Dec. 29, 1925. 1,567,040

E. H. CLARK

TELEPHONE EXCHANGE SYSTEM

Filed Dec. 6, 1923 3 Sheets-Sheet 1

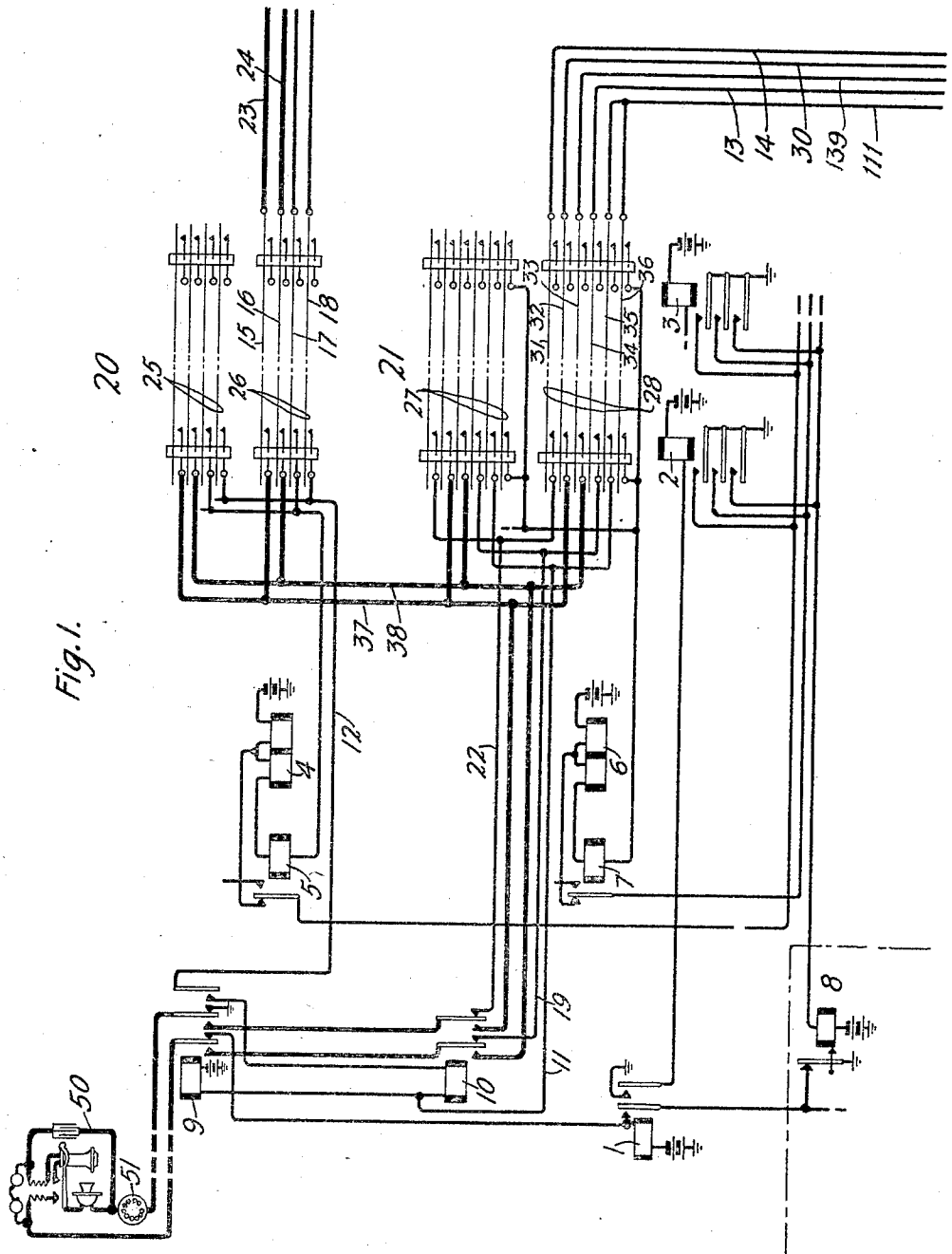

Fig. 1.

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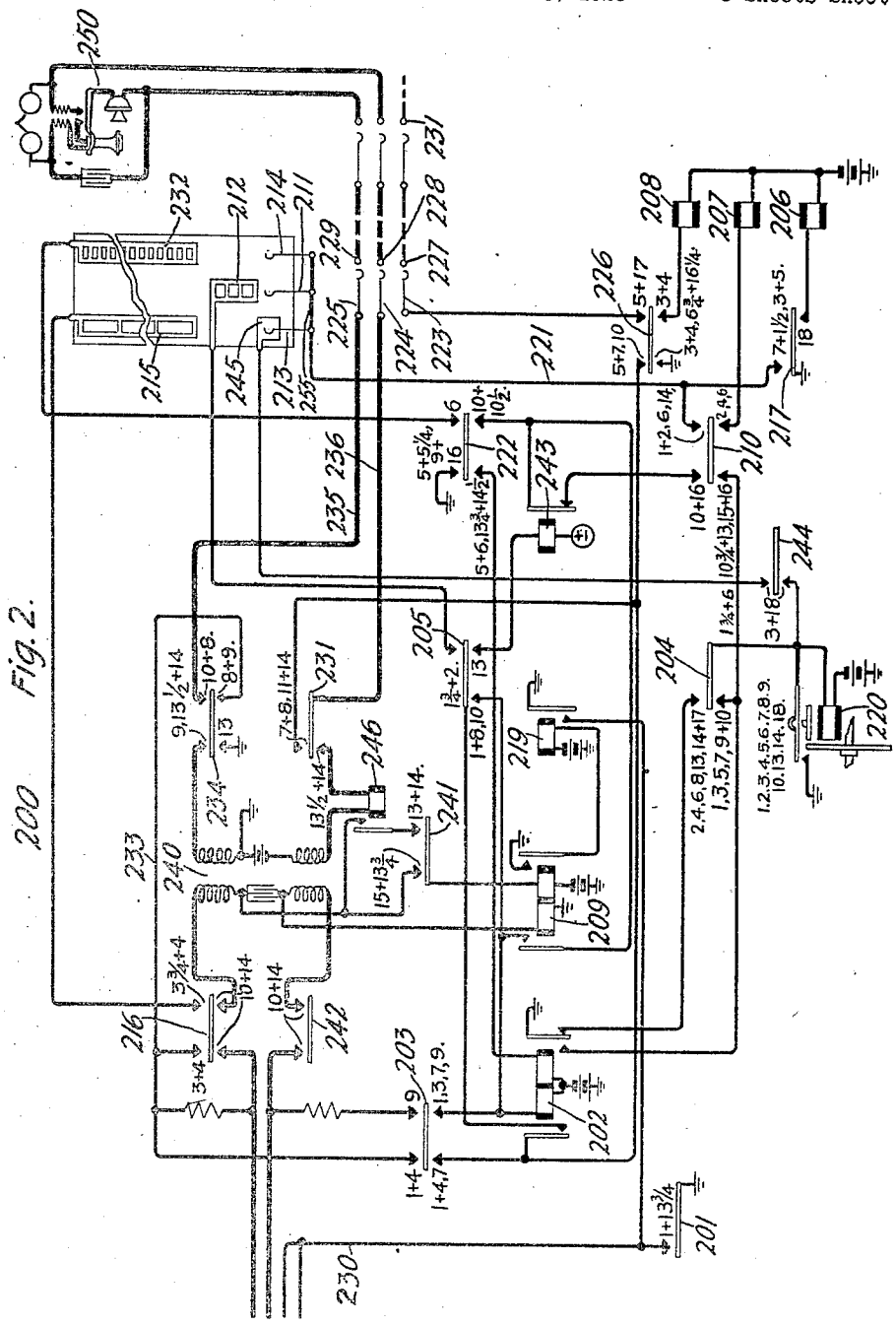

Fig. 2.

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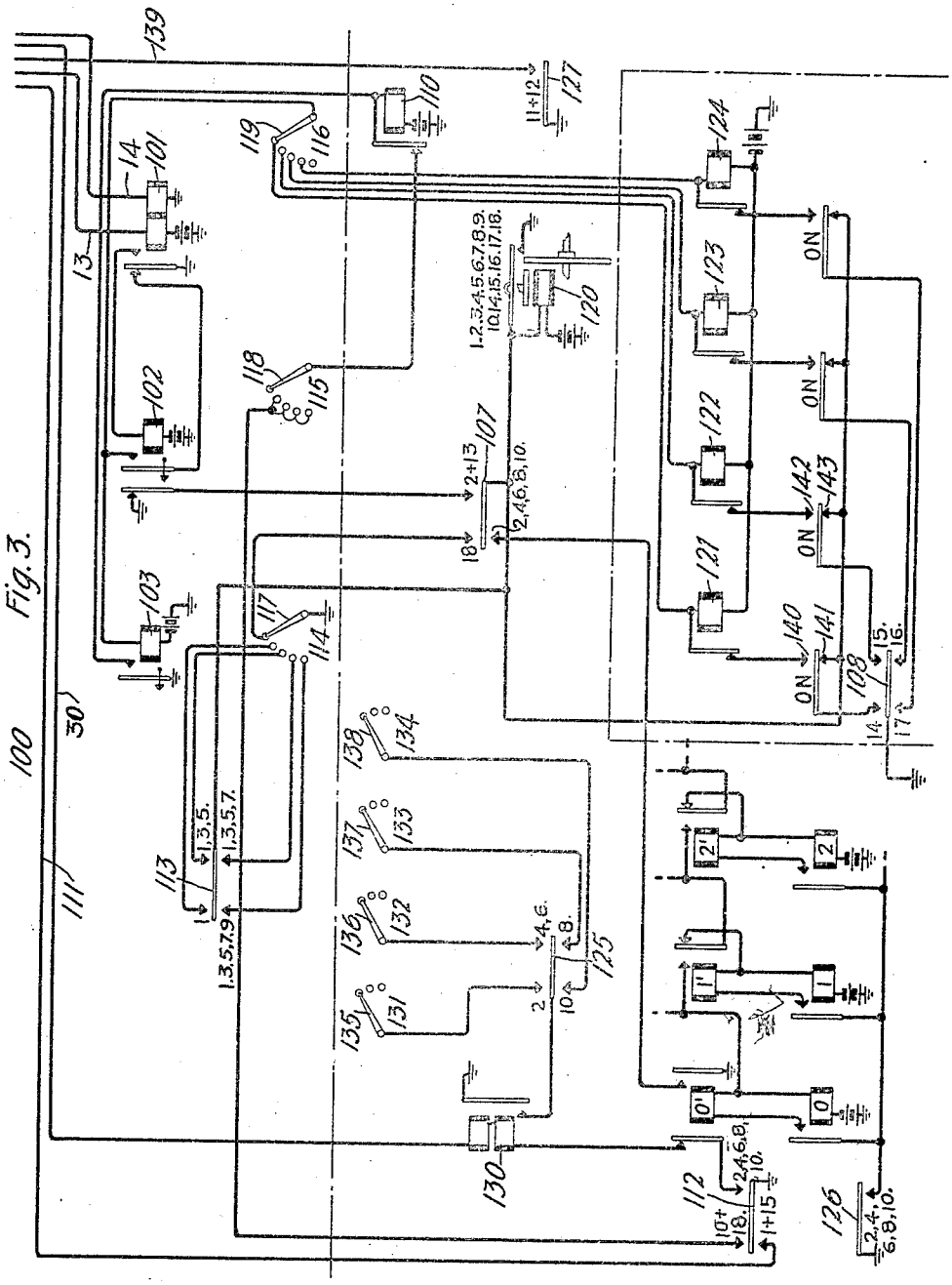

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UNITED STATES PATENT OFFICE.

EDGAR H. CLARK, OF RICHMOND HILL, NEW YORK, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed December 6, 1923. Serial No. 678,936.

To all whom it may concern:

Be it known that I, EDGAR H. CLARK, a citizen of the United States of America, residing at Richmond Hill, in the county of Queens 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 automatic telephone exchange systems, and more particularly to automatic telephone exchange systems wherein a call from a calling subscriber's line is routed through a selector switch and a sender mechanism.

In systems of this general character, it is a usual practice to terminate the subscriber's line in a line switch. When the calling subscriber lifts his receiver from the hook, the line switch operates and selects a selecting switch and a sender selector, the latter in turn operating and connecting an idle sender with the calling line. In order to effect a saving in operating time and in apparatus, it is proposed to provide a combined line switch and sender selector arranged to simultaneously and instantaneously connect a selecting switch and a sender mechanism to the line circuit associated with the calling line.

It is the object of this invention to provide a simple and economical switch for simultaneously connecting an automatic selecting switch and a sender to a line circuit.

A feature of this invention consists in providing means whereby the switch may be arranged to release the sender mechanism upon the complete establishment of the connection and to release the selecting switch following the termination of conversation.

In the drawings, Fig. 1 shows a line circuit of a calling subscriber and a combined line switch and sender selector switch. The upper portion of the switch designated "20" represents the line switch portion, and the lower portion of the switch designated "21" represents the sender selector switch portion. In the dotted rectangle is shown a release relay common to all lines accessible to said switch.

Fig. 2 represents an incoming selector switch of a type well known in the art. It is to be noted that Fig. 2 might represent a district selector switch or any type of distributing selector switch preferred. A final switch and a line to a called station are schematically illustrated to the right of the incoming selector switch on Fig. 2.

In Fig. 3 are shown sender control circuits and the arrangement whereby registering switches may be set in accordance with the designation of the wanted line under the control of the calling subscriber. The wipers and contacts shown above the dotted line in Fig. 3 are arranged to be controlled by a single escape magnet 110, the wipers all being fastened to the same shaft. Each wiper and set of contacts below the dotted line are arranged to be controlled by its corresponding escape magnet shown from left to right within the dotted rectangle in the lower right hand portion of Fig. 3. In the lower left hand portion of Fig. 3 is shown a sequence switch and a set of counting relays controlled by the aforesaid step-by-step registers shown below the dotted line.

The various controlling sequence switches shown are of the type shown in Patent 1,127,808 issued February 9, 1915, to J. N. Reynolds and C. F. Baldwin, and the side switch shown in Fig. 3 is substantially of the type disclosed in Patent 1,252,420 issued January 8, 1918, to O. F. Forsberg. The side switch is arranged to have five positions and the wipers 117, 118 and 119 are arranged to be moved from position to position upon the successive deenergizations of the escape magnet 110.

The operation of the system is as follows: The subscriber whose substation is indicated at 50, when desiring to establish a connection to a subscriber whose substation is indicated at 250, removes his receiver from the switchhook, whereupon a circuit is completed from grounded battery, winding of relay 1, inner back contact and armature of relay 9, through the loop of the calling subscriber's station at 50, middle armature and back contact of relay 9, to ground, operating relay 1. Upon the operation of relay 1, an obvious circuit is completed for operating vertical magnet 2.

Vertical magnet 2 in operating, completes a circuit for operating horizontal magnets 4 and 6 simultaneously. The circuits for operating horizontal magnets 4 and 6 may be traced respectively from grounded battery, right hand winding of magnet 4, back contact of relay 5, to ground on the inner-

most front contact of vertical magnet 2, and from grounded battery, right hand winding of horizontal magnet 6, back contact of relay 7, to ground on the middle front contact of vertical magnet 2. Vertical magnet 2 in operating, also completes an obvious circuit for operating relay 8. Relay 8 being slow operating, does not immediately operate but is arranged to operate immediately after the operation of horizontal magnet 6.

When the horizontal magnet 4 operates, it turns its associated rod, thereby connecting an idle incoming switch to the line circuit through the horizontal conductor 26 associated with the operated horizontal rod and the contacts of vertical magnet 2 associated with the horizontal conductor 26 in a manner well understood in the art and disclosed in the patent to S. B. Williams, No. 1,517,331, issued December 2, 1924. Horizontal magnet 6 in operating, causes its associated rod to connect an idle sender to the line circuit in a manner similar to that described for connecting an idle incoming switch to the line circuit.

As soon as an idle sender is connected to the line circuit, a circuit is completed from grounded battery, both windings of horizontal magnet 6 and the winding of relay 7 in series, contact of vertical magnet 2 and horizontal conductor lead 36, conductor 111, lower left hand contact of sequence switch spring 112 to ground, completing a holding circuit for horizontal magnet 6. Horizontal relay 7 is also operated in this circuit and at its left hand armature opens the original circuit for energizing horizontal magnet 6, thereby preventing any other calling line from connecting with horizontal magnet 6. Relay 7 in operating, also prepares a circuit for energizing another horizontal magnet similar to horizontal magnet 6 when a call originates on another calling line.

Similarly, as soon as an idle incoming switch is connected to the line circuit, a circuit is completed from grounded battery through both windings of horizontal magnet 4 and the winding of relay 5 in series, contact of vertical magnet 2, horizontal conductor lead 17, conductor 230 to ground at the contact of sequence switch spring 201, completing a holding circuit for horizontal magnet 6. Horizontal relay 5 operates in this circuit and opens the original energizing circuit for horizontal magnet 4 at its left hand armature and also prepares a circuit for energizing another horizontal magnet similar to horizontal magnet 4 when another call is originated.

A circuit is also completed from grounded battery, winding of relay 9, conductor 11, contact of vertical magnet 2 and horizontal conductor lead 35, to ground on the lower left hand contact of sequence switch spring 112 as previously described. Relay 9 operates and at its back contacts opens the initial circuit for energizing relay 1. Slow operating relay 8 is also completely energized at this time as prearranged, and opens the holding circuit for relay 1 which deenergizes, in turn opening the energizing circuit for vertical magnet 2 which deenergizes. The connection between the line circuit and the incoming selector switch 200 and the sender 100, is not opened since the connections are arranged to be held by the operated horizontal magnets in a manner well known in the art and described in the aforesaid patent to S. B. Williams.

Relay 9 in operating, completes a circuit from grounded battery, windings of relays 9 and 10 in series, outer front contacts of relay 9, conductor 12, contact and lead 18 of horizontal conductors 26, conductor 230, left hand contact of sequence switch spring 201, to ground. Relay 10 does not operate in this circuit since the winding of relay 10 is shunted by the circuit to ground in the sender.

Relay 9 in operating, also completes a circuit for operating pulsing relay 101 in a circuit from grounded battery, left hand winding of relay 101, conductor 13, horizontal lead 34 and vertical contact of horizontal conductors 28, inner back contact and armature of relay 10, inner front contact and armature of relay 9, loop of subscriber's station 50, pulse sending device 51, middle armature and front contact of relay 9, outer armature and back contact of relay 10, conductor 22 contact and lead 31 of horizontal conductors 28, conductor 14, right hand winding of pulsing relay 101, to ground. Relay 101 in operating, completes an obvious circuit for operating slow-release relay 102.

The sender 100 is now in a position to receive the dial pulses from the calling subscriber's station, and the setting of the registers under the control of a calling subscriber's impulse dial will now be described. When the subscriber operates his impulse device 51 to send the first series of impulses, pulsing relay 101 is intermittently deenergized. Upon the first deenergization of relay 101, a circuit is completed from grounded battery, winding of slow-release relay 103, inner armature and front contact of relay 102, to ground through the back contact and armature of pulsing relay 101. Relays 103 and 102 being slow-release relays, retain their armatures during the sending of each series of impulses. The energization of relay 103 completes a circuit for energizing escape magnet 110 from grounded battery, winding of escape magnet 110, to ground on the front contact and armature of relay 103. Each deenergization of pulsing relay 101 causes the thousands register wiper 135 to be advanced one step under the control of the stepping magnet 121, the circuit of this

stepping magnet being from grounded battery, winding of stepping magnet 121, side switch wiper 119 and contact 1 of side switch arc 116, left front contact of slow-release relay 102, to ground on the back contact of pulsing relay 101. After the thousands series of impulses are sent, relay 101 remains energized for a comparatively long period of time, thereby allowing slow-release relay 103 to deenergize causing in turn the deenergization of escape magnet 110, thereby advancing the wipers 117, 118 and 119 of the side switch to their second positions on the arcs 114, 115 and 116, respectively.

The operation of setting the hundreds register upon the receipt of the next series of impulses, is identical with that previously described for setting the thousands register, except in this case the hundreds register wiper 136 is advanced under the control of the stepping magnet 122, the circuit of stepping magnet 122 being extended through the side switch wiper 119 advanced to its second position. Upon the termination of the second series of impulses, the side switch is moved into its third position upon the deenergization of escape magnet 110 as previously described.

With the side switch wipers in their third position, the tens register wiper 137 is advanced under the control of stepping magnet 123 through the side switch wiper 119 in its third position, and upon the completion of this series of impulses, escape magnet 110 again deenergizes, advancing the side switch wipers into their fourth positions in the manner previously described.

In the fourth position of the side switch wiper 119, the units register wiper 138 is advanced under the control of stepping magnet 124 through the side switch wiper 119 in its fourth position, and upon the termination of the last series of impulses, escape magnet 110 again deenergizes, advancing the side switch wipers into their fifth position as described.

When side switch wiper 117 arrived in its second position, a circuit was completed from grounded battery, power magnet of sequence switch 120, upper left hand contact of sequence switch spring 113, wiper 117 in its second position to ground, for moving sequence switch 120 out of position 1 into position 2. A circuit is then completed for energizing line relay 202 in the incoming selector switch from grounded battery, left hand winding of relay 202, lower right hand and upper left hand contacts of sequence switch spring 203, conductor 23, lead 15 and contact of horizontal conductors 26, conductor 37, contact and lead 32 of the horizontal conductors 28, conductor 30, winding of stepping relay 130, back contact of counting relay 0′, upper right hand contact of sequence switch spring 112, to ground. Relays 202 and 130 are energized in this circuit, relay 202 completing a circuit from ground on its right front contact, lower left hand contact of sequence switch spring 204, power magnet of sequence switch 220, to grounded battery for moving sequence switch 220 out of position 1 into position 2. Relay 202 in operating, also completes a locking circuit for holding itself operated in position 2 of sequence switch 120 from grounded battery, left hand winding of relay 202, lower left hand contact of sequence switch spring 205, left front contact of relay 202, left hand contacts of sequence switch spring 203, to ground as previously described. Relay 130 is held operated in this circuit during position 2 of sequence switch 220. With sequence switch 220 in position 2 and relay 202 operated, a circuit is completed from grounded battery, winding of up-drive magnet 207, lower contacts of sequence switch spring 210, to ground on the front contact and armature of relay 202, operating up-drive magnet 207. A plurality of brush sets, corresponding to the one including brushes 225, 224 and 223, are then moved upwardly under the control of magnet 207, into a position wherein one of such sets may be tripped.

The registers indicated by the wipers 135, 136, 137 and 138 and their associated contact arcs 131, 132, 133 and 134 are set in accordance with the numerical designation of the wanted line. Other contacts and wipers (not shown) are associated with the registers and are electrically connected in such a manner as to control the translation of the pulses as dialed into the proper settings on the registers and translator for making selections necessary on the 500 point switches to establish a connection to the wanted line. Since the translation into the desired register is well known in the art, it has been considered unnecessary to disclose the winding arrangement of the register in the present description. If, however, we assume that the number of the wanted line is 7823, it will be necessary to trip the fourth set of brushes and establish a connection to an idle trunk in the fourth group of the switch shown in Fig. 2. With the final switch which is indicated in Fig. 2, it will be necessary to trip the fourth set of brushes and then establish a connection to the fourth line in the third sub-group served by such brush. Therefore, it will be necessary to send out four incoming brush selecting impulses, four incoming group selecting impulses, four final brush selecting impulses, three tens selecting impulses, and four units selecting impulses.

The energization of relay 130 completed a circuit from grounded battery, winding of No. 3 counting relay, not shown, armature and back contact of No. 3′ counting relay, not shown, a contact of the register control wiper 135, upper left hand contact of se-

quence switch spring 125, to ground on the front contact and armature of relay 130. It will be remembered that the energization of relay 202 caused the operation of up-drive magnet 207 thereby advancing the brush sets associated with the incoming selector switch. As soon as the commutator brush 211 engages the first conducting segment of commutator 212, the stepping relay 130 is shunted over a path from grounded battery, left hand winding of relay 202, lower left hand contact of sequence switch spring 205, upper right hand contact of sequence switch spring 205, commutator 212, brush 211, upper right hand contact of sequence switch spring 210, lower left hand contact of sequence switch spring 210 to ground, on the right front contact and armature of relay 202. The resultant deenergization of stepping relay 130 allows No. 3′ counting relay to energize in the well known manner. The counting relays are actuated successively as the brush 211 successively passes over conducting segments of commutator 212, and when the 0′ counting relay is energized, the original energizing circuit of relay 202 is permanently opened at the left hand armature of the 0′ counting relay, and when a moment later brush 211 engages an insulating segment of commutator 212 this relay deenergizes breaking the circuit of the up-drive magnet 207 and bringing the brush sets to rest in a position wherein the fourth set of brushes may be tripped.

The counting relays when energized lock up to ground through sequence switch spring 126. The 0′ counting relay at its right hand armature completed a circuit from grounded battery, power magnet of sequence switch 120, lower left hand contact of sequence switch spring 107, to ground on the front contact and armature of 0′ counting relay, for moving sequence switch 120 out of position 2 and into position 3. During this movement the locking circuit for the counting relay is broken at sequence switch spring 126 and the counting relays are restored. The deenergization of relay 202 completed a circuit from grounded battery, power magnet of sequence switch 220, upper left hand contact of sequence switch spring 204, to ground on the back contact and armature of relay 202, moving sequence switch 220 out of position 2 into position 3. In position 3 of sequence switch 220, a circuit is completed from grounded battery, winding of trip magnet 208, lower contacts of sequence switch spring 226 to ground, the operation of this magnet resulting in the movement of a trip rod (not shown) to engage the positioned set of brushes, so that on subsequent upward movement of the shaft, these brushes will be released and rendered operative with relation to the group of terminals served by them.

Provided that the register setting operation has advanced to a stage wherein the side switch has reached its third position or some later position, thereby insuring that the hundreds register has been set, a circuit is completed from grounded battery, winding of the power magnet of sequence switch 120, upper right hand contact of sequence switch spring 113, side switch wiper 117 in its third position to ground, for moving sequence switch 120 out of position 3 into position 4.

A circuit is now completed from grounded battery, left hand winding of relay 202, lower right hand contact of sequence switch spring 203, upper left-hand contact of sequence switch spring 203, conductor 23 to ground, through the winding of stepping relay 130, and the upper right hand contact of sequence switch spring 112 in position 4. Relays 202 and 130 are operated in this circuit as before. Relay 202 completed a circuit from grounded battery, power magnet of sequence switch 220, lower left hand contact of sequence switch spring 204, to ground, on the front contact and armature of relay 202, for moving sequence switch 220 out of position 3 into position 4. When relay 202 energized it completed a locking circuit for holding itself energized during sequence switch positions 3 and 4, in a circuit from grounded battery, left hand winding of relay 202, lower left hand contact of sequence switch spring 205, left front contact of relay 202, left hand contacts of sequence switch spring 203, conductor 23, to ground through the winding of stepping relay 130 as previously described. Relay 130 remains locked in series with relay 202. The energization of relay 202 also completed a circuit from grounded battery, winding of up-drive magnet 207, lower contacts of sequence switch spring 210 to ground, on the front contact and armature of relay 202, for moving the brush sets upwardly and advancing the selector brush set in a group selecting movement.

The energization of the stepping relay 130 completed a circuit from grounded battery, winding of No. 3 counting relay (not shown) armature and back contact of No. 3′ counting relay, (not shown) through contacts controlled jointly by the thousands and hundreds registers, wiper 136, upper right hand contact of sequence switch spring 125, to ground, on the front contact and armature of stepping relay 130. When the commutator brush 213 engages a conducting segment of the commutator 215, the stepping relay 130 is shunted by a circuit extending from grounded battery, left hand winding of relay 202, lower left hand contact of sequence switch spring 205, front contact and armature of relay 202, left hand contacts of sequence switch spring 203, upper

contacts of sequence switch spring 216, commutator 215, commutator brush 213, conductor 221, upper left hand contact of sequence switch spring 217 to ground. The deenergization of the stepping relay 130 allows the No. 3′ counting relay to energize. The counting relays are actuated in the well known manner and when the No. 0′ counting relay is energized, which occurs when the selected brush is just below the first terminal in the fourth sub-group, the branch circuit through stepping relay 130 of the energizing circuit of relay 202 will be broken. When a moment later brush 213 engages an insulated segment of commutator 215 at which time the brushes will be centered upon the first trunk in the selected sub-group, the relay 202 is deenergized, breaking the circuit of updrive magnet 207 and bringing the brushes to rest. The deenergization of relay 202 completed a circuit from grounded battery, the winding of power magnet of sequence switch 220, upper left hand contact of sequence switch spring 204, to ground, on the back contact and armature of relay 202, moving sequence switch 220 out of position 4 into position 5.

With sequence switch 220 in position 5 a circuit is completed from grounded battery, right hand winding of relay 202, left hand contacts of sequence switch spring 222, to ground. Relay 202 is energized and moves sequence switch 220 out of position 5 into position 6 in a circuit from grounded battery, power magnet of sequence switch 220, lower left hand contact of sequence switch spring 204, to ground on the right hand front contact and armature of relay 202.

If we assume that the trunk upon whose terminals the brushes 223, 224 and 225 are resting, is busy, a circuit will be completed from grounded battery, left hand winding of relay 202, lower left hand contact of sequence switch spring 205, left front contact and armature of relay 202, upper contacts of sequence switch spring 226, brush 223, test terminal 227 of the busy trunk upon which the selected brushes are resting, a test terminal 227 of the same busy trunk appearing before the selector brush of another incoming selector switch, engaged with the trunk of the test terminal 227, the upper right hand contact and lower left hand contact of sequence switch spring 226 on the other incoming selector switch connected to the busy trunk, to ground.

When sequence switch 220 moved out of position 5 into position 6, the energizing circuit through the right hand winding of relay 202 was opened at the upper left hand contact of sequence switch spring 222, but relay 202 remains operated over the circuit previously traced. With relay 202 operated in position 6 of sequence switch 220, because of a busy trunk, a circuit is completed from grounded battery, winding of updrive magnet 207, lower contacts of sequence switch spring 210 to ground on the right front contact and armature of relay 202, completing a circuit for operating updrive magnet 207. Magnet 207 operates and causes the brush sets to be again moved upwardly.

When a moment later brush 214 engages a conducting segment of commutator 232, a circuit is completed for holding relay 202 operated until brush 223 passes over test terminal 227 of the busy trunk and is engaged with the test terminal of the next succeeding trunk. This circuit may be traced from grounded battery, right hand winding of relay 202, lower left hand contact and upper right hand contact of sequence switch spring 222, conducting segment of commutator 232, brush 214, upper right hand contact and lower left hand contact of sequence switch spring 210 to ground on the right front contact and armature of relay 202. If the next succeeding trunk is idle, when brush 223 engages its test terminal a circuit will not be completed through the left hand winding of relay 202, as previously described, as there will be no ground connected to the test terminal. When a moment after brush 214 engages with an insulating segment of commutator 232, the circuit through the right hand winding of relay 202 is opened, causing thereby the deenergization of relay 202. Relay 202 in deenergizing opens the circuit through the updrive magnet 207 which deenergizes and causes the selected brush set including brushes 223, 224 and 225 to rest upon the terminals 227, 228 and 229 of the idle trunk. Relay 202 in deenergizing also completes a circuit from grounded battery, power magnet of sequence switch 220, upper left hand contact of sequence switch spring 204 to ground on the back contact and armature of relay 202, for moving sequence switch 220 out of position 6 into position 7.

In position 7 of sequence switch 220 a circuit is completed from grounded battery, left hand winding of relay 202, lower contacts of sequence switch spring 203, left hand contacts of sequence switch spring 226 to ground. Relay 202 operates and completes a locking circuit for holding relay 202 operated during positions 7 and 8 of sequence switch 220 from grounded battery, left hand winding of relay 202, lower left hand contact of sequence switch spring 205, left front contact and armature of relay 202, upper contact of sequence switch spring 231, conductor 236, brush 224, terminal 228 to ground, through sequence switch spring, closed at this time in the final selector switch (not shown). Relay 202 in operating also completes a circuit from grounded battery, power magnet of sequence switch 220, lower left hand contact of sequence switch spring

204 to ground on the right front contact and armature of relay 202, for moving sequence switch 220 out of position 7 into position 8. Relay 202 remains operated in this position by reason of the completed circuit through its right hand winding to ground in the final selector switch previously described.

The operation of the 0′ counting relay completed a circuit from grounded battery, winding of power magnet of sequence switch 120, lower left hand contact of sequence switch spring 107, to ground, on the front contact and armature of 0′ counting relay, for moving sequence switch 120 out of position 4 into position 5. On leaving position 4 a locking circuit for the counting relays is opened at sequence switch spring 126 and the counting relays are restored. If at this time the register setting operation has been advanced to a stage such that side switch wiper 117 is in either its third, fourth or fifth position, a circuit will then be completed from grounded battery, winding of power magnet of sequence switch 120, right upper contact or either of the lower contacts of sequence switch spring 113 as determined by the position of side switch wiper 117, through side switch wiper 117 in its third, fourth or fifth position, to ground, for moving sequence switch 120 out of position 5 into position 6.

With sequence switch 120 of the sender in position 6 and sequence switch 220 of the incoming selector switch in position 8, the fundamental control circuit is extended to the selected final switch in a circuit over conductor 23, right hand contacts of sequence switch spring 234, conductor 235, brush 225, terminal 229, to grounded battery, through the winding of a line relay similar to relay 202 in the final selector switch circuit, to control the final selection at such switch in a manner well known in the art and in substantially the same manner as incoming selection was controlled. The sender sequence switch 120 is moved through positions 6, 8 and 10 to control the selections at the final switch. After the final units series of impulses have been registered the wipers 117, 118 and 119 of the sender register control side switch, are in their fifth positions. Therefore when the sequence switch 120 is moved into position 10 for controlling the final units selection, a circuit is completed from grounded battery, winding of side switch control magnet 110, wiper 118 in its fifth position, upper left hand contact of sequence switch spring 112, to ground. Side switch magnet 110 intermittently operates and returns its associated wipers to their normal position.

When sequence switch 120 is moved out of position 10 upon the last energization of 0′ counting relay, it is moved into position 14. When final selection is completed in the final selector switch, ground is removed from the circuit through the left-hand winding of relay 202, causing relay 202 to deenergize. Relay 202 in deenergizing completes a circuit from grounded battery, power magnet of sequence switch 220, upper left hand contact of sequence switch spring 204 to ground, on the back contact and armature of relay 202, for moving sequence switch 220 out of position 8 into position 9.

When sequence switch 120 reached position 11, in passing through positions 11 to 14, a circuit was completed from ground, upper right hand contact of sequence switch spring 127, conductor 139, lead 33 and contact of horizontal conductors 28, lead 16 and contact of horizontal conductors 26, conductor 24, right hand contacts of sequence switch spring 203, to grounded battery through the left hand winding of relay 202. Relay 202 is energized and completes a circuit from grounded battery, power magnet of sequence switch 220, lower left hand contact of sequence switch spring 204 to ground on the right hand front contact and armature of relay 202 for moving sequence switch 220 out of position 9 into position 10. When sequence switch 220 moves out of position 9, the circuit for energizing relay 202 is opened at the right contacts of sequence switch spring 203, thereby causing relay 202 to deenergize.

When sequence switch 120 reaches position 14, a circuit is completed from grounded battery, winding of thousands register magnet 121, its left back contact and armature, off normal contact 140 of the thousands register step-by-step switch, upper left hand contact of sequence switch spring 108 to ground. Magnet 121 is intermittently operated and advances its associated register wiper 135 until it reaches its normal position, whereupon the off normal contact 140 is permanently opened and magnet 121 is deenergized. Immediately thereafter the normal contact 141 is closed completing a circuit from grounded battery, power magnet of sequence switch 120, normal contact 141, upper left hand contact of sequence switch spring 108, to ground for moving sequence switch 120 out of position 14 into position 15. With sequence switch 120 in position 15, a circuit is completed for intermittently operating the hundreds register magnet 122, through the upper right contact of sequence switch spring 108 for returning the hundreds register wiper 136 to its normal position. With wiper 136 in its normal position, a circuit is completed from grounded battery, power magnet of sequence switch 120, normal contact 143 of hundreds step-by-step register switch, upper right hand contact of sequence switch spring 108 to ground, for moving sequence switch 120 out of position 15 into position 16. In a

similar manner the registers for the tens and units impulses are returned to normal, and the sequence switch 120 advances through contacts of sequence switch spring 108 into position 18. In position 18 a circuit is completed from grounded battery, power magnet of sequence switch 120, upper left-hand contact of sequence switch 107, wiper 117 in its normal position, to ground for moving sequence switch 120 out of position 18 into its normal position. It is to be observed that all the apparatus included in the sender 100 has now been restored.

When sequence switch 120 moved out of position 15, the sender selector switch horizontal magnet 6 and horizontal relay 7 were opened, thereby permitting the sender 100 to be disconnected from the line circuit. Sequence switch 120 in moving out of position 15 also opened the shunt circuit around relay 10 at the lower left-hand contact of sequence switch spring 112, thereby energizing relay 10 in the circuit already described. Relay 10 in operating completes a circuit from grounded battery, right-hand winding of relay 209, left-hand contact of sequence switch spring 241, upper left-hand winding of repeating coil 240, lower contacts of sequence switch spring 216, conductor 23, lead 15 and contact of horizontal conductor 26, outer front contact and armature of relay 10, middle front contact and armature of relay 9, pulse sending mechanism 51, through the subscriber's station 50, inner front contact and armature of relay 9, inner front contact and armature of relay 10, lead 16 and contact of horizontal conductor 26, conductor 24, upper contacts of sequence switch spring 242, through the lower left-hand winding of repeating coil 240 to ground through the left-hand winding of relay 209. Relay 209 is operated in this circuit and a circuit is completed from grounded battery, left-hand winding of relay 202, left front contact and armature of relay 209, lower right-hand contact and upper left-hand contact of sequence switch spring 222, to ground. Relay 209 in operating, also completes an obvious circuit for operating relay 219. Relay 219 in operating at this time, performs no useful function. Relay 202 in operating, also completed a locking circuit for itself from grounded battery, left-hand winding of relay 202, left front contact and armature of relay 209, back contact of ringing relay 243, left-hand contacts of sequence switch spring 210, to ground, on the right front contact and armature of relay 202. Relay 202 in operating, completes a circuit from grounded battery, power magnet of sequence switch 220, lower left-hand contacts of sequence switch spring 204 to ground on the right front contact and armature of relay 202, moving sequence switch 220 out of position 10 into position 13.

With sequence switch 220 in position 13 a circuit is completed for ringing the wanted subscriber's line. This circuit may be traced from grounded battery, winding of ringing relay 243, lower right-hand contact of sequence switch spring 205, left front contact and armature of relay 202, upper contact of sequence switch spring 231, conductor 236, brush 224, terminal 228, through the final selector switch, (not shown), out over the wanted subscriber's line. When the wanted subscriber answers relay 243 operates in a manner well known in the art and opens the locking circuit for holding relay 202 energized. Relay 202 deenergizes and completes a circuit from grounded battery, power magnet of sequence switch 220, upper left-hand contact of sequence switch spring 204, to ground on the back contact and armature of relay 202, for moving sequence switch 220 out of position 13 into position 14. When sequence switch 220 moves out of position 13 into position 14, it opens the energizing circuit for ringing relay 243 at the lower right-hand contact of sequence switch spring 205.

Supervisory relay 246 is energized when sequence switch 220 moved out of position 13 into position 13½ and remains energized in position 14 in a circuit from grounded battery, lower right-hand winding of repeating coil 240, winding of supervisory relay 246, lower contact of sequence switch spring 231, conductor 236, brush 224, terminal 228, through the ring side of the final switch circuit, out over the wanted subscriber's loop, terminal 229, brush 225, conductor 235, upper contacts of sequence switch 234, through the upper right-hand winding of repeating coil 240 to ground.

With relay 246 operated, a circuit for holding relay 209 operated during positions 13½ and 14 of sequence switch 220 under the control of supervisory relay 246 is completed from grounded battery, right-hand winding of relay 209, right-hand contact of sequence switch spring 241, front contact and armature of relay 246, upper left-hand winding of repeating coil 240 to ground through the left-hand winding of relay 209 as previously described.

It is to be observed that the right-hand and left-hand contacts of sequence switch spring 241 are cut so that they overlap each other in positions 13 to 13¾ in order that during the moving of sequence switch 220 from position 13 to position 14, the relay 209 will be continually held energized.

As soon as sequence switch 220 reaches 14, ground for holding the horizontal magnet 4 is transferred to ground on the right front contact of relay 219 so as to quickly release the horizontal magnet if the connection should be discontinued.

With sequence switch 220 in position 14 a circuit is completed from grounded battery, left-hand winding of relay 202, left front

contact and armature of relay 209, back contact and armature of ringing relay 243, upper contacts of sequence switch spring 210, left-hand contact of sequence switch spring 217 to ground. When sequence switch 220 reaches position 14 the talking circuit between the calling and called subscribers is established.

When the connection is no longer desired, the calling subscriber replaces his receiver, causing the deenergization of relay 209. Relay 209 deenergizes and in turn deenergizes relays 202 and 219. Relay 219 in deenergizing, immediately releases relay 5 and horizontal magnet 4 thereby disconnecting the incoming selector switch 200 from the line circuit. When the incoming selector switch is disconnected, the circuits for energizing relays 9 and 10 are opened causing them to deenergize. When relay 202 deenergizes a circuit is completed from grounded battery, power magnet of sequence switch 220, upper left-hand contact of sequence switch 204, to ground on the back contact and armature of relay 202, for moving sequence switch 220 out of position 14 into position 18. In position 18, a circuit is completed from grounded battery, down-drive magnet 206, lower contact of sequence switch spring 217 to ground. Magnet 206 operates and causes the brush sets to be returned to their normal positions. A circuit is then completed from grounded battery, power magnet of sequence switch 220, upper contacts of sequence switch spring 244, normal contact 245, brush 213 to ground, through the left-hand contact of sequence switch spring 217 for moving sequence switch 220 out of position 18 into its normal position 1.

When the wanted subscriber no longer desires connection and hangs up his receiver on the hook, supervisory relay 246 deenergizes and opens the circuit for holding relay 209 energized. Relay 209 is deenergized, in turn deenergizing relays 202 and 219. Relay 219 in releasing, disconnects the incoming selector switch 200 from the line circuit, thereby deenergizing relays 9 and 10. Relay 202 in deenergizing, completes a circuit from grounded battery, power magnet of sequence switch 220, upper left contact of sequence switch spring 204 to ground on the back contact and armature of relay 202, moving sequence switch 220 into position 18. The selector brush sets are then returned to their normal positions as previously described.

The final selector switch, not shown, will have been restored to normal independent of the restoration of the incoming selector switch upon the release of talking connection in a manner well known in the art.

What is claimed is:

1. In a telephone exchange system, a calling subscriber's line, a group of lines of one character, a group of lines of another character, an automatic switch, means under the control of said calling line for operating said automatic switch to independently connect an idle one of each of said group of lines to said calling line.

2. In a telephone exchange system, an automatic switch, a calling subscriber's line associated with said automatic switch, a group of lines of one character accessible to said switch, a group of lines of another character accessible to said switch, and means under the control of said subscriber's line for operating said automatic switch to simultaneously select an idle one of each of said group of lines.

3. In a telephone exchange system, a calling subscriber's line, a called subscriber's line, means for establishing a connection between said lines, means for controlling the operation of said last mentioned means, an automatic switch, means for operating said automatic switch to simultaneously connect said first mentioned means and said controlling means to said calling line.

4. In a telephone exchange system, a calling subscriber's line, a called line, a plurality of means for establishing a connection between the calling subscriber's line and the called line, a plurality of means any one of which may be employed for controlling any of said plurality of last mentioned means, an automatic switch, and means for operating said automatic switch to simultaneously select one of said plurality of first mentioned means and one of said plurality of controlling means for connection to said calling line.

5. In a telephone exchange system, calling subscribers' lines, called subscribers' lines, an automatic switch associated with said calling lines, a plurality of selector switches for extending a connection from said automatic switch to a called line, a plurality of sender mechanisms for controlling said plurality of selector switches, means for operating said automatic switch to simultaneously select an idle one of said plurality of selector switches and an idle one of said plurality of sender mechanisms and to connect said selected selector switch and said selected sender mechanism with the calling subscriber's line.

6. In a switching system, a group of lines of one character, a group of lines of another character, an automatic switch, lines other than said mentioned groups of lines, means under the control of any one of said last mentioned lines to operate said automatic switch to independently select one line of each of said groups of lines, and connect said selected lines to each other.

7. In a telephone exchange system, a group of lines of one character, a group of lines of another character, an automatic switch, lines other than said mentioned

groups of lines, means under the control of any of said last mentioned lines to operate said automatic switch to simultaneously select one line of each of said groups of lines, and connect said selected lines to each other.

8. In a telephone exchange system, a group of lines of one character, a group of lines of another character, a line other than of said mentioned groups of lines, an automatic switch directly associated with all of said lines, means under the control of said last mentioned line to operate said automatic switch to simultaneously select a line of each of said groups of lines and to connect said line and said selected lines together.

9. In a telephone exchange system, a plurality of lines, an automatic switch common to said plurality of lines, a group of lines of one character accessible to said automatic switch, a group of lines of another character accessible to said automatic switch, means under the control of any certain line of said plurality of lines for operating said automatic switch to select and connect an idle line of each of said groups of lines to said certain line, and means for releasing the selected line of one of said groups while the selected line of the other of said groups is connected to said certain line.

10. In a telephone exchange system, a plurality of lines, an automatic switch common to said plurality of lines, a plurality of groups of lines, each group of lines of a different character from every other group of lines, means under the control of any certain line of said plurality of lines for operating said automatic switch to simultaneously select and connect an idle line of each group of lines to said certain line, and means for releasing a portion of said selected lines while the remaining portion of said selected lines is connected to said certain line.

11. In a telephone exchange system, a calling subscriber's line, a called subscriber's line, a line circut associated with each of said calling subscriber's lines, an automatic switch common to said line circuits, a plurality of automatic switches for extending a connection to a called subscriber, a plurality of senders for controlling the operation of said automatic switches, means for operating said first mentioned automatic switch to simultaneously select an idle one of said plurality of automatic switches and said plurality of senders, means thereafter for releasing said selected sender while said selected automatic switch is connected to said first mentioned automatic switch, and means thereafter for releasing said selected automatic switch.

12. A unitary automatic switch, a calling line, a plurality of groups of lines, means responsive to the last preceding operation of said unitary automatic switch for preselecting a line in each of said groups of lines, and means for operating said automatic unitary switch to simultaneously connect said calling line to a preselected line in each of said groups of lines.

13. In a telephone exchange system, a calling subscriber's line, a called subscriber's line, an automatic unitary switch, a plurality of selector switches for extending a connection to said called subscriber's line, a plurality of sender mechanisms, means for operating said automatic unitary switch to simultaneously and instantaneously connect a preselected selector switch of said plurality of selector switches and a preselected sender mechanism of said plurality of sender mechanisms to said calling line.

14. In a telephone exchange system, calling subscribers' lines, called subscribers' lines, an automatic unitary switch common to said calling subscribers' lines, a plurality of selector switches for extending a connection from said automatic unitary switch to a called subscriber's line, a plurality of sender mechanisms, means for operating said automatic unitary switch to simultaneously select an idle one of said plurality of selector switches and an idle one of said plurality of sender mechanisms to connect said selected selector switch and said selected sender mechanism with the calling subscriber's line.

15. In a telephone exchange system, calling lines, an automatic unitary switching mechanism, a group of links of one character, a group of links of another character, means under the control of any one of said calling lines to operate said automatic unitary switching mechanism to connect a preselected link in each of said groups to said certain calling line, and means responsive to the last preceding operation of said automatic unitary switching mechanism to select a link in each of said groups preparatory to connecting said selected links to the next calling line.

16. In a telephone exchange system, calling lines, a group of links of one character, a group of links of another character, an automatic unitary switching mechanism arranged to normally connect any one of said calling lines to a particular link in each of said groups of links, means under the control of any one of said calling lines to operate said automatic unitary switching mechanism, and means operated in response to the operated condition of said automatic unitary switching mechanism to select a particular link in each of said groups of links for connection to the next subsequent calling line.

17. In a telephone exchange system, calling lines, a group of links of one character, a group of links of another character, an

automatic unitary switching mechanism, means for operating said automatic unitary switching mechanism to normally connect one of said calling lines to a particular link in each of said groups of links, and means operated in response to the last preceding connecting operation, to the last preceding releasing operation and to the joint action of the last preceding connecting and releasing operations of said automatic unitary switching mechanism to select a link in each group of links for connection to the next subsequent calling line.

18. In a telephone exchange system, a calling subscriber's line, a group of lines of one character, a group of lines of another character, an automatic switch comprising a group of horizontal rods associated with said first-mentioned group of lines, a group of horizontal rods associated with said second group of lines, a horizontal magnet for operating each of said horizontal rods, a vertical rod associated with said calling line and common to said groups of horizontal rods, a vertical magnet for operating said vertical rod, means for operating said vertical magnet, means responsive to the last preceding operation of said automatic switch for pre-selecting a horizontal magnet associated with one of each of said groups of horizontal rods and means under the control of said vertical magnet to operate said preselected horizontal magnet to simultaneously connect said calling line to one of each of said groups of lines.

In witness whereof, I hereunto subscribe my name this 5th day of December, A. D. 1923.

EDGAR H. CLARK.

DISCLAIMER.

1,567,040.—*Edgar H. Clark, Richmond Hill, N. Y.* TELEPHONE-EXCHANGE SYSTEM. Patent dated December 29, 1925. Disclaimer filed February 26, 1929, by the assignee, *Western Electric Company, Incorporated.*

Hereby enters this disclaimer to the said claims of said Letters Patent which are in the following words to wit:

"1. In a telephone exchange system, a calling subscriber's line, a group of lines of one character, a group of lines of another character, an automatic switch, means under the control of said calling line for operating said automatic switch to independently connect an idle one of each of said group of lines to said calling line.

"2. In a telephone exchange system, an automatic switch, a calling subscriber's line associated with said automatic switch, a group of lines of one character accessible to said switch, a group of lines of another character accessible to said switch, and means under the control of said subscriber's line for operating said automatic switch to simultaneously select an idle one of each of said group of lines."

[*Official Gazette March 12, 1929.*]