A. B. SPERRY.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED MAY 1, 1916.

1,221,773.

Patented Apr. 3, 1917.

4 SHEETS—SHEET 1.

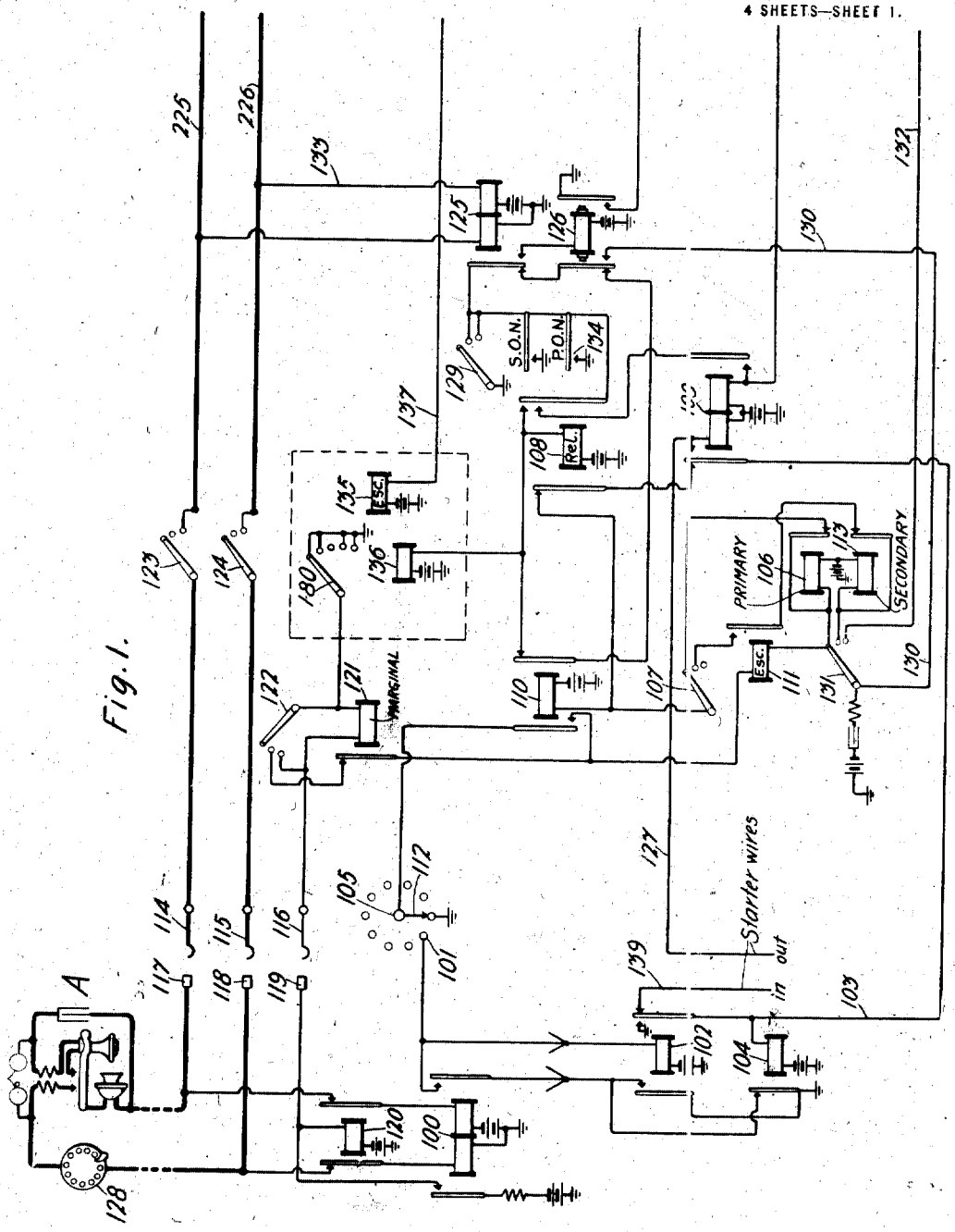


Fig. 1.

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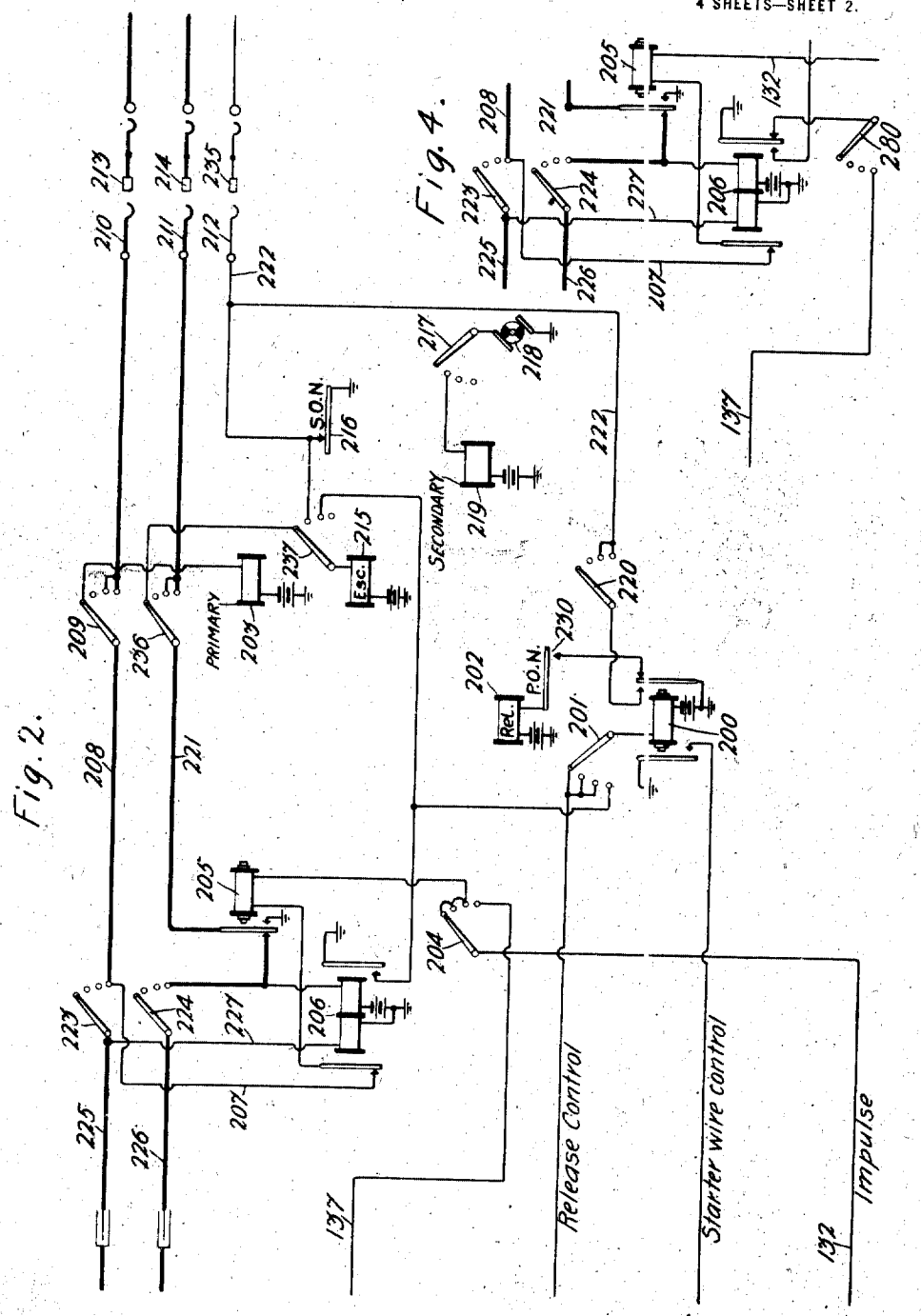
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4 SHEETS—SHEET 2.



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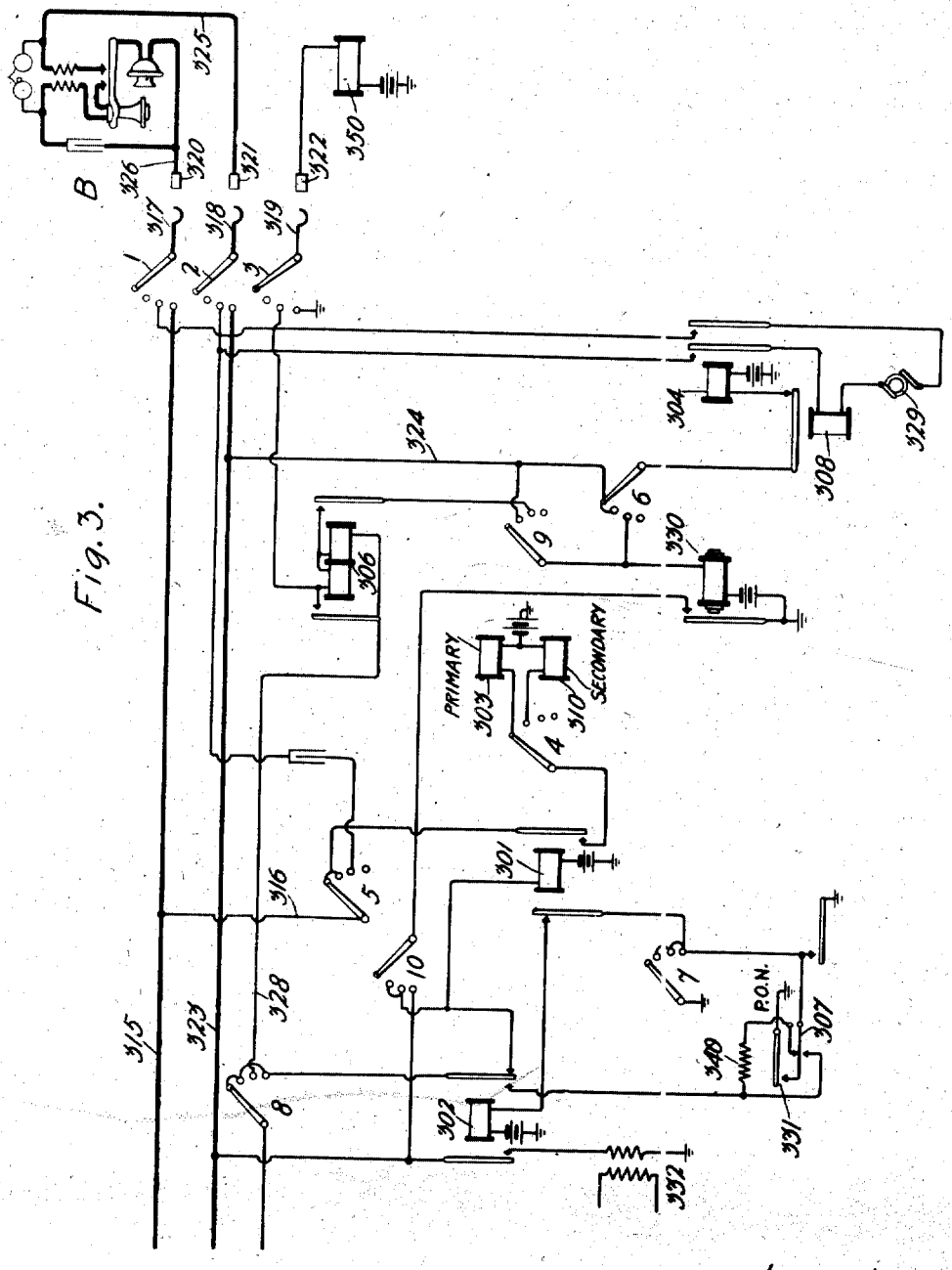


Fig. 3.

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TELEPHONE EXCHANGE SYSTEM.

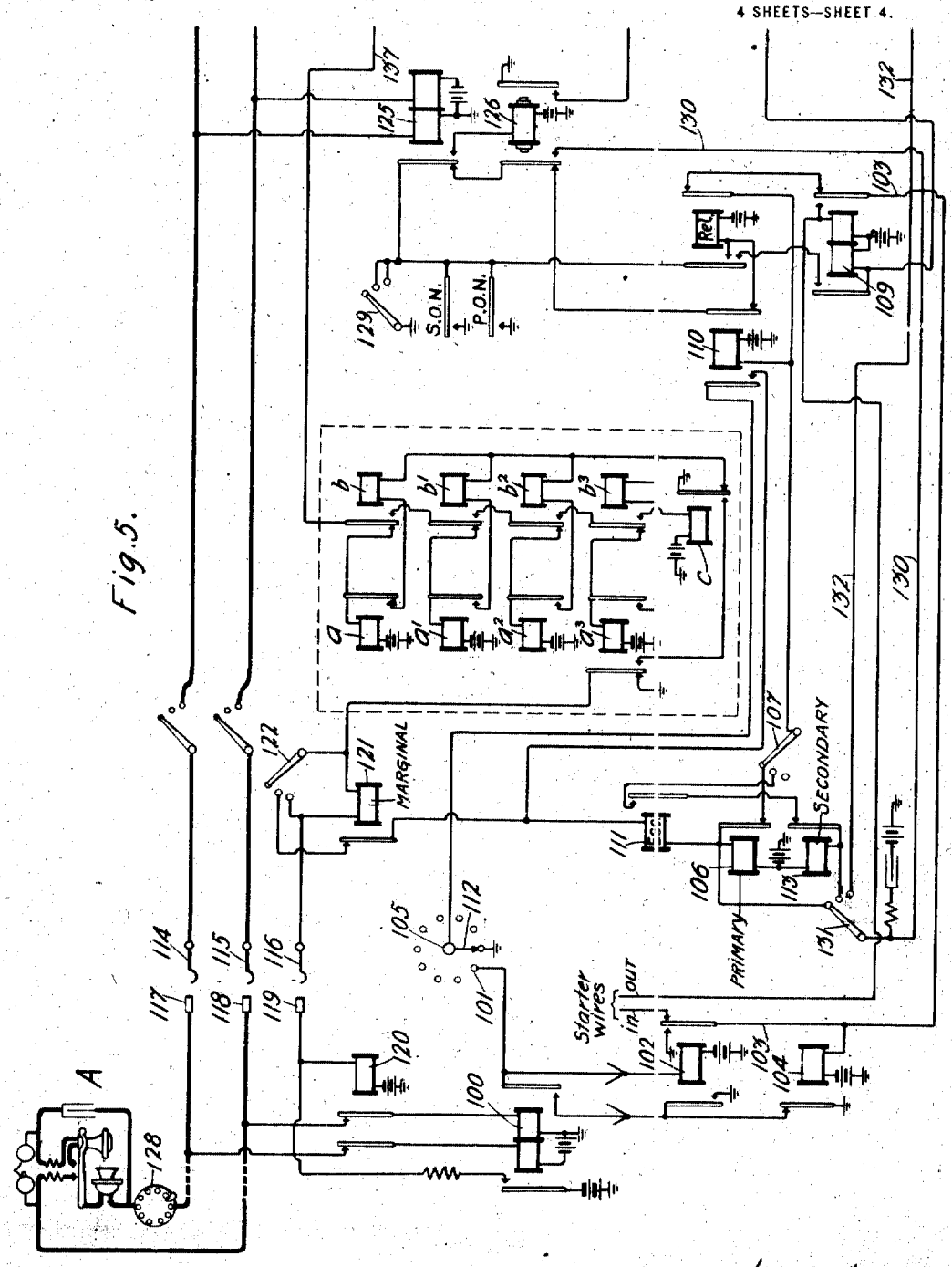
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4 SHEETS—SHEET 4.

Fig. 5.



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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

1,221,773. Specification of Letters Patent. Patented Apr. 3, 1917.

Application filed May 1, 1916. Serial No. 94,672.

To all whom it may concern:

Be it known that I, ARTHUR B. SPERRY, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone exchange systems employing machine switching with subscriber's control.

Its object is to provide a circuit arrangement whereby a calling party, after being connected with a called party over a non-numerical automatic switch, such as a line finder, and a number of numerical switches, such as selectors and a connector, may, by operating his sender, bring a third party into the connection over another train of automatic switches. Provision is also made for introducing another party or parties into the talking circuit thus established, if desired.

In the embodiment shown, the subscribers' lines terminate in automatic finder switches and in connectors. Upon the removal of the receiver by a calling party, a calling condition is set up on the test multiples of such line in the finders in which it appears, and an idle line finder is set in motion to connect with such multiples. The test brush of the finder, on reaching the calling line test multiple appearing therein, closes a circuit including said multiple, which causes the finder to stop thereon, whereupon the cut-off relay of such line is energized. This relay, in attracting its armatures, deënergizes the line relay. The line relay, in releasing its armatures, removes the calling condition from the test multiples of such line to render the same non-calling in the other finders in which it appears. The subscriber then sets the selector associated with such finder to pick out a connector having access to the called party's line, which is then set upon such line. If, after conversing, it is desired to bring a third party into the connection, the calling party operates his sender to transmit a number of impulses to a switch associated with the finder connected to his line. This switch operates in response to such impulses and effects the deënergization of the calling line cut-off relay, which, in releasing its armatures, again closes the circuit of the line relay over the calling line. The energization of the line relay sets up a calling condition on the calling line multiples in the finders in which such line appears, and initiates the operation of an idle line finder having access to such multiples, which connects therewith. The calling subscriber now, by means of his sender, operates the selector associated with such finder to pick out and set a connector having access to the group containing the line of the third party, who is then signaled, if his line is idle, and is brought into the connection.

More specifically, a step-by-step switch is provided for each finder, which, in the present embodiment, is a side switch controlled by an escape magnet, which releases a contact arm from position to position upon its deënergization in the well-known manner. It will be understood, however, that the finder is also provided with the usual side switch having a plurality of arms, and which controls the various finder operations. In the through position of the special side switch and the connector side switch, the escape magnet of this special side switch is connected to a contact of the calling party's stepping relay. The circuit for maintaining the cut-off relay of the calling line energized leads through the arm of said special side switch and its first contact. The connection to one of the following contacts of said arm is left open. Consequently, when the calling party operates his sender to transmit a given number of impulses, after having set up a connection, the stepping relay operates the escape magnet of this side switch, which advances its arm into engagement with said open contact, whereupon the cut-off relay is deënergized, and when its armatures reach their back contacts, the line relay energizes over the calling line circuit, and in energizing, applies a calling condition to the calling line multiples in the finders, and starts an idle finder in operation to connect with multiples of such line in such finder to provide another path over which the call to the third party may be set up. The contacts following such open contact are grounded so that in case a greater number of impulses are transmitted, the arm, after passing the open contact and reaching the succeeding grounded contacts, again energizes the cut-off relay to remove the calling condition, if such cut-off relay deëner-

gizes during the short interval in which the arm is passing over the open contact.

In a modification of the invention, a series of counting relays is associated with the finder instead of the special side switch. The circuit of the cut-off relay is controlled at an armature and back contact of the last one of these relays in the string. When a connection is completed, these relays are connected to a contact of the calling party's stepping relay. When the proper number of impulses are transmitted, the counting relays are successively energized and locked up, the energization of the last relay in the series opening the circuit of the cut-off relay, whereupon the line relay operates to cause a second finder to connect with the calling line. If a smaller number of impulses are transmitted, the last counting relay is not reached, and if a greater number, although the last relay is energized and opens the circuit of the cut-off relay, the next impulse operates a relay, which again energizes such cut-off relay to again remove the calling condition, if such cut-off relay has had time to deënergize.

Referring to the drawings which illustrate diagrammatically the circuit arrangement of this invention, Figure 1 shows the line finder circuit; Fig. 2 shows the first selector circuit; Fig. 3 shows the connector circuit; Fig. 4 is a view of a portion of a modified selector circuit; and Fig. 5 is a view of a modified finder circuit.

The invention will be more clearly understood from a detailed description of the operations involved in setting up a connection. Upon the removal of the receiver at the calling substation A, the line relay 100 is energized, and by attracting its right armature, grounds the commutator multiple segments 101 of the calling group and energizes the starting relay 102 common to this group. Relay 100, by attracting its left armature, closes a shunt path about cut-off relay 120 to the calling line test multiples 119. Relay 102, by attracting its left armature, locks itself to ground independently of relay 104, and by attracting its right armature, grounds the in-starter wire 103 and energizes relay 104. The relay 104 operates idly at this time.

Assuming the brush shaft 105 of the finder assigned to the group of lines containing substation A to be in its normal position, one step only of such brush shaft will be required to position a set of its brushes 114, 115, 116 in operative relation to multiples of the calling group containing those of the calling line 117, 118, 119. The grounding of in-starter wire 103, by the energization of relay 102, closes the following circuit for the primary stepping magnet 106 of the line finder: free pole of battery, magnet 106, its armature and back contact, arm 107, armature and back contact of finder release magnet 108, left armature and back contact of relay 109, starter wire 103, to ground at the right armature and front contact of relay 102. In parallel with the circuit just traced, a relay 110 is energized which connects the escape magnet 111 to the commutator brush 112. Magnet 111 does not energize at this time, however, since it is short-circuited by the path just traced over finder side switch arm 107 to ground at the right armature and front contact of relay 102. The shaft 105 is thus given one step by magnet 106, in which position the commutator brush 112 thereon engages the calling commutator segment 101, and since at this moment the shunt about magnet 111 is open at the armature and back contact of magnet 106, magnet 111 energizes over the following circuit: free pole of battery, magnets 106, 111, left armature and front contact of relay 110, brush 112, segment 101, right armature and front contact of relay 100, left armature and front contact of relay 102 to ground. Magnet 111 is constructed to release the side switch arms from position 1 to position 2, upon its energization. Magnets 106, 111 remain locked up in position 2 in the following circuit: free pole of battery, magnets 106, 111, armature and back contact of relay 121, arm 122, side switch arm 180 to ground. Arm 180 does not belong to the side switch controlled by escape magnet 111, but to an escape magnet 135.

In position 2 the circuit of secondary stepping magnet 113 is closed to drive the brushes 114, 115, 116 over the multiples of the group containing those of the calling line 117, 118, 119. This circuit is as follows: free pole of battery, magnet 113, its armature and back contact, armature and front contact of the magnet 111, arm 107 and its second contact, armature and back contact of magnet 108, left armature and back contact of relay 109 to ground at the right armature and front contact of relay 102. Relay 121 is marginal and is not energized through the high resistance cut-off relays 120 of the non-calling lines. When, however, finder test brush 116 engages test contact 119 of the calling line to which is connected the low resistance shunt about the cut-off relay 120, relay 121 is energized, and by attracting its armature, opens the circuit of the magnet 111, which in deënergizing releases the side switch into position 3, arm 107, in passing out of position 2 opening the circuit of magnet 113. In position 3, arm 122 shunts out relay 121 and connects ground directly to cut-off relay 120 of the calling line, which, in attracting its armatures, deënergizes line relay 100, which in retracting its left armature, removes the shunt from about the cut-off relay 120 to

render the line non-calling in the finders in which it appears, and, by retracting its right armature, deënergizes starting relay 102, which removes ground from the starter wire, thus deënergizing relay 110 which disconnects magnet 111 from brush 112. The right armature of relay 102 in retracting reconnects the section 139 of the in-starter wire coming from the preceding finder to section 103. Arms 123, 124, in position 3, extend the calling line to a stepping relay 125, which thereupon energizes, and by attracting its armature, energizes a slow relay 126. Relay 126 by attracting its left armature, interposes a break in the circuit of finder release magnet 108, and by attracting its right armature, energizes a slow relay 200 (Fig. 2) over arm 201 and its first contact. Relay 200, in attracting its right armature, interposes a break in the circuit of selector release magnet 202, and by attracting its left armature, energizes relay 109. This relay, by attracting its left armature, extends the in-starter wire 103 to the out-starter wire 127 leading to the next idle finder. The calling party now operates his sender 128, in accordance with the first digit of the wanted number. The stepping relay 125 deënergizes at each interruption of the circuit, but the relay 126 being slow to release, maintains its armatures attracted during these interruptions. Each time the armature of relay 125 is retracted, an impulse is sent to primary stepping magnet 203 of the first selector over the following path: arm 129 and its third contact, armature and back contact of relay 125, armature and front contact of relay 126, conductor 130, arm 131 and its third contact, conductor 132, arm 204 and its first contact, slow relay 205, left armature and back contact of relay 206, conductor 207, conductor 208, arm 209 and its first contact, magnet 203 to free pole of battery. The selector brush shaft is thus given a movement in a primary direction to position a set of brushes 210, 211, 212 on the selector brush shaft in operative relation to the desired group of outgoing trunks. Relay 205 being slow to release, maintains its armature attracted while impulses are being sent to the magnet 203, and connects ground over arms 236 and 237 to the escape magnet 215 of the selector, which magnet releases its arms from position to position upon its deënergization, in the well-known manner. When the sender 128 reaches its normal position and the relay 125 is maintained energized, slow relay 205 becomes deënergized after a short interval, and by retracting its armature, deënergizes magnet 215, which releases the side switch into position 2. In position 2 magnet 215 is again energized over a secondary off-normal contact 216, which opens on the first secondary step of the selector shaft. Arm 217 in position 2 connects an interrupter 218 to the secondary stepping magnet 219. The brushes 210, 211, 212 are thus stepped over the multiples 213, 214, 235 of the selected group of trunks. The multiple test terminals 235 of busy trunks are grounded, as will hereinafter appear. Consequently, magnet 215 is maintained energized over test brush 212 and such grounded test terminals. When an ungrounded test terminal 235 is reached, the escape magnet 215 is deënergized and releases the side switch into position 3. Arm 217, in passing out of position 2, opens the circuit of magnet 219, stopping the brushes upon the seized trunk. In position 3, arm 220 connects the right grounded armature and front contact of relay 200 to the multiples 235 of the seized trunk to cause the same to test busy to other testing selectors. When the side switch moves into position 3, arms 209, 236 connect the conductors 208, 221 to the selector brushes 210, 211. Relay 301 at the connector (Fig. 3) is thereupon energized over the following circuit: ground, right armature and front contact of relay 200, arm 220, conductor 222, brush 212, terminal 235, connector side switch arm 8 and its first contact, right armature and back contact of connector release magnet 302, relay 301, free pole of battery. Relay 301, by attracting its left armature, interposes a break in the circuit of connector release magnet 302, and by attracting its right armature, connects the primary magnet 303 of the connector to the upper talking conductor 315. The calling party now operates his sender 128 to transmit the tens digit of the wanted line. Each time relay 125 retracts its armature, an impulse is sent over the following path to magnet 303: ground, arm 129 and its third contact, armature and back contact of relay 125, left armature and front contact of relay 126, conductor 130, arm 131 and its third contact, conductor 132, arm 204 and its third contact, slow relay 205, left armature and back contact of relay 206, conductors 207, 208, arm 209 and its third contact, brush 210, terminal 213, conductors 315, 316, arm 5 and its first contact, right armature and front contact of relay 301, magnet 303, free pole of battery. The connector brush shaft is thus stepped in a primary direction to place the set of brushes 317, 318, 319 in operative relation to the group of multiples containing those of the wanted line 320, 321, 322. Relay 205 in attracting its armature, as before, grounds the lower talking conductor 221 to which is connected the escapement magnet 304 of the connector. This circuit is as follows: ground, armature and front contact of relay 205, conductor 221, arm 236, brush 211, terminal 214, conductors 323, 324, arm 6 and its first contact, armature and back contact of relay 308, escape magnet 304 to free pole

of battery. When the dial 128 reaches its normal position and relay 125 is maintained energized, relay 205 after a short interval becomes deënergized, and removes ground from the lower talking conductor 221, whereupon the escape magnet 304 releases the side switch into position 2. In position 2, arm 4 substitutes the secondary stepping magnet 310 for the primary magnet 303 in the stepping circuit. The calling party now operates his dial to transmit the units digit of the wanted number. Each time the relay 125 retracts its armature, an impulse is sent over the path just traced to conductor 316 (Fig. 3), from whence it passes, by way of side switch arms 5 and 4 in position 2, to magnet 310. As before, relay 205 grounds the lower talking conductor 221, again energizing the escape magnet 304, the circuit being the same as that hereinbefore traced for this magnet to conductor 324, from whence it passes by way of arm 6 to such magnet. In parallel with magnet 304 a slow relay 330 is energized. When the dial reaches its normal position, relay 125 is maintained energized, and when relay 205 retracts its armature, ground is removed from the lower talking conductor 221, whereupon magnet 304 becomes deënergized, releasing the side switch into position 3. A busy line is indicated by reduced potential upon its test multiples 322. The relay 306 is marginal and is not adapted to respond to such reduced potential. If the line is free, however, full potential is present upon multiples 322 thereof.

Assuming the line selected to be free, relay 306 energizes over the following circuit: free pole of battery, cut-off relay 350 of the called line, terminal 322, brush 319, arm 3 and its third contact, both windings of relay 306 in series, conductor 328, arm 8 and its third contact, terminal 235, brush 212, conductor 222, arm 220 and its third contact, right armature and front contact of relay 200 to ground. Relay 306, by attracting its left armature, renders the selected line busy by connecting its multiples directly to ground at the right armature and front contact of relay 200. By attracting its right armature, it locks itself over the following circuit: free pole of battery, magnet 304, arms 6 and 9, right armature and front contact of relay 306, right winding of said relay to conductor 328, to ground at the right armature and front contact of slow relay 200. Slow relay 330 is maintained energized in parallel in this circuit, and thus maintains relay 301 energized to hold open the circuit of connector release magnet 302. In moving out of position 2, arm 8 opens the circuit which was holding relay 301 energized over the grounded third wire 222. Magnet 304, in attracting its armatures, applies ringing current from generator 329 to the called line. When the subscriber removes his receiver, relay 308 is energized, and in attracting its armature, opens the circuit of magnet 304, which, in deënergizing, releases the side switch into position 4, in which arms 1 and 2 connect conductors 315, 323 to connector brushes 317, 318, and arm 3 connects ground to test terminal 322. Relay 330, energized in parallel with the escape magnet 304, being slow, maintains its armature attracted for an interval after arm 9 leaves its third position. An impulse is thus transmitted from ground by way of the left armature and front contact of relay 330, arm 10 and its fourth contact to the lower talking conductor 323, terminal 214, brush 211, arm 236 and its third contact, conductor 221, armature and back contact of relay 205, right winding of relay 206 to free pole of battery. Relay 206 is momentarily energized by this impulse, and in attracting its right armature, energizes and deënergizes the escape magnet 215, which releases the side switch into position 4. Arm 8 of the connector side switch in position 4 again connects the grounded test conductor 222 to relay 301 before slow relay 330 deënergizes. In position 4, selector side switch arms 223, 224 connect the talking conductors 225, 226 to conductors 208, 221, thus completing the talking circuit. The called line battery supply relay 206 is then energized over the called line circuit, as follows: free pole of battery, right winding of relay 206, armature and back contact of relay 205, conductor 221, arm 236, brush 211, terminal 214, conductor 323, arm 2 and its fourth contact, brush 318, terminal 321, line conductor 325, through the telephonic apparatus at the called substation, conductor 326, terminal 320, brush 317, arm 1 and its fourth contact, conductor 315, terminal 213, brush 210, arm 209 and its fourth contact, conductor 208, arm 223, conductor 227, left winding of relay 206 to ground. When the side switch moved from position 3 to position 4, arm 201 transferred the control of slow relay 200, and consequently the release of the selector and connector from the calling to the called party.

Assuming now that the parties to the connection just set up desire to bring another party into the connection for the purpose of intercommunication, the calling party at substation A will operate his dial 128 to transmit two impulses. Each time relay 125 retracts its armature, an impulse is sent over the following path to an escape magnet 135 of a special side switch associated with the finder shown in Fig. 1 and controlling the side switch arm 180: free pole of battery, magnet 135, conductor 137, arm 204 and its fourth contact, conductor 132, arm 131 and its third contact, conductor 130, left arma-

ture and front contact of relay 126, armature and back contact of relay 125, arm 129 and its third contact, to ground. Magnet 135 is arranged to release side switch arm 180 from position to position upon its deenergization. Upon receipt of these two impulses, this magnet releases the side switch arm 180 from position 1 to position 3. In passing out of position 2, ground is removed from the cut-off relay 120 of the calling line, which thereupon deënergizes, whereupon line relay 100 energizes over the calling line circuit. Line relay 100, by attracting its left armature, closes the low resistance shunt about the cut-off relay 120 to the test multiples 119, and by attracting its right armature, grounds the group multiples 101 and energizes relay 102. Relay 102, in attracting its right armature, grounds the starter wire 103 to start the next idle finder. This circuit is as follows, assuming the finder of Fig. 1 to be the next idle finder: ground, right armature and front contact of relay 102, conductor 103, left armature and front contact of relay 109, out-starter wire 127, in-starter wire 139, right armature and back contact of relay 102 of the next idle finder, starter wire 103, left armature and back contact of relay 109, left armature and back contact of magnet 108, arm 107 and its first contact, armature and back contact of primary magnet 106, magnet 106, free pole of battery. This finder is now given a primary and secondary movement to pick out the multiples 117, 118, 119 of the calling line on such finder as described. When the finder connects with such multiples, ground is applied to the cut-off relay 120 over side switch arm 180 of the special side switch associated with such finder, and arm 122 and its third contact of the side switch controlling such finder, thus energizing the cut-off relay 120, which in attracting its armatures, deënergizes line relay 100. This latter relay in retracting its left armature, removes the low resistance shunt from about the cut-off relay 120 to render the line non-calling in the other finders in which it appears, and in retracting its right armature, removes ground from the group multiples 101 and deënergizes relay 102, which restores the connection of the in-starter wire to conductor 103. A relay 104 of the group to which the first finder set belongs is energized in parallel with the primary and secondary magnets 106, 113 during the setting operation just traced. This relay removes the control of relay 102 from its group during such setting operation to prevent interference. The calling party at substation A now operates his dial 128 to set the first selector, associated with the second finder, to pick out a connector, which is then set upon the terminals of the third line. This operation is similar to that described in setting up the first call. The parties may now converse. If, after talking, the parties desire to bring another party into the connection, the calling party will again transmit two impulses to the special escape magnet 135 of the finder which last connected to his line and which is maintaining the same non-calling. This magnet then releases its arm 180 to position 3 and renders the line calling and starts the next idle finder in search of multiples thereof, which finder, when it connects therewith, removes the calling condition and furnishes another outlet over which the calling subscriber connects with another party to bring him into the connection.

Upon the termination of the conversation, the replacement of the calling party's receiver deënergizes relays 125 of the finders connected to his circuit, which, in retracting their armatures, energize the release magnets 108 thereof to restore such finders, the circuit leading over the armature and back contact of relays 110, 126, 125 and the primary off-normal contact 134. Magnet 108 locks itself to ground at such contact and provides a circuit for relay 109 to hold the same operated to maintain the in-starter wire 103 extended to the next idle finder until the finder shown in Fig. 1 completely restores, in case the called party hangs up his receiver first, thereby deënergizing relay 200. When the called parties hang up their receivers, the respective selectors and connectors are released as follows: relay 206 becomes deënergized, opening the circuit of relay 200. When relay 200 releases its right armature, release magnet 202 is energized over primary off-normal contact 230 to restore the selector, and ground is removed from conductor 222 leading to the connector, causing the deënergization of relay 301, which in retracting its left armature, energizes release magnet 302 over primary off-normal contact 331, which restores the connector.

Referring now to Fig. 4, this view shows a modification of the invention wherein the coöperation of the calling and called parties is necessary in order to bring a third party into the connection. In this case, when the parties desire to bring another party into the connection, the called party must operate his dial to transmit two impulses. This causes the called supervisory relay 206 to deëenergize twice, whereupon two impulses are sent over the following path to operate the special side switch 155: right armature and back contact of relay 206, arm 280 and its fourth contact, conductor 137, magnet 135, free pole of battery. The escape magnet, in energizing and deënergizing twice, moves its side switch arm 180 into position 3, in which position ground is removed from the cut-off relay 126, which, in causing the energization

of relay 100, starts another finder which picks up the calling line, as before. The calling party can then, by operating his sender 128, set the selector associated with this finder onto a connector having access to the wanted third party, and then set such connector upon such party's line. It will be noted that impulse conductor 132 in this modification is connected directly to magnet 205, instead of through side switch arm 204.

If the selected line is busy, test multiples 322 are grounded. Therefore relay 306 will not energize, and since the circuit of relay 330 is opened when arm 9 moves off its second contact, this relay, after an interval, releases its left armature, removing ground from the circuit of relay 301. In position 3, the circuit for this relay 301, hereinbefore traced including test conductor 222, is opened at side switch arm 8. Consequently, relay 301 retracts its armatures, and its right armature, in closing its back contact, closes the circuit of release magnet 302 as follows: free pole of battery, magnet 302, left armature and back contact of relay 301, primary off-normal contact 331 to ground. Magnet 302 releases the connector and, in attracting its left armature, locks itself to the grounded test wire 222 as follows: free pole of battery, magnet 302, left armature and back contact of relay 301, contact 307 closed before contact 331 opens, resistance 340, right armature and front contact of magnet 302, arm 8 and its first contact, terminal 235, brush 212, conductor 222, arm 220 to ground at the right armature and front contact of relay 200, and closes the following circuit from a busy machine 332 to indicate to the calling party that the desired line is busy: busy tone apparatus 332, left armature and front contact of magnet 302, lower talking conductor 323, terminal 214, brush 211, arm 236 and its third contact, armature and back contact of relay 205, right winding of relay 206 to free pole of battery. This tone is transmitted inductively by the windings of relay 206 to the calling party over the following path: ground, left winding of relay 206, conductors 227, 225, arm 123 and its third contact, brush 114, terminal 117, the telephonic apparatus at substation A, terminal 118, brush 115, arm 124 and its third contact, conductor 133, right winding of relay 125 to free pole of battery. When the calling party replaces his receiver, relay 125 is deënergized, and, by releasing its armature, closes the finder release circuit as hereinbefore traced. Relay 125, in deënergizing, releases relay 126, which, in retracting its right armature, removes ground from slow relay 200. This relay, in retracting its right armature, energizes selector release magnet 202, whereupon the selector restores. The release magnets of the finder, selector and connector restore the side switch arms in the well-known manner. Arm 220, in restoring, removes ground from conductor 222, whereupon release magnet 302 becomes deënergized, disconnecting the busy tone apparatus 332 from lower talking conductor 323.

Another modification of the invention is shown in Fig. 5. In this modification, instead of the special side switch 135, a series of counting relays a, b is associated with the finder. When the first selector side switch moves into position 4 upon the response of the called party, the first primary relay a is connected over conductor 137 with the back contact of the stepping relay 125. In this circuit arrangement, when the parties desire to bring a third party into the connection, the calling party operates his sender 128 to transmit four impulses. These impulses operate and lock up relays a, b in succession until relay a^3 is reached. This relay, in attracting its armature, opens the circuit of cut-off relay 120, which, in retracting its armatures, re-connects the line relay 100 to the calling line. The line relay thereupon energizes and causes a second finder to hunt for and connect with the calling line, as already described. Considered more in detail, the circuit for operating the cut-off relay 120, completed in position 4 of the selector side switch, leads over the right armature and back contact of relay a^3. When the connection is established and the calling party at substation A operates his sender 128 to transmit four impulses, stepping relay 125 retracts its armature for each interruption of the line circuit. The first retraction causes an impulse to pass over the following path to the first relay a:

Free pole of battery, relay a, armature and back contact of relay b, conductor 137, side switch arm 204 and its fourth contact, conductor 132, side switch arm 131 and its third contact, conductor 130, left armature and front contact of relay 126, left armature and back contact of relay 125, arm 129 to ground. Relay a, in attracting its armature, prepares a locking circuit for itself and relay b leading to ground at the armature and back contact of relay c, which circuit is closed when relay 125 again energizes and removes the shunt from about such relay b. Relay b, in energizing, as relay 125 attracts its armature, prepares a circuit for relay a^1. When the stepping relay 125 next retracts its armature, an impulse is sent over the path traced to conductor 137, from whence it passes by way of armature and front contact of relay b, armature and back contact of b^1, relay a^1, free pole of battery. Relay a^1, in attracting its right armature, locks itself in series with relay b^1, which prepares a circuit for relay a^2 when relay 125 next energizes. Upon the next retraction of the armature of stepping relay 125, an impulse is sent over the circuit traced to

conductor 137, from whence it passes over the armatures and front contacts of relays b, b^1 to the armature and back contact of relay b^2, relay a^2 to free pole of battery. Relay a^2 thereupon locks itself up in series with relay b^2. Relay b^2 energizes when relay 125 next energizes and prepares a circuit for relay a^3. When the stepping relay 125 next retracts its armature, an impulse is sent over the path traced to conductor 137, from whence it passes over armatures and front contacts of relays b, b^1 and b^2 to relay a^3. Relay a^3 thereupon locks itself up in series with relay b^3 to ground at the armature and back contact of relay c. Relay a^3, in attracting its left armature, opens the circuit of the cut-off relay 120, which, in retracting its armature, reconnects the line relay 100 to the calling line circuit. The line relay thereupon energizes with the results hereinbefore stated. When the second finder connects with the calling line, ground is supplied to operate cut-off relay over side switch arm 122 and the left armature and back contact of a relay corresponding to a^3. The relays a b, etc., remain locked up during the conversation. Upon the replacement of the receiver by the calling party, relay 125 deenergizes and opens the circuit of relay 126 of each of the finders. Relay 126 being slow to release, an impulse is transmitted over the following circuit to relay c: ground, arm 129 and its third contact, armature and back contact of relay 125, left armature and front contact of relay 126, conductor 130, arm 131 and its third contact, conductor 132, arm 204 and its fourth contact, conductor 137, left armatures and front contacts of relays b, b^1, b^2, b^3, relay c, to free pole of battery. Relay c, in attracting its armature, opens the locking circuit of relays a, b, etc., which thereupon restore. In the circuit arrangement of Fig. 5, as in the circuit arrangement of Fig. 1, the calling subscriber can, if desired, bring a fourth party into the connection by again transmitting four impulses to operate relays a, a^1, a^2 and a^3 associated with the second finder to connect with the calling line.

From the foregoing it will be seen that the present invention provides a simple and efficient means for enabling the parties to a connection to add an additional party or parties thereto, with provision for causing the lines of such parties to test busy after being brought into the connection, and for automatically releasing all the switches and apparatus involved in the connection upon the mere replacement of the receivers: also, inasmuch as several impulses are required in order to cause the circuit of the cut-off relay of the calling line to be opened and thereby start a second line finder in search of the calling line, false starting of a second finder, due to an accidental actuation of a calling party's switchhook, is prevented. It will be understood, however, that it is within the scope of the invention to so arrange the circuit that a single impulse will cause the deenergization of the cut-off relay. Any series of impulses, either greater or less than a predetermined number (as two in Fig. 1 and four in Fig. 5) will not cause a second finder to pick up the calling line, since, referring to Fig. 1, the contacts with which arm 180 coöperates are all grounded, except the third, and consequently, although the transmission of more than two impulses may deënergize the cut-off relay 120 due to its circuit being opened as arm 180 moves from position 2 to position 4, this interval is not long enough to hold relay 102 energized until a second finder connects with the calling line, and referring to Fig. 5, if more than four impulses are sent, the relay c will energize on the fifth impulse and reconnect ground to the cut-off relay. Thus, the privilege of setting up connections of this character may be restricted to certain parties, and the number of the series of impulses required to start a second finder may be changed from time to time by merely altering the connection of ground to the special side switch contacts and to the counting relays.

What is claimed is:

1. In a telephone exchange system, the combination with a calling and a called line, automatic switching means, a sender associated with said calling line adapted to control said switching means to establish a talking circuit including said lines, and a third line, of means whereby the calling party may operate said automatic switching means to include said third line in said talking circuit, and means for causing said lines to test busy.

2. In a telephone exchange system, the combination with a calling and a called line, automatic switching means, a sender associated with said calling line adapted to control said switching means to establish a talking circuit including said lines, and a third line, of means whereby the calling party may operate said automatic switching means to include said third line in said talking circuit, means for causing said lines to test busy, and means for automatically releasing said switching means.

3. In a telephone exchange system, the combination with a calling and a called line, automatic switching means, a sender associated with said calling line adapted to interconnect said lines over said switching means, and a third line, of means controlled by the coöperation of the calling and called parties for operating said automatic switching means to include said third line in the connection, and means for causing said lines to test busy.

4. In a telephone exchange system, the combination with a calling and a called line, a sender in said calling line, a train of automatic switches adapted to be set thereby to interconnect said lines, and a third line, of another train of automatic switches adapted to connect said third line in circuit with said interconnected lines, and an electromagnetic switch adapted to be operated by said sender to associate the first switch of said second train of switches with said calling line only upon the receipt of a predetermined number of impulses, whereupon the remaining switches may be operated by said sender to bring said third line into the connection.

5. In a telephone exchange system, the combination with a calling and a called line, a sender in said calling line, a train of automatic switches adapted to be set thereby to interconnect said lines, and a third line, of another train of automatic switches adapted to interconnect said third line with said interconnected lines, and an electromagnetic switch adapted to be operated by said sender after the calling and called lines are interconnected to associate the first switch of said second train of switches with said calling line upon the receipt of a predetermined number of impulses, whereby said sender may operate the remaining switches of the train to bring a third party into the connection.

6. In a telephone exchange system, the combination with a calling and a called line, a line relay, a cut-off relay and a sender for said calling line, numerical and non-numerical automatic switches, said line relay being adapted upon the initiation of a call to cause one of said non-numerical switches to connect with the calling line and operatively associate one of said numerical switches with said sender, whereby said sender may control the same to interconnect said lines, and a third line, of a switch associated with the non-numerical switch connected to the calling line adapted to be operated upon the receipt of a number of impulses from said sender to open the circuit of said cut-off relay to permit said line relay to energize to cause another non-numerical switch to connect with the calling line.

7. In a telephone exchange system, the combination with a calling and a called line, a line relay, a cut-off relay and a sender for said calling line, numerical and non-numerical automatic switches, said line relay being adapted upon the initiation of a call to cause one of said non-numerical switches to connect with the calling line and operatively associate one of said numerical switches with said sender, whereby said sender may control the same to interconnect said lines, and a third line, of a switch associated with the non-numerical switch connected to the calling line adapted to be operated upon the receipt of a predetermined number of impulses from said sender to open the circuit of said cut-off relay to permit said line relay to energize to cause another non-numerical switch to connect with the calling line, said switch upon receipt of a lesser number of impulses failing to open said cut-off relay circuit and upon receipt of a greater number reclosing said circuit before a second finder can reach the calling line.

8. In a telephone exchange system, the combination with a calling and a called line, a line and cut-off relay for said calling line, automatic switches including line finders, means adapted upon the energization of said line relay upon the initiation of a call for causing one of said finders to connect with the calling line, a circuit for operating said cut-off relay completed by said finder, a special switch controlling the circuit of said cut-off relay, a sender in said calling line adapted to set up a connection with said called line over said finder by means of said automatic switches, and after the completion of such connection, to cause said special switch to deënergize said cut-off relay to permit said line relay to reënergize, and means operated thereby to cause a second finder to connect with the calling line.

9. In a telephone exchange system, the combination with a calling and called line, a line relay, a cut-off relay for said calling line adapted when energized to disconnect said line relay from said line, automatic switches including line finders, a sender, means adapted upon the energization of said line relay upon the initiation of a call for causing one of said finder switches to connect with the calling line, a circuit for operating said cut-off relay closed when said finder connects with said line, a stepping relay adapted under the control of said sender to transmit impulses to said automatic switches to effect connection with said called line, and a third line, of a step-by-step switch associated with said line finder including a control magnet, said switch having an arm controlling the circuit of said cutoff relay, means for connecting said control magnet to a contact of said stepping relay after the completion of a connection, said switch when operated by said stepping relay being adapted to open the circuit of said cut-off relay to cause the energization of the calling line relay, and means controlled by the energization of said line relay for causing a second finder to connect with the calling line.

10. In a telephone exchange system, the combination with a calling and called line, a line relay, a cut-off relay for said calling line adapted when energized to disconnect said line relay from said line, automatic switches including line finders, a sender, means adapted upon the energization of said line relay upon the initiation of a call for caus-

ing one of said finder switches to connect with the calling line, a circuit for operating said cut-off relay closed when said finder connects with said line, a stepping relay adapted under the control of said sender to transmit impulses to said automatic switches to effect connection with said called line, and a third line, of a special side switch associated with said line finder including a control magnet, said switch having an arm controlling the circuit of said cutoff relay, means for connecting said control magnet to a contact of said stepping relay after the completion of a connection, said switch when operated by said stepping relay being adapted to open the circuit of said cut-off relay to cause the energization of the calling line relay, and means controlled by the energization of said line relay for causing a second finder to connect with the calling line.

11. In a telephone exchange system, the combination with a calling and called lines, a line relay and a cut-off relay for said calling line, the latter when energized disconnecting the line relay from the line, automatic switches including line finders, side switches therefor, a sender, means adapted upon the energization of said line relay upon the initiation of a call for causing one of said finder switches to connect with the calling line, a circuit for operating said cut-off relay closed when said finder connects with said line, a stepping relay adapted under the control of said sender to transmit impulses to said automatic switches to effect connection with said called line, and a third line, of a special side switch associated with said line finders having a control magnet adapted to be connected to a contact of said stepping relay over a selector side switch arm after the completion of a connection and having an arm controlling said cut-off relay circuit, said switch when operated by said stepping relay being adapted to open the circuit of said cut-off relay to cause the energization of the calling line relay, and means controlled by the energization of said line relay for causing a second finder to connect with the calling line.

12. In a telephone exchange system, the combination with a calling and called line, a line relay, a cut-off relay for said calling line adapted when energized to disconnect said line relay from said line, automatic switches including line finders, side switches therefor, a sender, means adapted upon the energization of said line relay upon the initiation of a call for causing one of said finder switches to connect with the calling line, a circuit for operating said cut-off relay closed by said finder, a stepping relay adapted under the control of said sender to transmit impulses to said automatic switches to effect conection with said calling line, and a third line, of a special side switch associated with said finders having a control magnet, a called supervisory relay, said side switches upon the establishment of a connection connecting said control magnet to a contact of said called supervisory relay, an arm of said special switch being included in the circuit of said cut-off relay, whereby the called party, by operating his sender, causes said special side switch to deënergize the calling line cut-off relay to permit the energization of the line relay, which in energizing, causes another finder to connect with the calling line.

In witness whereof, I hereunto subscribe my name this 29th day of April A. D., 1916.

ARTHUR B. SPERRY.