line will be open at springs 272 and 270, the test terminals being free as just described. Had the operator pressed the locking key at an instant after position 11 of the line switch circuit, the relays 253[b] and 283 of the final circuit would have been deënergized and energized respectively, as was the case before, and the sequence switch will be moved to position 16 and will there remain, locked in this position until the relay 255 becomes deenergized by the opening of the holding circuit over relay 174 (Fig. 2).

Referring to circuit Fig. 2[a], when the key 68 was depressed, the group sequence switch went to position 13. When, however, the relay 174 was placed across the line and became energized, it moved the sequence switch on to position 14, by closing a circuit over spring 176 bottom. The group sequence switch in moving from position 11 to position 13, momentarily opened the circuit leading to the first line finder over the brush 204[a] at spring 65 bottom, thereby causing the momentary release of relay 107 and the consequent moving of the line finder sequence switch 105 to position 7. Relay 107 will, in position 13 of the group sequence switch 205, again be energized and so maintained over spring 65 bottom (Fig. 2). The cut-off relay 62 of the calling subscriber's line, however, has been released due to the opening of its circuit at spring 61 bottom of the line finder sequence switch.

Hence, with the locking key 68, (Fig. 2[a]) actuated, the first line finder circuit will be locked in position 7 of the line finder sequence switch, the second finder and group selector circuits will be locked in position 14 or 15 of the group sequence switch, and the final selector circuit will be locked in position 11 or 16 of the final selector sequence switch, until such a time as the operator releases the circuits by restoring the locking key to normal, and depressing either the key

280 or the keys 288 and 289. The calling subscriber's line thus freed, by throwing key 68, is ready immediately to be picked up by an idle line finder if his receiver be still off its switch-hook, and a desired connection can now be established over a new set of line finder switches and selectors.

If, when a subscriber desiring to make a call removes the receiver from its hook at his substation, one of the first line finder switches 100 should be standing with its brushes 101^a—104^a upon the terminals 101 to 104 of such subscriber's line, the circuit for the relays 108 and 107 of the test circuit of the line finder will be closed at the same time that the circuit for the pilot relay 52 is closed. The relay 107 will therefore be energized before the power magnet 106 can receive current over the circuit controlled by the front contact of the pilot relay 52, and since the energization of the relay 107 opens the circuit of the power magnet the line finder switch will not move, but will immediately seize the line placing the test guards on the test terminals thereof and initiating the action of the second line finder switches, as has been hereinbefore fully described.

Similarly, if a second line finder switch should be standing with its brushes 201^a—204^a on the terminals 201—204 of a line to a first line finder switch when the spring 63 of such switch is closed, such second line finder switch will not move but will seize such line, placing the usual test guard thereon by the inclusion of the upper (low) resistance winding of relay 208 in the test circuit leading to the brush 204^a and starting the operation of the group sequence switch by the response of the relay 207, as has been hereinbefore described.

I claim:—

1. In a telephone exchange system, the combination with a plurality of lines, a plurality of positions, means for bringing calling lines to said positions, manual means adapted to render a position accessible to calls awaiting attention at another position, and means for automatically diverting said calls thereto.

2. In a telephone exchange system, the combination with a plurality of lines, a plurality of operators' positions, means for automatically bringing calling lines to said positions, and means for transferring calls from a position at which they are awaiting attention to another position.

3. In a telephone exchange system, the combination with a plurality of lines, a plurality of operators' positions, means for automatically bringing calling lines to said positions, manual means for rendering each position accessible to calls awaiting attention at another position, and means for automatically diverting said calls thereto.

4. In a telephone exchange system, the combination with a plurality of lines, a plurality of operators' positions, means for automatically bringing calling lines to said positions, manual means for rendering each position accessible to calls awaiting attention at an adjacent position, and means for automatically diverting said calls thereto.

5. In a telephone exchange system, the combination with a plurality of lines, an operator's position, means for automatically bringing calling lines to said position, a second position, numerical controlling keys at each of said positions, means whereby either operator can divert calls from the other position to her own, and means for supervising said calls.

6. In a telephone exchange system, the combination with a plurality of lines, an operator's position, means for automatically connecting calling lines to said position, a second position, manual means for rendering said second position accessible to calls awaiting attention at said first position, means for automatically diverting calls from said first to said second position upon the actuation of said manual means, numerical controlling keys and selection controlling equipments, selectors adapted to extend connections under control of said keys and equipments, and means for supervising calls.

7. In a telephone exchange system, the combination with groups of lines, operators' positions, means for automatically bringing calls from different groups of lines to each of the positions independently, numerical controlling keys at each position, and means whereby any operator may divert calls from another operator's position to her own.

8. In a telephone exchange system, the combination with a plurality of lines, operators' positions, means for automatically connecting calling lines to said positions, manual means for rendering each position accessible to calls awaiting attention at an adjacent position, means for automatically diverting said calls thereto, and signals for supervising said calls.

9. In a telephone exchange system, the combination with a plurality of lines, connecting circuits, means for automatically extending calling lines to said connecting circuits, operators' positions, the calls on a given group of connecting circuits being normally answered at a given position, visual signals located at said position for indicating the number of calls awaiting connection thereat, and a manual key at each position adapted when actuated to render the corresponding position accessible to unanswered calls normally answered and awaiting connection at an adjacent position, and automatic apparatus for thereupon diverting said calls thereto.

10. In a telephone exchange system, the combination with a plurality of lines, con-

necting circuits, means for automatically extending calling lines to idle connecting circuits, operators' positions, means for automatically extending connecting circuits to which calling lines are connected to idle ones of said positions, visual signals at each position associated with the connecting circuits thereof and actuated by the connection of calls thereto, and a manual key at each position adapted when actuated to render the corresponding position accessible to unanswered calls normally answered and awaiting connection at another position, and automatic apparatus for thereupon diverting said calls thereto.

11. In a telephone exchange system, the combination with a plurality of lines, operators' positions, connecting circuits apportioned to each position, means for automatically extending calling lines thereto, an electromechanism adapted normally to cause the connection of a call on one of said connecting circuits to a given position if idle and if busy to direct the connection of said call to another of said positions if idle.

12. In a telephone exchange system, the combination with a plurality of lines, operators' positions, means for automatically connecting a calling line to an idle one of a plurality of positions, a signal adapted to be actuated at a particular one of said positions by a calling line awaiting connection thereto, means for connecting said calling line to one of the other positions to which it has access if the position at which the signal is located is busy, and means for preventing the subsequent idle condition of the position at which said signal is located from affecting the extension of said calling line by the position to which it has been connected.

13. In a telephone exchange system, the combination with a plurality of lines, connecting circuits, operators' positions, selection controlling equipments thereat, automatic means for connecting a calling line to an idle connecting circuit, automatic means for extending such connecting circuit to any one of a plurality of positions, and means for selectively associating therewith an idle equipment.

14. In a telephone exchange system, the combination with a plurality of lines, operators' positions, connecting circuits, means for automatically extending calling lines to said connecting circuits, a plurality of selection controlling equipments for each of said positions, and a sequence switch adapted to respond upon the connection of a calling line to a connecting circuit to move to one of a plurality of its positions individual to an idle operator and then select a position corresponding to an idle equipment of such operator.

15. In a semi-automatic telephone exchange system, the combination with a plurality of lines, connecting circuits, automatic switches for extending calling lines to idle connecting circuits, a plurality of operators' positions, selection controlling equipments thereat, a visual signal for each connecting circuit operated at a particular position upon connection of a call to said connecting circuit, and means for extending said call to said position if idle and for selecting an idle one of the controlling equipments of the said position.

16. In a semi-automatic telephone exchange system the combination with a plurality of lines, connecting circuits, first and second line finders for distributing calls thereto, a line relay adapted upon the initiation of a call to cause a first line finder to seek the line wherein said call originated, and means actuated upon the arrival of the said finder on the calling line terminals for causing a second line finder to seek for and connect with said first line finder, operators' positions, a signal actuated at one of said positions by the connection of said second line finder with said first line finder, means for automatically connecting said call to an idle position, selector switches for interconnecting said lines, a selection controlling equipment at said position for controlling said switches under the guidance of the operator, and signals for permitting the operator to supervise the connection when established.

17. In a semi-automatic telephone exchange system, the combination with a plurality of lines, automatic switches for interconnecting said lines, a plurality of positions, automatic selection controlling equipments at said positions for controlling said switches in the extension of connections, means at one operator's position for establishing a connection and means at another for supervising the same.

18. In a semi-automatic telephone exchange system, the combination with a plurality of lines, connecting circuits, automatic means for extending a call to an idle one of said connecting circuits, automatic means for extending said connecting circuit to any one of a plurality of operators' positions, the calls on a particular connecting circuit being normally answered at a given position, means for diverting said calls to another position, means thereat for answering said calls and establishing the desired connections, and means at the normal position for supervising calls so established.

19. In a semi-automatic telephone exchange system, the combination with a plurality of lines, operators' positions, selection controlling equipments for each position, a set of manual keys adapted to control severally said equipments when associated therewith, connecting circuits, automatic switches for connecting calling lines thereto,

and switching mechanism actuated by the connection of a calling line with a connecting circuit for associating one of said equipments with said connecting circuit and such set of keys with said equipment.

20. In a semi-automatic telephone exchange system, the combination with a plurality of lines, operators' positions, telephones thereat, selection controlling equipments for each position, a set of manual keys adapted severally to control said equipments when associated therewith, connecting circuits, means for connecting a calling line to an idle connecting circuit, means for associating an operator's telephone with said connecting circuit, and automatic means for connecting a controlling equipment to said connecting circuit.

21. In a semi-automatic telephone exchange system, the combination with a plurality of lines, operators' positions, selection controlling equipments for each position, a set of manual keys adapted severally to control said equipment when associated therewith, connecting circuits, means for connecting a calling line to an idle connecting circuit, means for simultaneously associating with said connecting circuit an operator's telephone and a controlling equipment, and means for disconnecting the telephone during the operation of the controlling equipment.

22. In a semi-automatic telephone exchange system, the combination with a plurality of lines, connecting circuits including automatic switches, means for automatically connecting calling lines to idle ones of said connecting circuits, operators' positions, telephones and selection controlling equipments thereat, a set of manual keys for controlling said equipments, means for automatically associating an operator's telephone, selection controlling equipment and set of keys with a connecting circuit to which a calling line has been connected, means actuated upon the completion of the designation of the desired line upon said keys for disconnecting said telephone from said connecting circuit, and means actuated upon the completion of control of said connection by said equipment for disconnecting the same from said connecting circuit.

23. In a semi-automatic telephone exchange system, the combination with a plurality of lines, connecting circuits, means for automatically connecting calling lines to idle ones of said connecting circuits, means for associating an operator's telephone therewith, selection controlling equipments, a set of manual keys for controlling said equipments, means for associating said equipment and keys with the connecting circuit to which the telephone has been connected, a final selector controllable over said connecting circuit, means actuated upon the completion of the designation of the desired line upon said keys for disconnecting said telephone from said connecting circuit, and means actuated when the brushes of the final selector reach the terminals of the desired line for disconnecting the equipment from said connecting circuit.

24. In a telephone exchange system, the combination with a plurality of selectable selection controlling equipments, an individual circuit to be connected to an idle one thereof, an automatic switch adapted to select an idle one of said equipments and to extend said individual circuit thereto, and a second automatic switch for maintaining said individual circuit open until it has been connected to the selected equipment by said automatic switch whereupon said second automatic switch closes said individual circuit.

25. In a telephone exchange system, the combination with a group of lines, a group of line finder switches to which said lines are multipled, connecting circuits adapted to be connected to calling ones of said lines by said finder switches, and a pilot relay adapted upon the initiation of a call in any of said lines to cause said finder switches to seek said calling line, and a relay actuated upon connection being made by the first arriving finder switch to cause said pilot relay to arrest the travel of the remaining finder switches if no other call has in the meantime been initiated in the same line group.

26. In a telephone exchange system, the combination with a group of lines, a group of line finder switches to which said lines are multipled, connecting circuits adapted to be connected to calling ones of said lines by said line finder switches, a pilot relay adapted upon the initiation of a call in any of said lines to cause said finder switches to seek said calling line, and a relay actuated upon connection being made by the first arriving finder switch to open the power circuit of such finder switch independent of the condition of said pilot relay.

27. In a telephone exchange system, the combination with a plurality of lines, line finders to which said lines are multipled, means actuated upon the initiation of a call in any of said lines for causing said line finders to seek for and one of them to connect with said calling line, second line finders to which said first line finders are multipled, and means actuated upon said first line finder connecting with the calling line for causing said second line finders to seek for and one of them to connect with said first line finder.

28. In a telephone exchange system, the combination with a plurality of lines, line finders to which said lines are multipled, means actuated upon the initiation of a call

in any of said lines for causing one of said line finders to seek for and connect with said calling line, second line finders to which said line finder is multipled, and a sequence switch actuated by the first arriving first line finder to close the starting circuit of the second line finders, the particular second line finder connecting with said first line finder being adapted to control said sequence switch to place the apparatus of the first line finder in through or talking position.

29. In a semi-automatic telephone exchange system, the combination with a plurality of lines, automatic switches for establishing connections therebetween, and means controlled by the operator for rendering the parties to said connection free to call or be called without disestablishing the connection already set up.

30. In a semi-automatic telephone exchange system, the combination with a plurality of lines, finder and selector switches for establishing connections therebetween, test and calling conductors for the interconnected lines, and means controlled by the operator for clearing the test and talking conductors of both lines at the finder and selector switches, without releasing said switches.

31. In a semi-automatic telephone exchange system, the combination with a plurality of lines, automatic switches for interconnecting the same, manually set electromagnetic means for directing said switches, means for supervising said connection when established and manual means at the central office for disestablishing a connection.

32. In a telephone exchange system, the combination with a plurality of lines, a plurality of connecting circuits, line finder switches for extending calling lines to idle connecting circuits, means for guarding extended calling lines against seizure, means actuated immediately the brushes of a finder arrive at the calling line terminals for placing a test guard thereon, and means for continuing the travel of said brushes until centered upon such terminals.

33. In a telephone exchange system the combination with a plurality of lines, a plurality of connecting circuits, line finder switches for extending calling lines to idle connecting circuits, means for guarding extended calling lines against seizure, a relay associated with each finder adapted to respond immediately the brushes of the finder arrive at the calling line terminals for placing a test guard thereon, and a relay adapted to respond when the brushes are squarely centered upon said terminals for stopping said switch.

34. In a telephone exchange system, the combination with a plurality of lines, a plurality of connecting circuits, line finder switches for extending calling lines to idle connecting circuits, means for guarding extended calling lines against seizure, a relay associated with each finder adapted to respond immediately the brushes of the finder arrive at the calling line terminals for placing a test guard thereon, a relay adapted to respond when the brushes are squarely centered upon said terminals, for stopping said switch, and an interrupter, the first said relay being double wound and applying said test guard by closing a circuit through its low resistance in parallel with its high resistance winding normally in the test circuit, the second relay being shunted by said interrupter except when the brushes are centered upon the terminals.

35. In a telephone exchange system, the combination with a plurality of lines, a plurality of connecting circuits, line finder switches for extending calling lines to idle connecting circuits, means for guarding extended calling lines against seizure, a relay associated with each finder adapted to respond immediately the brushes of the finder arrive at the calling line terminals for placing a test guard thereon, and a relay adapted to respond when the brushes are squarely centered upon said terminals to arrest the movement of the switch, said latter relay being subsequently transferred to a circuit over the connecting circuit to which the calling line is extended, and means actuated upon initiation of disconnection of the connection to operate said relay to restore said finder and associated apparatus.

36. In a telephone exchange system, the combination with a plurality of lines, a plurality of connecting circuits, line finder switches for extending calling lines to idle connecting circuits, means for guarding extended calling lines against seizure, a relay associated with each finder adapted to respond immediately the brushes of the finder arrive at the calling line terminals for placing a test guard thereon, and a relay adapted to respond when the brushes are squarely centered upon said terminals to arrest the travel of the switch, said latter relay being subsequently transferred to a circuit over the connecting circuit to which the calling line is extended, a manual key, said relay being actuated by the operation of said key to cause the freeing of the calling line without releasing the finder.

37. In a telephone exchange system, the combination with a plurality of lines, connecting circuits, of first and second line finder switches for extending a calling line to a connecting circuit, means for restoring said second finder and the associated connecting circuit upon termination of conversation, and for subsequently restoring said first line finder.

38. In a telephone exchange system, the

combination with a plurality of lines, connecting circuits, first and second line finder switches for extending a calling line to a connecting circuit, means for guarding extended calling lines against seizure, and means actuated upon the initiation of the disconnecting operation for removing the test guard from the calling line while maintaining the first line finder in contact with the line terminals, means for thereafter restoring the second finder and connecting circuit, and means actuated upon restoration of said second finder and connecting circuit for restoring said first finder.

39. A telephone exchange system including telephone lines extending to an exchange; link connectors at the exchange for uniting lines in conversation; calling line operators' responsive devices at different operators' positions; selector switches operable by calling lines for selecting responsive devices that are free for selection; means for holding a succeeding or second operating responsive device hunting selector switch in position to connect the same responsive device with the calling line operating such succeeding selector switch; and operator controlled means for freeing the selected responsive device from the first selector switch and bringing it into connection with the second selector switch and thereby with the calling line operating the second selector switch.

40. A telephone exchange system including telephone lines extending to an exchange; link connectors at the exchange for uniting lines in conversation; operators' telephones at different operators' positions; selector switches operable by calling lines for selecting operators' telephones that are free for selection; means for holding a succeeding or second operating operator's telephone hunting selector switch in position to connect the same operator's telephone with the calling line operating such succeeding selector switch; and operator controlled means for freeing the selected operator's telephone from the first selector switch and bringing it into connection with the second selector switch and thereby with the calling line operating the second selector switch.

41. A telephone system comprising circuits severally available for calling purposes, an operator's telephone set common to said circuits, means responsive to the initiation of a call over any of said circuits to extend such circuit into conversational connection with the operator's set but only when said set is free for use, and means under the control of an operator for further extending such an extended circuit.

42. A telephone system comprising a circuit available for calling purposes, an operator's telephone set for use with said circuit, other circuits for use with said set, means responsive to the initiation of a call over said first mentioned circuit to extend it into conversational connection with said operator's set but only when said set is free for use, and means under the control of an operator for further extending such extended circuit.

43. A telephone system comprising circuits severally available for calling purposes, operators' telephone sets available for connection to said circuits, means responsive to calls over said circuits to extend said circuits individually into conversational connection with said sets but only when said set is free for use, and means under the control of an operator for further extending such extended circuits.

44. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, an operator's telephone set common to said link-circuits, means responsive to the initiation of a call over any of said lines to connect the calling line into conversational connection with one of said link-circuits and thence to said operator's set but only when the latter is free for use and means under operator control for further extending the conversational circuit thus established.

45. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' sets available for connection to said link-circuits, means responsive to the initiation of calls over said lines to certain of said link-circuits and thence into conversational connection with said operators' sets but only when the latter are free for use and means under operator control for further extending the conversational circuits thus established.

46. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' sets available for connection to said link-circuits, means responsive to the initiation of a call over any of said lines to connect the calling line to one of said link-circuits and thence into conversational connection with one of said operators' sets but only when the latter is free for use and means under operator control for further extending the conversational circuit thus established.

47. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, an operator's telephone set common to said link-circuits, means responsive to the initiation of a call over any of said lines to connect the calling line and an idle one of said link-circuits into a conversational circuit with the operator's set and means under operator control for further extending the conversational circuit thus established.

48. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' sets available for connection to said link-circuits, means responsive to the initiations of calls over said lines to connect the calling lines and idle ones of said link-circuits into conversational circuits with the associated operators' sets and means under operator control for further extending the conversational circuits thus established.

49. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' sets available for connection to said link-circuits, means responsive to the initiation of a call over any of said lines to connect the calling line and an idle one of said link-circuits into a conversational circuit with the operator's set associated with that link-circuit and means under operator control for further extending the conversational circuit thus established.

50. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, an operator's telephone set common to said link-circuits, means responsive to every initiation of a call over said lines to test said link-circuits successively in the same order and connect the calling line and an idle one of said link-circuits into a conversational circuit with said operator's set and means under operator control for further extending the conversational circuit thus established.

51. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' sets available for connection to said link-circuits, means responsive to all initiations of calls over said lines to test said link-circuits successively in the same order and connect the calling lines and idle ones of said link-circuits into conversational circuits with the associated operators' sets and means under operator control for further extending the conversational circuits thus established.

52. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' sets available for connection to said link-circuits, means responsive to every initiation of a call over said lines to test said link-circuits successively in the same order and connect the calling line and an idle one of said link-circuits into a conversational circuit with the operator's set associated with that link-circuit and means under operator control for further extending the conversational circuit thus established.

53. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said circuits, an operator's telephone set common to said link-circuits, a relay common to said link-circuits, automatic means for connecting a calling line to an idle one of said link-circuits whenever said relay is deënergized, means for deënergizing said relay only when said operator's set is free for use, and means for automatically connecting said operator's set into conversational connection with the utilized link circuit.

54. A telephone system comprising circuits severally available for calling purposes, operators' telephone sets available for connection to said circuits, means responsive to the initiation of a call over any of said circuits to test said operators' sets successively and connect said calling circuit into conversational connection with the first said set found idle and means under operator control for further extending the conversational circuit thus established.

55. A telephone system comprising a circuit available for calling purposes, operators' sets available for use with said circuit and otherwise, means responsive to the initiation of a call over said circuit to test said operators' sets successively and connect said calling circuit into conversational connection with the first said set found idle and means under operator control for further extending the conversational circuit thus established.

56. A telephone system comprising circuits severally available for calling purposes, operators' telephone sets available for connection to said circuits, means responsive to the initiations of calls over said circuits to test said operators' sets successively and connect said calling circuits individually into conversational connection with the first said set found idle and means under operator control for further extending the conversational circuit thus established.

57. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' sets available for connection each to a plurality of said link-circuits, means responsive to the initiation of a call over any of said lines to test the link-circuits of the different operators' sets successively and connect such calling line through a link-circuit into conversational circuit with the first operator's set found idle and means under operator control for further extending the conversational circuit thus established.

58. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' sets available for connection each to a plurality of said link-circuits, means responsive to the initiations of call over said lines to test the link-circuits of the

different operators' sets successively and connect such calling lines respectively through link-circuits into conversational circuits with the first operators' sets found idle and means under operator control for further extending the conversational circuits thus established.

59. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' sets available for connection each to a plurality of said link-circuits, means responsive to every initiation of a call over said lines to test the link-circuits of the different operators' sets successively in the same order and connect the calling line through a link-circuit into conversational circuit with the first operator's set found idle, and means under operator control for further extending the conversational circuit thus established.

60. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' sets available for connection each to a plurality of said link-circuits, means responsive to all initiations of calls over said lines to test the link-circuits of the different operators' sets successively in the said order and connect the calling lines respectively through link-circuits into conversational circuits with the first operators' sets found idle and means under operator control for further extending the conversational circuits thus established.

61. A telephone system comprising circuits severally available for calling purposes, operators' telephone sets available for connection to said circuits, a relay individual to each operator's set, means for maintaining said relays energized or deënergized according to the busy or idle conditions of the associated operators' sets respectively means responsive to the initiation of a call over any of said circuits to test the conditions of said relays and to connect said calling line into conversational circuit with the operator's set whose relay is first found idle and means under operator control for further extending the conversational circuit thus established.

62. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' telephone sets available for connection to said link-circuits, a relay for each operator's set, means for maintaining said relays energized or deënergized according to the busy or idle condition of the associated operators' sets respectively, means responsive to the initiation of a call over any of said circuits to test the conditions of said relays and to connect said calling line to a link-circuit and thence into conversational circuit with that operator's set whose relay is first found idle, and means under operator control for further extending the conversational circuit thus established.

63. A telephone system comprising circuits severally available for calling purposes, an operator's telephone set common to said circuits, automatic switch mechanism for extending said circuits into conversational connection with said set, means under the control of an operator for further extending such extended circuits, and means for preventing said mechanism from extending a calling circuit until the orders of all previous calls have been received by an operator.

64. A telephone system comprising circuits severally available for calling purposes, operators' telephone sets available for connection to said circuits, automatic switch mechanism for extending said circuits into conversational connection with said sets, means under operator control for further extending such extended circuits, and means for preventing said mechanism from extending a calling circuit to any particular operator's set until the orders of all previous calls for that operator have been received by her.

65. A telephone system comprising circuits severally available for calling purposes, an operator's telephone set common to said circuits, automatic switch mechanism responsive to calls over said circuits to extend said circuits into conversational connection with said set, said mechanism refusing to thus extend more than one circuit so long as said set is in use, and means under operator control for further extending such extended circuits.

66. A telephone system comprising circuits severally available for calling purposes, operators' telephone sets available for connection to said circuits, automatic switch mechanism responsive to calls over said circuits to extend said circuits into conversational connection with said sets, said mechanism refusing to extend more than one circuit per set so long as said set is in use, and means under operator control for further extending such extended circuits.

67. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, an operator's telephone set common to said link-circuits, means responsive to calls over said lines to connect said set to said link-circuits and thence to the calling lines, the set being connected to but one link-circuit and line at a time and means under operator control for further extending the circuit thus established by said connecting means.

68. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' telephone sets available for connection to said link-circuits, means respon-

sive to calls over said lines to connect said sets to different link-circuits and thence to different calling lines, each set being connected to but one link-circuit and line at a time and means under operator control for further extending the circuit thus established by said connecting means.

69. A telephone system comprising circuits severally available for calling purposes, an operator's telephone set common to said circuits, means responsive to the initiation of a call over any of said circuits to connect such circuit into conversational circuit with said operator's set when idle, means for preventing other calling circuits from being connected therewith until the operator has performed a subsequent act and means under operator control for further extending the conversational circuit thus established.

70. A telephone system comprising circuits severally available for calling purposes, an operator's telephone set common to said circuits, means responsive to the initiation of a call over any of said circuits to connect such circuit into conversational circuit with said operator's set when idle, a relay for determining the selectivity of said operator's set, means under the control of the operator for actuating said relay and means under operator control for further extending the conversational circuit thus established.

71. A telephone system comprising circuits severally available for calling purposes, an operator's set common to said circuits, a control relay, means responsive to the initiation of a call over any of said circuits to connect said circuit into conversational circuit with said operator's set upon one condition of said relay and to pass by said set upon another condition of said relay, relays and circuits under the control of the calling party and the operator for establishing the different conditions of said relay, and means under operator control for further extending any conversational circuit thus established.

72. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, an operator's set common to said link-circuits, switch mechanism for connecting said lines and link-circuits, relays and circuits for connecting said operator's set to said link-circuits, a control relay for determining the action of said switch mechanism and said relays and circuits, and means under the control of the operator for determining the action of said control relay.

73. A telephone system comprising circuits severally available for calling purposes, an operator's telephone set available for connection to said circuits, automatic means dependent upon the idle condition of said operator's telephone set for extending a calling one of said circuits into conversational connection with said set, and means under operator control for further extending such an extended circuit.

74. A telephone system comprising a circuit available for calling purposes, an operator's telephone set available for use with said circuit, other circuits for use with said set, automatic means dependent upon the idle condition of said operator's telephone set for extending said first-mentioned circuit into conversational connection with said set, and means under operator control for further extending such extended circuit.

75. A telephone system comprising circuits severally available for calling purposes, operators' telephone sets available for connection to said circuits, automatic means dependent upon the idle condition of said operators' sets to extend calling ones of said circuits into conversational connection with said sets severally, and means under operator control for further extending such extended circuits.

76. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, an operator's telephone set available for connection to said link-circuits, and means dependent upon the idle condition of said operator's set for connecting it to one of said link-circuits and thence automatically to a calling one of said lines.

77. A telephone system comprising a line available for calling purposes, link-circuits available for connection to said line, an operator's telephone set available for use with said link-circuits and otherwise, and means dependent upon the idle condition of said operator's telephone set for connecting it to one of said link-circuits and thence automatically to said line in response to a call over said line.

78. In a telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, operators' telephone sets available for connection to said link-circuits, and means dependent upon the idle condition of said operators' sets to connect said sets to different link-circuits and thence automatically to different calling lines.

79. A telephone system comprising circuits severally available for calling purposes, an operator's telephone set available for connection to said circuits, a control relay, means for giving it a definite electrical condition when said operator's set is not in use, means for automatically connecting a calling one of said circuits into conversational connection with said operator's set while said control relay is in said electrical condition and means under operator control for further extending the conversational circuits thus established.

80. A telephone system comprising circuits

severally available for calling purposes, an operator's set available for connection to said circuits, a control relay being energized or deënergized according to the busy or idle condition of said operator's set, traveling means responsive to the initiation of a call over any of said circuits to pass or establish a conversational circuit with said operator's set according to the energized or deënergized condition of said control relay, and means under operator control for further extending the conversational circuits thus established.

81. A telephone system comprising lines severally available for calling purposes, link-circuits available for connection to said lines, an operator's telephone set available for connection to said link-circuits, a control relay having definite electrical conditions corresponding to the busy and idle conditions of said operator's set, automatic switch mechanism for connecting said lines and link-circuits into conversational circuits with said operator's set, means for determining the operation of said mechanism according to the condition of said control relay and means under operator control for further extending the conversational circuits thus established.

82. A telephone system comprising circuits severally available for calling purposes, other circuits severally available for called purposes, an operator's telephone set common to said first mentioned circuits, automatic switch mechanism responsive to the initiation of a call over any of said circuits to extend such circuit into conversational connection with the operator's set, but only when said set is free for use, and means under the control of an operator for combining with said switch mechanism to unite calling and called circuits.

83. A telephone system comprising circuits severally available for calling purposes, other circuits severally available for called purposes, means including automatic switch mechanism, for uniting calling and called circuits, part of said means being under the control of an operator, means coöperating with said uniting means to enable orders of calling parties to be communicated to an operator, and means for preventing the communication of any such calling party's order until all the orders of previously calling parties have been received by the operator and the operator's receiver is in circuit ready for the operator to receive such order.

84. A telephone system comprising circuits severally available for calling purposes, other circuits severally available for called purposes, means including automatic switch mechanism, for uniting calling and called circuits, part of said means being under the control of an operator, and means coöperating with said uniting means in response to calls over said circuits to enable orders of calling parties to be communicated to an operator and to prevent the communication of any such calling party's order so long as the orders of previously calling parties have not been received by the operator and the operator's receiver is in circuit ready for the operator to receive such order.

85. A telephone system comprising circuits severally available for calling purposes other circuits severally available for called purposes, means including automatic switch mechanism, for uniting calling and called circuits, part of said means being under the control of an operator, an operator's telephone set, and means coöperating with said uniting means to extend a calling one of said circuits into conversational connection with said set, said combined means being dependent in their extending function upon the idle condition of said operator's telephone set.

86. A system comprising lines severally available for calling purposes, conductors available for interchangeable connection to said lines, receiving mechanism available for connection to said conductors, and means dependent upon the idle condition of said receiving mechanism for connecting it to one of said conductors and thence automatically to a calling one of said lines.

87. The combination with a plurality of operators' positions, of means for extending calls thereto, a relay for each position, means responsive to the unengaged condition of the corresponding position for rendering each relay operable, energizing circuits for all of said relays that are operable closed in the operation of said connection extending means, and means for selecting one of the positions the relay of which is operated.

88. The combination with a plurality of operators' positions and means for extending calls thereto, of a device associated with each position for rendering the same when unengaged selectable by said call extending means, and means actuated in initiating a call for operating said devices of the unengaged operators' positions.

29. The combination with a plurality of operators' positions and means for extending calls thereto, of a device associated with each position for rendering the same selectable by said call-extending means, means actuated in initiating a call for operating said devices of the various positions, and a switch at each position operated when the position is busy for preventing the operation of said associated device.

90. The combination with a plurality of operators' positions, of means for extending calls thereto, selection-controlling apparatus common to said positions and adapted to be operated to direct a call to one or another of

them, a relay associated with each position for controlling said selecting apparatus, means actuated in the initiation of a call for operating said devices of the various positions, and means at each position responsive to the busy condition of that position for preventing the operation of said associated device.

91. The combination with a plurality of operators' positions, of a switch for selectively extending calls thereto, apparatus for controlling the selection of a particular position by said switch, and means made active in the initiation of a call for placing said apparatus under the control of said operators' positions.

92. The combination with an operator's position, of a plurality of switches for extending connections thereto, means for selecting one of said switches for operation and at the same time making the other switches inoperable, and means actuated in the selection of a switch for causing the operation of the same.

93. The combination with an operator's position, of a plurality of switches for extending calls thereto, electromagnetic mechanism associated with each switch for selecting the same for operation, means made operative in the actuation of one of said selecting mechanisms for rendering the other mechanisms inoperative, and means for operating the selected switch.

94. The combination with an operator's position, of a plurality of switches for extending calls thereto, electromagnetic mechanism for each switch, means controlled thereby for rendering the associated switch operable, an initial energizing path common to said mechanisms, means made active in the operation of any of said mechanisms for opening said initial energizing path to render the other mechanisms inoperative and means for operating the switch that has been rendered operable.

95. The combination with an operator's position, of a plurality of switches for extending calls thereto, a magnet for each switch adapted when operated to cause said switch to extend a call to said position, a relay associated and coöperating with each of said magnets, a common initial energizing path for said relays, a relay at said operator's position controlling said initial energizing path in resting contacts thereof, and an energizing path for said operator's position relay closed in the operation of any of said first mentioned relays.

96. The combination with a plurality of electrical switch devices, of a controlling relay for each, a common relay, initial energizing circuits for said controlling relays controlled in contacts of said common relay, and an energizing circuit for said common relay controlled in the operation of any of said controlling relays.

97. The combination with a plurality of telephone circuits, of a common circuit therefor, a plurality of switch devices each controlling the connection of an associated one of said telephone circuits with said common circuit, a controlling relay for each of said switch devices, a common relay, initial energizing circuits for said controlling relays controlled in resting contacts of said common relay, and an energizing circuit for said common relay closed in the operation of any of said controlling relays.

98. A telephone exchange system comprising telephone lines, link circuits for interconnecting the lines, an operator's telephone set, a switching device for each link circuit operating upon connection thereof with the telephone line to connect therewith the operator's telephone set, and a disabling circuit for all other switching devices established upon the operation of one switching device.

99. A telephone exchange system, including a calling subscriber's line, terminals therefor at the exchange, a primary link-circuit, means for automatically connecting said link-circuit with said line on initiation of a call, an operator's keyboard, means interposed between said primary link-circuit and said keyboard comprising a secondary switch for picking out said primary link-circuit and tertiary switch for extending the connection to said keyboard.

100. A telephone exchange system, including a calling subscriber's line, terminals therefor at the exchange, a primary link-circuit, means for automatically connecting said link circuit with said line on initiation of a call, an operator's keyboard, a link-circuit interposed between said primary link-circuit and keyboard comprising a secondary and tertiary switch, means controlled by the calling subscriber's line to cause the secondary switch to pick out the primary trunk and the tertiary switch to pick out said keyboard.

101. A telephone exchange system, including a calling subscriber's line, terminals therefor at the exchange, a primary link-circuit, means for automatically connecting said link-circuit with said line on initiation of a call, an operator's position, means interposed between said primary link-circuit and said position comprising a secondary switch and its permanently mated tertiary switch for jointly extending said connection to said position.

102. A telephone exchange system, including a calling subscriber's line, a primary link-circuit, means for automatically connecting said link-circuit with said line on initiation of a call, an operator's position,

means interposed between said primary link-circuit and said position comprising a secondary switch and its permanently mated tertiary switch for jointly extending said connection to said position.

103. In a telephone system, the combination with connecting circuits, of automatic switches, a telephone line extended to a connecting circuit by the operation of one of said switches, busy test means for rendering said extended line unavailable for other connections, a key associated with said connecting circuit for rendering said busy test means inoperative in order to permit the establishing of other connections with said line, and means controlled by said key for holding operated said automatic switch to continue the connection already established.

104. The combination with a connecting circuit, of a telephone line, an automatic switch for extending said line to said circuit, other means for establishing connection with said line, means actuated in extending said telephone line to said connecting circuit for producing a busy test condition on said line to prevent the establishment of other connections therewith, a switch associated with said connecting circuit, and means controlled by said switch for withdrawing said busy test condition and holding said automatic switch to continue the connection between said line and said connecting circuit.

105. The combination with a connecting circuit, of a telephone line extended thereto, other means for establishing connection with said line, means actuated in extending said line to said connecting circuit for producing a busy test condition on said line to prevent the establishment of other connections therewith, electrical devices connected with said line extension, and a switch associated with said connecting circuit for disconnecting said electrical devices and removing said busy test condition from the line without disconnecting said line from said connecting circuit.

106. The combination with a plurality of connecting circuits, of automatic switches, a calling line extended to a connecting circuit through one of said switches, busy test means for rendering said extended line unavailable for other connections, a switch associated with said connecting circuit, means actuated in the operation of said switch for holding the connection already established and rendering said busy test means inoperative, and means actuated in the operation of said switch for opening the conductors of said extended connection to avoid interference with any other connection established with said line.

107. The combination with a telephone line, of a connecting circuit, an automatic switch for extending said line to said connecting circuit, means for establishing other connections with the same line, busy test means operated in extending said line to said connecting circuit for preventing the establishment of said other connections with said line, a switch associated with said connecting circuit operable to render said busy test means inoperative and to hold operated said automatic switch to maintain the connection of said line with said connecting circuit, a repeating coil in the talking conductors of said connecting circuit, and means for opening the talking conductors between said repeating coil and said calling line when said switch is operated.

108. The combination with a connecting circuit, of a telephone line extended thereto, other means for establishing connection with said line, means actuated upon the extension of the line to said connecting circuit for producing a busy test condition on said line to prevent the establishment of other connections therewith, an apparatus-controlling switch associated with said connecting circuit and automatically actuated upon the extension of said line to said connecting circuit, a holding switch associated with said connecting circuit, and means actuated in the operation of said switch for returning said apparatus-controlling switch to normal and removing said busy test condition from said line while holding the existing connection of said line with said connecting circuit.

109. The combination with a connecting circuit, of a telephone line extended thereto, other means for establishing connection with said line, means actuated in extending said line for producing a busy test condition thereon to prevent the establishment of other connections, operator's position apparatus, means for connecting the same with said connecting circuit, a holding switch associated with said connecting circuit, means actuated thereby for removing said busy test condition from said telephone line while holding the connection of the same with said connecting circuit, and means actuated in operating said switch for disconnecting said operator's position apparatus from said connecting circuit.

Signed at Antwerp, in the Province of Antwerp and Kingdom of Belgium, this 20th day of August, 1912.

FRANK R. McBERTY.

Witnesses:
G. De Lerty,
N. Adams.