

June 22, 1926.

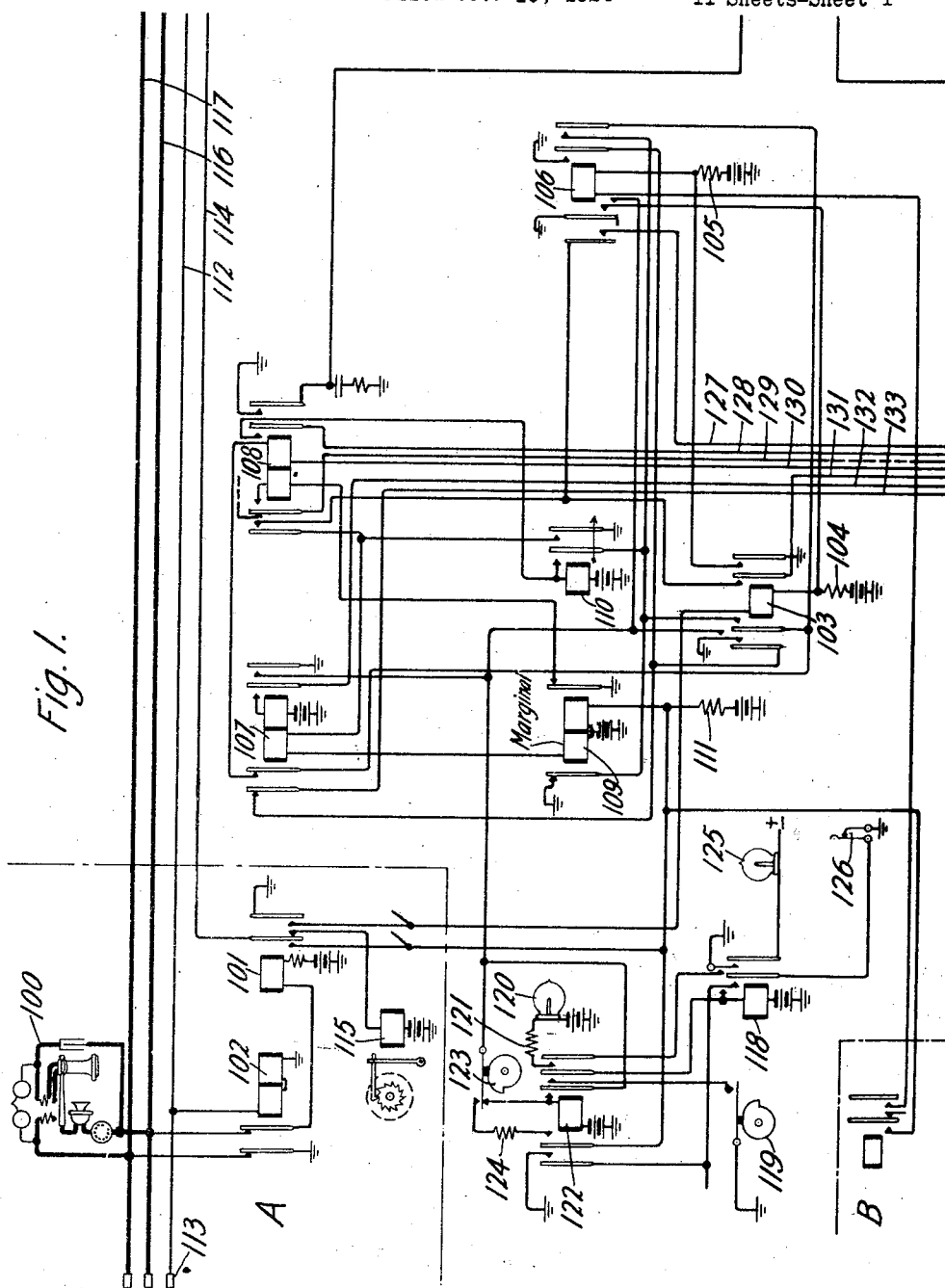
O. H. KOPP

1,589,402

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 16, 1924

11 Sheets-Sheet 1



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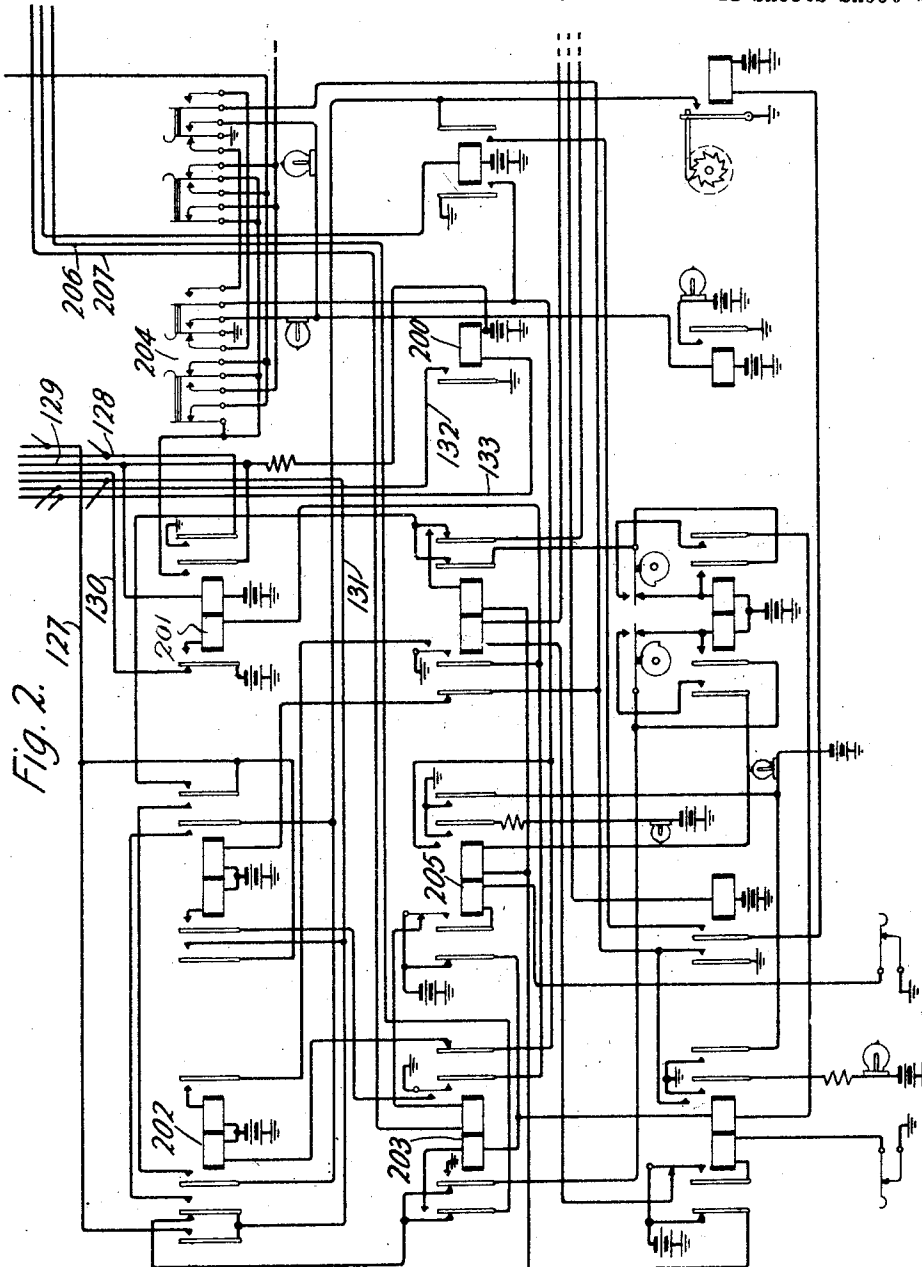
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11 Sheets-Sheet 2



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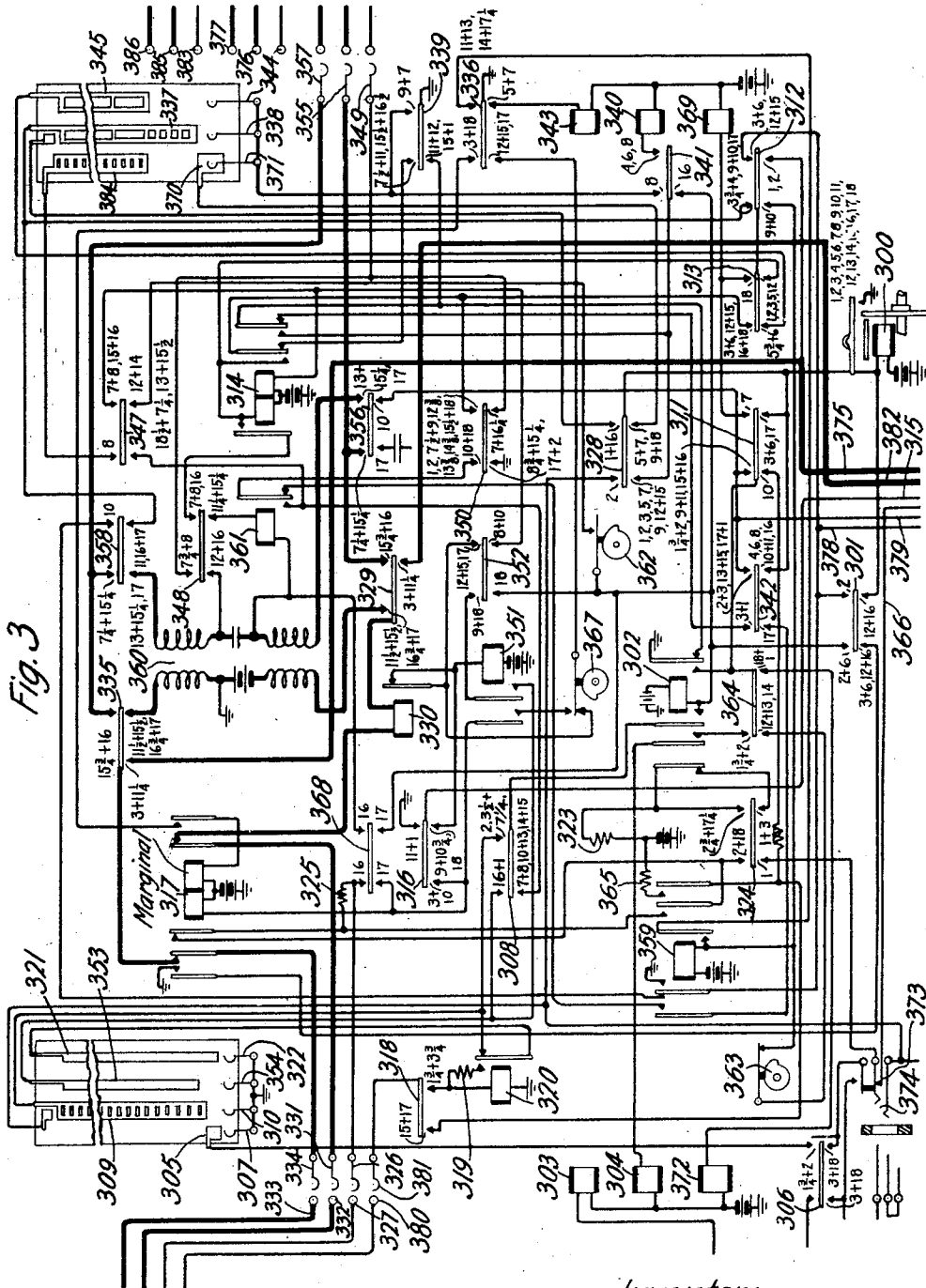
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11 Sheets-Sheet 3



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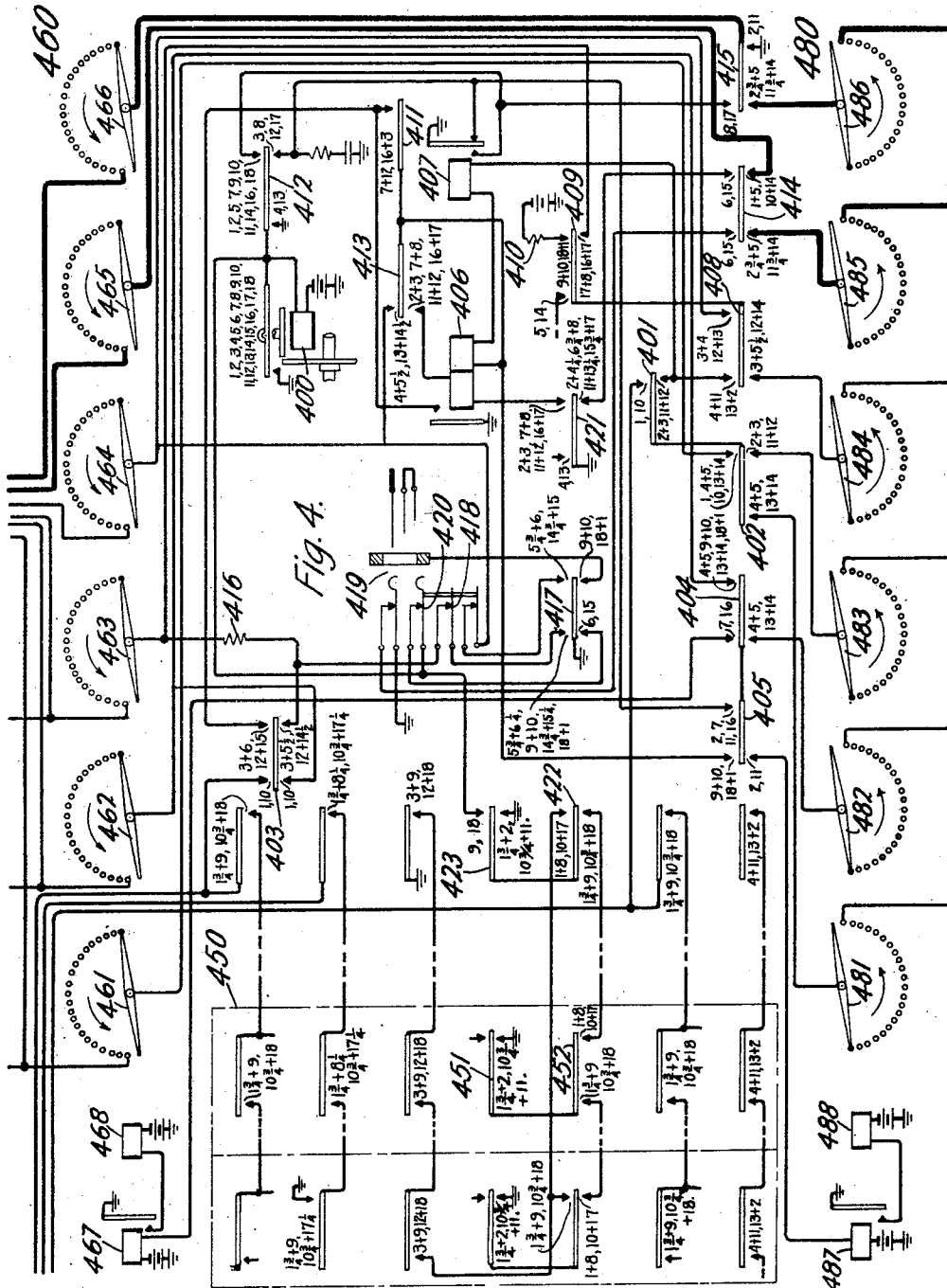
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TELEPHONE EXCHANGE SYSTEM

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11 Sheets-Sheet 4



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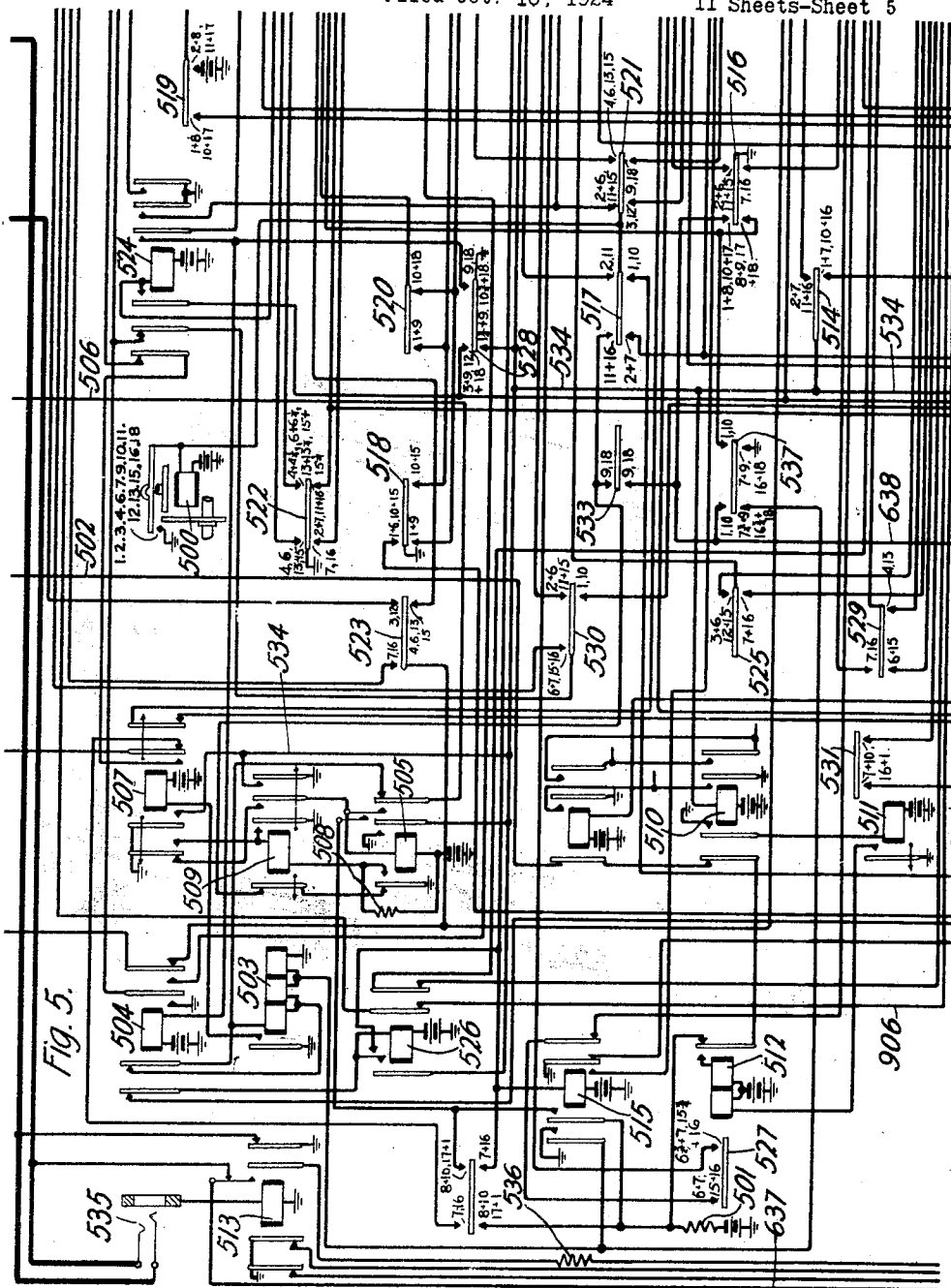
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TELEPHONE EXCHANGE SYSTEM

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11 Sheets-Sheet 5



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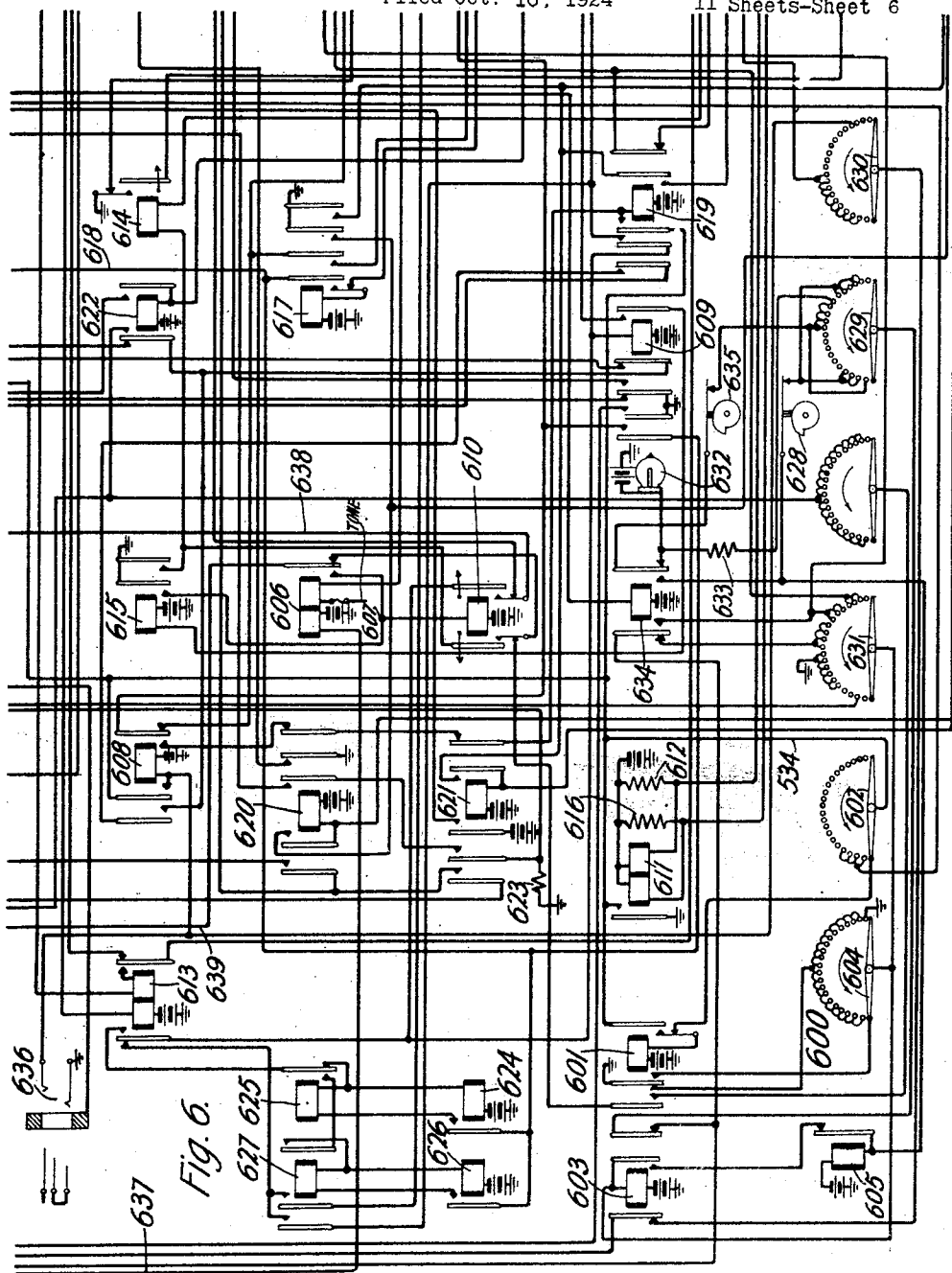
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11 Sheets-Sheet 6



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TELEPHONE EXCHANGE SYSTEM

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11 Sheets-Sheet 7

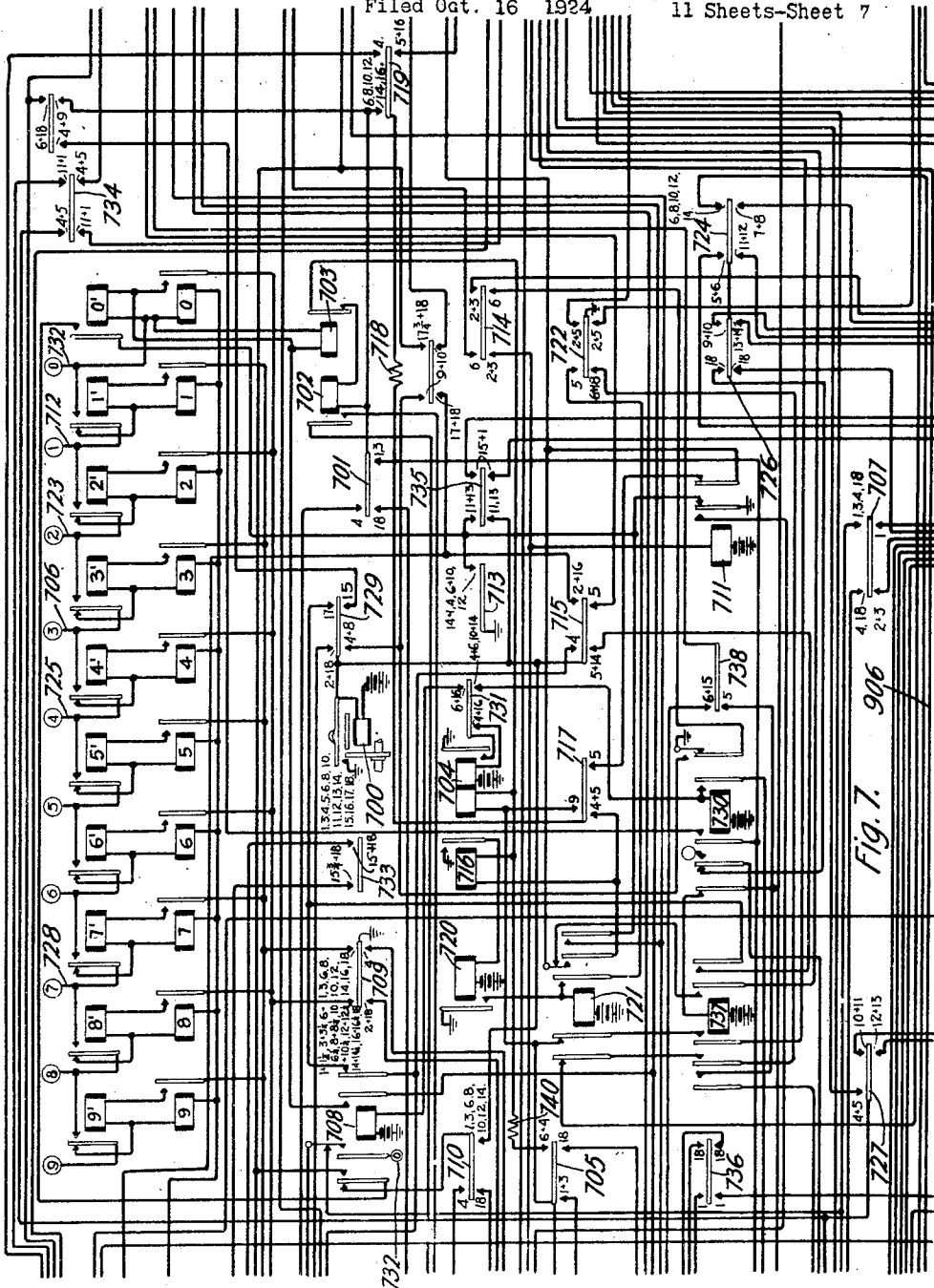


Fig. 7.

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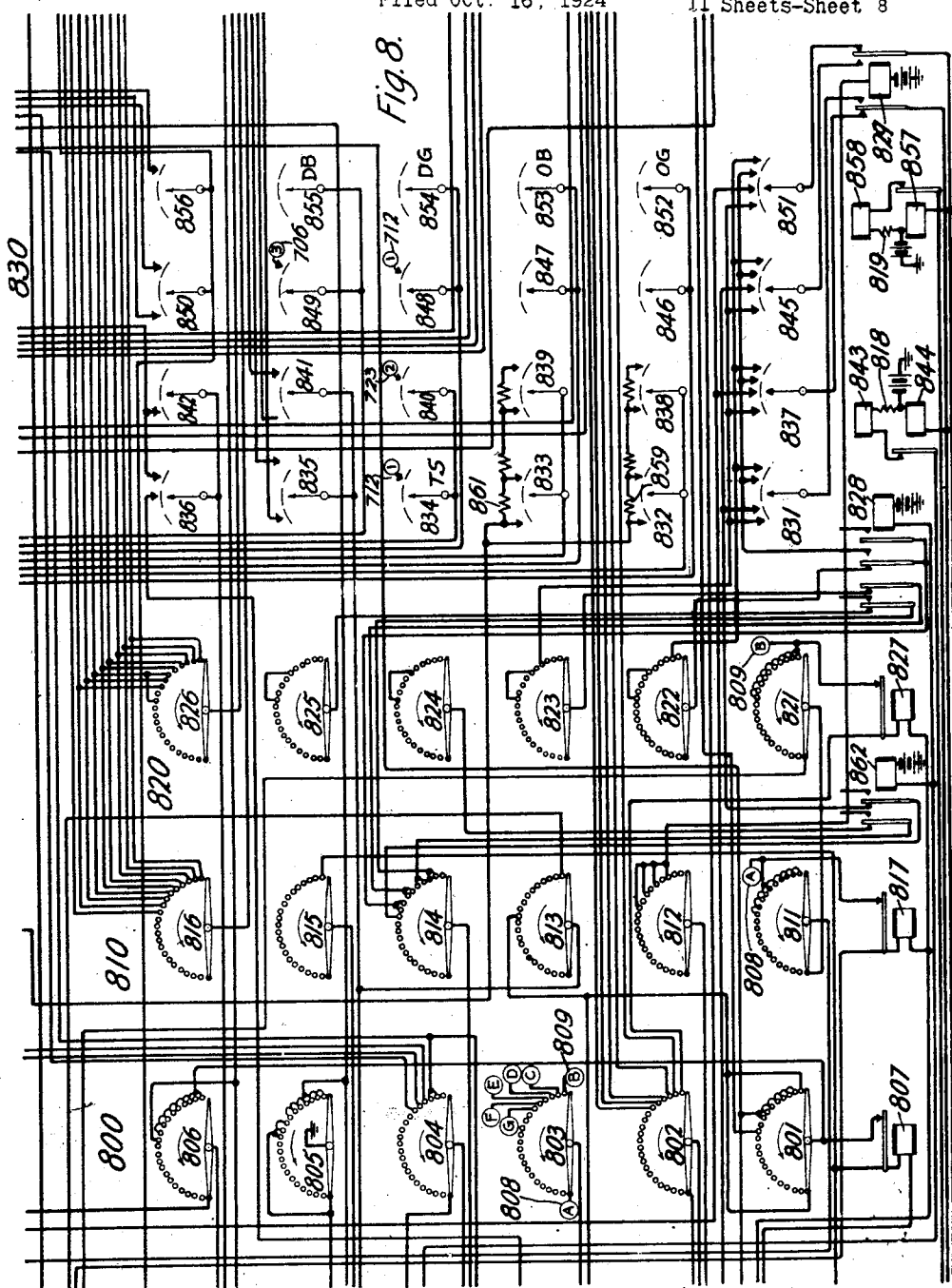
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TELEPHONE EXCHANGE SYSTEM

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11 Sheets-Sheet 8



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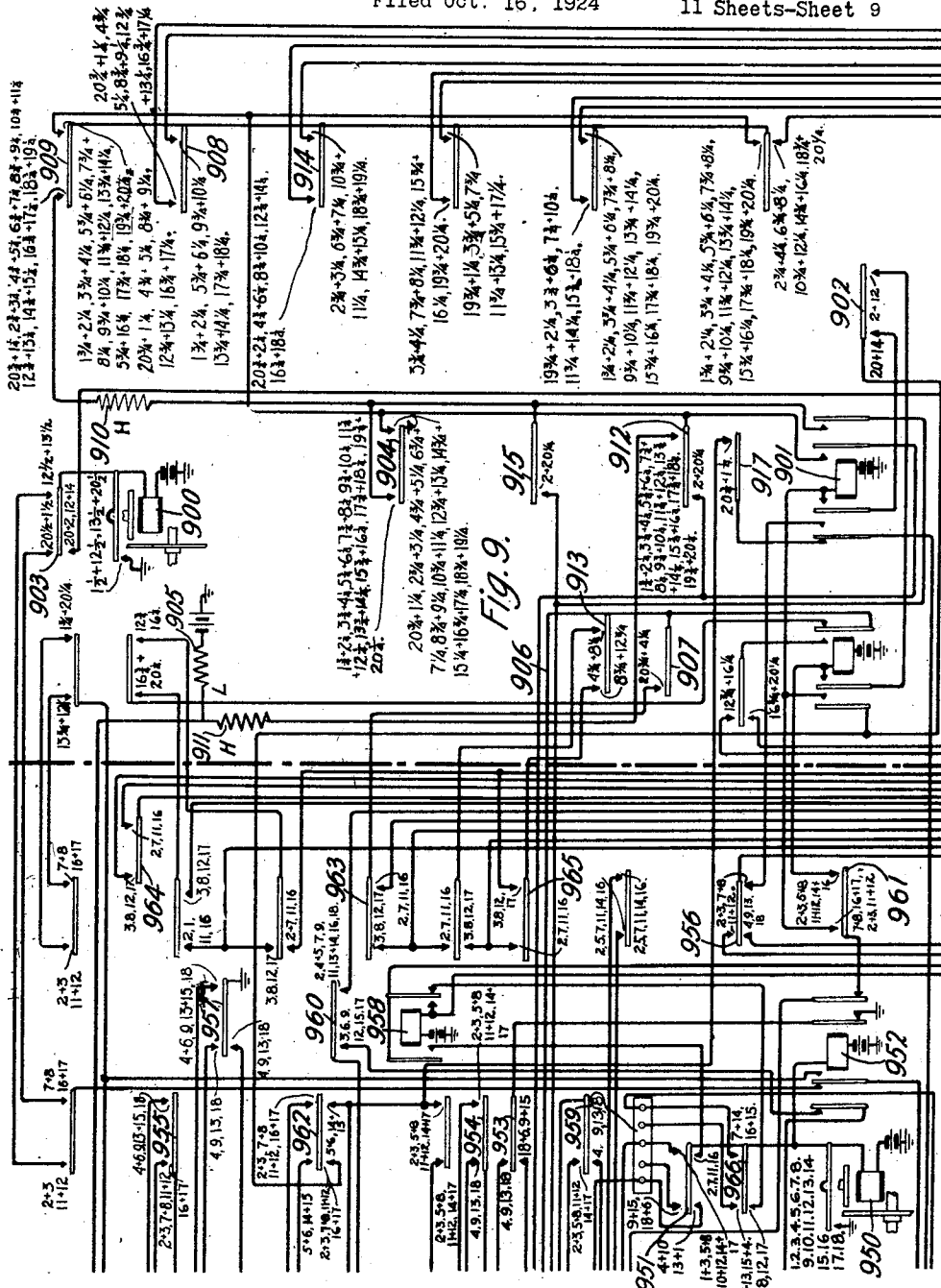
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11 Sheets-Sheet 9



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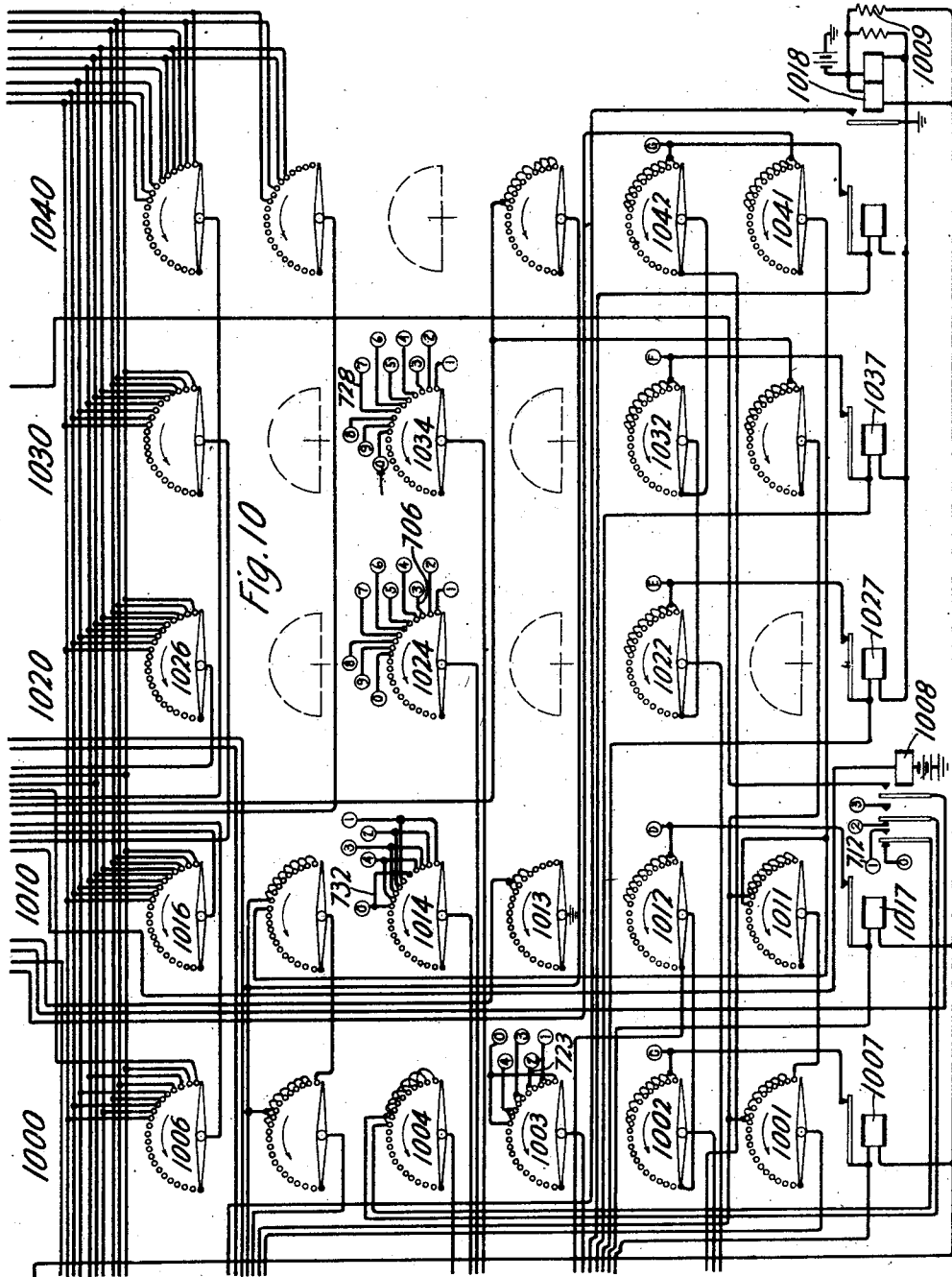
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11 Sheets-Sheet 10



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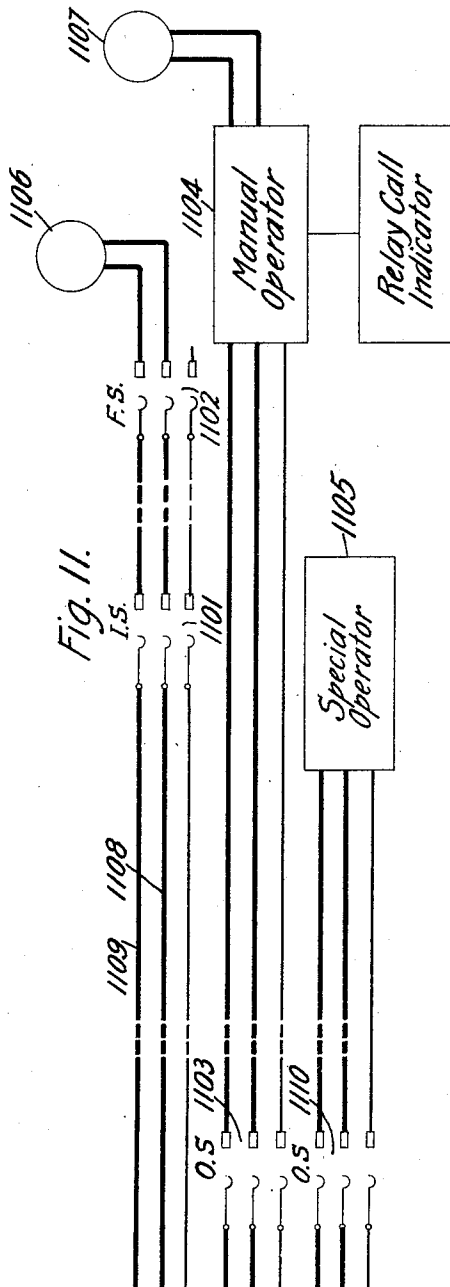
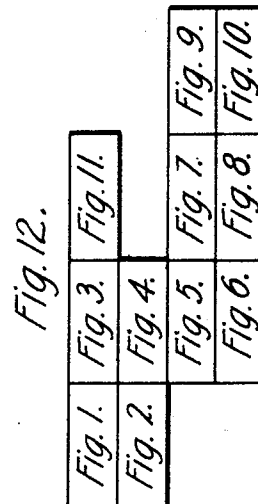
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TELEPHONE EXCHANGE SYSTEM

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11 Sheets-Sheet 11



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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

Application filed October 16, 1924. Serial No. 743,919.

This invention relates to telephone exchange systems and more particularly to systems employing automatic switches for the extension of connections.

In telephone systems where the extension of connections is under the control of register senders, calls for special positions, such as wire chief, trouble man, business office, etc., have been accomplished by dialing a first digit from two to nine. This digit is followed by one or more ones, other digits being reserved to regular office codes. In areas where office codes are made up of a plurality of digits this arrangement is satisfactory since the digit one is never used in an office code. In exchange areas where the office code consists of a single digit, the use of such a code for obtaining connections to special positions would seriously limit the number of subscribers in an office, since the 1000 group and the 100 group could not be used for subscribers' numbers as well as for an operator's code.

It is therefore an object of the present invention to provide codes of universal applicability for reaching such special positions in a telephone exchange.

A feature of the invention lies in utilizing a plurality of single pulses followed by a series of pulses to direct calls to special positions.

Another feature of the invention lies in recording such single pulses on recording relays and the series of the pulses on the first of the registers.

A further feature of the invention lies in the setting of the translator under the joint control of said register and said recording relays to extend calls to special positions at the telephone exchange.

These and other features of the invention will be apparent from a consideration of the following description. It may be noted that the office codes of the present application may be used in addition to those formerly in use in large exchange areas.

The present disclosure is based on an arrangement by which a start circuit common to a group of lines is associated with an idle sender and with an idle district selector by means of a link circuit. This arrangement is disclosed and claimed in U. S. Patent No. 1,567,072, granted December 29, 1925, to W. H. Matthies.

Referring to the drawings, Fig. 1 shows one of a group of subscribers' lines together with the line and the trip circuit common to the group of lines, which serves to control a start circuit.

Fig. 2 shows the start circuit serving a plurality of groups of lines.

Fig. 3 shows a line finder-district selector circuit for extending the line to subsequent selectors.

Fig. 4 shows one of a plurality of link circuits serving the start circuit of Fig. 2 and having access to a plurality of line finder-district selector circuits such as shown in Fig. 3. A portion of two other link circuits are also shown.

Figs. 5, 6, 7, 8, 9 and 10 show the circuits of a sender adapted to be selected by link circuits such as shown in Fig. 4 and to control the setting of selector switches.

Fig. 11 shows in a diagrammatic manner the switches and apparatus necessary to extend a call to a subscriber in a full mechanical office, to a subscriber in a manual office or to an operator.

Fig. 12 shows the manner in which Figs. 1 to 11 are to be arranged for a proper disclosure of the invention.

Brief description.

Before proceeding with the detailed description a brief statement as to the operation of the circuits will be given.

Subscribers' lines such as line 100 are connected to multiple terminals appearing before a plurality of line finders. These multiple terminals are arranged in a plurality of groups, each group being served by a separate brush set on each finder and each group being divided into two subgroups. A trip circuit is provided individual to each group; a start circuit is provided for all the groups of lines served by the group of line finders; and a plurality of link circuits are provided for each group of lines and line finders. The line finders and link circuits are divided into two subgroups and each such subgroup normally serves calls in the corresponding subgroups of lines. The arrangement is such that, except when all link circuits are busy, a particular link circuit will be in readiness to serve a call and will be connected by its district finder to an idle line finder.

When a call is initiated by a subscriber in a particular group, the trip circuit individual to the group, and the start circuit are taken for use by that line and means are provided for preventing the extension of a call in the other subgroup of the group or in any other group until a line finder has been started in search of this calling line. Means are also provided for preventing the extension of a second call in this group until after simultaneous calls in other groups have been taken care of. The operation of the start circuit causes the line finder associated with the link circuit allotted for use to hunt for the calling line and also causes the link circuit to hunt for an idle sender. As soon as a particular link is taken for use with a call the next link is allotted to serve the next incoming call in the particular subgroups which they serve. As soon as a brush set on the line finder has been tripped the start circuit will be freed to permit the extension of calls in other groups. As soon as the line has been found the trip circuit of the group is freed by the line finder to extend another call in the same group provided no call is awaiting extension in another group. As soon as selections are completed the sender and link circuit are released by the district selector circuit and the link circuit immediately hunts for another idle district.

Detailed description.

When the subscriber at substation 100 removes his receiver from the switchhook a circuit is closed for line relay 101 extending from battery through that relay, inner contact of relay 102 over the subscriber's loop to ground at the outer contact of relay 102. Relay 101 operates and closes a circuit from battery, resistance 104, through the winding of relay 103 to ground at the outer contact of relay 101.

The operation of relay 103 closes a circuit from battery, resistance 105 to ground at the outer right contact of relay 103. This circuit is in shunt of the winding of relay 106, which relay serves the second subgroup of the group to which line 100 belongs, thus preventing the extension of a call from that subgroup, while the trip circuit is in use with line 100. The operation of relay 103 also closes a circuit from battery, through the winding of relay 200, conductor 133, outer left contact of relay 107, outermost left contact of relay 103 to ground. In addition relay 103 closes a circuit from battery, over the back contact of relay 201, conductor 130, right winding of trip relay 108, inner left contact of relay 107, innermost left contact of relay 103, left contact of relay 109 to ground.

Relay 108 operates in this circuit and closes a locking circuit for itself from

ground, right contact of relay 109, left winding and inner left contact of relay 108, over the inner left back contact of the trip relays of the other groups of lines, conductor 129, right winding of start relay 201 to battery. Relay 201 operates in this circuit. A circuit is now closed for relay 110 extending from battery through the winding of relay 110, right contact of relay 108, conductor 128, to ground at the outer right contact of relay 201. Relay 110 locks in an obvious circuit to ground at the left back contact of relay 109. Relay 108, together with relay 103 prepares a circuit from the outer contact of relay 110, outer left front contact of relay 108, inner right contact of relay 103, conductor 131, left back contact of relay 202, outer left back contact of relay 203, conductor 206, upper contact of cam 401, upper contact of cam 402, brush 431 and its associated terminal, conductor 378, upper contacts of cam 301, winding of relay 302, to battery, assuming that the line finder of Fig. 3 had been allotted for use by the switch 460 and the sequence switch 300 is therefore standing in position 2.

The operation of relay 108 also closes a circuit from ground over its outer right contact, through the winding of the trip magnet 303, serving the group in which line 100 appears on the line finder frame, to battery. Relay 110 upon energizing closes a circuit from battery, through the left winding of relay 109, left winding of relay 107, outer contact of relay 110 to ground. Relay 107 operates and locks through its right winding and inner right contact to the contact of relay 200.

The operation of relay 302 closes a circuit from battery, through the winding of updrive magnet 304, middle left contact of relay 302, upper left contact of cam 364, left front contact of relay 302 to ground.

Under the control of the updrive magnet 304 the line finder shaft is moved upwards. Due to the operation of the trip magnet 303 the set of brushes serving the group of lines to which line 100 belongs is tripped. When the magnet leaves the tripping zone a circuit is closed from ground over brush 307, through commutator segment 305, upper contacts of cam 306, outer left normal contact of key 204, inner right contact and right winding of relay 201 to battery. Relay 201 is held operated in this circuit but the circuit through the locking winding of relay 108 is shunted and that relay releases, in turn releasing the trip magnet 303. As soon as brush 307 leaves segment 305 the circuit of relay 201 is opened and that relay releases again connecting battery to the operating windings of relay 108 and the corresponding relays in other trip circuits, so that subsequent calls may be served.

Relay 302 closes a locking circuit for itself over its inner left contact, right contact of cam 308, back contact of relay 320, commutator segment 321, brush 322, to
 5 ground, which is closed as soon as the line finder shaft moves upward. Relay 302 also closes a circuit from battery, over the inner left contact of relay 205, right winding of relay 203, conductor 207, left contacts of
 10 cam 403, brush 462, and its associated terminal, conductor 379, upper left contact of cam 311, right front contact of relay 302 to ground. The operation of relay 203 removes ground from conductor 206 thus preventing the start of another line finder until the brushes are tripped. Relay 203 locks in a circuit from battery, over the outer left contact of relay 205, left winding and outer left front contact of relay 203, left back contact of relay 202, conductor 131, inner right contact of relay 103, outer left contact of relay 108, outer contact of relay 110 to ground. The operation of relay 203 also closes a locking circuit for relay 201 from battery, left contact and left winding of relay 201, inner right contact of relay 203 to ground. The circuits just traced are established before relay 108 is released by the shunting action of commutator segment 305.
 30 As soon, however, as relay 108 deenergizes it opens the locking circuit of relay 203, restoring the start circuit to condition to serve subsequent calls.

When relay 302 operates it also closes a
 35 circuit from ground through its right front contact, upper left contact of cam 311, conductor 379, brush 462, and its associated contact, right contact of cam 404, upper left contact of cam 405, right winding of relay
 40 406, winding of relay 407, upper left contact of cam 408, upper right contact of cam 409, resistance 410 to battery. Relays 406 and 407 operate, relay 406 closing a locking circuit for itself and relay 407 from battery, through resistance 410, upper right contact of cam 409, upper left contact of cam 408, winding of relay 407, right winding of relay 406, contact of cam 411, contact of relay 406 to ground. Relay 407 operates in this locking circuit and closes a circuit from battery, through the winding of sequence switch magnet 400, upper contact of cam 412, contact of relay 407 to ground. Magnet 400 operates advancing the link circuit sequence switch to position 2.
 55

In position 2 ground is connected from the right contact of cam 415 to brush 466 and its associated contact, conductor 375, lower right contact of cam 312, lower right contact of cam 313, left winding of relay 314 to battery. Relay 314 operates, but performs no function until the calling line has been found. Ground from the front contact of relay 406 is also extended over the
 60 contact of cam 411, upper left contact of

cam 405, upper right contact of cam 404, left contacts of cam 403, conductor 207, right winding of relay 203, inner left contact of relay 205 to battery, holding relay 203 operated until the link circuit is moved
 70 out of position 1. When the link circuit arrives in position 2 relays 406 and 407 release. The release of relay 407 completes a circuit from ground at the back contact of relay 407, upper right and lower left
 75 contact of cam 405, winding of magnet 487 to battery. Magnet 487 operates and closes an obvious circuit for magnet 488. Magnet 488 is the rotary magnet for sender selector switch 480 and causes the switch to rotate in search of an idle sender.
 80

An idle sender is characterized by the connection of battery, through a 150 ohm resistance, such as resistance 501, to conductor 502 and its corresponding terminal in the set engaged by brush 483. With the link circuit sequence switch in position 2 ground is connected over the upper right contact of cam 421, through the left winding of relay 406, lower contact of cam 413, right winding of relay 406, winding of relay 407, lower contact of cam 401, lower right contact of cam 402 to brush 483.
 85

When brush 483 encounters a terminal corresponding to an idle sender, to which
 90 battery is connected, relay 406 operates, short circuiting its left hand winding over its contact and the contact of cam 411, permitting relay 407 to operate in series with the right hand winding of relay 406. The
 100 operation of relay 407 opens the circuit of magnet 487 and closes a circuit from battery through the winding of sequence switch magnet 400, upper contact of cam 412, front contact of relay 407 to ground advancing
 105 the link sequence switch to position 3.

In position 3 a circuit is prepared extending from ground through the right and middle windings of relay 503, inner left contact of relay 504, right back contact of relay 505, conductor 506, brush 484 of sender selector 480, lower left and upper right contacts of cam 408, brush 464 of district finder 460 to conductor 315, left contact of cam 316, left winding of relay 317 to battery, which
 110 circuit is not completed until the district sequence switch reaches position 3.
 115

In the meantime the line finder shaft continues to move upwards until it reaches the terminal corresponding to the calling subscriber's line. When these terminals are encountered a circuit is completed from battery, through the right winding of relay 109 and resistance 111, inner front contact of line relay 101, conductor 114, terminal
 120 380, brush 381, right contact of cam 318, winding of relay 320 to ground. Relay 320 operates and closes a circuit in shunt of its winding through resistance 319, right front contact of relay 320, commutator segment
 125 130

321, brush 322 to ground. Relay 109, which is marginal, is so adjusted as not to operate in the circuit previously traced in series with relay 107 or in the circuit traced for the winding of relay 320. With resistance 319 in parallel with relay 320 relay 109 operates. The operation of relay 109 opens the locking circuit of relay 110 and relay 110 releases after an interval due to the fact that relay 110 is slow to release.

Relay 320 opens the locking circuit of relay 302 and that relay releases as soon as brush 310 encounters an insulating segment of centering commutator 309. The release of relay 302 opens the circuit of updrive magnet 304 and stops the line finder on the calling subscriber's line. It also connects battery through resistance 323 and its left back contact, lower right and upper left contacts of cam 324, inner back contact of relay 317, resistance 325, brush 326, and terminal 327, over conductor 112, windings of cut-off relay 102 to ground. Relay 102 operates and releases line relay 101 removing the calling condition from terminal 380. The release of relay 101 opens the energizing circuit of relay 109 permitting its release as soon as relay 110 releases. The release of relay 101 permits relay 103 to release and also opens the circuit of relay 320. The connection of battery with terminal 327 marks terminal 113 and the other multiple terminals of calling line 100 in the terminal banks of final selectors with reduced battery potential to render the line busy at such final selectors. The release of relay 302 closes a circuit from battery through the winding of sequence switch magnet 300, lower left contact of cam 328, outer right front contact of relay 314, right back contact of relay 302 to ground. Sequence switch 300 is advanced in this circuit to position 3.

When sequence switch 300 leaves position 2 the circuit of relay 314 is opened and that relay releases. When the sequence switch 300 reaches position 3, the previously traced circuit for relays 503 and 317 is completed. Relay 317, being marginal, does not operate at this time. Relay 503 operates and closes an obvious circuit for relay 507 which in turn closes a circuit from battery, through resistance 508, winding of relay 509, outer left front contact of relay 507 to ground. Relay 509 operates and locks over its inner right front contact. Relay 507 closes a circuit for relay 510 from battery, winding of relay 510, conductor 534, to ground, at the inner left front contact of relay 507. It also closes a circuit from battery, through the winding and right normal contact of relay 601, normal contact of brush 602 of timing switch 600 and thence to ground over conductor 534 to the inner right front contact of relay 507. The operation of relay 510 closes an obvious circuit for relay 511

which in turn closes a circuit through the left winding of relay 512. The operation of relay 601 closes a circuit from battery, through the winding of relay 603, normal terminal and brush 604 of switch 600, inner left front contact of relay 601 to ground. Relay 603 operates and closes a circuit through the winding of stepping magnet 605, and its back contact, front contact of relay 603, brush 604 and its normal terminal, to ground at the inner left contact of relay 601. Magnet 605 operates and steps switch 600 to its first terminal. The further operation of the timing switch 600 will be described later.

The operation of relay 512 opens the circuit previously traced from battery, through resistance 501, to relays 406 and 407 and these relays release. The release of relay 407 closes a circuit from battery, through the winding of sequence switch magnet 400, lower right contact of cam 412, back contact of relay 407 to ground. Sequence switch 400 is advanced to position 4 from which position it is moved to position 5 by means of ground over the lower left contact of cam 412.

In position 5 of the link sequence switch 400 the dialing leads and the fundamental circuit leads are cut through directly from the district circuit to the sender circuit. The dialing circuit may be traced from battery, through the left winding of relay 606, conductor 637, normal contact of relay 513, sender selector brush 485, and its corresponding terminal, lower contacts of cam 414, district finder brush 465 and its corresponding terminal, conductor 382, lower contacts of cam 329, winding of relay 330, right back contact of relay 317, line finder brush 331, terminal 332, conductor 116 through the subscriber's substation, conductor 117, terminal 333, brush 334, middle left back contact of relay 317, left contact of cam 335, conductor 375, brush 466, and its associated terminal, lower left contact of cam 415, brush 486, and its associated terminal, outer right back contact of relay 513 to ground.

In position 5 of the link circuit sequence switch 400, relays 406 and 407 are connected in a circuit extending from brush 484, left contacts of cam 408, winding of relay 407, right winding of relay 406, upper contact of cam 413, to brush 464. The circuit of these relays is extended from these brushes as will be later described. When the dialing circuit above traced is completed, relay 606 operates and closes a circuit from battery, through the winding of relay 610, front contact of relay 606, conductor 639, inner right back contact of relay 515 to ground. Relay 610 operates and closes a circuit from battery, through the winding of relay 609, right front contact of relay 610, conductor

638, upper left contact of cam 516 to ground. As soon as relay 609 operates the dialing tone circuit is completed as follows: from source of tone 607, right winding of relay 606, normal terminal and brush 804 of register steering switch 800, outermost left contact of relay 609, conductor 618, lower contact of cam 514, conductor 534, to ground at the inner left front contact of relay 507.

Due to the closure of this circuit a tone is induced in the left winding of relay 606 and over the dialing circuit to the receiver of the subscriber's telephone to indicate that dialing may be started. The subscriber now dials the number of the wanted subscriber.

Call to subscriber in mechanical office.

It will be assumed that the wanted subscriber is located in an office reached from the district selector and that the number is Warren 4537 which would be equivalent to dialing 9-2-4537. The operation of the subscriber's dial alternately opens and closes the circuit of relay 606 as many times as there are units in each digit. Relay 606 releases and operates each time this circuit is opened and closed. The first release of relay 606 closes a circuit from battery, through the right winding of relay 611 and resistance 612 in parallel, winding of magnet 817, right back contact of relay 613, normal terminal and brush 802 of register control switch 800, winding of slow to release relay 614, left front contact of relay 610, back contact of relay 606, conductor 639, inner right back contact of relay 515 to ground. Relays 611 and 614 and magnet 817 are energized in this circuit.

At the same time a branch of this circuit extends from battery through the winding of relay 615, over the right contact of relay 609, brush 803 of register control switch 800 and its normal terminal, conductor 808, back contact of magnet 817, right back contact of relay 613 and thence as traced to ground on conductor 639. Relay 615 operates and connects ground from its armatures to the windings of relays 610 and 614 to prevent their premature release if relay 606 makes its front or back contact very briefly. Relay 610 being slow to release holds operated during the short interruptions of its circuit when relay 606 is released. Relay 614 being slow to release also holds operated during the short interruptions of its circuit when relay 606 is energized between dial impulses. It does not hold over, however, during the longer periods between digits.

The operation of relay 614 closes a circuit from battery, through the left winding of relay 611 and resistance 616 in parallel, winding of stepping magnet 807, front contact of relay 614, to ground. Relay 807 attracts its armature but does not step regis-

ter control switch 800 until relay 614 is released at the completion of the first digit. Magnet 817 is energized each time that relay 606 makes it back contact and steps the A code register 810 one position for each interruption of the dialing circuit. Since the first digit is 9 register 810 will come to rest in its 9th off normal position. At the completion of the first digit, relay 614 releases releasing magnet 817 and steps the register control switch to its first off normal terminal. With the register control switch 800 in this position the pulsing circuit is extended to the stepping magnet 827 of the B code register 820. The circuit of magnet 827 may be traced from battery through the right winding of relay 611 and resistance 612 in the parallel, winding of magnet 827, brush 802 and its first off normal terminal, winding of relay 614, left front contact of relay 610, back contact of relay 606 to ground on conductor 639. The circuit of relay 615 is also completed at this time from battery, through the winding of that relay, right contact of relay 609, brush 803 and its first off normal terminal, conductor 809, back contact of magnet 827, brush 802 and its first off normal terminal and thence as traced for magnet 827 to ground. In each successive position of register control switch 800 these two circuits are successively completed through the winding and over the back contact respectively, of each of the numerical register stepping magnets.

Since the second digit is 2, the B code register 820 comes to rest in its second off normal position after which register control switch 800 is stepped to its second off normal position. As soon as switch 800 reaches this position a circuit is completed from battery through the winding of relay 617 and its normal contact, brush 804 and its second terminal, outermost left contact of relay 609, to grounded conductor 618. Relay 617 operates and locks over its innermost front contact to ground on conductor 618. The operation of relay 617 closes a circuit from battery through resistance 818, winding of rotary magnet 843, back contact of magnet 844, outermost front contact of relay 617 to ground; and also from battery, through resistance 819, winding of rotary magnet 858, back contact of magnet 857, next to the outermost contact of relay 617 to ground. The translator 830 consists of two power driven rotary switches which are provided with two sets of brushes, arranged opposite one another. Translators of this type have been disclosed in a number of previous applications and reference is made to the patent to A. E. Lundell, No. 1,550,377, granted August 18, 1925.

The energization of magnets 843 and 858 rotates the switches constituting the translator 830. The energization of relay 617

also closes a circuit from ground on conductor 618 over the outermost left contact of relay 609, back contact of relay 608, next to the innermost contact of relay 617, brush 814 and its ninth off normal terminal, next to the innermost contact of relay 828, brush 822 and its second off normal terminal to a contact in each set served by translator brushes 831, 837, 845 and 851. Since the A code switch 810 is set in position 9 a circuit is also completed from battery, through the winding of relay 829, 9th off normal terminal and brush 812, right back contact of relay 619, register control brush 805 and its third terminal to ground. The operation of relay 829, opens the circuits including brushes 851 and 837 and closes the circuits including brushes 831 and 845. Therefore the circuits from ground to terminals of brushes 831 and 845 are extended over the front contacts of relay 829 to the stop magnets 844 and 857 of the translator 830. These magnets operate, opening the circuit of the rotary magnets 843 and 858 bringing the switches of the translator to rest on the terminals corresponding to those grounded. Circuits are also completed for relays 620 and 621. The circuit of relay 620 may be traced from battery through its winding, and the right front contact of relay 829 over brush 845 to ground on its terminal. The circuit of relay 621 extends from battery, through its winding, left front contact of relay 829, brush 831 and its terminal to ground. The operation of relay 620 closes a locking circuit for itself over its inner left contact to ground at the next to the outermost front contact of relay 617. Relay 621 closes a locking circuit for itself over its inner right contact to ground at the outermost contact of relay 617. The stop magnets 857 and 844 are also held operated in these locking circuits. The operation of relay 620 closes a circuit from ground over the terminal upon which brush 850 has come to rest, cross connecting rack 959, upper right contact of cam 951, winding of magnet 950 and relay 952 in parallel to battery. The class sequence switch 950 is advanced in this circuit to position 4, 9, 13 or 18, each of which represents the full mechanical class of call. If the switch was standing in position 3, for example, it would come to rest in position 4.

The class sequence switch controls the operation of the sender in accordance with the class of call to be extended. The joint operation of relays 620 and 621 closes a circuit from battery, through the winding of sequence switch magnet 500, lower right contact of cam 517, outer left contact of relay 620, outer left contact of relay 621, upper contact of cam 518 to ground. Sequence switch 500 operates in this circuit to advance the sender control sequence switch

to position 2. With the sequence switch 500 in position 2 the fundamental circuit is completed from battery, through the left winding of relay 314, lower right contact of cam 313, upper right contact of cam 312, conductor 378, brush 461 and its associated terminal, upper right and lower left contact of cam 402, brush 481 and its associated terminal, right back contact of relay 504, right contact of cam 701, winding of stepping relay 702, back contact of relay 703, left winding of relay 704, left contact of cam 705, inner right contact of relay 620, middle left contact of relay 621, resistance 623 to ground. Relays 314 and 702 operate in this circuit but relay 704 is polarized and does not. Relay 314 locks through its inner right front contact, upper left contact of cam 313, upper right contact of cam 312, to the fundamental circuit as previously traced. Relay 314 in operating also closes a circuit from battery through the winding of sequence switch magnet 300, lower left contact of cam 328, outer right front contact of relay 314, right back contact of relay 302 to ground. Magnet 300 energizes in this circuit and advances the sequence switch to position 4.

In position 4 the energizing circuit for relay 314 is opened but the locking circuit is maintained closed. At the same time a parallel circuit is prepared from the inner right front contact of relay 314, upper left contact of cam 313, upper left contact of cam 312, commutator segment 337, brush 338, right contact of cam 339 to ground. In position 4 relay 314 closes a circuit from battery, through the winding of updrive magnet 340, upper right contact of cam 341, outer right front contact of relay 314, back contact of relay 302 to ground. The updrive magnet energizes in this circuit and causes the district selector switch shaft to move upward in a brush selecting movement. Each time that brush 338 makes contact with a conducting segment of strip 337 the parallel circuit above traced is completed, in which circuit relay 314 is held operated and the stepping relay of the sender shunted.

When the fundamental circuit above traced was closed and stepping relay 702 operated, it closed a circuit from battery, inner left contact of relay 621, left contact of cam 519, winding of the No. 3 counting relay, back contact of the No. 3' counting relay, conductor 706, translator brush 849 and its corresponding terminal, right contacts of cam 707, inner left back contact of relay 708, left contact of cam 520, contact of relay 702, lower left contact of cam 518 to ground. The No. 3 counting relay operates in this circuit and locks through the winding of the No. 3' counting relay, front contact of the No. 3 counting relay, upper right

contact of cam 709 to ground. The No. 3' counting relay does not operate at this time since its winding is shunted by the energizing circuit of the No. 3 counting relay.

5 When, in its upward movement, brush 338 of the district selector encounters the first conducting segment of commutator strip 337, stepping relay 702 is shunted and de-energized, opening the above traced circuit
10 for the No. 3 counting relay permitting the No. 3' counting relay to operate in the locking circuit of the No. 3 counting relay.

The energization of the No. 3' counting relay connects conductor 706 through the
15 back contact of the No. 2' counting relay to the winding of the No. 2 counting relay and thence to battery. When brush 331 encounters an insulating segment the shunt is removed from relay 702 and that relay again
20 energizes closing the circuit from ground to conductor 706 causing the energization of the No. 2 counting relay. As the district selector switch shaft continues upward and brush 338 engages the insulating and con-
25 ducting portions of the commutator segment 337, stepping relay 702 is alternately deenergized and energized and the counting relays successively operated. When brush 338 reaches the fourth conducting segment
30 and stepping relay 702 deenergizes for the fourth time, the 0' counting relay operates in parallel with relay 703 and in series with the No. 0 counting relay. The operation of relay 703 opens the fundamental circuit and
35 permits the release of relay 314 as soon as brush 338 leaves the conducting segment. The operation of the 0' counting relay closes a circuit from battery through the winding of sequence switch magnet 700, right con-
40 tact of cam 710, left back contact of relay 708, front contact of the 0' counting relay to ground at the inner back contact of relay 711. Sequence switch 700 is energized in this circuit and advances the sender sequence
45 switch to position 3. As soon as sequence switch 700 leaves position 1 1/4 the locking circuits of all operated counting relays are opened, releasing such relays. The release of relay 314 as previously described opens
50 the circuit of updrive magnet 340 and closes a circuit from battery, through the winding of sequence switch magnet 300, lower right and upper left contact of cam 342, outer right back contact of relay 314,
55 back contact of relay 302 to ground, in which circuit the sequence switch is advanced to position 5.

With sequence switch 300 in position 5 and sequence switch 700 in position 3 the
60 fundamental circuit is again closed from battery, through the left winding of relay 314, lower right contact of cam 313, upper right contact of cam 312, conductor 378, thence as previously traced, right
65 back contact of relay 504, right contact of

cam 701, winding of relay 702, contact of relay 703, left winding of relay 704, left contact of cam 705, innermost right contact of relay 620, middle left contact of relay 621, resistance 623 to ground. Relays 314 and 70
702 operate in this circuit as before. Relay 314 locks as previously described and closes the previously traced circuit for sequence switch 300 in which circuit the sequence
75 switch advances to position 6. The operation of stepping relay 702 closes a circuit from battery, right contact of cam 519, through the winding of the No. 1 counting relay, back contact of the No. 1' counting relay, conductor 712, translator brush 848, 80
lower right and upper left contact of cam 707, inner right back contact of relay 708, left contact of cam 520, contact of relay 702, lower left contact of cam 518 to ground. In
85 positions 5 to 7, inclusive, of sequence switch 300 trip magnet 343 is energized in a circuit extending from battery through its winding, lower right contact of cam 336 to ground. When the sequence switch arrives in position
90 6 updrive magnet 340 is again energized and the district selector switch shaft is moved upward in a group selecting movement. Due to the energization of trip magnet 343 and the positioning of the district selector in
95 accordance with the brush selecting operation just described the fourth brush set is tripped and moved over its corresponding terminals.

As in the case of brush selection a shunt circuit is prepared extending from ground
100 over the upper right contact of cam 339, brush 344, commutator segment 345, lower left contact of cam 313 to the fundamental circuit as previously traced. As the district selector moves upward the stepping relay
105 702 will be periodically shunted and the counting relays operated beginning with the No. 1 counting relay. When the 0' counting relay operates at the second release of relay 702, relay 703 is operated
110 releasing relay 314 and bringing the district selector to rest with its brushes engaging the first terminal of the second group to which the fourth brush set has access.

The release of relay 314 also closes a circuit from battery through the winding of
115 sequence switch magnet 300, lower right and upper left contacts of cam 342, outer right back contact of relay 314 to ground at the back contact of relay 302 advancing the
120 sequence switch to position 7.

In position 7 of sequence switch 300, relay 314 is operated in a circuit from bat-
tery through its right winding, upper right and lower left contacts of cam 347, lower
125 left and upper right contacts of cam 308, line finder commutator segment 353, brush 354 to ground. The operation of relay 314 closes a circuit from battery, through the winding of sequence switch magnet 300, 130

lower left contact of cam 328, outer right front contact of relay 314, back contact of relay 302 to ground. Sequence switch 300 is advanced in this circuit to position 8.

5 In position $7\frac{3}{4}$ to 8 relay 314 locks over its left front contact, upper contacts of cam 348, to the sleeve brush 349 and ground over the sleeve terminal of the trunk, provided that trunk is busy. The energizing circuit
10 of relay 314 is opened in position 8. If the first trunk of the group is busy and relay 314 is held energized in position 8, a circuit is completed for the updrive magnet 340 from battery, through the winding of the magnet
15 340, upper right contact of cam 341, outer right front contact of relay 314 to ground at the back contact of relay 302. The updrive magnet is energized and causes the district selector to move upward in search
20 of an idle outgoing trunk. Relay 314 is held operated between terminals over a circuit extending from battery, through its right winding, upper contacts of cam 347, commutator segment 384, brush 371, upper left
25 contact of cam 341, outer right front contact of relay 314, back contact of relay 302 to ground. As soon as an idle trunk is reached, characterized by the absence of ground on its sleeve terminal, the locking
30 circuit of relay 314 is opened and the relay releases in turn releasing the updrive magnet bringing the district selector to rest on the first idle outgoing trunk of the group. The release of relay 314 closes a circuit from
35 battery, winding of sequence switch magnet 300, lower right and upper left contacts of cam 342, outer right back contact of relay 314, back contact of relay 302 to ground advancing the sequence switch to position 9.

40 As soon as relay 314 releases, ground is connected to sleeve terminal 383, over the upper left contact of cam 339, inner right back contact of relay 314, right contacts of cam 350, through sleeve brush 349, to render
45 the selected trunk busy. As soon as the sequence switch arrives in position $8\frac{3}{4}$ ground is connected over the lower contacts of cam 350 and sleeve brush 349, to sleeve terminal 383, independent of relay 314, which ground
50 is maintained until the sequence switch leaves position $15\frac{1}{4}$.

With sequence switch 300 in position 9 a circuit is completed from battery through the winding of relay 351, lower right con-
55 tact of cam 316, conductor 315, to brush 464 and its associated terminal, and thence through the right winding of relay 406, and the winding of relay 407, to brush 484 and its associated contact as previously traced.
60 From brush 484 this circuit is extended over conductor 506, right back contact of relay 505, inner left contact of relay 504, middle and right windings of relay 503 to ground. A parallel circuit is also closed through the
65 left winding of relay 317, left contact of

cam 316 and thence as traced for relay 351 to ground. Relay 351 operates in this circuit, but relay 317 being marginal does not. The operation of relay 351 closes a circuit
70 from battery, through the right winding of relay 314, lower right and upper left contacts of cam 352, inner contact of relay 351, line finder commutator segment 353, brush 354 to ground. Relay 314 operates and
75 closes a circuit from battery, through the winding of sequence switch magnet 300, lower left contact of cam 328, outer right front contact of relay 314, back contact of relay 302 to ground. Sequence switch 300 is
80 advanced in this circuit to position 10 in which position it remains during subsequent selections.

Since the call was to an office reached directly through a district selector without passing through an office selector relay 711
85 was operated as soon as sequence switch 700 reached position 2 in a circuit from battery through the winding of relay 711, lower left and upper right contacts of cam 714, translator brush 836 and its corresponding
90 terminal, outer left contact of relay 621, upper contact of cam 518 to ground. Relay 711 operates and closes a circuit from battery, through the winding of sequence switch magnet 500, upper left contact of cam
95 521, front contact of relay 711 to ground. Sequence switch 500 is advanced in this circuit to position 7.

When sequence switch 500 leaves position 6, relay 711 is deenergized. As long as relay 711 is operated sequence switch 700 is
100 prevented from leaving position 3. When the 0' counting relay has operated and relay 711 has closed its back contact a circuit is closed from battery, through the winding
105 of sequence switch magnet 700, right contact of cam 710, back contact of relay 708, contact of the 0' counting relay, back contact of relay 711 to ground advancing the sequence switch to position 4. When sequence switch
110 500 reaches position 7 a circuit is closed from battery through the winding of sequence switch magnet 700 upper left contact of cam 715, lower left contact of cam 522 to
115 ground advancing the sequence switch to position 5 in which position incoming selections are made.

With sequence switch 500 in position 7 and sequence switch 700 in position 5 the trunk leading to the wanted office is tested.
120 If the incoming selector associated with the trunk selected by the district selector has been released from a previous call but has not yet returned to normal, 24 volt battery is connected to the tip conductor, but if the incoming selector is normal, 48 volt battery is
125 connected through a relay of the incoming selector to the tip conductor. With the sequence switches 500 and 700 in positions 7 and 5, respectively, the fundamental cir-
130

cuit is closed from ground (not shown) at the incoming selector 1101, over the ring conductor 1108, terminal 385, brush 355, upper left and lower right contacts of cam 356, conductor 379, brush 462 and its corresponding terminal, upper right and lower left contacts of cam 404, brush 482 and its corresponding terminal, inner left front contact of relay 507, outer left contact of relay 524, compensating resistance 859, brush 832 of translator 830, lower contact of cam 525, left winding of relay 704, winding of relay 716, lower left contact of cam 717, resistance 718, lower contact of cam 719, left contact of cam 954, upper right contact of cam 523, right back contact of relay 504, brush 481 and its corresponding terminal, lower left and upper right contacts of cam 402, brush 461 and its corresponding terminal, conductor 378, left back contact of relay 359, upper contacts of cam 358, brush 357, terminal 386, over tip conductor 1109 of the trunk to battery (not shown) at the incoming selector 1101. Assuming that the incoming selector is in its normal condition relay 716 operates closing an obvious circuit for relay 720 which also closes an obvious circuit for relay 721.

Relay 721 locks from battery, through its winding, inner right contact, upper left contact of cam 722 to ground. The operation of relay 721 also closes a circuit from battery through the winding of sequence switch magnet 700, lower right contact of cam 715, right contact of cam 955, outer right front contact of relay 721, to ground at the inner back contact of relay 711. Sequence switch magnet 700 is energized in this circuit advancing the sequence switch to position 6. Relay 721 releases as soon as switch 700 leaves position 5. If the incoming selector had not been normal, and only 24 volt battery included in the fundamental circuit as above traced the presence of resistance 718 would have prevented the operation of relay 716. This resistance also prevents the operation of the incoming selector relay during trunk testing. When switch 700 reaches position 6 the fundamental circuit is closed as previously traced through the winding of relay 704, and thence over the back contact of relay 703, through the winding of stepping relay 702, upper left and lower right contacts of cam 719, upper contact of cam 954 and thence as previously traced to battery at the incoming selector circuit. Incoming brush selections are now accomplished in the same manner as district brush selections, except that the counting relay circuit extends from battery, over the right contact of cam 519, winding of the No. 2 counting relay, back contact of the No. 2' counting relay, conductor 723, to the #4 terminal and brush 1003 of thousands register 1000, upper contacts of cam 724, outer right contact of relay

526, inner left back contact of relay 708, left contact of cam 520, contact of relay 702, lower left contact of cam 518 to ground.

At the completion of incoming brush selection the 0' counting relay and relay 703 are operated as before. The operation of the 0' counting relay advances the sequence switch 700 to position 8 for incoming group selection. As the sequence switch leaves position 6 1/4 all operated counting relays are released, their holding circuits being opened at cam 709. It should be noted at this time that since hundreds register 1010 is set in position 5, a circuit is closed from battery, through the winding of relay 1008, lower left contact of cam 956, No. 5 terminal and brush 1013 to ground. Incoming group selection takes place in the same manner as incoming brush selection except that the counting relay circuit extends from battery, over the right contact of cam 519 through the winding of the No. 1 counting relay, back contact of the No. 1' counting relay, conductor 712 to the outermost front contact of relay 1008, No. 4 terminal and brush 1004 of thousands register 1000, right contacts of cam 724, and thence as traced for incoming brush selection to ground.

At the completion of incoming brush selection the operation of the 0' counting relay advances sequence switch 700 to position 10. As the sequence switch leaves position 8 1/4 all operated counting relays release, their holding circuits being opened at contacts of cam 709. During the time that switch 700 is advanced from position 8 to 10 the incoming selector hunts for and selects an idle final selector associated with the wanted group of lines. While switch 700 is passing through position 9 the fundamental circuit is again closed through resistance 718, upper contact of cam 717, lower contact of cam 525, through compensating resistance 859 and thence as previously traced to ground for the purpose of discharging the trunk circuit before making final selections in order that relay 702 may not be falsely operated by the discharge of the line. When switch 700 reaches position 10, the fundamental circuit is closed through the control relay of the final selector 1102 and final brush selection is made in a manner similar to incoming brush selection except that the circuit for the counting relays extends from battery, over the right contact of cam 519, through the winding of the No. 0 counting relay, back contact of the No. 0' counting relay, conductor 732 to the No. 5 terminal and brush 1014 of hundreds register 1010, upper right contact of cam 726, upper right contact of cam 724, outer right contact of relay 526, inner left back contact of relay 708, left contact of cam 520, contact of relay 702, lower left contact of cam 518 to ground.

At the completion of the final brush selec-

tion sequence switch 700 is advanced to position 11 and all operated counting relays released, and is advanced thence to position 12 provided register control switch 800 has advanced beyond position 4 due to the setting of the tens register. If the tens register has not been set, relay 711 is operated from battery, through its winding, contacts of cam 527, outer right back contact of relay 515, upper right contact of cam 727, No. 4 terminal and brush 804 of register control switch 800, outermost left front contact of relay 609, to ground on conductor 618. The operation of relay 711 opens the circuit for advancing the sequence switch from position 11 to position 12. When sequence switch 700 reaches position 12 the fundamental circuit is again closed and final tens selection is completed in the usual manner; the counting relay circuit extending through the No. 3 counting relay, back contact of the No. 3' counting relay, conductor 706 to the No. 3 terminal and brush 1024 of tens register 1020, lower left and upper right contacts of cam 724, and thence as previously traced to ground. At the completion of final tens selection, sequence switch 700 is advanced to position 13 releasing all operated counting relays, and then to position 14 provided the units register has been set.

With switch 700 in position 14 final units selection is made, the counting relay circuit extending from battery, right contact of cam 519, through the No. 7 counting relay, back contact of the No. 7' counting relay, conductor 728, No. 7 terminal and brush 1034 of units register 1030, lower right contact of cam 726, upper right contact of cam 724, and thence to ground as previously traced.

At the completion of final units selection the operation of the No. 0' counting relay advances the switch 700 to position 15. Sequence switch 700 is then advanced to position 16 in a circuit through the winding of that magnet, lower right contact of cam 729, lower contact of cam 957 to ground. After selections are completed incoming selector 1101 is advanced to a position in which battery is connected to the ring side of the fundamental circuit. The fundamental circuit is closed as previously traced through compensating resistance 859 and brush 832, lower contact of cam 525, left winding of relay 704, back contact of relay 703, winding of relay 702, upper left and lower right contacts of cam 719, left contact of cam 954, left contact of cam 533, right back contact of relay 504 and thence to ground at the incoming selector. The current in this case is in the direction to cause the operation of relay 704, which closes a circuit from battery, through the winding of relay 708, upper contact of cam 731, contact of relay 704 to ground. Relay 704 also locks in

a circuit over the lower left contact of cam 731 to ground at its contact.

The operation of relay 708 closes a circuit from battery, right contact of cam 519, winding of the No. 0 counting relay, conductor 732, to the inner left front contact of relay 708, left contact of cam 520, contact of relay 702, lower left contact of cam 518 to ground. The No. 0 counting relay operates in this circuit and closes the usual locking circuit for itself through the winding of the No. 0' counting relay and relay 703. The incoming selector opens the fundamental circuit and permits the operation of the No. 0' counting relay.

The operation of the No. 0' counting relay closes a circuit from battery, through the winding of relay 524, outer left front contact of relay 708, contact of the No. 0' counting relay, contact of cam 713 to ground. Relay 524 locks over its inner left contact, upper left contact of cam 528 to ground. Relay 524 in operating closes a circuit through the winding of relay 504, inner right front contact of relay 524, upper contacts of cam 733, No. 18 to 21 terminals and brush 602 of time measure switch 600, to ground over conductor 534, provided the time measure switch 600 has reached position 18 or beyond. The operation of switch 600 will be subsequently described. Relay 524 opens the ring side of the fundamental circuit, and advances the sequence switch 700 to position 17 in a circuit from battery, winding of magnet 700, upper right contact of cam 715, outer right front contact of relay 524 to ground. When sequence switch 700 leaves position 16 the circuits of relays 704 and 708 are opened and these relays release. Relay 708 closes a circuit from battery, winding of magnet 700, upper right contact of cam 729, right back contact of relay 708, lower left contact of cam 522, to ground advancing the sequence switch to position 18. In position 18 talking selection is made.

When relay 504 operated it opened the shunt around the right winding of relay 503 and the high resistance of the left winding is included in the circuit of relay 503. This increase in resistance decreases the current for relay 351 to such an extent that it de-energizes. The release of relay 351 in turn releases relay 314 which closes a circuit from battery through the winding of sequence switch magnet 300, lower right and upper left contacts of cam 342, outer right back contact of relay 314, back contact of relay 302 to ground. Sequence switch 300 is advanced to position 12 in this circuit. As soon as sequence switch 300 reaches position 11 ground is connected over the upper contact of cam 316, conductor 315, brush 464 and its corresponding terminal, upper con-

5 tact of cam 413, right winding of relay 406, winding of relay 407, left contacts of cam 408, brush 484 and its corresponding terminal, right back contact of relay 505, to the
 10 left winding of relay 503. Since both sides of this relay are now connected to ground relay 503 releases. The release of relay 503 opens the circuit of relay 507, which relay releases and closes a circuit for operating
 15 relay 505 from battery, through the winding of relay 505, middle right contact of relay 509, left back contact of relay 507 to ground. Relay 505 operates and shunts battery from the circuit of relay 509 so that relay 509 re-
 20 leases. Relay 505 locks through its winding and outer right front contact, conductor 506, to ground at the upper contact of cam 316.

When sequence switch 300 leaves position 11 $\frac{1}{4}$ the circuit of relay 606 is opened and
 25 that relay releases in turn releasing relays 610 and 609. With sequence switch 300 in position 12, sequence switch 500 in position 7 and sequence switch 700 in position 18, a circuit is closed from battery, through the
 30 left winding of relay 314, lower right contact of cam 313, upper right contact of cam 312, conductor 378, brush 461 and its corresponding terminal, upper right and lower left contacts of cam 402, brush 481 and its
 35 corresponding terminal, outer right front contact of relay 504, lower left contact of cam 701, winding of relay 702, back contact of relay 703, resistance 740, right contacts of cam 705, outer right contact of relay 507,
 40 resistance 623 to ground. The operation of relay 314 in this circuit closes a circuit from battery through the winding of sequence switch magnet 300, lower left contact of cam 328, outer right front contact of relay
 45 314, right back contact of relay 302 to ground. As the sequence switch moves through positions 12 $\frac{3}{8}$, 13 $\frac{3}{8}$ and 14 $\frac{3}{8}$ ground is connected to the fundamental circuit over the lower left and upper right
 50 contacts of cam 350 releasing the stepping relay of the sender in a manner similar to the commutator for other selections.

The position in which sequence switch 300 comes to rest is determined by the count-
 55 ing relay circuit closed through the contact of stepping relay 702 and the talking selection arc of translator 830 which is the one served by brush 834. Since this is a call for which the subscriber is to be charged, the counting relay circuit extends from bat-
 60 tery, right contact of cam 519, winding of the No. 1 counting relay, back contact of the No. 1' counting relay, conductor 712, to the talking selection arc of the translator, brush 834, left contacts of cam 726, middle
 65 back contact of relay 730, upper contact of cam 529, upper contacts of cam 707, inner left back contact of relay 708, left contact of cam 520, contact of relay 702, lower left contact of cam 518 to ground.

When sequence switch 300 passes position 12 $\frac{3}{8}$ stepping relay 702 is deenergized per-
 70 mitting the energization of the No. 1' counting relay to extend the counting relay circuit to the No. 0 counting relay. When sequence switch 300 leaves position 12 $\frac{3}{8}$ relay 702 again energizes in turn energizing the No. 0 counting relay. When sequence
 75 switch 300 reaches position 13 $\frac{3}{8}$ the stepping relay is again deenergized and the No. 0' counting relay and relay 703 energize, opening the fundamental circuit, releasing relay 314 and bringing sequence switch 300 to rest in position 14 which is the talking
 80 position for a charge call. The operation of the 0' counting relay closes a circuit from battery, through the winding of relay 515, lower left contact of cam 710, outer left back contact of relay 708, contact of the 0' counting relay, contact of cam 713 to ground,
 85 causing the restoration of the sender which will be subsequently described.

At the time sequence switch 300 left posi-
 90 tion 11 $\frac{1}{4}$ battery was connected through the lower left winding of repeating coil 360, left contact of cam 329, winding of relay 330, right back contact of relay 317, brush 331 and terminal 332 conductor 116, through the subscriber's substation, conductor 117, ter-
 95 minal 333 and brush 334, middle left contact of relay 318, lower right contact of cam 335, upper left winding of repeating coil 360 to ground. Relay 330 operates opening an alternative circuit for relay 351.

Immediately after final selection is made
 100 and before talking selection is made, the subscriber's line is tested to see if it is idle. Assuming that it is idle, talking selection is made as above described and thereafter the subscriber is signaled in the usual manner.
 105 When the called subscriber answers relay 361 is operated in the well known manner. With relay 361 operated, and sequence switch 300 in position 14, relay 302 operates as soon as interrupter 362 closes its contact, in
 110 a circuit from battery, through the winding of relay 302, contact of interrupter 362, lower contacts of cam 347, front contact of relay 361, left contacts of cam 350 to ground. Relay 302 operates and locks through its in-
 115 ner left front contact, lower contact of cam 308, front contact of relay 361, left contacts of cam 350 to ground. The operation of relay 302 prepares a circuit for relay 359 which may be traced from battery, through
 120 the winding of relay 359, contact of interrupter 363, lower left contact of cam 364, right front contact of relay 302 to ground. Relay 359 operates and locks through its inner right contact, upper right contact of cam 336 to ground. The operation of relay
 125 359 closes a circuit from battery, through resistance 365 and its outer right front contact, left contact of cam 318, brush 381, terminal 380, and thence over conductor 114,
 130

back contact of line relay 101 to the winding of message register 115. This circuit, however, is not closed until sequence switch 300 is advanced to position 15.

5 In the meantime conversation is in progress and the sender is undergoing restoration. As soon as translator 830 is set and sequence switch 950 has been positioned so that relay 952 closes its back contact, a circuit is completed from battery through resistance 612 and the right winding of relay 611 in parallel, winding and back contact of magnet 817, off normal terminals and brush 811 of register 810, middle left contact of relay 524, upper right contact of cam 530, lower contact of cam 953, inner right back contact of relay 952 to ground. Register 810 is advanced to normal in this self-interrupting circuit, whereupon the circuit is extended from brush 811 over its normal terminal, through brush 821 and its off normal terminals, back contact and winding of stepping magnet 827, resistance 612 and right winding of relay 611 in parallel to battery restoring the register 820 to normal. As soon as sequence switch 500 reaches position 7 and switch 700 reaches position 11 a circuit for restoring the numerical registers is prepared from battery through resistance 1009 and the left winding of relay 1018 in parallel, winding and back contact of stepping magnet 1007, off normal terminals and brush 1002, lower contacts of cam 531, normal terminal and brush 821 of switch 820, normal terminal and brush 811 of register 810, middle back contact of relay 524, left contact of cam 530, upper right and lower left contacts of cam 734, upper contact of cam 953, inner back contact of relay 952 to ground. The thousands register 1000 is restored to normal in this circuit whereupon the circuit is extended over the normal terminal of brush 1002, to brush 1012 and its off normal terminals, winding and back contact of magnet 1017, resistance 1009 and left winding of relay 1018 to battery, in which circuit the hundreds register 1010 is restored to normal. With register 1010 normal, as soon as sequence switch 700 reaches position 15, the above traced circuit is extended over the normal terminal of brush 1012, right contacts of cam 735, brush 1022 and its off normal terminals, winding and back contact of magnet 1027 to battery, restoring the tens register 1020 to normal. This circuit is then extended in turn to brush 1032 and magnet 1037. Since stations register 1040 has not been stepped off normal that register will not need restoration. As soon as units register 1030 reaches normal a circuit is completed, assuming that relay 610 has been released, from battery through resistance 616 and the left winding of relay 611 in parallel, winding and back contact of magnet 807, off normal terminals and brush

806 of register control switch 800, right back contact of relay 610, upper left contact of cam 516 to ground. Register control switch 800 is stepped to position 10 in this circuit. When it reaches position 10 a circuit is closed from battery, through resistance 616 and left winding of relay 611 in parallel, winding and back contact of magnet 807, brush 801 and its No. 10 terminal, normal terminal and brush 1042 of stations register 1040, normal terminal and brush 1032 of units register 1030 normal terminal and brush 1022 of tens register 1020, right contacts of cam 735, normal terminal and brush 1012 of hundreds register 1010, normal terminal and brush 1002 of thousands register 1000, lower contacts of cam 531, normal terminal and brush 821 of B code register 820, normal terminal and brush 811 of A code register 810, middle back contact of relay 504, left contact of cam 530, upper right and lower left contacts of cam 734, upper contact of cam 953, inner left back contact of relay 952 to ground. In this circuit the register control switch 800 is restored to normal.

The operation of relay 515, at the completion of talking selection as previously described, connects battery, through resistance 501, and the inner left contact of relay 515, over the middle right front contact of relay 505 in parallel with battery through the winding of relay 505 to conductor 506. This reduces the resistance in the circuit of relays 406 and 407 sufficiently to permit these relays to operate. The operation of relay 407 closes a circuit from battery through the winding of sequence switch magnet 400, upper right contact of cam 412, front contact of relay 407 to ground. Sequence switch 400 advances in this circuit to position 6. The operation of relay 406 connects ground through its contact and the right contacts of cam 403, resistance 416 brush 463 and its corresponding terminal to conductor 366 to mark the district selector busy to other link circuits until ground is placed on conductor 366 over the upper left contact of cam 417, contact 418 of make busy jack 419, through resistance 416 and brush 463 in positions $5\frac{3}{4}$ to $6\frac{1}{4}$ of sequence switch 400 which keeps the district busy until the link circuit is disconnected. When switch 400 leaves position $5\frac{1}{2}$ the circuit of relays 406 and 407 is opened and these relays release. At the same time the circuit of relay 505 is opened at cam 408 and that relay releases. Switch 400 is moved to position 7 in a circuit from battery through the winding of sequence switch magnet 400, contact 420 of make busy jack 419, lower left contact of cam 417 to ground. When switch 400 arrives in position 7 ground is connected over the upper right contact of cam 421, left winding of relay

406, lower contact of cam 413, right winding of relay 406, winding of relay 407, upper left contact of cam 408, lower right contact of cam 409 to brush 463.

5 At the same time a circuit is completed from battery, through the winding of magnet 467, upper left contact of cam 404, upper right contact of cam 405, back contact of relay 407 to ground. Magnet 467 operates
10 and closes an obvious circuit for magnet 468. The energization of magnet 468 rotates the district finder switch 460 in search of an idle district selector. An idle district selector is characterized by battery through
15 150 ohm resistance connected to a terminal of the arc served by brush 463. As soon as brush 463 encounters a terminal to which battery is connected through 150 ohms, relay 406 is operated connecting ground
20 through its contact and the upper contact of cam 411 to its right winding and the winding of relay 407, in which circuit relay 407 also operates. The operation of relay 407 opens the circuit of magnet 467 and
25 switch 460 comes to rest with its terminals engaging an idle district.

The operation of relay 407 also closes a circuit from battery through the winding of sequence switch magnet 400, upper contact of cam 412, front contact of relay 407
30 to ground, in which circuit sequence switch 400 is advanced to position 8. In position 8 ground is connected over the front contact of relay 407, upper contact of cam 415, brush 466 and its associated contact, conductor 375 of the district selector just seized, lower right contact of cam 312, lower right
35 contact of cam 313, left winding of relay 314 to battery. The operation of relay 314 closes a circuit from battery through the winding of sequence switch magnet 300, lower left contact of cam 328, outer right front contact of relay 314, lower contact of cam 339, to ground advancing the sequence
40 switch to position 2. The advance of sequence switch 300 to position 2 removes battery from conductor 366 permitting the release of relays 406 and 407. The release of relay 407 closes a circuit for advancing sequence switch 400 to position 9. The link
45 circuit remains in position 9 until the next link circuit moves out of position 1 or 10 due to the receipt of a call as previously described. The dotted rectangle 450 represents the next link circuit. It will therefore be seen that when the sequence switch of link 450 moves from position 1 to position 2 a circuit is closed from ground over cam 451, right contact of cam 452, lower contact of
50 cam 422, upper contact of cam 423, winding of sequence switch magnet 400 to battery advancing sequence switch 400 to position 10. Since the link circuit performs two cycles of operation to one revolution of the sequence switch, position 10 is the equivalent
55

of position 1 and the link circuit is now ready to respond to the reception of a call. The link circuit now remains in position 10 and the associated district in position 2 until another call is received.

The operation of relay 515 which was previously described also closes a circuit from battery, through the winding of sequence switch magnet 500, lower left contact of cam 517, right contacts of cam 736, inner
75 right front contact of relay 515 to ground. The sequence switch 500 advances to position 9 in this circuit. When sequence switch 500 reaches position 8 a circuit is closed from battery, winding of sequence switch
80 magnet 700, upper left contact of cam 729, lower left contact of cam 516 to ground. Sequence switch 700 advances to position 1 in this circuit. With sequence switch 700 in position 1, register control switch 800 normal and relays 505, 509, and 610 released, sequence switch 500 is advanced to position 10 in a circuit from battery, through the winding of that magnet, lower right contact of
85 cam 521, left contacts of cam 736, normal terminal and brush 806 of register control switch 800, right back contact of relay 610, contacts of cam 533, left back contact of relay 509, left back contact of relay 505 to ground. Sequence switch 500 also performs
90 its cycle of operation twice to one revolution and position 10 is its second normal position so that the sender is now in condition to control the extension of another connection.
100

When the calling subscriber hangs up, the circuit of relay 330 is opened and that relay deenergizes closing a circuit from battery, through the winding of relay 351, back contact of relay 330, lower contact of interrupter 367, lower left contact of cam 336
105 to ground. Relay 351 operates when the interrupter closes its contact and locks in a circuit through its winding and the back contact of relay 330, upper contacts of cam 352, inner front contact of relay 351, commutator segment 353, brush 354 to ground. When interrupter 367 closes its upper contact a circuit is completed from battery through the left winding of relay 317, outer
110 left front contact of relay 351, upper contact of interrupter 367, lower left contact of cam 336 to ground. Relay 317 operates in this circuit and closes a circuit from battery, through the winding of sequence switch magnet 300, lower contacts of cam 301, outer left front contact of relay 317 to ground, advancing sequence switch 300 to position
115 17. After a predetermined interval a circuit is closed from battery, through the winding of relay 302, lower contacts of cam 368, outer front contact of relay 351, upper contact of interrupter 367, lower left contact of cam 336 to ground.
120

Relay 302 operates and locks through its
125 130

inner left front contact, upper left contact of relay 308 to ground over the commutator segment 353. With sequence switch 300 in positions 15 to 17, the circuit previously described for message register 115 is completed causing the operation of the register. When sequence switch 300 passes through position 16 the locking circuit of relay 351 is opened but it is again operated in position 17 and locked as before described. The operation of relay 302 closes a circuit from battery, through the winding of sequence switch magnet 300, lower right contact of cam 311, right front contact of relay 302 to ground, advancing the sequence switch to position 18. Battery is held connected to conductor 112, through resistance 323, upper contacts of cam 324, middle right front contact of relay 359, resistance 325, brush 326, terminal 327, winding of cut-off relay 102 to ground holding the line busy.

In position 18 the down drive magnet 369 is operated from battery, through the winding of magnet 369, upper contacts of cam 313, upper right and lower left contacts of cam 350 to ground. The energization of the down drive magnet restores the district selector switch. When it reaches its normal position a circuit is closed from battery, winding of sequence switch magnet 300, lower right contact of cam 328, commutator segment 370, brush 371, upper right contact of cam 339 to ground advancing the sequence switch to position 1.

In position 18 the circuit of down drive magnet 372 of the line finder switch is also completed from battery, through the winding of magnet 372, lower right contact of cam 364, right front contact of relay 302 to ground. The line finder switch is restored under the control of down drive magnet 372. This circuit is maintained closed in position 1 as well as position 18 so that if the sequence switch was moved to position 1 due to the restoration of the district selector before the line finder has reached normal the circuit for restoring the line finder will not be opened prematurely. When the line finder reaches its normal position the locking circuit of relay 302 is opened at the commutator segment 353 and that relay releases in turn releasing magnet 372. Battery is connected through resistance 323, outermost left back contact of relay 302, lower contacts of cam 324, contact 373 of make busy jack 374 and thence to conductor 366 to indicate that the district selector is idle.

When a link circuit such as shown in Fig. 3 is released by ground from the district over conductor 315, at the completion of talking selection, the district finder switch 460 of that link will operate to rotate the brush set over the terminals leading to district selectors. When the brush 463 of that link makes contact with the terminal at-

tached to conductor 366 a circuit is completed from battery, through resistance 323 which causes the operation of relays 406 and 407, stopping the link circuit with its brushes on the terminals leading to the district selector. The sequence switch of the link circuit is advanced to position 8, in which position ground is connected from the front contact of relay 407 to the brush 466 operating relay 314 in a circuit from ground on conductor 375, lower right contact of cam 312, lower right contact of cam 313, left winding of relay 314 to battery. The operation of relay 314 closes a circuit from battery, through the winding of sequence switch magnet 300, lower left contact of cam 328, outer right front contact of relay 314, lower left contact of cam 339 to ground, advancing the sequence switch to position 2. The advance of sequence switch 300 to position 2 disconnects battery from conductor 366 and releases the relays of the link circuit. The release of these relays advances the link sequence switch to position 9. The link sequence switch remains in position 9 until it is allotted by the movement of the succeeding link out of position 1 as previously described whereupon it moves into position 1. The district selector sequence switch remains in position 2 and the link sequence switch in position 1 until they are taken for use by a call.

Call to subscriber in manual office.

The operation of the sender in connection with a relay call indicator call to a manual operator will next be described.

The action of the start and link circuit is the same as previously described. When an idle sender has been selected relay 606 is operated in turn operating relay 610 and relay 609 which closes the tone circuit for indicating to the subscriber that the sender is ready to receive dial pulses. Let us assume that the number of the wanted subscriber is Sherwood 10,358. The subscriber then operates his dial to send pulses corresponding to this number so that the A code register 810 is brought to rest in position 7, the B code register 820 in position 4, thousands register 1000 in position 1, hundreds register 1010 in position 10, tens register 1020 in position 3, units register 1030 in position 5 and stations register 1040 in position 8. As soon as registers 810 and 820 have been set translator 830 is set in a corresponding position in the manner previously described. Relays 620 and 621 are energized and sequence switch 500 is advanced to position 2. Since register 810 is set in position 7, relay 829 is operated and brushes 845 and 831 are used in stopping the translator and brushes 832 to 836 and 846 to 850 are effective to control selections.

Since register 1000 is set in position 1 and register 1010 is set in position 10 the circuit

for advancing register control switch 800 to position 9 is not closed until after switch 1040 has been set. After stations register 1040 has been set a circuit is closed from battery through the winding of relay 958, off normal terminals and brush 1041 of stations register 1040, No. 10 terminal and brush 1011 of hundreds register 1010, No. 1 terminal and brush 1001 of thousands register 1000, terminal of translator arc served by brush 835, back contact of relay 614 to ground. With translator 830 set, a circuit is closed from battery through the winding of sequence switch magnet 950, lower left contact of cam 951, cross connection rack 959, terminal of translator arc served by brush 850, middle right front contact of relay 620 to ground, relay 620 having been operated when the translator was brought to rest as previously described. Switch 950 is advanced to position 2 in this circuit.

The operation of relay 958 closes a circuit for advancing switch 950 to position 3 extending from battery through the winding of magnet 950, lower right contact of cam 951, left front contact of relay 958 to ground at the middle right front contact of relay 620. Relay 958 also locks to this ground. As soon as relay 952, which was energized in parallel with magnet 950, releases, a circuit is closed for advancing register control switch 800 to position 9 which may be traced from battery through the winding and back contact of magnet 807, brush 801 and its terminals 2 to 8, lower left contact of cam 960, outer left back contact of relay 952, upper right contact of cam 514, to ground at the inner left front contact of relay 507.

District selections take place as previously described except that an outgoing trunk is selected leading to an office selector. At the completion of the district selections the sequence switch 700 is moved to position 4. When sequence switch 700 reaches position 4 a circuit is closed from battery, through the winding of sequence switch magnet 500, upper right contact of cam 517, lower right contact of cam 709 to ground. Sequence switch 500 advances to position 3 in this circuit. With sequence switch 500 in position 3 and sequence switch 700 in position 4 the fundamental circuit is closed from ground at the office selector 1103 over terminal 376, brush 355, upper left and lower right contacts of cam 356, conductor 379, brush 462 of district finder switch 460 and its corresponding terminal, upper right and lower left contacts of cam 404, brush 482, of sender selector 480 and its corresponding terminal, inner right front contact of relay 507, outer left back contact of relay 524, compensating resistance 861, brush 833 of translator 830, upper right contact of cam 525, left winding of relay 704, winding of relay 716, lower left contact of cam 717,

resistance 718, upper right contact of cam 719, upper right contact of cam 523, outer right back contact of relay 504, brush 481 and its corresponding terminal, lower left and upper right contacts of cam 402, brush 461 and its corresponding terminal, inner left back contact of relay 359, upper contacts of cam 358, brush 357 and terminal 377 to battery through the trunk relay at office selector 1103. If the trunk circuit leading to the office selector is intact and the office selector is in its normal position, relay 716 operates, in turn operating relay 720 and relay 721.

The operation of relay 721 closes a circuit from battery, through the winding of sequence switch magnet 500, lower left contact of cam 521, outer right front contact of relay 721, inner right back contact of relay 711 to ground. The sequence switch 500 is advanced to position 4 in this circuit. With sequence switch 500 in position 4 the fundamental circuit is closed from brush 481, outer right back contact of relay 504, lower right contact of cam 523, upper contact of cam 701, winding of relay 702, back contact of relay 703, left winding of relay 704, and thence as previously traced to ground at the office selector. Office brush selection takes place in a manner similar to district brush selection except that the counting relay circuit extends from battery, lower right contact of cam 519, through the proper counting relay to terminals of arc of brush 847, lower right contact of cam 529, upper contacts of cam 707, inner left back contact of relay 708, lower right contact of cam 520, contact of stepping relay 702, lower left contact of cam 518 to ground. At the completion of office brush selection the 0' counting relay operates and closes a circuit for advancing sequence switch 500 to position 6 which circuit may be traced from battery, through the winding of magnet 500, upper right contact of cam 521, upper contact of cam 710, outer left back contact of relay 708, front contact of the 0' counting relay to ground at the inner right back contact of relay 711. When sequence switch 500 is in position 6, and sequence switch 700 in position 4, office group selection takes place in a manner similar to district group selection except that the counting relay circuit is completed through brush 846 of translator 830.

At the completion of office group selection the 0' counting relay is operated as before advancing sequence switch 500 to position 7 in the circuit previously described. As soon as sequence switch 500 reaches position 7 a circuit is closed through the winding of sequence switch magnet 700, upper left contact of cam 715, lower left contact of cam 522 to ground. Sequence switch 700 is advanced in this circuit to position 5.

With sequence switch 500 in position 7 and switch 700 in position 5 a test is made of the outgoing trunk to the manual operator's position. The circuit for this test extends from manual operator's position 1104 through office selector 1103 to brush 355 and thence as previously traced to brush 482, inner right front contact of relay 507, outer left back contact of relay 524, compensating resistance 859, brush 832 of translator 830, lower contact of cam 525, left winding of relay 704, winding of relay 716, lower contacts of cam 717, outer back contact of relay 711, right contact of cam 954, left contact of cam 523, outer right back contact of relay 504, brush 481 and thence as previously traced over brush 377 through the office selector to the manual operator's position. The circuit at the manual operator's position and the apparatus for receiving the relay call indicator pulses may be of the type disclosed in U. S. Patent No. 1,464,084 to A. E. Lundell et al., granted August 7, 1923.

If the selected trunk is not open, relay 716 operates in turn operating relays 720 and 721. Relay 721 locks through its inner right contact to ground at the upper left contact of cam 722, as long as sequence switch 700 remains in position 5. The operation of relay 721 also closes a circuit from battery through the winding of relay 737, outer left back contact of relay 730, lower contact of cam 738, upper left contact of cam 955, outer right front contact of relay 721, inner right back contact of relay 711 to ground. Relay 737 operates and locks over the outer left back contact of relay 730, outer right front contact of relay 737, lower right contact of cam 516 to ground.

The operation of relay 737 closes a circuit from battery, through the winding of sequence switch magnet 700, lower left contact of cam 715, outer right front contact of relay 737, outer right back contact of relay 708, lower left contact of relay 522 to ground in which circuit sequence switch 700 is advanced to position 15. During the rotation of switch 700 from position 5 to position 15 the fundamental circuit is extended from the winding of relay 716, over the middle right front contact of relay 721, to cam 954 instead of over the contacts of cam 717 so that relay 716 is maintained energized until the fundamental circuit is opened by the operation of the display key associated with the selected trunk at the manual office.

With sequence switch 950 in position 3, as soon as relay 952 releases after the setting of the class sequence switch 950 a circuit is closed from battery through the winding of relay 901, left contact of cam 961, outer right back contact of relay 952, upper right contact of cam 722, to ground. Relay 901

operates in this circuit and locks over its inner left front contact, lower left contact of cam 902, lower left and upper right contacts of cam 962, lower right contact of cam 522 to ground. Relay 901 remains locked in this circuit until the relay call indicator impulser switch 900 leaves position 14. When the display key at the manual office is operated the fundamental circuit is opened and relays 716, 720 and 721 release. The release of relay 721 closes a circuit from battery, winding of relay 1008, lower right contact of cam 956, outer left front contact of relay 901, outer left back contact of relay 721, middle left front contact of relay 737, lower left contact of cam 722 to ground. Relay 1008 in operating closes a circuit from battery through the winding of sequence switch magnet 900, lower left contact of cam 903, inner left front contact of relay 1008, upper left and lower right contacts of cam 956 and thence to ground over the energizing circuit of relay 1008. Magnet 900 is energized and starts the revolution of the relay call indicator sequence switch.

The release of relay 721 also closes the circuit for the transmission of relay call indicator pulses which extends from the inner right front contact of relay 901, inner left front contact of relay 737, inner left back contact of relay 721, lower contact of cam 525, brush 832, compensating resistance 859, outer left back contact of relay 524, inner right front contact of relay 507, brush 482 and its corresponding terminal and thence as previously traced through the district and office selectors, the operator's position, the manual office relay call indicator polarized and marginal relays, back through the office and district selectors to brush 481, outer right back contact of relay 504, left contact of cam 523, right contact of cam 954, middle right back contact of relay 721, inner right front contact of relay 737, to the outer right armature of relay 901. Code pulses are now sent out and are received on the relay call indicator at the manual office substantially as described in the above mentioned Patent No. 1,464,084.

Each digit of the allotted number is represented by four pulses the first impulse of which may be either positive or wanting, the second a light or heavy negative, the third positive or wanting and the fourth a light or heavy negative. These pulses are arranged in code combinations to represent the various digits. According to this code the pulses to be sent for the number of the wanted subscriber in the present case will be:

1	positive	light	negative	none	light	negative
0	none	light	negative	none	light	negative
3	positive	heavy	negative	none	light	negative
5	none	light	negative	none	heavy	negative
8	positive	heavy	negative	none	heavy	negative

While sequence switch 900 is rotated from

position 1 to $4\frac{1}{4}$ the pulses for the ten thousands digit are sent out; the thousands digit in positions $4\frac{3}{4}$ to $8\frac{1}{4}$; the hundreds digit from $8\frac{3}{4}$ to $12\frac{1}{4}$, the tens digit in positions $12\frac{3}{4}$ to $16\frac{1}{4}$ and the units digit in positions $16\frac{3}{4}$ to $20\frac{1}{4}$. In position $20\frac{3}{4}$ to $1\frac{1}{4}$ ground is connected to the inner right contact of relay 901, from the right contact of cam 904 and battery is connected through low resistance 905, inner right back contact of relay 526, conductor 906, upper contact of cam 907, left contact of cam 963, brush 1006 and its No. 1 terminal, left contact of cam 964, left contact of cam 908, left contact of cam 909, high resistance 910 to the outer right contact of relay 901.

In positions $1\frac{1}{4}$ to $2\frac{1}{4}$ ground is connected over the left contact of cam 904, to the outer contact of relay 901, and battery is connected through low resistance 905 and high resistance 911, right contact of cam 912 to the inner contact of relay 901, producing a light pulse in the opposite direction.

In position $2\frac{3}{4}$ to $3\frac{1}{4}$ ground is connected to the inner contact of relay 901, but since the thousands register 1000 is standing in its No. 1 position no circuit is closed from battery over conductor 906, to the outer contact of relay 901. Hence no pulse is sent out.

In position $3\frac{3}{4}$ to $4\frac{1}{4}$ ground is connected to the outer contact of relay 901 from the left contact of cam 904, and battery is connected to the inner contact of relay 901, through low resistance 905 and high resistance 911 in series and the right contact of cam 912.

The thousands digit is under the control of the hundreds register and since the hundreds register 1010 is standing in its No. 10 position no circuits are closed through brush 1016 and hence only light negative pulses can be sent. Therefore in position $4\frac{1}{4}$ to $5\frac{1}{4}$ ground is again connected to the inner contact of relay 901 but battery is not connected to the outer contact of that relay and no pulse is sent. In position $5\frac{3}{4}$ to $6\frac{1}{4}$ ground is connected to the outer contact of relay 901 and battery through resistances 905 and 911 and the right contact of cam 912 and inner contact of relay 901. In position $6\frac{3}{4}$ to $7\frac{1}{4}$ no pulse is sent and in position $7\frac{3}{4}$ to $8\frac{1}{4}$ a light negative pulse is transmitted as just described. The hundreds digit of this number is under the control of the tens register which is set in position 3. Therefore in position $8\frac{3}{4}$ to $9\frac{1}{4}$ ground is connected to the inner contact of relay 901 and battery from conductor 906 through the left contact of cam 913, right contact of cam 965, brush 1026 and its No. 3 terminal, left contact of cam 914, left contact of cam 909, resistance 910 to the outer contact of relay 901.

In position $9\frac{3}{4}$ to $10\frac{1}{4}$ ground is connect-

ed to the outer contact of relay 901 and battery is connected to the inner contact of relay 901, through low resistance 905 to conductor 906, left contact of cam 913, right contact of cam 965, brush 1026 and its No. 3 terminal, left contact of cam 914, right contact of cam 909 to the inner contact of relay 901. Since only resistance 905 is included in this circuit the pulse sent out is a heavy one.

In position $10\frac{3}{4}$ to $11\frac{1}{4}$ ground is connected to the inner contact of relay 901. No path is closed from brush 1026 to the outer contact of that relay and hence no pulse is sent out.

In position $11\frac{3}{4}$ to $12\frac{1}{4}$ ground is connected to the outer contact of relay 901 and battery is connected through resistances 905 and 911 and cam 912 to the inner contact of relay 901 producing a light negative pulse.

In subsequent positions of this sequence switch light and heavy negative and positive pulses are sent according to the table previously given and it is not thought necessary to trace these circuits in detail. The operation at the relay call indicator will be such as to cause the display of the number at that position in the manner described in the above identified Patent 1,464,084. The operator extends the call and the response of the called subscriber affects the district selector in the same manner as the response of a mechanical subscriber.

As soon as sequence switch 900 reaches position 2, alternative paths for the pulses to the outgoing conductors, are established over cam 915 and over the lower contact of cam 912 in parallel with the contacts of relay 901. When sequence switch 900 reaches position 14 the locking circuit of relays 1008 and 901 is opened and these relays release. As soon as sequence switch 900 reaches position $20\frac{3}{4}$ a circuit is closed for relay 524 from battery through the winding of that relay, contact of cam 917, outer left back contact of relay 901, outer left back contact of relay 721, middle left front contact of relay 737, lower left contact of cam 722 to ground. Relay 524 operates and closes a circuit from battery, winding of sequence switch magnet 700, upper right contact of cam 715, outer right front contact of relay 524 to ground advancing sequence switch 700 to position 17 from which it then advances to position 18 in a circuit over the upper right contact of cam 729, outer right back contact of relay 708, lower left contact of cam 522 to ground. With switch 700 in position 18 talking selection is completed in the manner previously described.

Registers 810 and 820 are restored to normal as soon as the class sequence switch is set in the manner previously described. The circuit for restoring the numerical registers

is not completed until after sequence switch 900 is restored to normal. The operation of relay 524 also closes the circuit previously described for relay 504 and the operation of that relay completes the restoration circuit of the numerical registers. The further restoration of the sender in this circuit is the same as previously described.

10 *Call to special operator.*

The operation of the circuits in connection with a call to a special operator's position reached by dialing a code the first two digits of which are 1 will now be described.

15 The operation of the start and link circuits and the line finder is the same as previously described. When the dialing circuit is completed relays 606, 610 and 609 are operated as previously described and the district selector sequence switch is advanced to position 3. Relays 503, 507, 509, 510, 511 and 512 are also operated. The release of relay 606 in response to the first digit closes the previously described circuit for magnet 817, advancing the A register 810 to position 1 after which relay 606 remains energized long enough to permit the release of relay 614. However, the register control switch 800 is not advanced since the magnet 807 is held operated in a circuit from battery through its winding, No. 1 terminal and brush 815, of register 810, right back contact of relay 608, outer left front contact of relay 609, to ground on conductor 618.

25 Since register 810 is in position 1, a circuit is completed from battery through the left winding of relay 613, No. 1 terminal of brush 813 of register 810, back contact of relay 614 to ground. The operation of relay 613 closes a circuit from battery through the winding of relay 624, right back contact of relay 625, left front contact of relay 613, right front contact of relay 610, conductor 638, upper left contact of cam 516 to ground. Relay 624 operates and closes a locking circuit for itself through the winding of relay 625, front contact of relay 624, to ground on conductor 618. Relay 625 does not energize in this circuit being shunted as long as relay 613 remains energized.

30 With relay 606 released in response to the next digit 1, relay 614 is operated and relay 613 held in a circuit from battery, through resistance 1009 and the left winding of relay 1018 in parallel, right winding of relay 613, front contact of relay 613, normal terminal and brush 802 of register control switch 800, winding of relay 614, left front contact of relay 610, back contact of relay 606, conductor 639, to ground at the inner right back contact of relay 515. The operation of relay 614 opens the initial energizing circuit of relay 613. At the end of this pulse, the operation of relay 606 opens the

locking circuit of relay 613 and that relay releases, permitting the energization of relay 625 in the locking circuit of relay 624.

Relay 614 being slow to release does not close its back contact until after relay 613 has released. When relay 614 closes its back contact relay 613 is again operated in the circuit previously traced and closes a circuit from battery, through the winding of relay 626, back contact of relay 627, front contact of relay 625, front contact of relay 613, right front contact of relay 610 to ground over conductor 638. Relay 626 operates and locks in a circuit through the winding of relay 627, front contact of relay 626, to ground on the conductor 618, but relay 627 is shunted at the contact of relay 613 and hence does not operate at this time. Magnet 817 was not operated at the time of the reception of the second digit 1 since its circuit was also open at that time at the contact of relay 613.

When the first pulse of the third digit is received relay 614 is operated in the holding circuit of relay 613 and opens the energizing circuit of relay 613. When relay 606 energizes between the first and second impulses of this digit the holding circuit of relay 613 is opened and that relay releases, but relay 614 being slow to release does not release but remains operated until relay 606 again closes its back contact at which time the circuit of relay 614 is completed over the back contact of relay 613, through the winding of magnet 817 to battery, energizing the magnet and causing the register 810 to be stepped to its next position. The release of relay 613 permits the energization of relay 627 in the locking circuit of relay 626. In response to succeeding impulses of the third digit the register 810 is further advanced.

The operation of relay 627 closes a circuit for relays 828 and 862 in parallel, inner left front contact of relay 627, left back contact of relay 613, right front contact of relay 610 to ground on conductor 638.

These relays operate and transfer the leads connected to terminals on the arc of brush 814 from the brushes of register 820 direct to points on the translator arcs. As soon as relay 614 releases after the completion of the last set of pulses, the circuit of magnet 807 is opened and that magnet retracts its armatures to step register control switch 800 to position 1. Relay 627, being operated, closes a circuit for moving switch 800 to position 2 which circuit may be traced from battery, winding and back contact of magnet 807, brush 801 and its No. 1 terminal, outer left front contact of relay 627, left back contact of relay 613, right front contact of relay 610 to ground on conductor 638. When register control switch 800 reaches position 2 relay 617 is energized as previously described and translator 830 is set in a position according

to the code dialed. Switch 950 is set in position 6 by means of a circuit from battery through the upper right contact of cam 966, cross connection rack 959, contact of the translator are served by brush 856, middle right contact of relay 620 to ground. Register control switch 800 is advanced to position 9 as soon as relay 952 releases after sequence switch 950 has been positioned in a circuit which may be traced from battery, through the winding and back contact of magnet 807, brush 801 and its terminals 2 to 8, left contact of cam 960, outer left back contact of relay 952, upper contact of cam 514, to ground at the inner left front contact of relay 507. The district and office selections are now completed under the control of the translator 830 to extend the connection to the operator's position 1105.

At the completion of office selection the trunk of the operator's position is tested in the manner described for the relay call indicator call except that the circuit of relay 737 is open at cam 955 and that relay is not operated. Relays 716 and 717 and 721 are operated. The operation of relay 721 closes a circuit for sequence switch 700 from battery, through the winding of magnet 700, lower right contact of cam 715, right contact of cam 955, outer right front contact of relay 721, to the inner right back contact of relay 711 to ground. The sequence switch 700 is advanced to position 6.

In position 6 of sequence switch 700 a circuit is completed from battery through the winding of relay 524, lower right and upper left contact of cam 962, upper left and lower right contacts of cam 714, outer right back contact of relay 730 to ground. Relay 524 operates and locks over its inner left front contact, upper left contact of cam 528 to ground. The operation of relay 524 closes a circuit from battery, winding of sequence switch magnet 700, upper right contact of cam 715, outer right front contact of relay 524 to ground, advancing sequence switch 700 to position 17. Sequence switch 700 is then advanced to position 18 in a circuit over the upper right contact of cam 729, outer right back contact of relay 708, lower left contact of cam 522 to ground. In position 18 talking selection takes place. The fundamental circuit is completed as previously described for talking selection but in this case the counting relay circuit extends from battery, over the right contact of cam 519, winding of the No. 2 counting relay, back contact of the No. 2' counting relay, conductor 723 to an arc of translator 830, brush 840, left contacts of cam 826, middle left back contact of relay 730, upper left contact of cam 529, upper contact of cam 707, inner left back contact of relay 708, left contact of cam 520, contact of stepping relay 702, lower left contact

of cam 518 to ground. The district sequence switch will therefore be moved through position 13 and position 14 to position 15 in order to satisfy the sender.

With the district selector in position 15 a circuit is closed from the operator's position through the office selector 1110 over the district selector brush 357, left contacts of cam 358, upper right winding of repeating coil 360, lower contacts of cam 348, winding of relay 361, lower right winding of repeating coil 360, upper contacts of cam 356, brush 355 and thence through the office selector to the operator's position. When the operator answers, relay 361 operates closing a circuit from battery through the right winding of relay 314, upper right and lower left contacts of cam 347, contact of relay 361, left contacts of cam 350 to ground. Relay 314 operates and closes a circuit from battery, winding of sequence switch magnet 300, lower left contact of cam 328, outer right front contact of relay 314, lower left contact of relay 339 to ground. Sequence switch 300 is advanced to position 16 in this circuit, opening the circuit of relay 361 as it leaves position 15 $\frac{1}{4}$ and permitting the release of that relay. Relay 314 is, however, maintained energized over a circuit through its left winding and inner right front contact, right contacts of cam 350, sleeve brush 349, to ground at the operator's position. With sequence switch 300 in position 16 the talking circuit extends from the operator's position through the office selector 1110 over brush 357, upper right contact of cam 335, middle left back contact of relay 317, the line finder brush 334, over the tip conductor 117 to the subscriber's substation, then over the ring conductor 116, line finder brush 331, right back contact of relay 317, winding of relay 330, upper right contact of cam 329, district selector brush 355 and thence through the office selector 1110 to the operator's position.

In position 16 of sequence switch 300 a circuit is closed from battery, through the winding of relay 302, lower left contact of cam 341, outer right front contact of relay 314 to ground on the lower left contact of cam 339. Relay 302 operates and locks over the upper left contact of cam 308, commutator segment 353, brush 354 to ground until the line finder is restored to normal.

When the operator disconnects, relay 314 releases and advances the sequence switch to position 17 in a circuit from battery through the winding of sequence switch magnet 300, lower right and upper left contacts of cam 342, outer left back contact of relay 314, to ground on the lower left contact of cam 339. Relay 302 being operated, the sequence switch is then advanced to position 18 in a circuit from battery through the winding

of sequence switch magnet 300, lower right contact of cam 311, right front contact of relay 302 to ground.

In position 18 the line finder and district selector are restored to normal in the manner previously described. The sender is restored to normal as previously described, except that, the B code register and numerical registers not having been moved from normal, it is not necessary to restore them. Relays 624 to 627, and 828 and 862 are released as soon as sequence switch 500 moves from position 7.

15 *Connection to monitoring operator's position.*

The operation of the timing switch 600 and the manner in which it directs a call to a sender monitoring operator's position in connection with uncompleted calls will now be described.

When relay 507 operates and connects ground from its inner left front contact to conductor 534, relay 601 is operated as previously described through the normal contact and brush 602 of the time measure switch 600. The operation of relay 601 closes a circuit from battery, through the winding of relay 603, normal terminal of brush 604, inner left front contact of relay 601 to ground. Relay 603 operates and closes a circuit from battery through the winding and back contact of stepping magnet 605, right contact of relay 603 to ground at the inner left front contact of relay 601. The operation of stepping magnet 605 steps time measure switch 600 to its No. 1 position. Ground connected to the No. 1 terminal served by brush 604 holds relay 603 operated and causes the stepping magnet 605 to step the switch to its No. 2 position. The stepping magnet 605 is then energized over contact of interrupter 628 and the Nos. 2 and 3 terminals of brush 629, outer right contact of relay 603, to ground at the outer left contact of relay 513. Switch 600 is advanced one step each time that interrupter 628 closes its contact until the switch reaches its No. 4 position.

If dialing has not been started at this time a circuit is closed from battery through the winding of relay 608, No. 4 terminal and brush 630, left back contact of relay 603, to ground at the inner left back contact of relay 513. Relay 608 operates and locks to ground on conductor 534. The operation of relay 608 closes a circuit from battery, through the winding of relay 619, right back contact of relay 621, right back contact of relay 620, right front contact of relay 608, outer left front contact of relay 609 to ground on conductor 618. Relay 619 locks through its inner left front contact to ground on conductor 534. The operation of relay 619 closes a circuit from battery

through the winding and back contact of stepping magnet 807 of register control switch 800, brush 801 and its normal terminal middle left front contact of relay 619, right front contact of relay 610 to ground at the upper left contact of cam 516. Register control switch 800 is stepped to its No. 1 position and then to its No. 2 position since the normal and No. 1 terminals of brush 801 are strapped together.

With switch 800 in position 2 relay 617 is operated and translator 830 is set in the position determined by ground placed on the translator arc served by brushes 837 and 851, through the inner right front contact of relay 619, from the outermost right contact of relay 617. This setting of the translator causes the district selector to pick one of a group of trunks leading to what is known as a permanent signal operator's position. The call then proceeds as for a call to an operator's position.

If the switch 800 has been advanced to its No. 1 position when switch 600 steps to its No. 4 position a circuit is closed from battery through the winding of relay 603, brush 631 and its No. 4 terminal, off normal terminals of brush 805 to ground. Relay 603 operates and causes the operation of stepping magnet 605 advancing switch 600 immediately to its No. 5 position. Switch 600 advances to its No. 7 position under the control of interrupter 628.

If switch 800 has not been advanced to its No. 8 or No. 9 terminal at this time, a circuit is closed from battery through lamp 632, resistance 633, No. 7 terminal and brush 629, outer right back contact of relay 603, to ground at the outer left back contact of relay 513, and switch 600 remains in this position. However, if switch 800 is in its No. 8, 9 or 10 position, a circuit is closed from battery, through the winding of relay 603, brush 631 and its Nos. 5 to 7 terminals, terminals Nos. 8 to 10 of brush 805 to ground. The operation of relay 603 causes the stepping magnet 605 to step switch 600 to its No. 8 position. Switch 600 is now advanced from the No. 8 to the No. 12 position due to the operation of relay 603 over brush 631, left back contact of relay 634 to ground at the outer left back contact of relay 513. It then advances to its No. 18 position due to the operation of relay 603 through brush 631 to grounded terminals No. 12 to No. 17. The switch 600 then advances from position No. 18 to position No. 20 in a circuit from battery through the winding of stepping magnet 605, interrupter 628, terminals No. 18 to No. 20, brush 629, outer right back contact of relay 603 to ground on the outer left back contact of relay 513.

If selections have not been completed by the time switch 600 comes to its No. 20 position a circuit is closed from battery through

the winding of relay 603, brush 631 and its No. 20 terminal, to ground at the upper right contact of cam 957. Switch 600 is immediately stepped to its No. 21 position in which position a circuit is closed from battery, lamp 632, right back contact of relay 634, interrupter 635, terminal No. 21 and brush 629, outer right back contact of relay 603 to ground on the outer left back contact of relay 513. Lamp 632 flashes at the monitor's position indicating that the sender has operated incorrectly.

When the operator notices lamp 632 she inserts a plug in jack 535 causing the operation of relay 513. Relay 513 in operating disconnects ground from brushes 629 and 630 extinguishing lamp 632. It also establishes a circuit from battery through the winding of relay 606, inner right front contact of relay 513, resistance 536, next to the outer left front contact of relay 609 to ground, holding relay 606 operated to prevent the call being wiped out.

The operator then talks over her cord to the subscriber. If she finds that the subscriber does not answer, she proceeds to release the sender by inserting a plug into jack 636, ground on the tip conductor of her cord causing the operation of relay 608 which locks to ground on conductor 534. If translation has been completed switch 500 is advanced to position 9 in a circuit from battery through the winding of magnet 500, lower left contact of cam 517, left back contact of relay 622, outer left contact of relay 608, outer left back contact of relay 619, lower right contact of cam 522 to ground. As switch 500 passes positions 7 $\frac{3}{4}$ to 9 the right winding of relay 503 is shunted in a circuit from ground, over the lower contacts of cam 537, thus causing the operation of relay 351 in the district selector circuit in turn operating relay 317, opening the tip and ring conductors leading to the sender. The opening of the ring conductor releases relay 606 in turn, releasing relays 610 and 609. With switch 500 in position 9 relay 504 operates from ground at the upper right contact of cam 528. With sequence switch 500 in position 9 sequence switch 700 is advanced to normal in a circuit from battery, through the winding of magnet 700, upper left contact of cam 729, lower left contact of cam 516 to ground. Due to the operation of relay 317 the district selector sequence switch advances, opening the circuit of relay 503 which relay releases, in turn releasing relays 507 and 509. Since relay 509 is slow to release a circuit is closed from ground through the outer left back contact of relay 507, middle right front contact of relay 509, winding of relay 505 to battery. The operation of relay 505 closes a circuit from battery through resistance 501 to conductor 506 advancing the link cir-

cuit sequence switch as previously described. The further release is the same as previously described.

When the sender has been disconnected, relay 601 releases and closes at its back contact a circuit over brush 604 to the winding of relay 603, in which circuit switch 600 is restored to normal. This circuit is effective at any time as soon as relay 601 releases.

Abandoned calls.

The operation of the circuits if the calling subscriber abandons a call prior to its completion will now be described. Upon restoration of the receiver to the switchhook at any time after the sender has been selected and before the call has proceeded to such an extent that the sender is not still associated with the calling line this opens the circuit of the pulsing relay 606 of the sender, which in turn releases relays 609 and 610. If no dialing has been done register 810 advances to position 1 and the release of relay 609 opens the circuit of magnet 807, advancing switch 800 to position 1 in the manner hereinbefore described. The release of relay 609 also closes a circuit for relay 526, extending from battery through the winding of this relay, outer left back contact of relay 504, brush of switch 600, front contact of relay 601, left normal contact of relay 610, back contact of relay 606, conductor 639 to ground at the inner right back contact of relay 515. Relay 610 also closes a circuit for advancing switch 800 from position 1 into position 10. This circuit extends from battery through the left winding of relay 611, winding and contact of magnet 807, terminals 1 to 9 and brush 806 of switch 800, right normal contacts of relay 610, conductor 638 to ground at the upper left contact of cam 537, the sequence switch 500 being at this time in position 1.

As the switch 800 advances through positions 1 to 7, relay 603 operates in a circuit extending through its winding, brush 631, terminals and brush 805 to ground. Relay 603 operating energizes magnet 605 to advance the timing switch 600 into position 5. As soon as switch 600 reaches position 5, the circuit to relay 603 is opened, but when switch 800 reaches position 8 a new circuit for relay 603 is established, extending through its winding, brush 631 to ground at brush 805. Relay 603 now advances switch 600 to position 8.

Relay 526 upon energizing as above described, locks through its left front contact to ground at the inner left contact of relay 507 and closes an obvious circuit for relay 515. Relay 515 at its outer left contact shunts the right winding of relay 503, increasing the current flowing through the winding of relay 317 of the district selector whereby relay 317 energizes. Relay 515 also

removes ground from conductor 639 for preventing relay 610 from reoperating should the subscriber again remove the receiver at this time.

When relay 317 operates, relay 302 is operated over a circuit extending from the left front contact of relay 317 and the left contacts of cam 301, advancing sequence switch 300 into position 7 over a circuit extending from ground at the right front contact of relay 302 and lower right contact of cam 311. From position 7 sequence switch 300 advances into normal position in the well known manner, restoring the line finder as previously described. When sequence switch 300 advances out of position 10, the circuit of relays 317 and 503 is opened, these relays releasing and relay 503 in turn releasing relay 507. The release of relay 507 operates relay 505 over an obvious circuit, relay 505 upon operating releasing relay 509. Relay 505 locks over its outer right front contact to conductor 506 and since relay 515 is at the time operated resistance 501 is connected over the inner front contact of relay 515 and the right front contact of relay 505, thus reducing the resistance to battery on conductor 506, resulting in the release of relays 406 and 407 of the link circuit. The release of relay 407 removes ground from conductor 506, releasing relay 505, which in turn releases relays 515, 526 and 601. Relay 601 advances switch 600 into normal position and the remaining operated apparatus of the sender and link circuit restore to normal as previously described.

If a call to a relay call indicator office is abandoned after district selections are completed, office selections are also completed if an office selector is used and a trunk to the call indicator office is selected. When the subscriber hangs up, relays 606, 609 and 610 release and relays 515 and 526 operate as previously described. In addition, the operation of relay 526 opens at its inner right contact the connection of battery to conductor 906 so that when the impulser switch 900 operates in response to the operation of the display key at the call indicator office in the manner previously described for a relay call indicator call the heavy negative and light positive impulses are not sent and since only light negative impulses will be sent, each digit for which code impulses are transmitted after relay 526 operates is displayed on the call indicator as zero. Relay 524 is operated as previously described in connection with a regular relay call indicator call advancing the district selector sequence switch from the selection beyond position. When the sequence switch advances the relays 503 and 507 release, relay 505 operates in turn releasing relay 509. The link circuit is then advanced as on a

regular call. Since, however, the calling subscriber has hung up the district sequence switch advances to normal and the sender is returned to normal as on a regular call.

If the manual operator has not depressed her display key in answer to the call incoming to her position at the time the calling subscriber abandons the call, relays 716, 720 and 721 operate as previously described, and since relay 515 is now operated, control switch 500 is advanced into position 9 from any position 2 to 7 over a circuit extending from battery, lower left contact of cam 517, back contact of relay 622, inner left back contact of relay 609, upper contact of cam 738, left contact of class sequence switch to cam 935, which is in either position 2 or 3 for a call of this class, outer right front contact of relay 721 to ground at the inner back contact of relay 711. As switch 500 passes through positions $7\frac{3}{4}$ to 9 the right winding of relay 503 is shunted over the lower contacts of cam 537, whereby relay 317 energizes and the district selector is advanced into normal as previously described, releasing relay 503. The entire sender then releases as previously described. By wiping out a connection to a call indicator office in the above described manner, if the calling subscriber abandons the call before the manual operator answers the sender holding time is materially reduced and a considerable load is removed from the manual operator, since such abandoned calls are not brought in upon her indicator, as has been the practice heretofore.

What is claimed is:

1. In a telephone exchange system, an impulse transmitting device, a register, means for positioning said register in response to either the first of a plurality of series of impulses or in response to the last of a plurality of series of impulses, means under the control of said register to make selections in two different groups, and means to discriminate between said groups according to whether said register is positioned by said first or said last series of impulses.

2. In a telephone exchange system, an impulse transmitting device, a register, means for positioning said register in response to impulses from said impulse transmitting device, and means under the control of said register to effect selections in one group when said register is positioned in response to the first of a plurality of series of impulses and to effect selections in another group when said register is positioned in response to the last of a plurality of series of impulses.

3. In a telephone exchange system, an impulse transmitting device, a register, means for positioning said register in response to the first of a plurality of series of impulses from said impulse transmitting device to

control a particular group of selections and means for positioning said register in response to the last of a plurality of series of impulses from said impulse transmitting device effective, when said earlier series are of a particular number, to control an additional group of selections.

4. In a telephone exchange system, an impulse transmitting device, a register, means for positioning said register in response to the first of a plurality of series of impulses from said transmitting device to control a particular group of selections, means effective, when the earlier ones of a plurality of series of impulses are of a particular number, to transfer the registration of said series of impulses to an auxiliary registering device and to register the last of said plurality of series of impulses on said first mentioned register to control an additional group of selections.

5. In a telephone exchange system, an impulse transmitting device, a register sending device comprising a plurality of registers, means for positioning said registers under the control of said impulse transmitting device, means under the joint control of said registers for controlling a particular group of selections, means for preventing the effective registration of a single impulse on the first of said registers, auxiliary means for registering a plurality of digits comprising single impulses, and means under the control of said auxiliary means and the first of said registers for controlling an additional group of selections.

6. In a telephone exchange system, an impulse transmitting device, a register sending device comprising a plurality of registers, means for positioning said registers under the control of said impulse transmitting device, means under the joint control of said registers for controlling a particular group of selections, means for preventing the effective registration of a single impulse on the first of said registers, means comprising a plurality of recording relays for registering a plurality of digits comprising single impulses and means under the joint control of said relays and the first of said registers for controlling an additional group of selections.

7. In a telephone exchange system, an impulse transmitting device, a register sending

device comprising a plurality of registers, means for positioning said registers under the control of said impulse transmitting device, a translator, means under the joint control of said registers for positioning said translator to control a particular group of selections, means for preventing the effective registration of a single impulse on the first of said registers, auxiliary means for registering a plurality of digits comprising single impulses, and means under the joint control of said auxiliary means and the first of said registers for positioning said translator to control an additional group of selections.

8. In a telephone exchange system, an impulse transmitting device, a register sending device comprising a plurality of registers, means for positioning said registers under the control of said impulse transmitting device, a translator, means under the joint control of said registers for positioning said translator to control a particular group of selections, means for preventing the effective registration of a single impulse on the first of said registers, means comprising a plurality of recording relays for registering a plurality of digits comprising single impulses and means under the joint control of said counting relays and the first of said registers for positioning said translator to control an additional group of selections.

9. In a telephone exchange system, an impulse transmitting device, a register sending device comprising a plurality of registers, a translator, a plurality of circuits extending from the first of said registers through the second of said registers serially to position said translator to control a particular group of selections, means for preventing the effective registration of a single impulse on the first of said registers, means comprising a plurality of recording relays for registering a plurality of digits comprising single impulses, and means under the control of said relays for extending said circuits from said first register directly to said translator to position said translator to control an additional group of selections.

In witness whereof, I hereunto subscribe my name this 7th day of October A. D., 1924.

OTTMAR H. KOPP.