A. E. LUNDELL.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED JUNE 17, 1916.

1,277,440.

Patented Sept. 3, 1918.

9 SHEETS—SHEET 1.

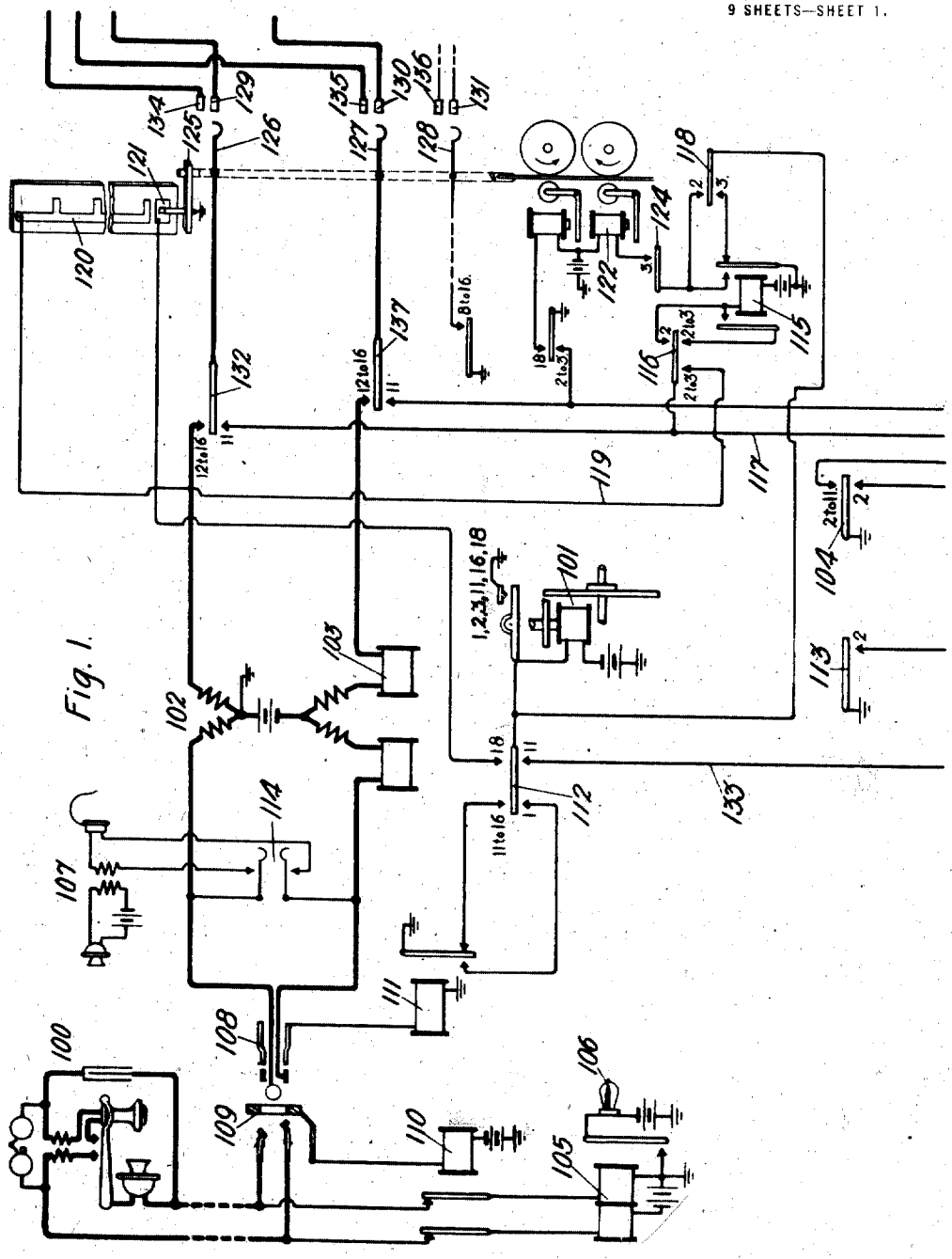


Fig. 1.

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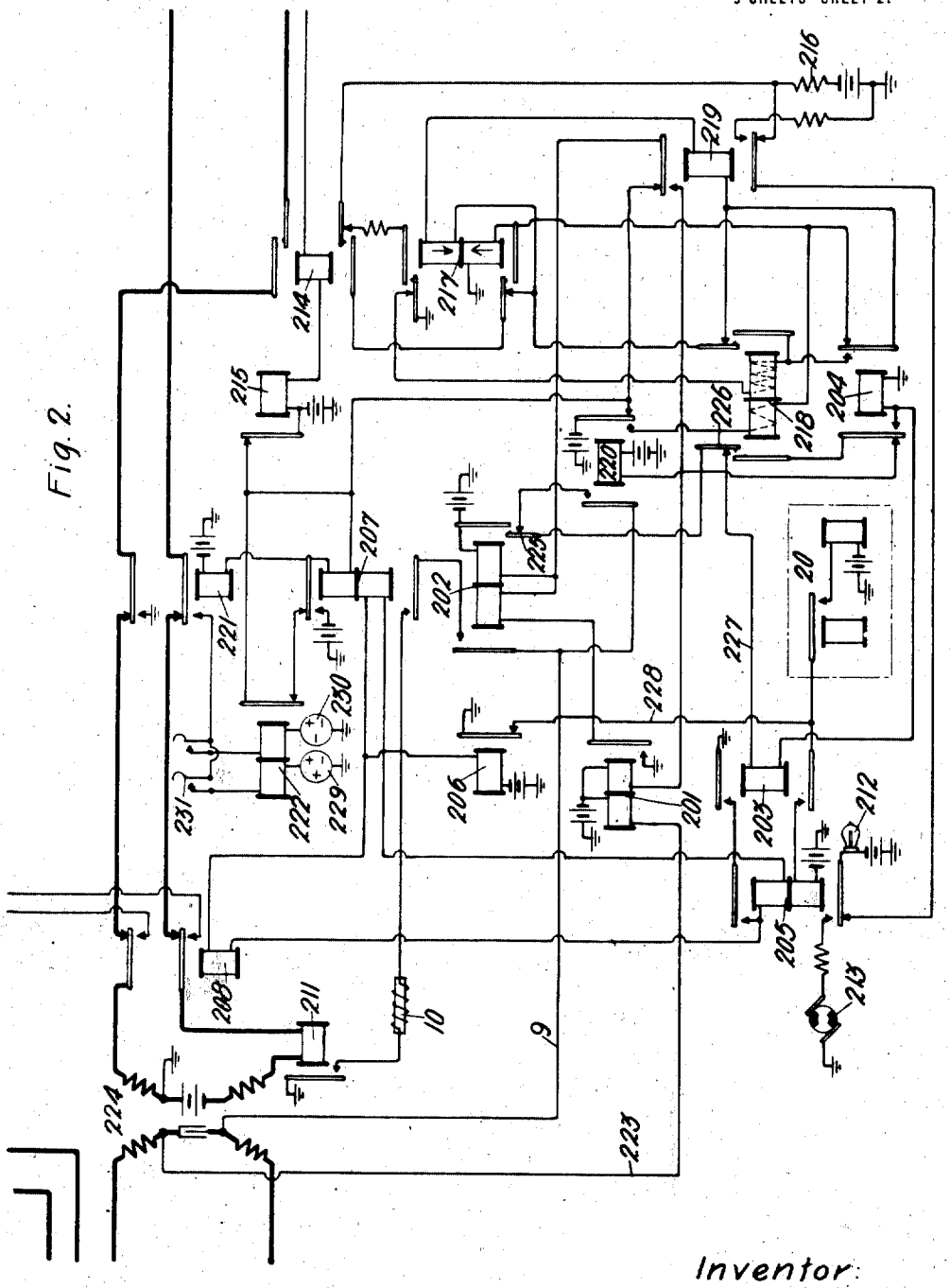
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9 SHEETS—SHEET 2.

Fig. 2.



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9 SHEETS—SHEET 3.

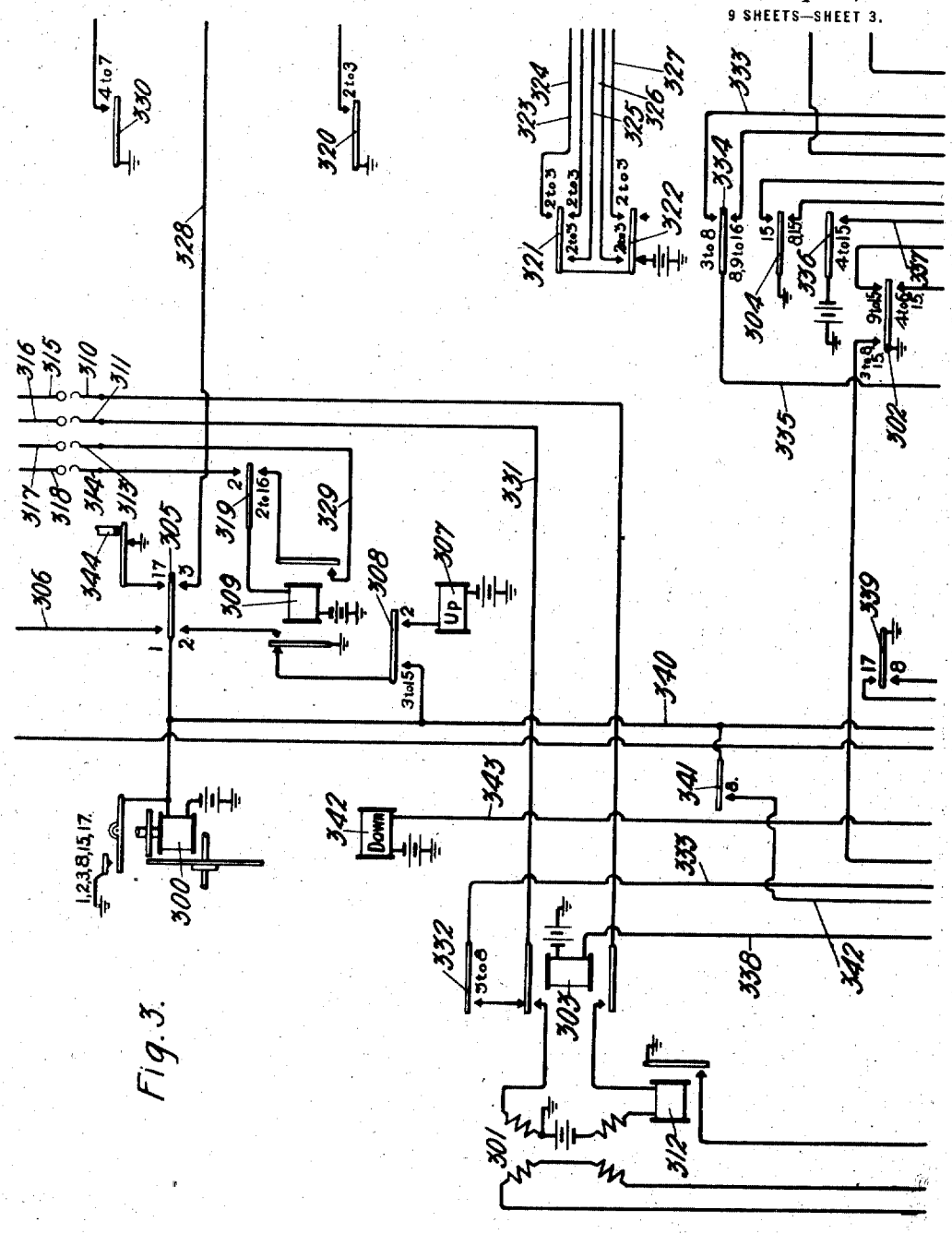


Fig. 3.

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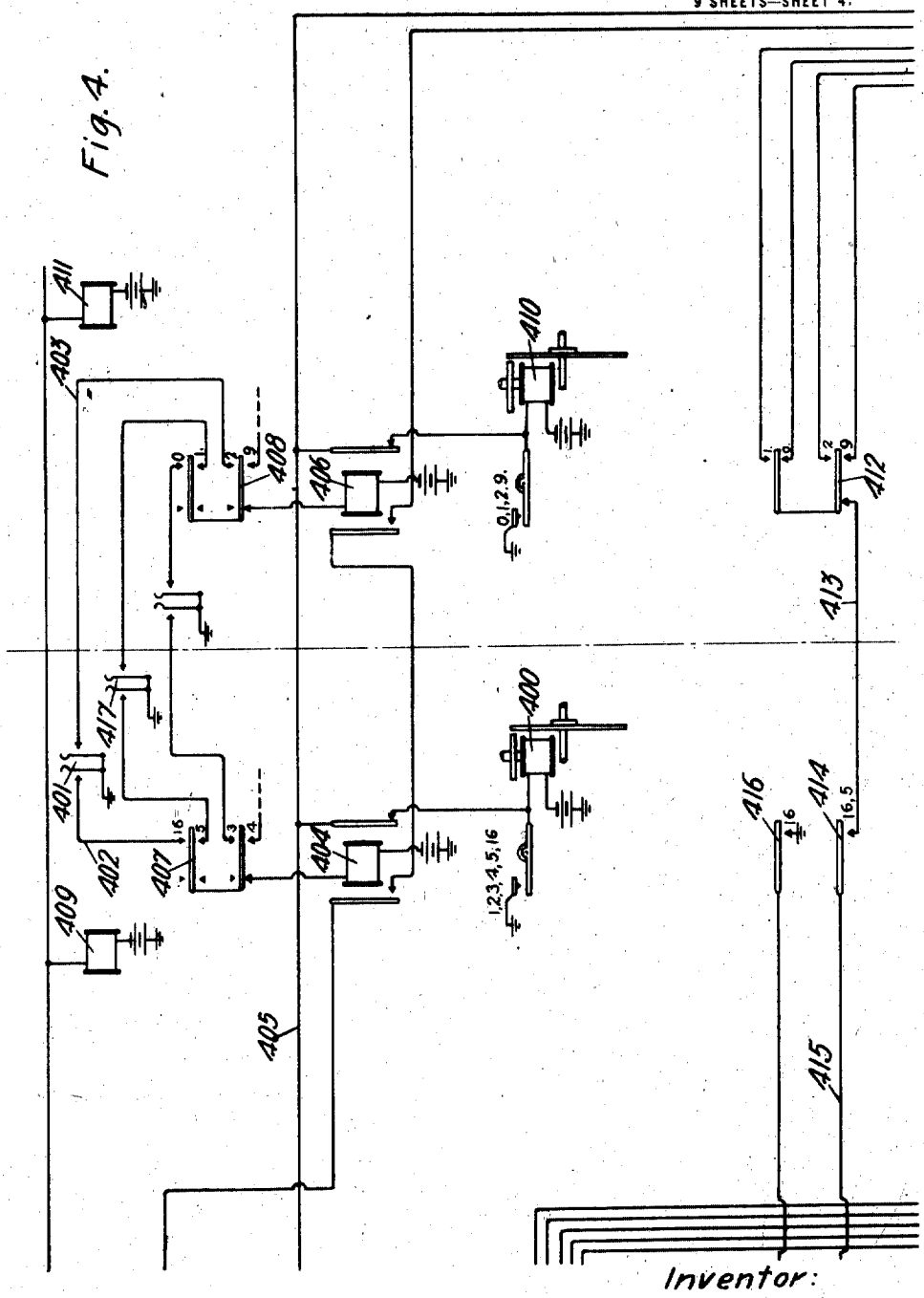
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9 SHEETS—SHEET 4.

Fig. 4.



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9 SHEETS—SHEET 5.

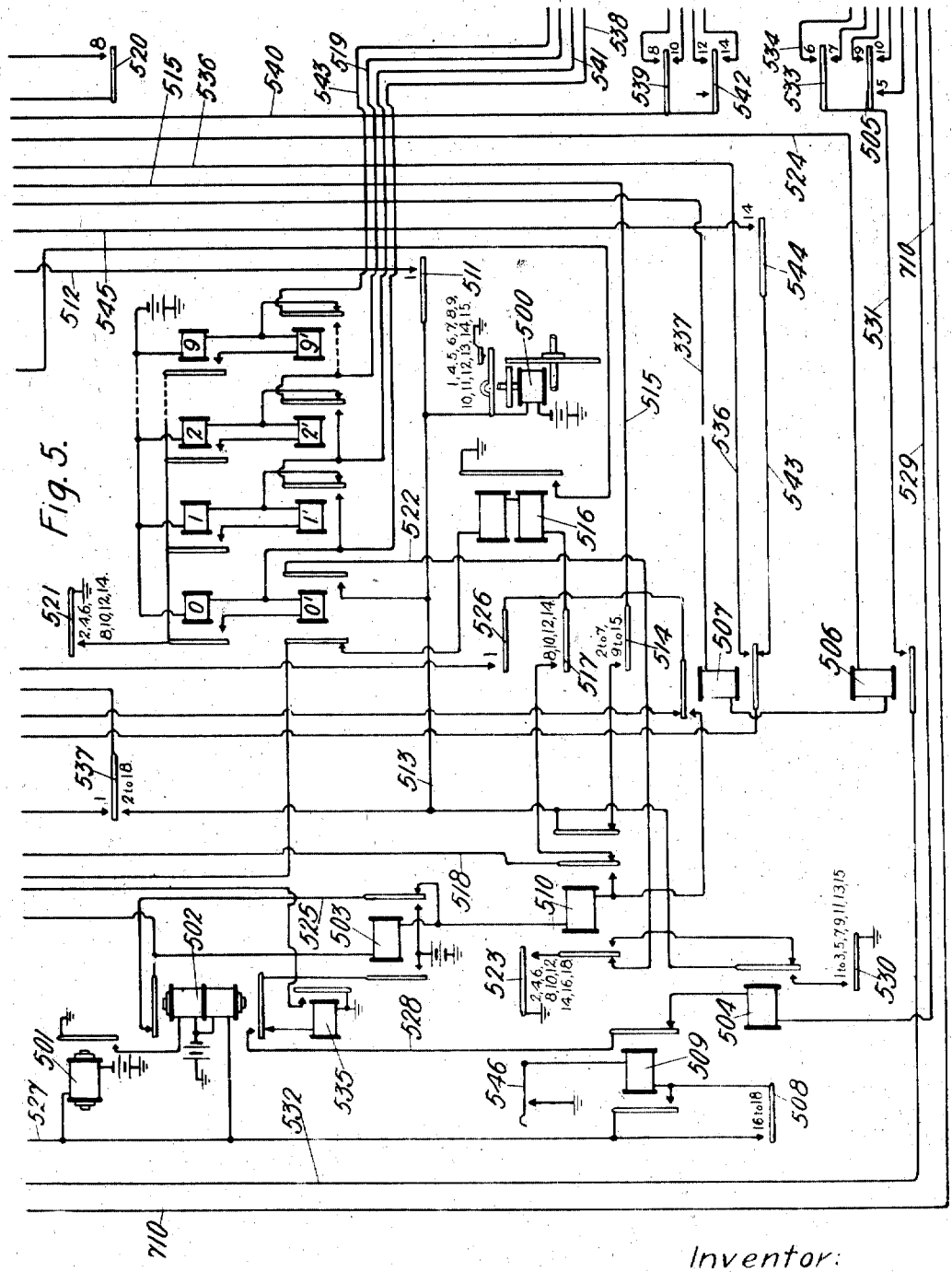


Fig. 5.

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9 SHEETS—SHEET 6.

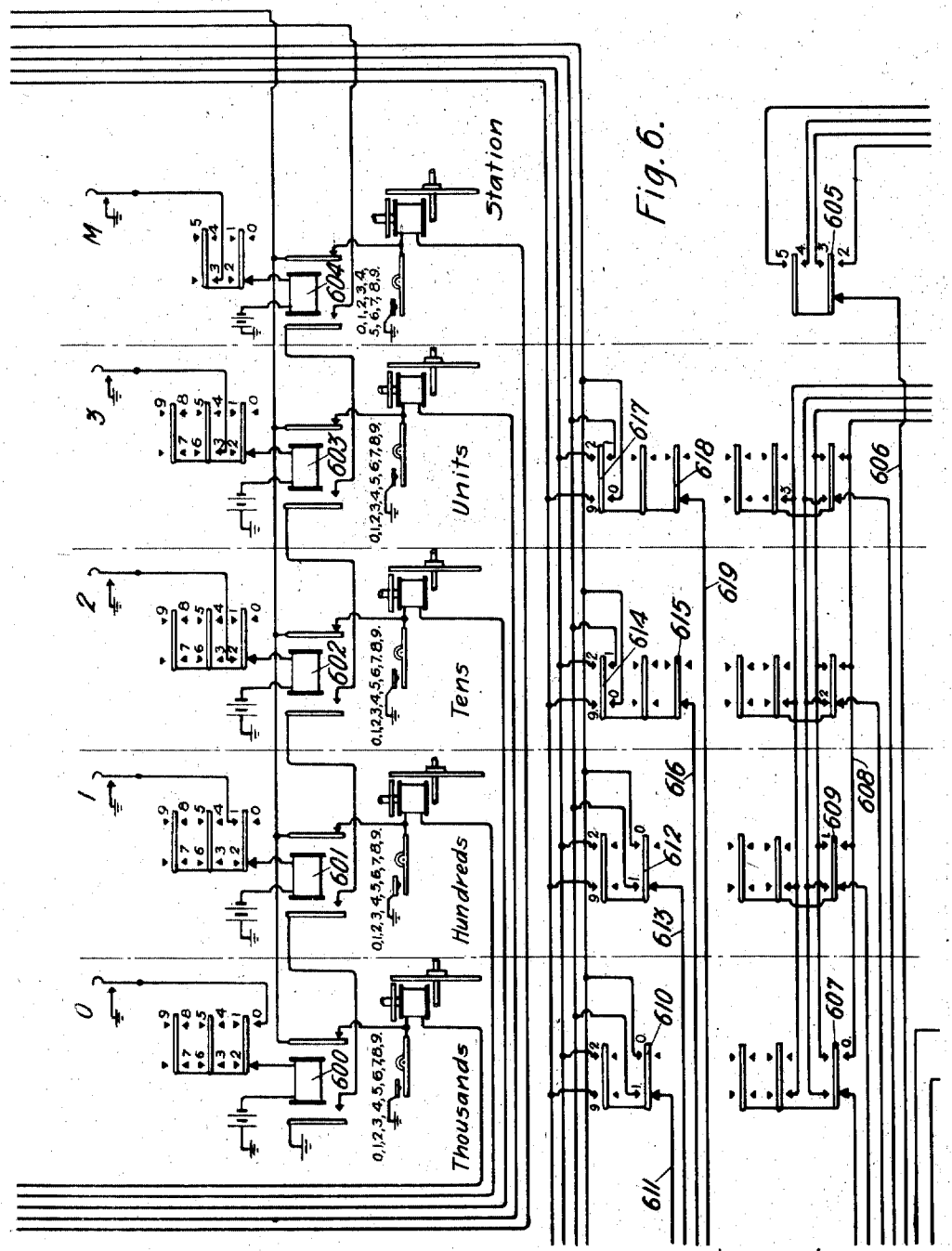


Fig. 6.

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TELEPHONE EXCHANGE SYSTEM.

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9 SHEETS—SHEET 7.

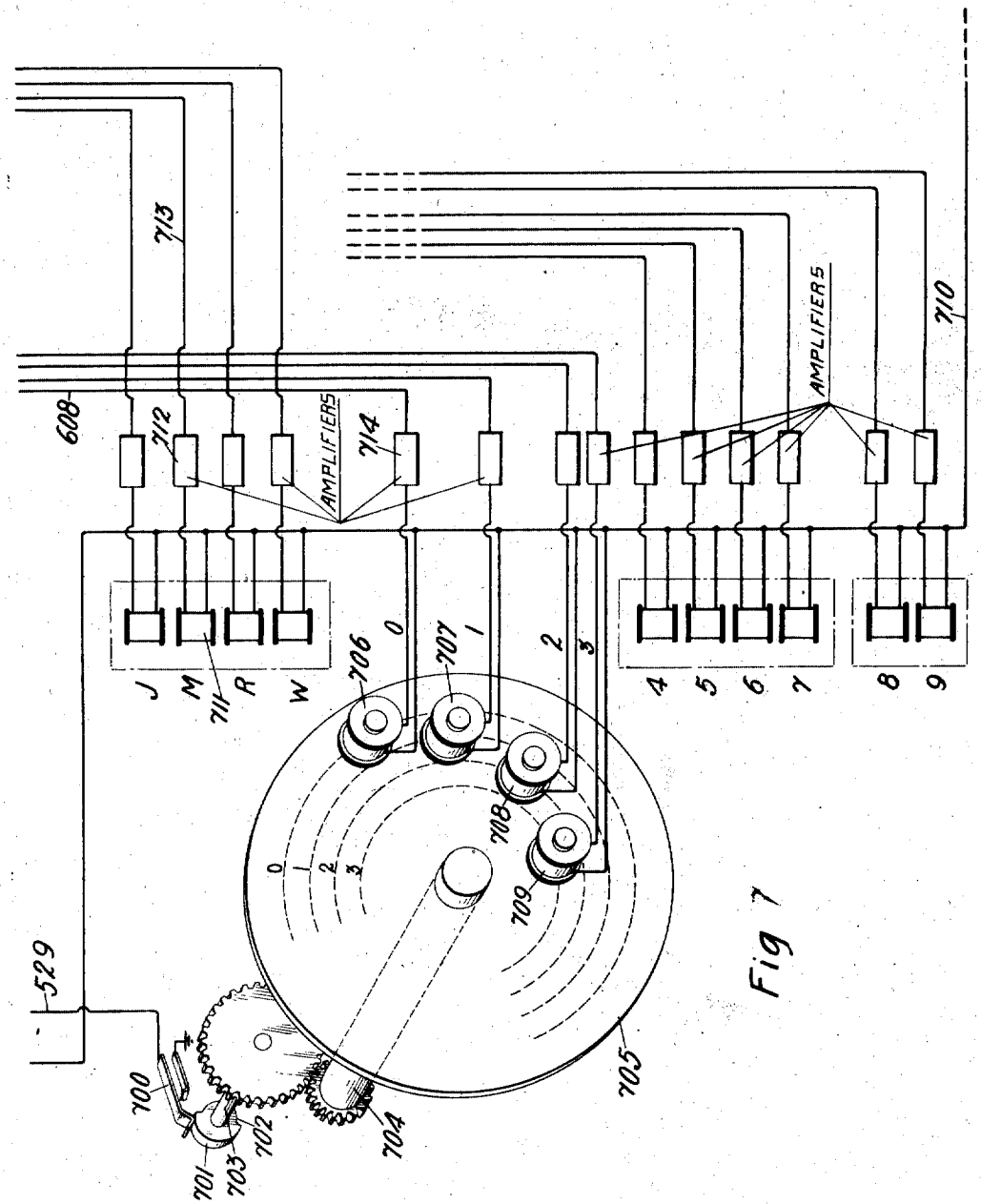


Fig 1

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TELEPHONE EXCHANGE SYSTEM.

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9 SHEETS—SHEET 8.

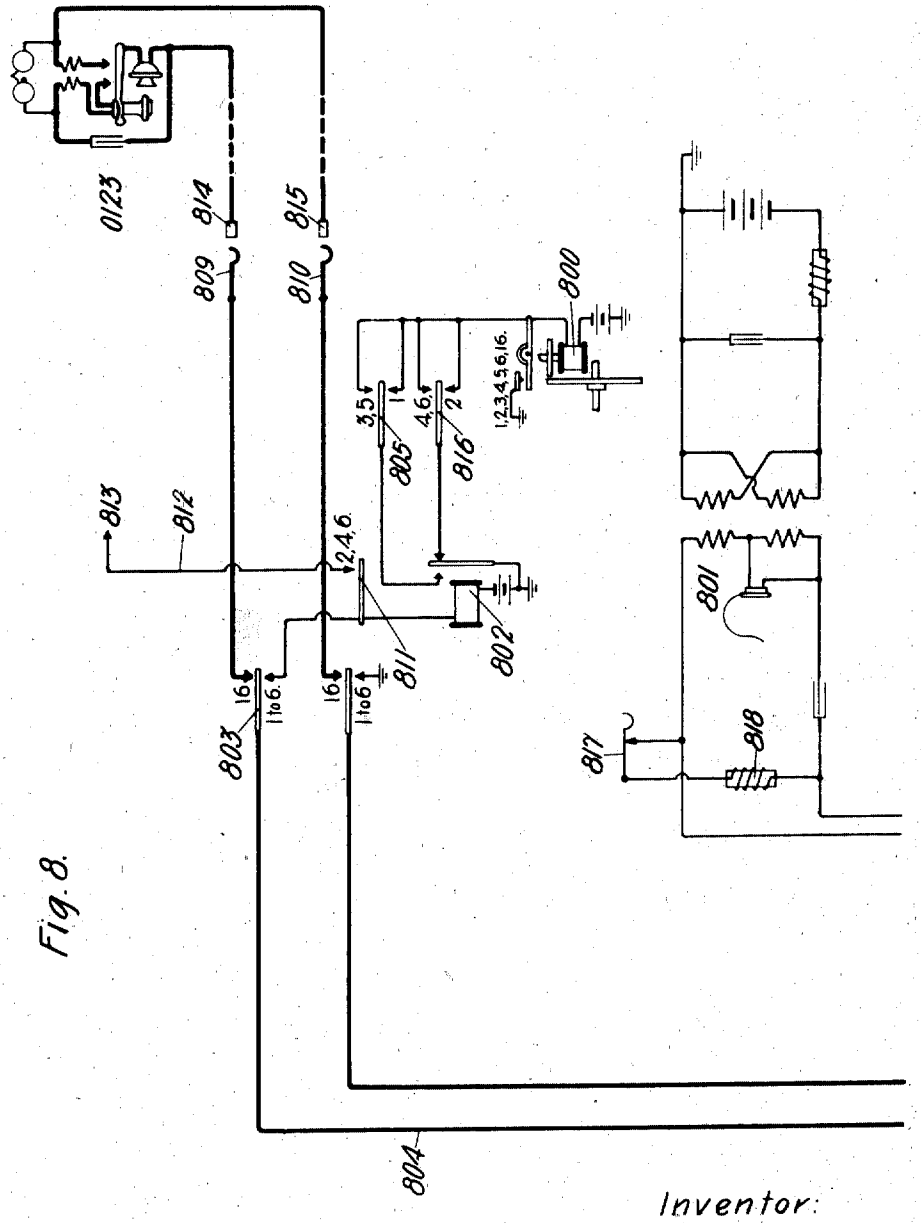


Fig. 8.

Inventor:
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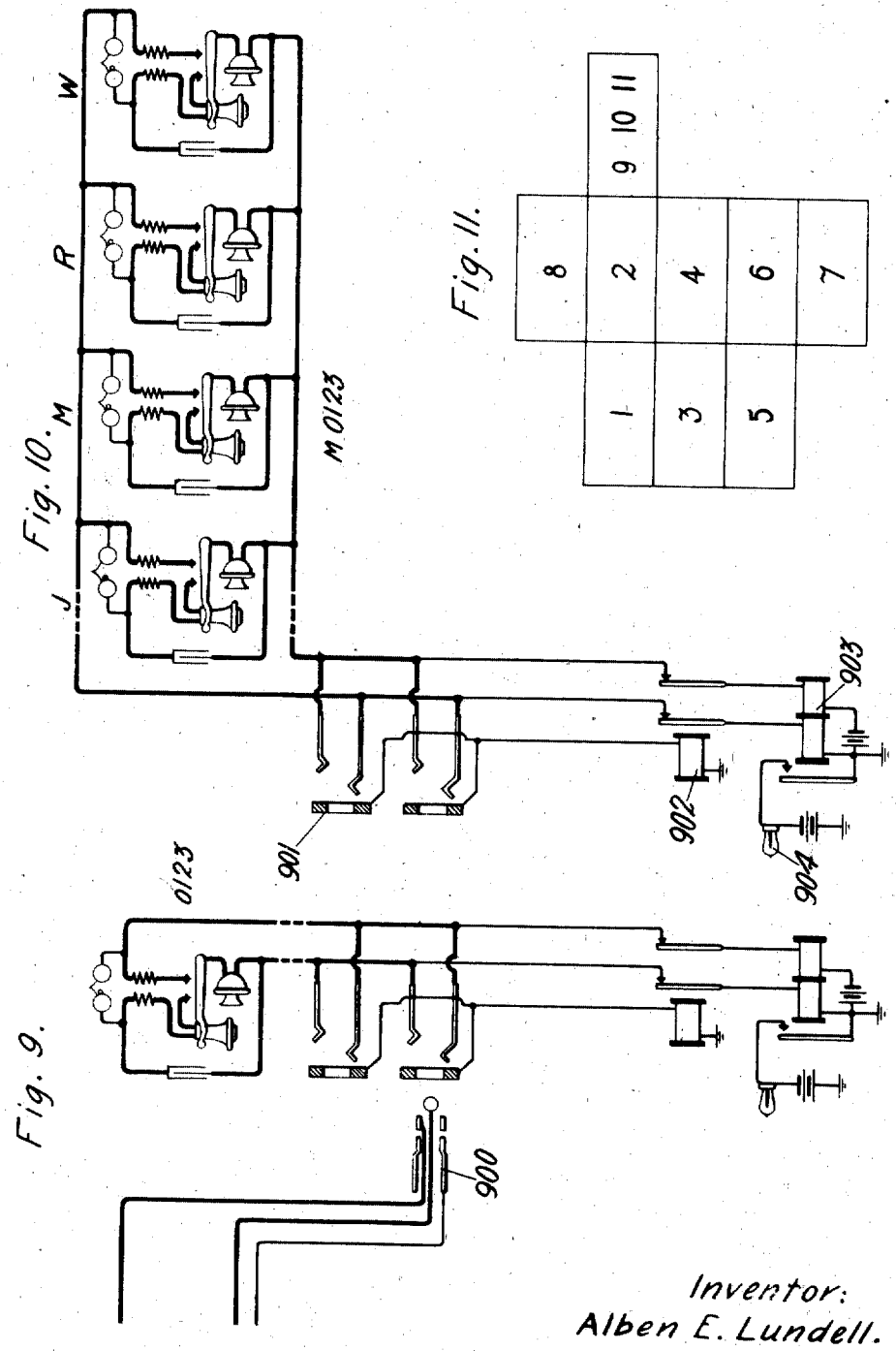
TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED JUNE 17, 1916.

1,277,440.

Patented Sept. 3, 1918.

9 SHEETS—SHEET 9.



Inventor:
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by A. C. Hamel. Att'y.

UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

1,277,440. Specification of Letters Patent. Patented Sept. 3, 1918.

Application filed June 17, 1916. Serial No. 104,231.

To all whom it may concern:

Be it known that I, ALBEN E. LUNDELL, a citizen of the United States, residing at New York, in the county of Bronx 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 and more particularly to a telephone exchange system in which a connection may be established between a calling line and a called line, either by means of automatic selector switches or by means of manually operated apparatus.

The object of the invention is the provision of a sending device which may be operated to impress upon a connecting circuit over which the call is established, either controlling impulses for controlling the operation of automatic switches, or audible signals for announcing to an operator the designation of the called line, depending upon whether the particular call is to be established by means of automatic switches or by means of manual apparatus.

A feature of the invention, therefore, relates to the provision of means for causing the sending device to operate in either one of two ways, which means in the particular systems disclosed includes keys adapted to be set by an operator in accordance with the designation of the desired line. If the desired line can only be reached by means of automatic switches, the operator will depress a key which will automatically eliminate the connection of the audible announcing means to the connecting circuit, whereas if connection to the desired line is to be establishd by means of another manual operator, the first operator will depress a key which will automatically connect the audible announcing means to a second operator's telephone to enable such second operator to extend the connection to the desired line.

In accordance with another feature of the invention, provision is made whereby the audible announcing means, having been connected to the telephone of the second operator, may be disconnected therefrom either automatically or by manual means under the control of either operator.

Still another feature of the invention relates to the use of an automatic switch which controls the association of a sending device, first to control the extension of a calling line to a trunk line leading either to an automatic selector switch or to an operator's position, and to connect such sending device to such connected trunk. This automatic switch subsequently performs either one of two other operations, one being the association of means for audibly announcing the number of the desired line with the connected trunk, and the second being the association of means for impressing controlling impulses with the connected trunk.

In the accompanying drawings, Figures 1 to 10 inclusive show a telephone system adapted for both manual and semi-automatic working, and to which the invention is applied, enough of the telephone system being shown to explain the use of the invention in connection therewith. Fig. 11 is a layout of the various figures showing how the same should be placed when reading the description thereon.

The invention will be most readily understood from a description of the operation of setting up a call and establishing the desired connection.

There are several cases which may arise. The call to be extended may be one to a regular office in a manual exchange, or one to a subscriber on a party line, or the call may be extended to a subscriber in a semi-automatic office. It will be assumed that the number of the wanted subscriber in all cases is 123, except that in the case of a call to a subscriber on a party line, the subscriber's number will be M—123.

If the call is to a subscriber on a party line in a manual office, subscriber 100 removes his receiver from the switchhook, closing a circuit in the usual manner through the line relay 105 and lighting the lamp 106 at the central office. The A operator whose telephone set is indicated at 107, inserts the plug 108 of a trunk into the jack 109

leading to the subscriber 100. The insertion of this plug into the jack closes a circuit from battery, through cut-off relay 110, jack 109, plug 108, relay 111 to ground, energizing both the cut-off relay 110 and relay 111. The energization of cut-off relay 110 cuts off the line relay 105, and extinguishes the lamp 106. The energization of relay 111 completes a circuit from battery, motor magnet of district sequence switch 101, lower left contact of sequence switch spring 112, armature and front contact of relay 111, energizing the motor magnet and moving sequence switch 101 out of position 1 and into position 2. In position 2 of sequence switch 101, a circuit is completed from battery, motor magnet of sequence switch 300, upper left contact of sequence switch spring 305, conductor 306, sequence switch spring 113 to ground, energizing the motor magnet and moving sequence switch 300 out of position 1 and into position 2. In position 2 of sequence switch 300, a circuit is closed from battery, through the up magnet 307 of the cord finder, sequence switch contact 308, left armature and back contact of stop relay 309 to ground, energizing the up magnet and causing a movement of the brush carriage to move the brushes 310, 311, 313, 314 over the contact bank in search of the terminals 315, 316, 317, 318 of the trunk taken for use. When the terminals are reached, a circuit is closed from battery, stop magnet 309, upper contact of sequence switch spring 319, brush 314, terminal 318, lower contact of sequence switch spring 104 to ground, energizing the stop magnet 309 which breaks, at its left armature and back contact, the circuit heretofore traced for the up magnet 307, which thereupon deënergizes, stopping the brush carriage with the brushes 310, 311, 313 and 314 in engagement with the terminals 315 to 318, inclusive, for the trunk taken for use. The energization of the stop magnet 309 also completes a circuit from battery, motor magnet of sequence switch 300, lower left contact of sequence switch spring 305, left armature and front contact of stop relay 309, moving sequence switch 300 from position 2 into position 3. In moving out of position 2, sequence switch 300 breaks, at the upper contact of sequence switch spring 319, the energizing circuit of the stop relay 309, but this relay is held energized over a circuit from battery, winding of stop relay 309, lower contact of sequence switch spring 319, right armature and front contact of the stop relay, conductor 329, brush 313, terminal 317 to ground at the upper contact of sequence switch spring 104, which circuit will be maintained until after sequence switch 101 moves out of position 11.

While the above operation has been taking place, the A operator has depressed her listening key 114, placing her telephone set 107 across the line, and has received from the calling subscriber 100 the designation of the wanted line, which I have assumed to be M—123. Having received this designation, the A operator depresses the office key 401, corresponding to the office in which the wanted subscriber is located, and then depresses the No. 0 key in the 1000's row, the No. 1 in the 100's, the No. 2 key in the 10's, the No. 3 key in the units, and the M key in the stations bank of keys, as indicated on Fig. 6, it being assumed that each of the keys depressed represents one out of a bank of ten keys, the remaining keys of the bank being omitted from the drawings for the sake of clearness. The depression of the office key 401 puts a ground on the conductors 402 and 403 leading to the class and brush register sequence switch contact springs, respectively, while the closure of the 0, 1, 2, 3, and M keys places a ground on the 1000's, 100's, 10's, units and stations register sequence switches respectively. When sequence switch 300 reaches position 2 the following circuits are now closed: from battery, motor magnet of class register sequence switch 400, right armature and contact of cut-off relay 404, conductor 405, sequence switch contact spring 320 to ground; from battery, motor magnet of brush register sequence switch 410, right armature and contact of cut-off relay 406, conductor 405 and to ground as above traced; and from sequence switch springs 321 or 322, conductors 323, 324, 325, 326 or 327 through the motor magnets of the 1000's, 100's, 10's, units and stations register sequence switches, respectively, right armature and contact of the cut-off relays 600 to 604, inclusive, of the 1000's, 100's, 10's, units and stations bank of keys, to the conductor 405 and to ground at sequence switch spring 320. The class register sequence switch 400 will continue to rotate through its various positions until position 10 is reached, at which time a circuit is closed for the cut-off relay 404 at the upper contact of sequence switch spring 407, energizing the relay 404 and stopping the sequence switch in this position. Brush register sequence switch 410 rotates until a circuit is closed for the cut-off relay 406 at the upper contact of sequence switch spring 408, stopping the sequence switch 410 in position 2. The 1000's sequence switch will continue to rotate until a ground is encountered on the lower contact spring of said switch when the following circuit is established over the cut-off relay 600; from battery, relay 600, lower contact in the 1000's sequence switch, the No. 0 1000's key to ground. The No. 1 key energizes the cut-off relay 601 to stop the 100's sequence switch

in position 1. The No. 210's key energizes the cut-off relay 602 to stop the 10's sequence switch in position 2. The No. 3 units key energizes the cut-off relay 603 to stop the units sequence switch in position 3. The stations key M energizes the cut-off relay 604 to stop the stations register sequence switch in position 3, which is a position corresponding to station M of a party line. The energization of the cut-off relays completes a circuit from battery, motor magnet of sequence switch 300, lower right contact of sequence switch spring 305, conductor 328 through the right armatures and contacts of the cut-off relays in series to ground, to move sequence switch 300 from position 3 into position 8.

In passing into position 4 and until passing out of position 7, sequence switch 300 at the upper contact of sequence switch spring 330 maintains a circuit for the release magnets 409 and 411 of the class and brush register keys and also the release magnets of the numerical and stations bank of keys (not shown), releasing the depressed keys in the usual manner.

In passing to position 4, sequence switch 300 completes a circuit from battery, motor magnet of sender sequence switch 500, contact of sequence switch spring 511, conductor 512, lower contact of sequence switch spring 302 to ground, moving sequence switch 500 from position 1 into position 4. In coming into position 2, a circuit is closed from battery of motor magnet of sender sequence switch 500, conductor 513, outer right armature and contact of relay 510, contact of sequence switch spring 514, conductor 515, lower contact of sequence switch spring 304 to ground, moving sequence switch 500 from position 4, through position 7 into position 8.

With district switch 101 in position 2, cord finder sequence switch 300 and sender sequence switch 500 in position 8, a fundamental circuit is established from battery, relay 115, upper contact of sequence switch spring 116, conductor 117, terminals 316, brush 311, conductor 331, upper armature and back contact of relay 303, contact of sequence switch spring 332, conductor 333, left armature and back contact of the 0′ counting relay, through the stepping relay 516, sequence switch spring 517, inner right armature and back contact of relay 510, conductor 518 to ground at sequence switch spring 302. Both the relay 115 and the stepping relay 516 energize in this circuit, the relay 115 at its right armature and front contact completing a circuit at the upper contact of sequence switch spring 118 to move sequence switch 101 out of position 2 and into position 3, and at its left armature and front contact completing a shunt circuit through lower right and left contact of sequence switch spring 116, conductor 119, commutator segment 120 to ground at the brush 121. which is for the purpose of shunting the stepping relay. Sequence switch 101, in coming into its third position, completes a circuit from battery, through the up magnet 122, contact of sequence switch spring 124 to ground at the right armature and front contact of relay 115, energizing the magnet to cause upward movement of the brush carriage 125. At this time, also, a circuit is completed from battery, through the No. 2 counting relay, armature and back contact of the No. 2′ counting relay, conductor 519, upper contact of brush register sequence switch spring 412, conductor 413, contact of sequence switch spring 414, conductor 415, contact of sequence switch spring 520, conductor 333, upper contact of sequence switch spring 334, conductor 335, armature of stepping relay 516 to ground, energizing the No. 2 counting relay, which attracts its armature and closes a circuit for the No. 2′ counting relay from battery to ground at the sequence switch spring 521. The brush carriage 125 moving upwardly completes the shunt circuit from ground at the brush 121. Each time such brush passes over one of the commutator segments 120, it shunts the stepping relay 516 which, deenergizing, breaks the circuits above traced for the No. 2 counting relay, allowing the No. 2′ counting relay to energize, extending the energizing circuit, which formerly passed through the No. 2 relay, to now pass through the No. 1 counting relay. The brush carriage 125 will move upwardly until the stepping relay has been energized and deenergized three times, at which time the 0′ counting relay will have energized, attracting its armatures, breaking the fundamental circuit above traced at its left armature and contact, causing the deënergization of the relay 115 and the stepping relay 516. Relay 115, deënergizing, broke, at its right armature and front contact, the circuit for the up magnet 122, stopping the upward movement of the brush carriage 125 with the brushes 126, 127 and 128 in engagement with the terminals 129, 130 and 131, respectively, of a trunk leading to a B operator's position, and at its right armature and back contact, completing a circuit to move sequence switch 101 out of position 3 and into position 11. Although, for the sake of brevity, the motion of this switch, under the control of the counting relays, has been described as placing the terminals of the switch on a trunk line leading to a B operator's position, it will be understood by those skilled in the art, that in practice this movement is for the purpose of selecting a group of trunks and that a further move-

ment, which ordinarily takes place in positions 4 to 10 of sequence switch 101, is for the purpose of selecting an idle trunk in said group. The energization of the 0′ counting relay at its right armature and front contact completes a circuit from battery, motor magnet of sender sequence switch 500, right armature and front contact of the 0′ counting relay, conductor 522, left armature and back contact of relay 510 to ground at sequence switch spring 523, moving sequence switch 500 out of position 8 and into position 9. In position 9, a circuit is closed for sender sequence switch 500 at the upper contact of sequence switch spring 514 and lower contact of sequence switch spring 304 to move the sequence switch 500 out of postion 9, through position 15 and back into position 1. A circuit is at this time closed from battery, contact of sequence switch spring 336, conductor 337, through the relays 507 and 506 in series, conductor 524 to ground at sequence switch spring 416. The energization of relay 507 closed a circuit which may be traced from battery, relay 303, conductor 338, upper armature and contact of slow acting relay 502, conductor 525, left armature and back contact of relay 503, energizing winding of relay 510, upper armature and front contact of relay 507, contact of sequence switch spring 526 to ground at lower contact of sequence switch spring 339, energizing in this circuit the relays 303 and 510. A circuit is now completed from battery, line relay 201, conductor 223, upper left winding of repeating coil 224, terminal 129, brush 126, lower contact of sequence switch spring 132, conductor 117, terminal 316, brush 311, conductor 331, upper armature and front contact of relay 303, upper right winding of repeating coil 301 to ground, energizing the line relay 201 which attracts its armature, completing a circuit from battery, through the high and low resistance windings of the local relay 202 in series, armature and contact of line relay 201 to ground, energizing the local relay 202 which completes a circuit from battery, right armature, contact 225, contact 226, conductor 227, relay 203, relay 204 to ground, energizing both said relays which attract their armatures. The energization of relay 203 completes a circuit from battery, lock-in relay 205, lower armature and front contact of relay 203, conductor 228 to ground at the armature of relay 206. When relay 205 energizes, a circuit is completed from battery, through the trunk lamp 212 to ground at the interrupter 213, which causes the trunk lamp 212 to flash until the B operator answer the call, as will be hereinafter described. Also, relay 205, when energized, completes at its upper armature a locking circuit for itself which will be maintained as long as relay 203 is energized. This locking circuit may be traced as follows: from battery, through relay 206, through the relay 207 and telephone relay 208 in parallel, the upper winding of relay 205, upper armature thereof to ground at the upper armature of relay 203. Relays 206, 207 and 208 are now energized, the relay 206 at its right armature and back contact removing ground from the relay 205 and also ground from any other corresponding relay 205′, preventing any other trunk from coming in and connecting to the operator until the present call is attended to. Relay 208 being energized attracts its armatures and connects the B operator's telephone set, 801 across the line and in position to hear the wanted subscriber phonographically.

As soon as relay 208 is energized, a circuit is closed for relay 211, from battery, lower right winding of repeating coil 224, lower armature and front contact of relay 208 through retarding coil 818, repeat key 817, upper armature and lower contact of relay 208, upper right winding of repeating coil 224 to ground. The energization of relay 211 closes a circuit for relay 312 which may be traced as follows: from battery, lower right winding of repeating coil 301, relay 312, lower armature and contact of 303, brush 310, terminal 315, lower contact of sequence switch spring 137, brush 127, terminal 130, lower left winding of repeating coil 224, conductor 9, left armature and contact of relay 202, lower armature and contact of 207, retardation coil 10, contact and armature of relay 211 to ground. The energization of relay 312 closes a circuit from battery, through a slow acting relay 501, conductor 527, armature and front contact of relay 312 to ground. The relay 501, at its armature and front contact, completes a circuit to energize the slow-acting relay 502, which attracts its armatures, at its upper armature cutting off the shunt around the relay 503, whereupon said relay 503 is energized in series with the relay 303 and 510. Relay 502, at its lower armature and front contact, closes a circuit which may be traced from battery, left armature and front contact of relay 503, lower armature and front contact of relay 502, conductor 528, right armature and back contact of relay 509, relay 504, conductor 529 through the interrupter contact 700 on the phonograph sending device shown in Fig. 7. The circuit, however, above traced, is intermittently made and broken, being made when the outer end of one of the cams of the contact 700 rides up on the cam surface 701 of the cam 702, which cam is mounted on a shaft 703, which is driven by the usual gearing from the main shaft 704 from the phonograph device. When relay 504 is energized, a circuit is completed from battery, through the motor magnet of the

sender sequence switch 500, conductor 513, armature and front contact of interrupter relay 504 to ground at sequence switch spring 530, moving the sender sequence switch from position 1 into position 4. As the shaft 704 of the phonograph device rotates, the end of the contact spring 700 moves off the cam face 701, breaking the energizing circuit for the interrupter relay 504, which thereupon deënergizes, closing at its armature and back contact, and left armature and front contact of relay 510, a circuit to move sender sequence switch 500 from position 4 into position 5.

In Fig. 7 is shown in schematic form a phonograph call indicator. A plurality of disks, of which but one (705) is shown, are mounted on a shaft 704, which is rotated continuously in any convenient manner. On the disks are magnetically recorded various digits or other information it is desired to transmit to the B operator. In the device as shown in Fig. 7, four disks are used, one of the disks having the letters J, M, R, and W magnetically recorded thereon, the letters representing the stations on the usual party line. Another of the disks, for instance 705, has recorded thereon the numerals 0, 1, 2, 3. Another disk has the numerals 4, 5, 6 and 7 recorded thereon, while the fourth has recorded thereon the numerals 8 and 9. Reproducing magnets 706, 707, 708 and 709, shown in perspective, and the other magnets to reproduce the letters and remaining numerals, are similarly mounted. The disk 705 being constantly rotated, when a circuit is closed through the reproducing magnet 706, 707, 708, or 709, the numeral or letter or other character desired is reproduced in the circuit including the reproducing magnets 706, 707, 708 or 709 and repeated in the telephone of the B operator, who thus hears the numeral or other information.

The record on the disks, as shown by the dotted lines 0, 1, 2, 3 on disk 705, does not extend in a complete circle thereon. The arc of the circle on which no record appears is so spaced with relation to the cam surface 701 as to permit the interruption of the circuit of relay 504 at the proper time to allow sender sequence switch 500 to move from one position to the next, so that the switching operation takes place between words.

In position 5 of sender sequence switch 500, a circuit is closed from the common return conductor 710, the M reproducing magnet 711, through the amplifier set 712, conductor 713, upper contact of sequence switch spring 605, conductor 606, lower left contact of sequence switch spring 505, conductor 531, armature and contact of relay 506, the conductor 532, through the lower and upper left windings of repeating coil 301, back through the common return conductor 710. The circuit for reproducing magnet 711 being completed, and the disk with which said magnet is associated being constantly rotating, the word M in this instance will be reproduced in said circuit and repeated by the repeating coil 301 into the repeating coil 224, where it will be repeated into the B operator's set 801. At this instant, contact 700 is again closed, energizing the interrupter relay in the manner before described, and closing, at its armature and front contact, a circuit to move sequence switch 500 out of position 5 and into position 6. In position 6 of sequence switch 500, a circuit is closed from the common return conductor 710, through the left side of repeating coil 301, through conductor 532, armature and contact of relay 506, conductor 531, upper contact of sequence switch spring 533, conductor 534, lower contacts of 1000's sequence switch spring 607, conductor 608, amplifier set 714, the 0 reproducing magnet 706, back to the common return conductor 710, completing circuit through the reproducing magnet 706 and, in the manner above described for station M, repeating the numeral 0 to the B operator. When this word has been transmitted, the circuit for the interrupter relay 504 is again broken at the contact 700, closing a circuit for sender sequence switch 500, moving it out of position 6 and into position 7, in which position a circuit is closed in the now well-known manner through the No. 1 reproducing magnet 707, the circuit in this instance being completed at the upper right contact of the 100's sequence switch contact spring 609.

In like manner, the circuits for the reproducing magnets 708 and 709 are completed to reproduce the numerals 2 and 3 to the B operator. It will be noted that the circuits for reproducing magnets 708 and 709 are closed in sequence switch positions 9 and 10, respectively, of sender sequence switch 500, and that no reproduction takes place in position 8 of such sequence switch. This is according to the usual telephone practice where a number consisting of four digits always has a pause between the second and third digit. When the last digit of the number has been transmitted, the circuit through the interrupter relay 504 is broken, allowing its armature to retract and closing a circuit for sender sequence switch 500 to move it out of position 10 and into position 11. In position 11, when contact 700 is again made, interrupter relay 504 is energized, attracting its armature and completing the circuit to drive sequence switch 500 from position 11 into position 12. When contact 700 is again opened, interrupter relay 504 becomes energized, at its armature and back contact completing a circuit to drive sequence switch 500 from position 12

into position 13. This alternate making and breaking of the circuit of interrupter relay 504 advances the sender sequence switch 500 through its various positions back into position 1. When the sender sequence switch is in position 16, if the key 546 is closed, a circuit is established from ground, through said key 546, through the relay 509 and sequence switch contact spring 508 to battery at either of the slow acting relays 501 or 502, energizing the relay 509, which attracts its armatures, breaking the circuit for the interrupter relay 504. If the key 546 is not closed, the number will be repeated indefinitely. During the transmission of the called number to the B operator, the trunk lamp 212 has been flashing due to the operation of the interrupter 213. The B operator now takes the plug 900 on the end of the trunk taken for use and tests the wanted line in the usual manner. If the wanted line is not busy, she plugs into the multiple jack 901, leading to such subscriber. Plugging into the jack 901 completes a circuit from battery, through the second plug relay 215, first plug relay 214, sleeve of plug 900, sleeve contact of jack 901, cut-off relay 902 to ground, energizing the three relays described. The cut-off relay 902, at its armatures, prevents line relay 903 from energizing, thus preventing the lighting of line lamp 904. The energization of relays 214 and 215 completes a circuit from battery, through the resistance 216, lower armature and front contact of relay 214, right contact spring of relay 218, right armature and front contact of relay 204, through the high resistance winding of relay 218 to ground at the upper contact of differential relay 217. Relay 218 energizes and, at its left armature, opens the energizing circuit of the relay 203, and relay 203 opens the energizing circuit for relays 205, 206, 207 and 208. The deenergization of relay 208 removes the operator's set 801 from the trunk and deënergizes the supervisory relay 211. Supervisory relay 211, deënergizing, breaks, at its armature and contact, the energizing circuit for the relay 312. Relay 312, deënergizing, breaks the energizing circuit for the slow acting relays 501, 502 and 509. The relays 503 and 510, however, remain energized after the deënergization of relay 502 over a circuit which may be traced from battery, right armature and front contact of relay 503, conductor 525, upper armature and back contact of slow acting relay 502, through the energizing winding of relays 503 and 510 in series; right armature and front contact of said relay 510, conductor 518 to ground at the sequence switch spring 302 of the cord finder. Relay 303 is, however, shunted out, and, on deënergizing, disconnects the repeating coil 301 from the trunk. Slow acting relay 502 deënergizing, a circuit is completed at its lower armature and back contact from battery, left armature and front contact of relay 503, lower armature and back contact of relay 502, through relay 535 to ground, energizing said relay 535 and completing a circuit from battery, through motor magnet of cord finder sequence switch 300, conductor 340, sequence switch spring 341, position 8, conductor 342, armature and front contact of relay 535 to ground, moving cord finder sequence switch from position 8 and into position 15. When relay 303 deenergized, cutting off the repeating coil 301 from the trunk, it broke the energizing circuit of relay 201, which, at its armature and front contact, broke the energizing circuit for the local relay 202. This relay 202, in turn deënergizing, breaks, at its right armature and contact, the circuit for relay 204. The deënergization of relay 204 removes, at its right armature and front contact, the shunt around the relay 219, which thereupon energizes. This circuit is from battery, resistance 216, armature and spring of relay 214, lower spring of relay 207, upper winding of relay 207, winding of relay 219, right armature and back contact of relay 204, and lower winding of relay 207 to ground.

On cord finder sequence switch 300 coming into position 15, a circuit is closed from district sequence switch 101, lower right contact of sequence switch spring 112, conductor 133, lower armature and front contact of relay 507, conductor 536, upper contact of sequence switch spring 304 to ground, moving sequence switch 101 out of position 11 into position 16. With district switch 101 in position 16, a circuit is again closed from battery, line relay 201, upper left winding of repeating coil 224, terminal 129, brush 125, upper contact of sequence switch spring 132, upper right winding of repeating coil 102 to ground, energizing the line relay 201, which, in turn, energizes local relay 202.

As the relay 218 is still energized and relay 204 deënergized, a circuit is completed from battery, through winding of relay 220, left armature and back contact of relay 204, left armature and contact of relay 218, right armature and swinging contact of local relay 202 to positive battery. The energization of this relay 220 in turn completes a circuit from battery, right armature and front contact of said relay 220, low resistance winding of relay 218, lower winding of differential relay 217, energizing the relay 217, which, at its lower armature and contact, breaks the energizing circuit for relay 219. The deënergization of relay 219 completes a circuit from battery, through the relay 221, upper winding of relay 207, upper armature and back contact of relay 219, low resistance winding of local relay 202 to ground at the armature and contact of line

relay 201. Relay 221 attracts its armatures, connecting the source of ringing current 229 or 230 to the cord leading to the called subscriber.

It will be remembered that the cord finder sequence switch 300 has come into position 15, and that a circuit for relay 309 has been maintained at either the upper or lower contact of sequence switch spring 104 in positions 2 to 11 of the district sequence switch 101 and in positions 2 to 16 of cord finder sequence switch 300. When district sequence switch 101 passed out of position 11, energizing circuit for the relay 309 is broken at the upper contact of sequence switch spring 104, allowing relay 309 to deënergize, completing a circuit from battery, through motor magnet of sequence switch 300, conductor 340, contact of sequence switch spring 308, left armature and back contact of relay 309 to ground, moving sequence switch 300 from position 15 to position 17, in which position, the sender sequence switch 500 being in position 1, a circuit is closed from battery, through the down magnet 342, conductor 343, upper contact of sequence switch spring 537 to ground at sequence switch spring 339, moving the brush carriage carrying the brushes 310, 311, 313 and 314 downward to their initial position. When the brush carriage reaches its lowermost position, the off-normal contact 344 is closed, completing a circuit from battery, through motor magnet of cord finder sequence switch 300, upper right contact of sequence switch spring 305 to ground at the off-normal contact 344, moving the cord finder sequence switch 300 from position 17 into position 1.

The call being to a subscriber on a party line, the B operator, before inserting the plug 900 into the multiple jack 901, depresses the proper ringing key 231 so that when the line has been tested and found to be idle and the plug inserted, the proper current from sources 229 or 230 may be projected over the outgoing line to ring the calling device at the subscriber's station. A relay 222 is in series with the source of current 229 or 230, and is of such character that it will not respond to the intermittent current from such source when this current is passing through the same in series with the calling device and condenser at the substation, but when the subscriber removes his receiver from the switchhook, cutting out the calling device and condenser, a circuit is closed which may be traced from the source of current 229 or 230, the energizing winding of relay 222, the depressed key 231, inner armature and front contact of relay 221, the ring of the plug 900, ring contact of jack 901, through the subscriber's substation set, back through tip contact of jack 901, the tip of plug 900, upper armature and swinging contact of first plug relay 214 to ground at the outer armature and front contact of relay 221. Relay 222 energizes in the circuit just traced, attracting its armature and breaking the energizing circuit for the relay 221, cutting off the ringing current and completing the connection through from the calling to the called subscriber. The call is supervised in the usual manner, but as this operation forms no part of the present invention, it will not be described.

In the case of a manual operation from one calling subscriber to another, the other subscriber being on a straight line as distinguished from a party line, the operation above described is repeated, except that the key for setting the station's register sequence switch shown in Fig. 6, is not depressed, and therefore the phonograph record of the station is not operated. The call, however, progresses in the same way, and the same ringing apparatus is brought into use.

In the case, however, of a call to a semi-automatic office where the switching operation is under the control of the central operator, the B operator is eliminated entirely, the call being under the sole control of the A operator. If we assume that the call in this instance is to a subscriber numbered 0123 located in a semi-automatic office, the A operator receiving the required information from the calling subscriber depresses an appropriate office key 417 to set the class and brush register sequence switches 400 and 410, respectively, in position to select a trunk leading to the semi-automatic office. She then, as before, depresses the No. 0 1000's, No. 1 100's, No. 2 10's and No. 3 units keys to set their respective sequence switches in the proper position for transmitting these digits. The operation of the cord finder shown on Fig. 3 is identical with that above described. Therefore as the sequence switch 300 reaches position 2, the class and brush register sequence switches and the thousands, hundreds, tens and units sequence switches are started in motion as before. The depression of office key 417 completes a circuit for the cut-off relay 404 when the class register sequence switch 400 reaches position 5 and completes a circuit for the cut-off relay 406 when the brush register sequence switch 410, reaches position 1. The setting of the 1000's, 100's, 10's and units sequence switches is identical with that above described.

Referring to Fig. 5, it will be noted that relays 506 and 507 are the relays which determine whether or not the phonograph apparatus shown in Fig. 7 shall be used in extending a call. It will be noted that the circuit for these two relays is only closed when the class register sequence switch 400

is in position 16. Therefore, in the present instance, these relays 506 and 507 will not be energized, but the setting of the 1000's, 100's, 10's and units register sequence switches will be used to control switching apparatus to extend the call under the sole direction of the A operator. As before, the cord finder will be connected with the district apparatus shown in Fig. 1, and district sequence switch 101 will move through positions 1, 2, 3 until it stops in position 11, where, as before, in response to the setting of brush register sequence switch 410, the brushes 126, 127 and 128 on brush carriage 125 will be moved over the proper bank of contacts and brought to rest in engagement with the terminals 134, 135 and 136 respectively, of a trunk leading to the semi-automatic office shown in Fig 8.

The present invention is not concerned with the detailed circuits and apparatus located in the semi-automatic office. This apparatus may be of the type disclosed in patent to A. E. Lundell No. 1,168,319 of January 18, 1916. Therefore, in Fig. 8 the connector switch is merely indicated by the brushes 809 and 810 and the terminals 814 and 815. The usual connector sequence switch 800 is also shown as well as the line relay 802. The usual interrupter or commutator carried by the connector switch is not shown, but a conductor leading to such commutator is indicated at 813.

With the sequence switch 800 in position 1, district sequence switch 101 in position 11, cord finder sequence switch in position 15, and sender sequence switch 500 in position 8, a fundamental circuit is established from battery through line relay 802, sequence switch spring 803, lower contact, conductor 804, terminal 134, brush 126, lower contact of sequence switch spring 132, conductor 117, terminal 316, brush 311, conductor 331, inner armature and back contact of relay 303, sequence switch spring 332, conductor 333, left armature and back contact of counting relay 0′ through stepping relay 516, sequence switch spring 517, inner armature and back contact of relay 510, conductor 518 to ground at sequence switch spring 302. The line relay 802 and stepping relay 516 energize in this circuit, relay 802 completing a circuit which may be traced from battery through the motor magnet of sequence switch 800, lower contact of sequence spring 805, armature and front contact of line relay 802, to ground, moving such sequence switch from position 1 into position 2. In position 2 of the sequence switch 800, the usual energizing circuit is established for the power magnet of the connector, starting such connector in its preliminary or brush choosing operation. As the connector moves, the commutator carried thereby intermittently places ground on the conductor 813, and, through the sequence switch spring 811 in position 2, places a shunt around the stepping relay 516, causing such stepping relay to be intermittently energized and deënergized until the fundamental circuit is opened in the usual manner in response to the operation of the counting relays. When the last counting relay is energized, a circuit is closed thereby to drive sequence switch 500 into position 10. Brush selection having taken place in the usual manner as the relay 802 deënergizes, owing to the opening of the fundamental circuit, a circuit is closed to drive the sequence switch 800 from position 2 to position 3, from battery to the motor magnet of sequence switch 800, lower contact of sequence switch spring 816, back contact of relay 802 to ground.

The deënergization of relay 802 also opens the circuit of the power magnet of the connector and stops the movement thereof.

In position 3 of the sequence switch 800 and position 10 of sequence switch 500, the fundamental circuit is reëstablished and the relay 802 again energized. In response to this energization of relay 802, a circuit is established from ground, armature and front contact of relay 802, sequence switch spring 805 top, motor magnet of sequence switch 800, to the ungrounded side of battery, moving the sequence switch into position 4.

In position 4 of the sequence switch, the connector is started in motion and the commutator carried thereby intermittently places ground on the conductor 813, and, through sequence switch spring 811 in position 4, intermittently to the stepping relay 516, causing such stepping relay to be intermittently energized and deënergized until the fundamental circuit is opened in the usual manner in response to the operation of the counting relays, thereby terminating this selection. The energization of the last counting relay closes a circuit to drive sequence switch 500 into position 12. Upon the opening of the fundamental circuit, relay 802 deënergizes and at its back contact closes a circuit from battery, motor magnet of sequence switch 800, sequence switch spring 816 top, back contact and armature of relay 802 to ground. Sequence switch 800 moves to position 5, and awaits the reëstablishment of the fundamental circuit. When the fundamental circuit is reëstablished, the relay 802 energizes and closes a circuit from battery, motor magnet of sequence switch 800, sequence switch spring 805 top, front contact and armature of relay 802 to ground, moving the sequence switch into position 6. In this position of the sequence switch, the connector is again started in motion and the commutator carried thereby intermittently places ground on the conductor 813,

and, through sequence switch spring 811, in position 6, intermittently to the stepping relay, causing such stepping relay to be intermittently energized and deënergized until the fundamental circuit is opened in the usual manner in response to the operation of the counting relays, thereby terminating units selection. The operation of the last counting relay closes a circuit to drive sequence switch 500 into position 14. The opening of the fundamental circuit deënergizes relay 802, and a circuit is established from battery, motor magnet of sequence switch 800, sequence switch spring 816 top, back contact and armature of relay 802 to ground. The sequence switch leaves position 6, and in the positions between 6 and 16, the usual testing and ringing operations take place. As these operations are well known, they will not be further described and, for the sake of clearness, the sequence switch positions corresponding thereto are omitted, it being sufficient to state that after the selection of the desired line in position 6 and the testing and ringing operations, the sequence switch 800 moves into position 16, which is the through or talking position and the desired connection is established.

What is claimed is:

1. A telephone exchange system including telephone lines extending to an operator's position, trunk lines extending from such operator's position to a second operator's position, means under the control of the first operator for connecting the calling line to one of such trunk lines, means for audibly announcing the number of the desired line, and automatic means for connecting such announcing means to the telephone of such second operator.

2. A telephone exchange system including telephone lines extending to an operator's position, trunk lines extending from such operator's position to a second operator's position, means under the control of the first operator for connecting the calling line to one of such trunk lines, means for audibly announcing the number of the desired line, means for automatically connecting such announcing means to such second operator's telephone, means for automatically disconnecting such announcing means, and means for manually disconnecting such announcing means.

3. A telephone exchange system including telephone lines extending to an operator's position, trunk lines extending from such operator's position to a second operator's position, means under the control of the first operator for connecting the calling line to one of such trunk lines, means for audibly announcing the number of the desired line, automatic means for connecting such announcing means to the telephone of the second operator, and manual means under the control of either operator for disconnecting such announcing means.

4. A telephone exchange system comprising means for connecting a calling line to a desired line including a connecting circuit at an operator's position, a sending arrangement at such position adapted to operate under the control of such operator either to impress controlling impulses on said connecting circuit or audible signals for the purpose of announcing the designation of the desired line, depending upon whether the further extension of the call is accomplished by another operator or by an automatic selector switch.

5. In a telephone exchange system, means for connecting calling to called lines including a connecting circuit, an operator's position, an impulse sending device and an audible announcing device at such position, an automatic switch also at such position, and means under the control of the operator for causing said automatic switch to associate either said impulse sending device or said audible announcing device with said circuit.

6. A telephone exchange system, an operator's position, a connecting circuit at said operator's position, trunk lines extending from said operator's position to another operator's position, other trunk lines extending from said first operator's position terminating in automatic selector switches, a controlling equipment at said first operator's position including an impulse sending device and an audible announcing device, an automatic circuit changing switch associated with said controlling equipment, means for driving said automatic circuit changing switch through two complete cycles of movement, contacts operated by said switch in the first cycle of movement for extending said connecting circuit to a trunk line, contacts operated by said switch in its second cycle of movement for associating either said impulse sending device or said audible announcing device with said connecting circuit, and means under the control of said first operator for determining the association with said connecting circuit of either of said devices to the exclusion of the other.

7. A telephone exchange system comprising means for connecting a calling line to a called line including a connecting circuit, a registering and controlling equipment, an impulse sending device and an audible announcing device either of which may be associated with such connecting circuit and controlled by the set positions of the registers of such equipment, and means for determining which of such devices is controlled by such registers in controlling the extension of a particular call.

8. A telephone exchange system including telephone lines extending to an operator's position, a second operator's position,

trunk lines extending between said operators' positions, means for associating said lines with said trunk lines, means for audibly announcing the number of a line, means under the control of the first operator for determining the number announced by said announcing means, an operator's telephone set at said second operator's position, and automatic means for associating said announcing means and said operator's telephone set with one of said trunk lines.

In witness whereof, I hereunto subscribe my name this 15th day of June, A. D. 1916.

ALBEN E. LUNDELL.