

Sept. 15, 1925.

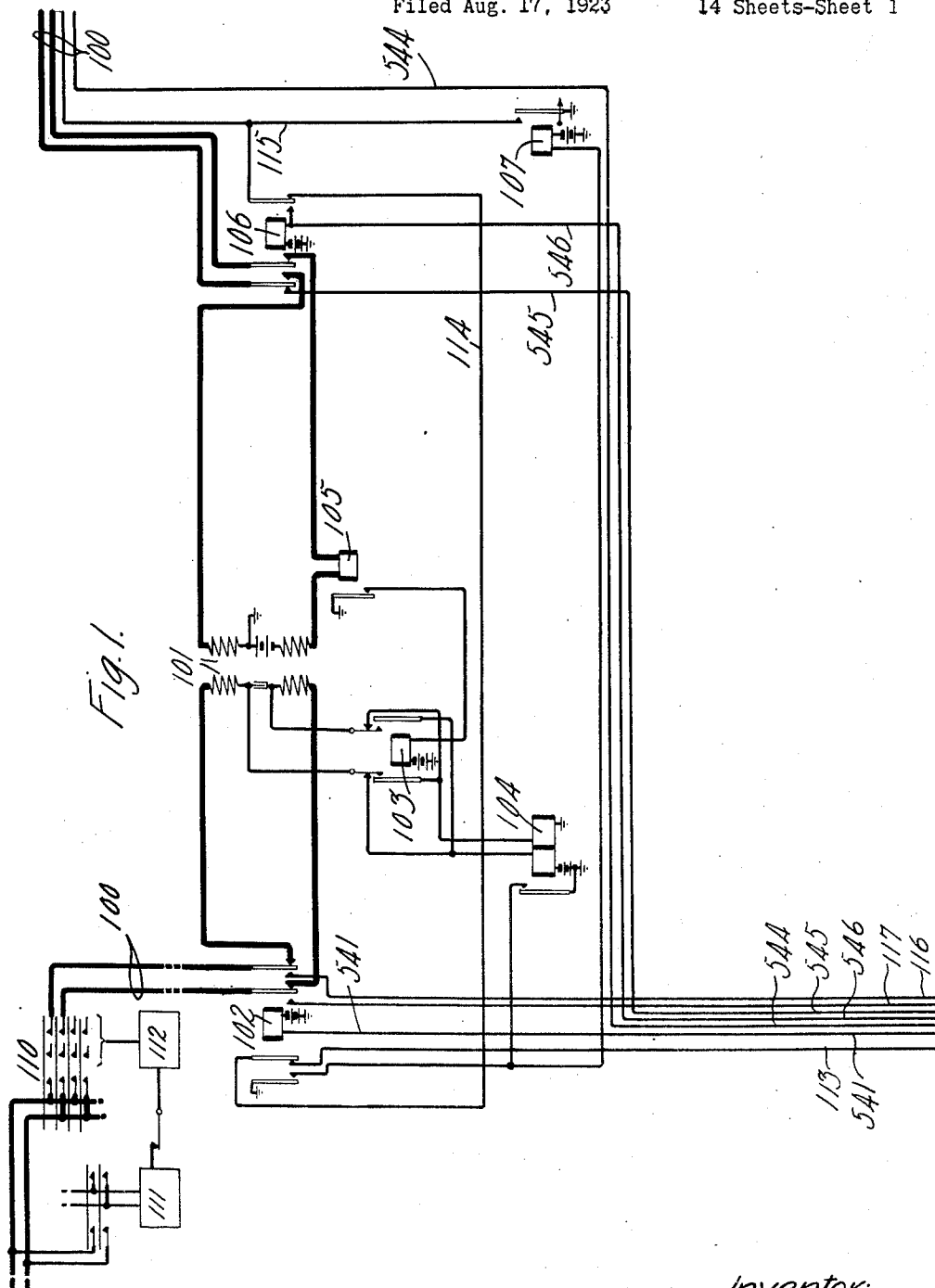
1,553,347

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TELEPHONE EXCHANGE SYSTEM

Filed Aug. 17, 1923

14 Sheets-Sheet 1



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S. B. WILLIAMS
TELEPHONE EXCHANGE SYSTEM

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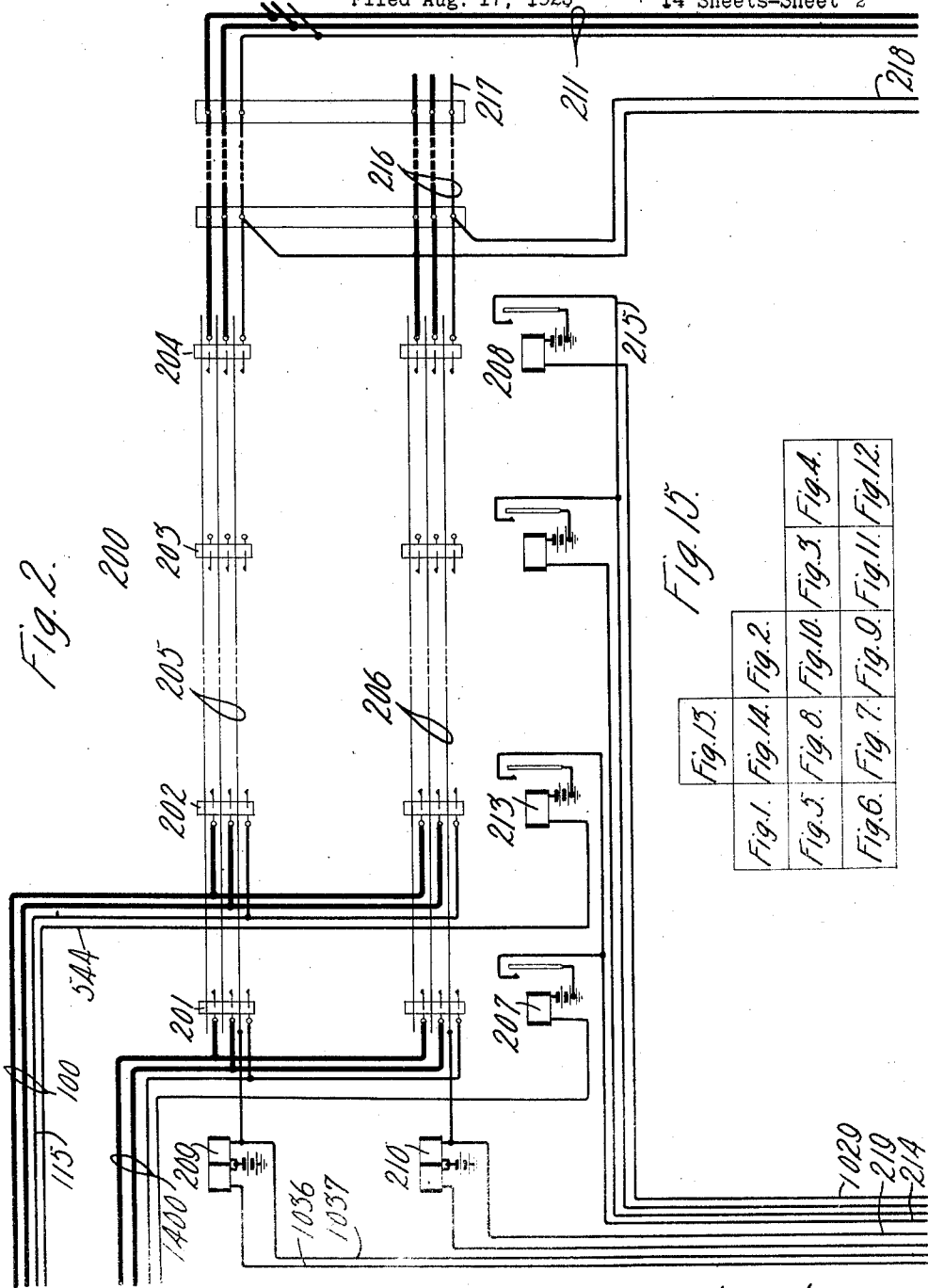


Fig. 13.

<i>Fig. 1.</i>	<i>Fig. 14.</i>	<i>Fig. 2.</i>
<i>Fig. 5.</i>	<i>Fig. 8.</i>	<i>Fig. 10.</i>
<i>Fig. 6.</i>	<i>Fig. 7.</i>	<i>Fig. 9.</i>

Fig. 15.

<i>Fig. 3.</i>	<i>Fig. 4.</i>
<i>Fig. 11.</i>	<i>Fig. 12.</i>

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14 Sheets-Sheet 3

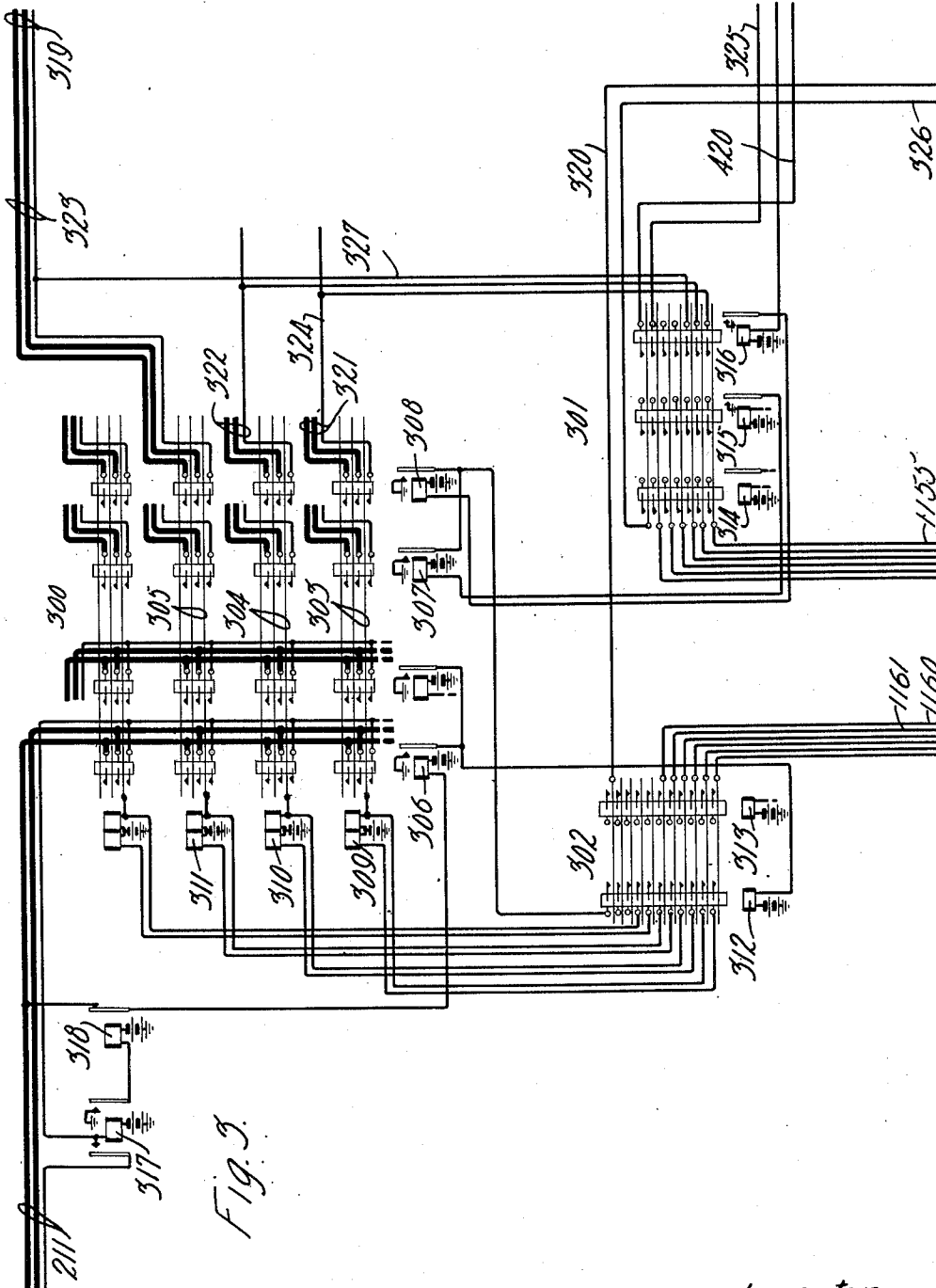


Fig. 3.

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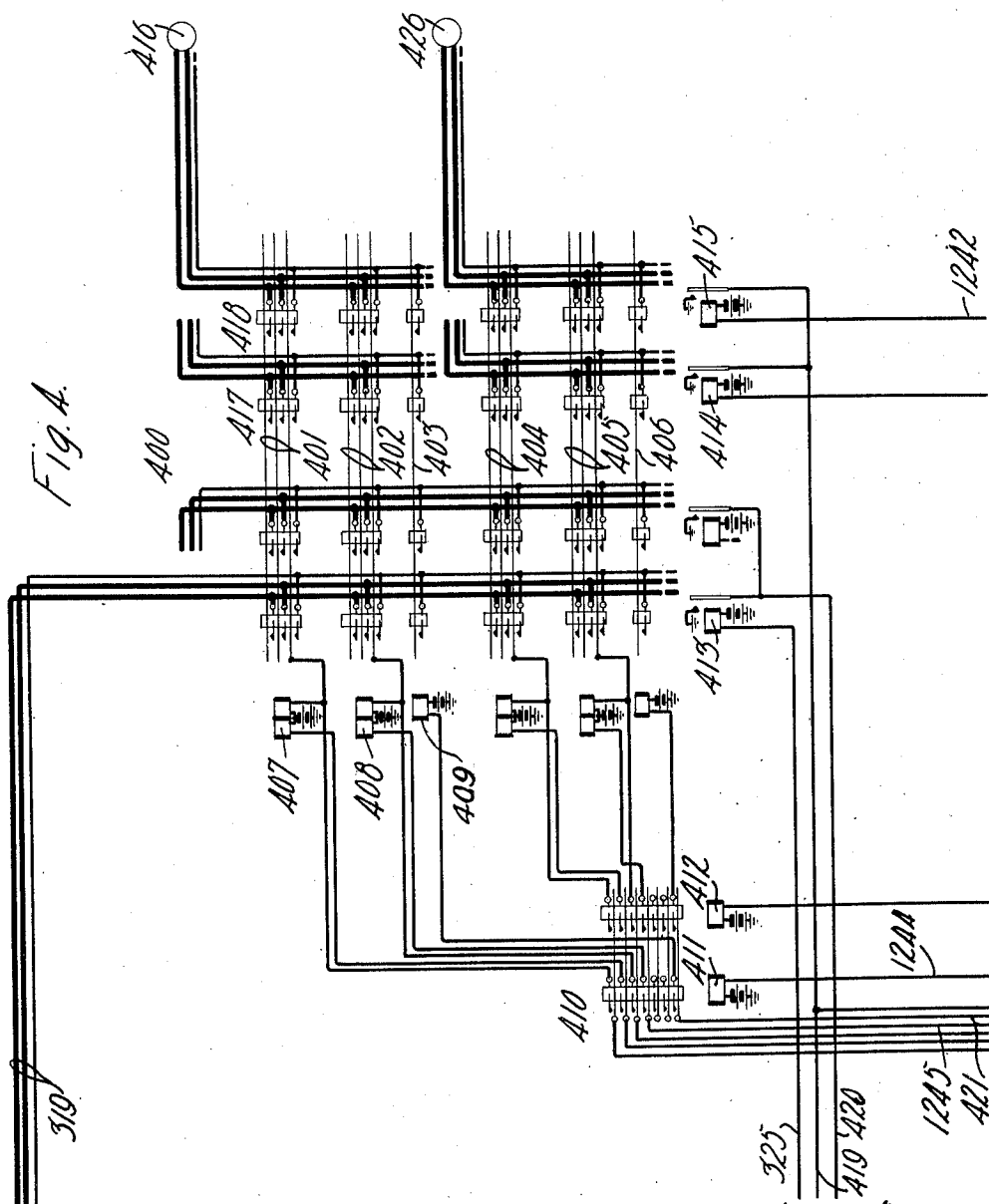
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14 Sheets-Sheet 4



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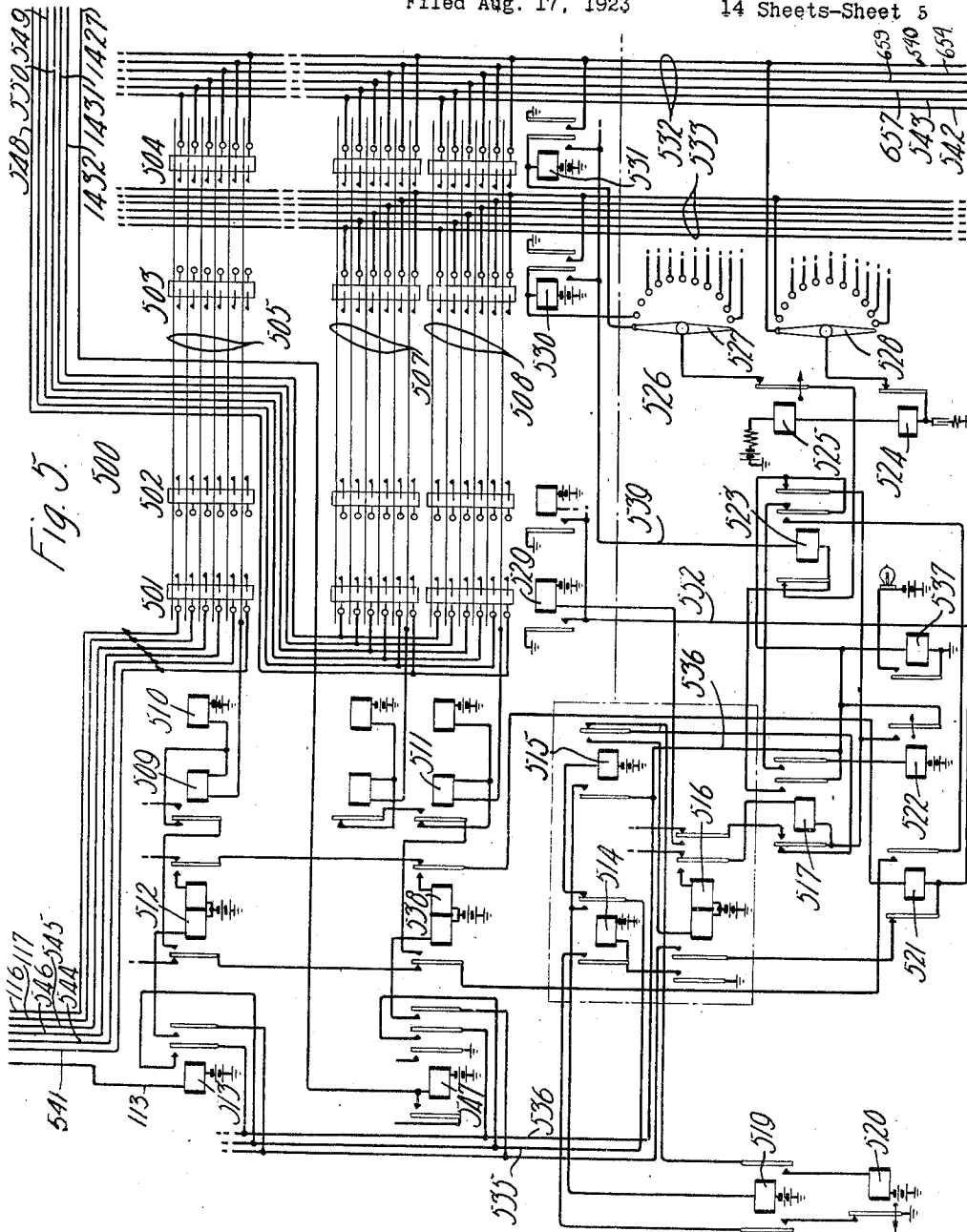
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TELEPHONE EXCHANGE SYSTEM

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14 Sheets-Sheet 5



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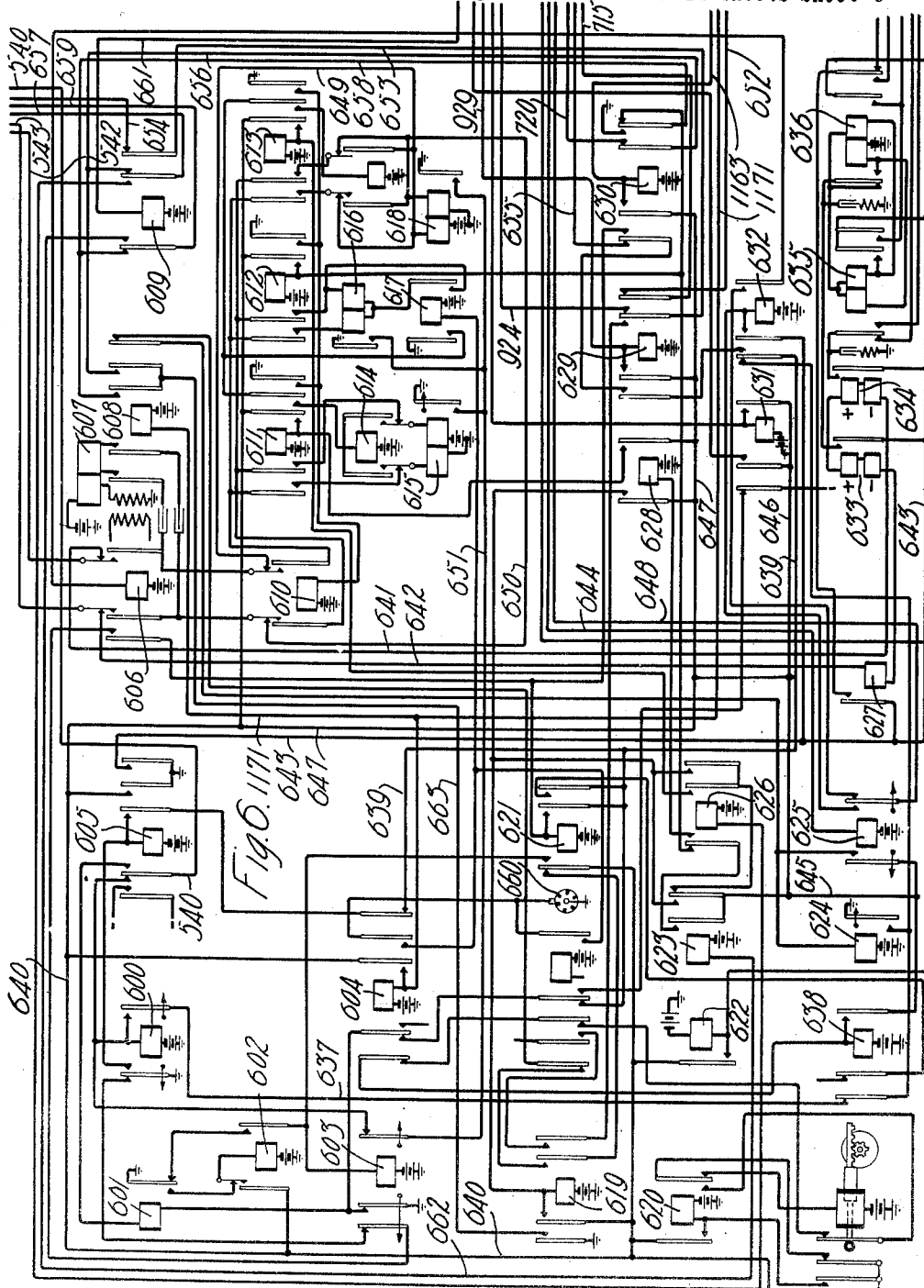
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14 Sheets-Sheet 6



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TELEPHONE EXCHANGE SYSTEM

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14 Sheets-Sheet 7

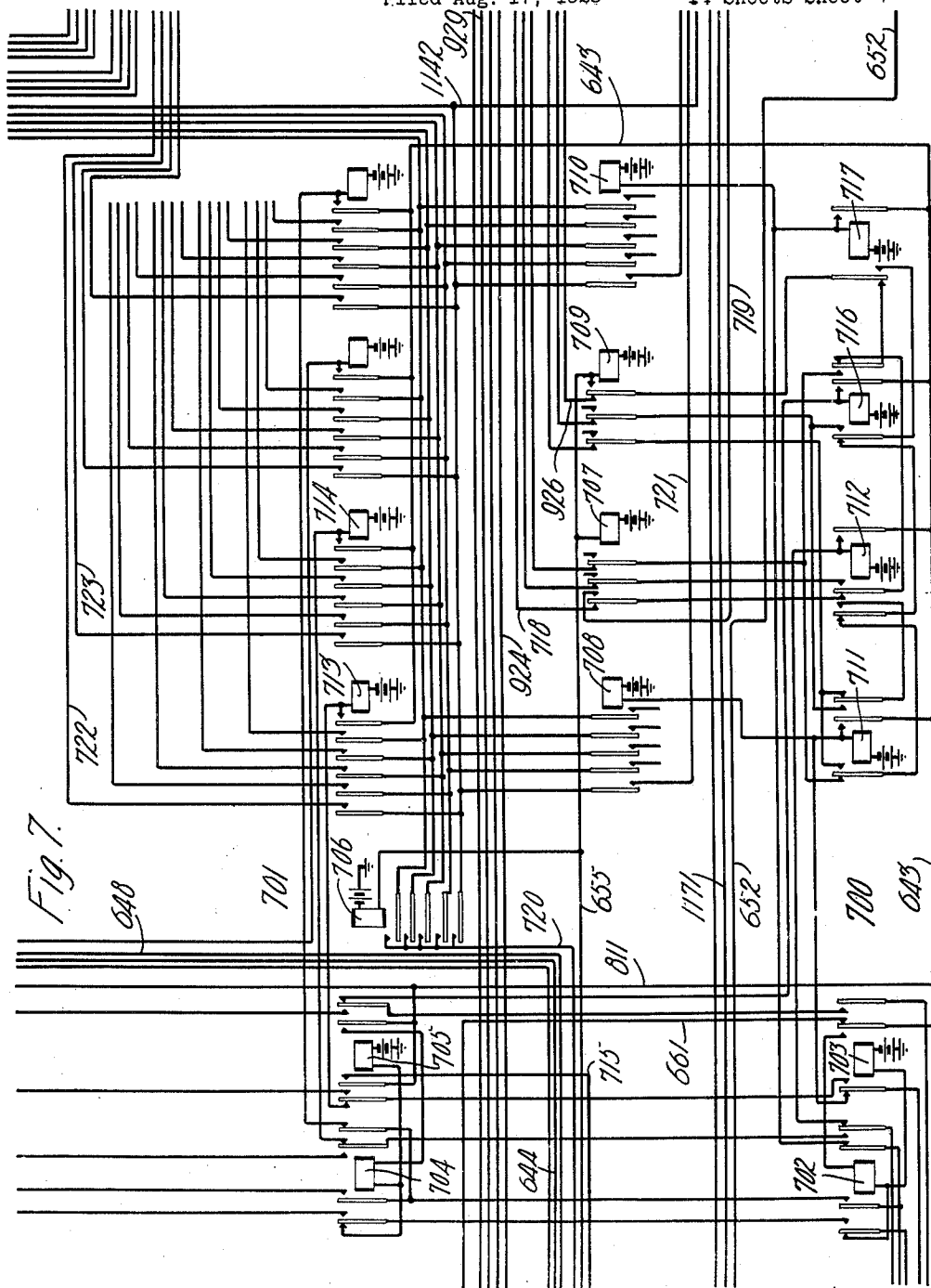


Fig. 7.

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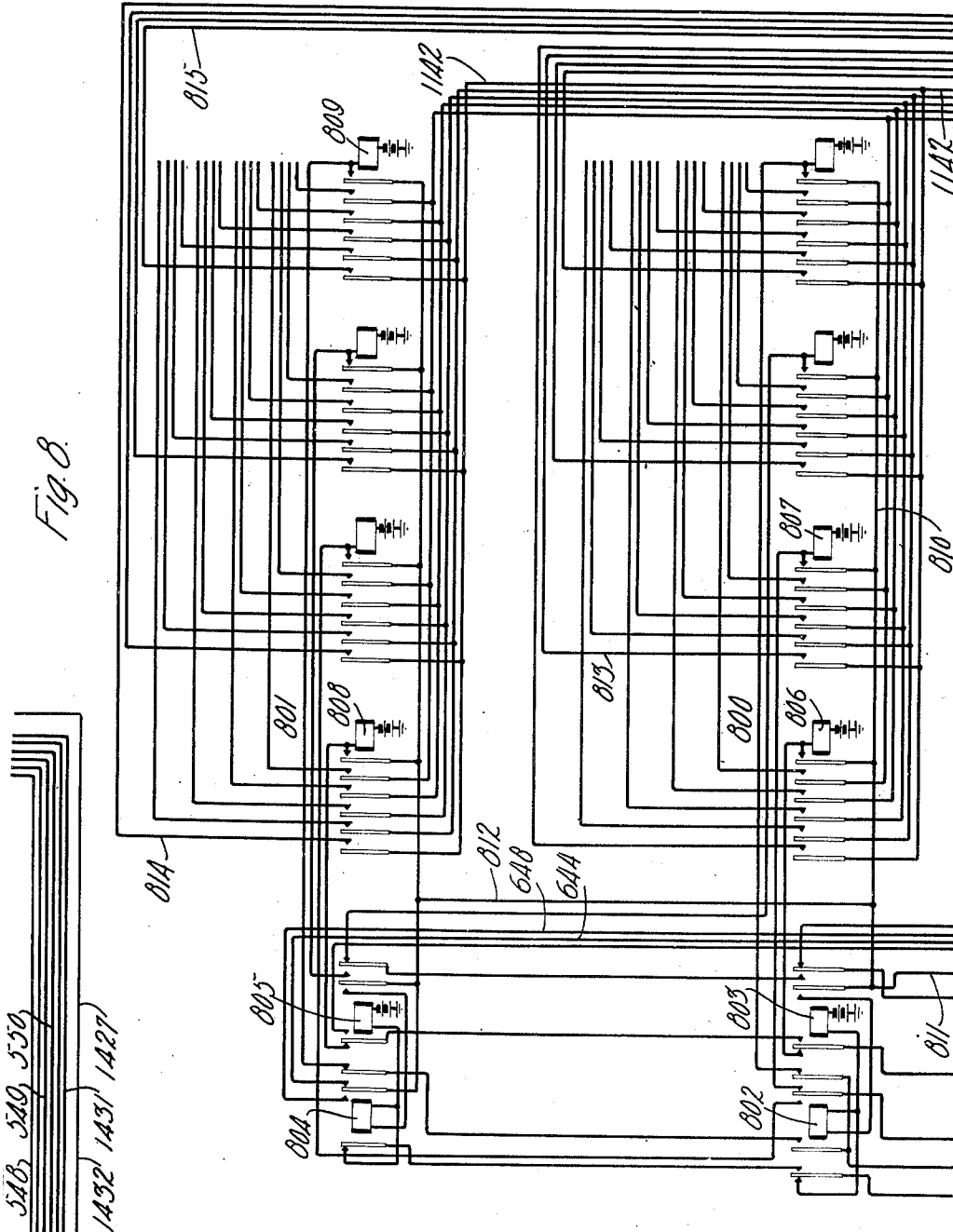
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14 Sheets-Sheet 8



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TELEPHONE EXCHANGE SYSTEM

Filed Aug. 17, 1923

14 Sheets-Sheet 9

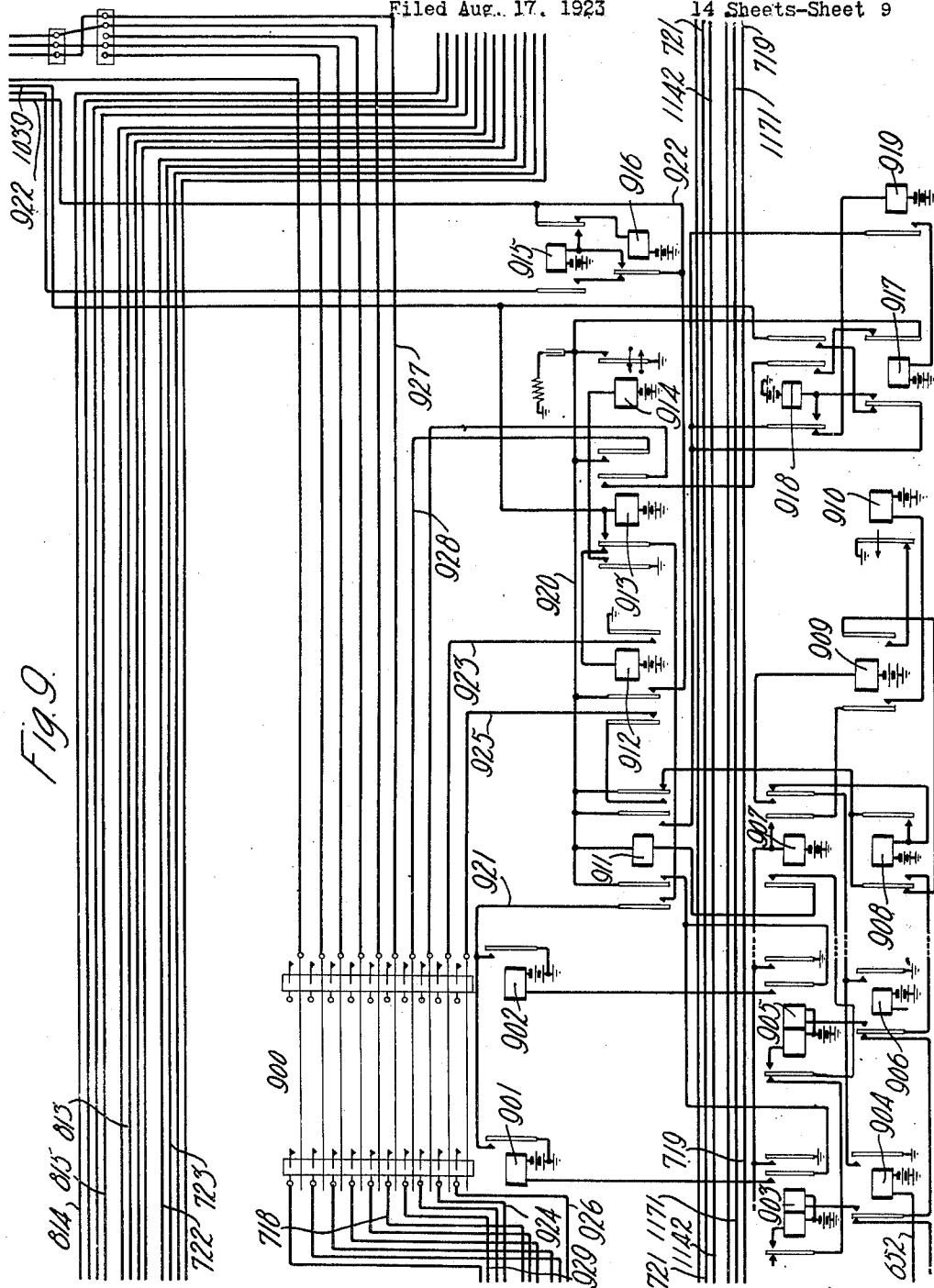


Fig. 9.

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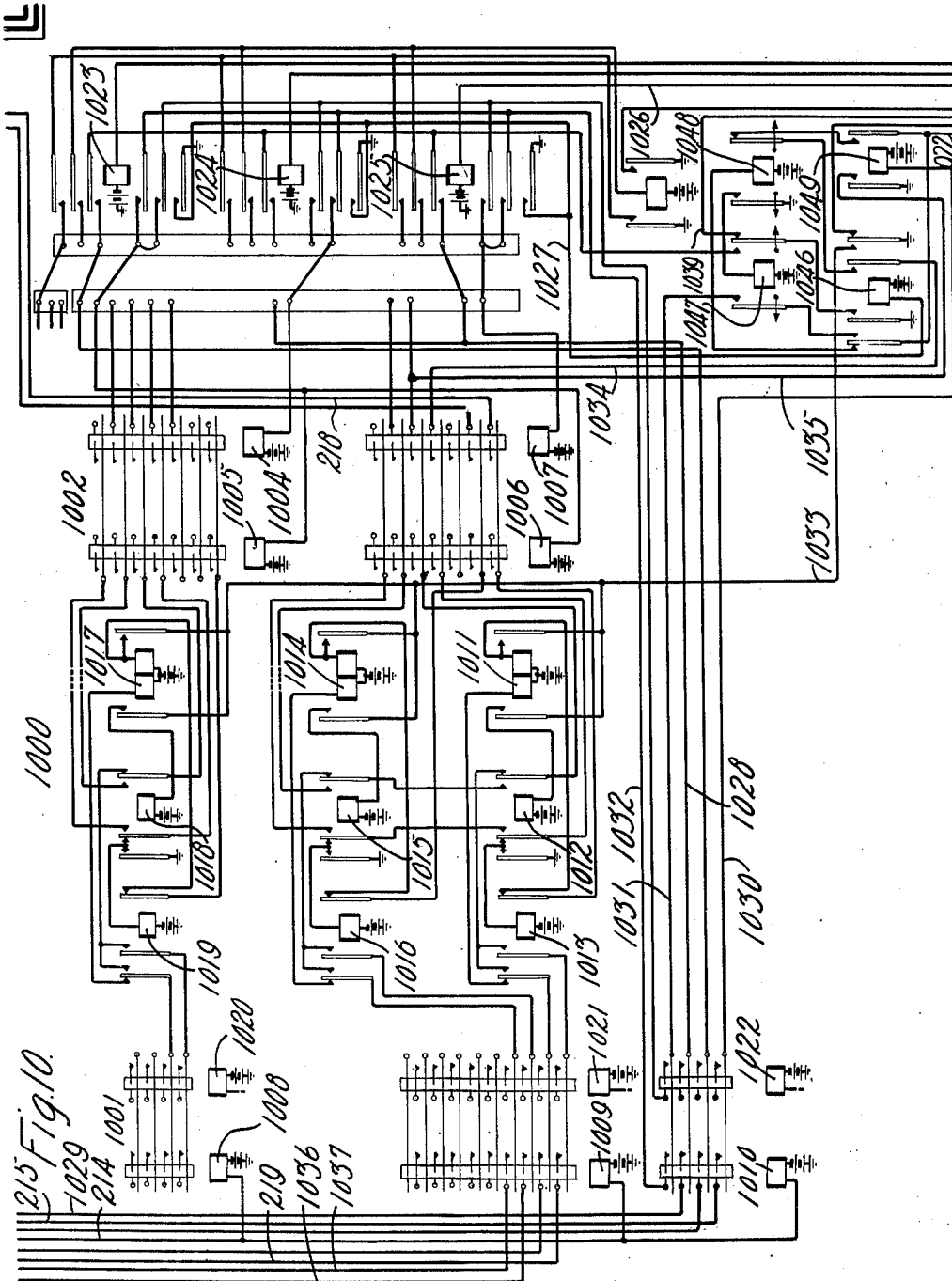
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Filed Aug. 17, 1923

14 Sheets-Sheet 10



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TELEPHONE EXCHANGE SYSTEM

Filed Aug. 17, 1923

14 Sheets-Sheet 11

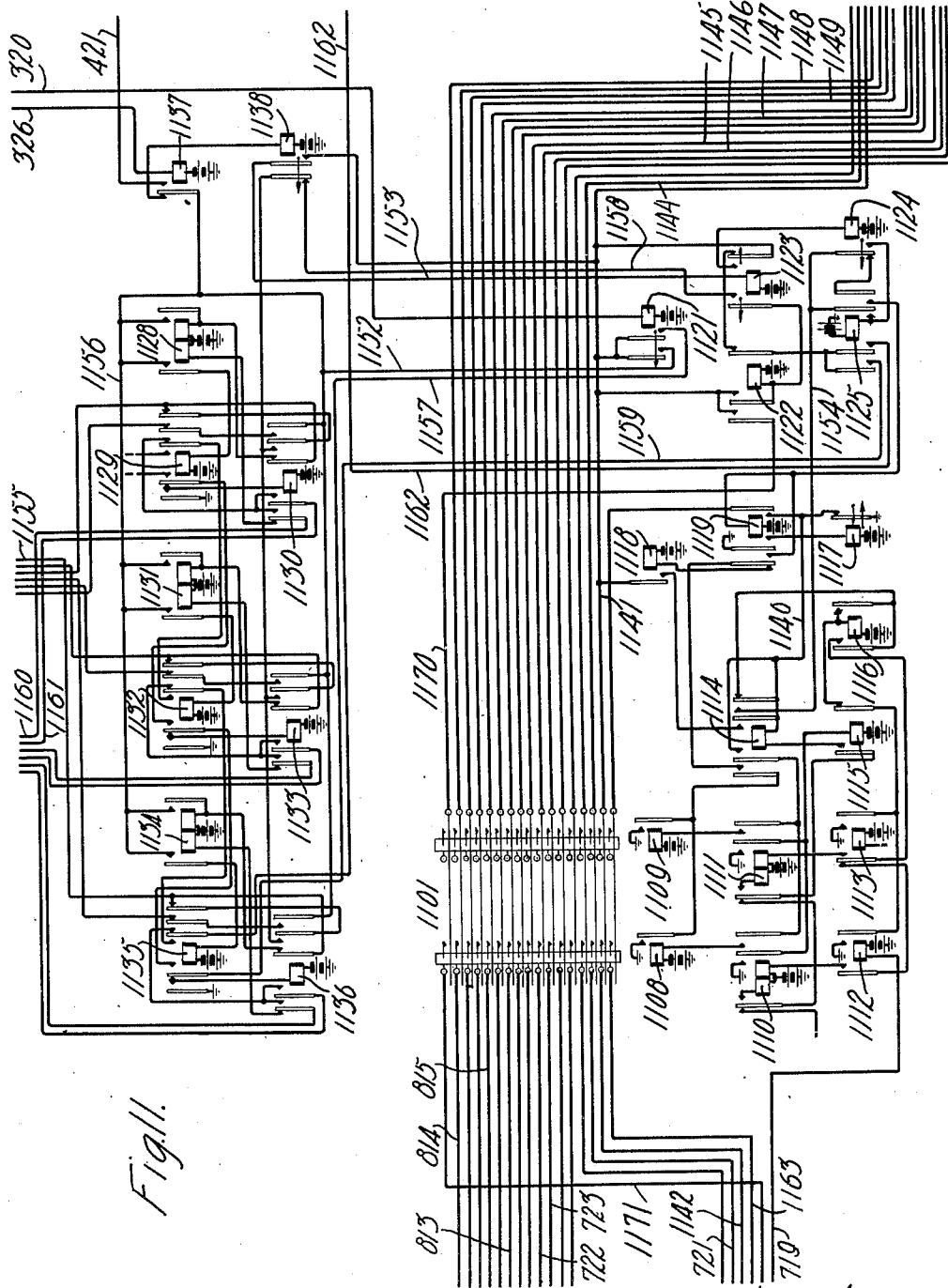


Fig. 11.

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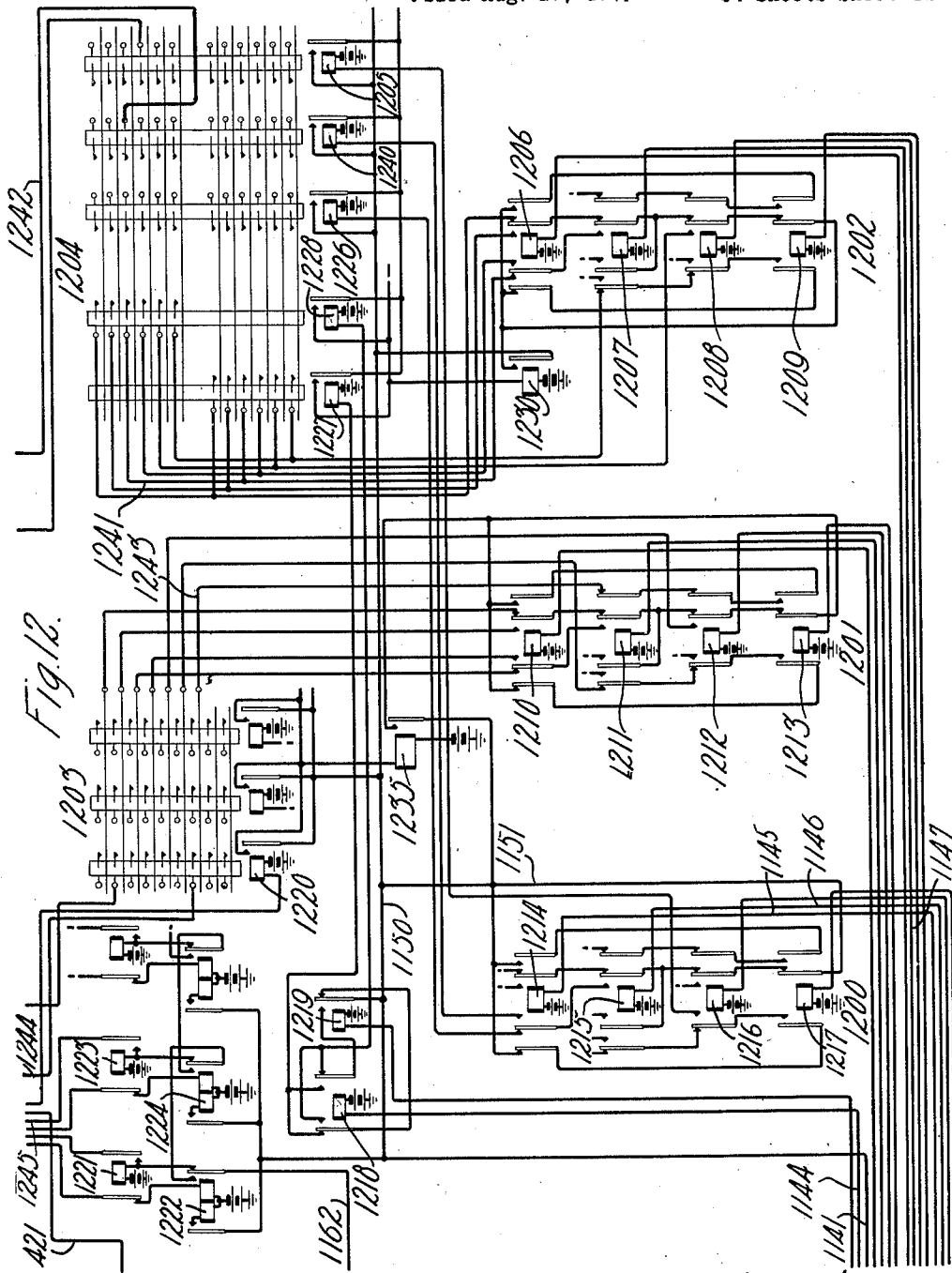
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Filed Aug. 17, 1923

14 Sheets-Sheet 12



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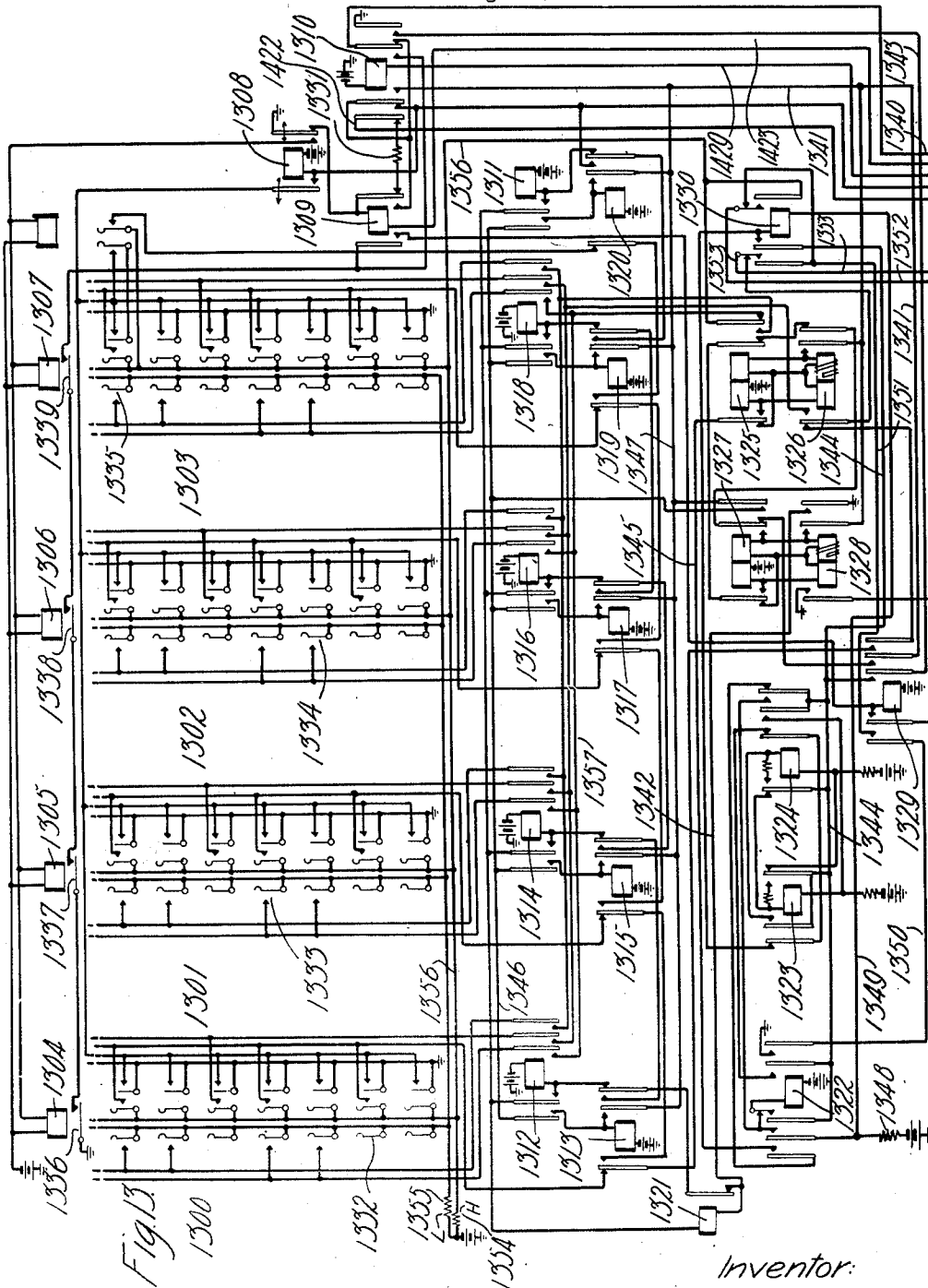
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S. B. WILLIAMS

TELEPHONE EXCHANGE SYSTEM

Filed Aug. 17, 1923

14 Sheets-Sheet 13



Inventor:
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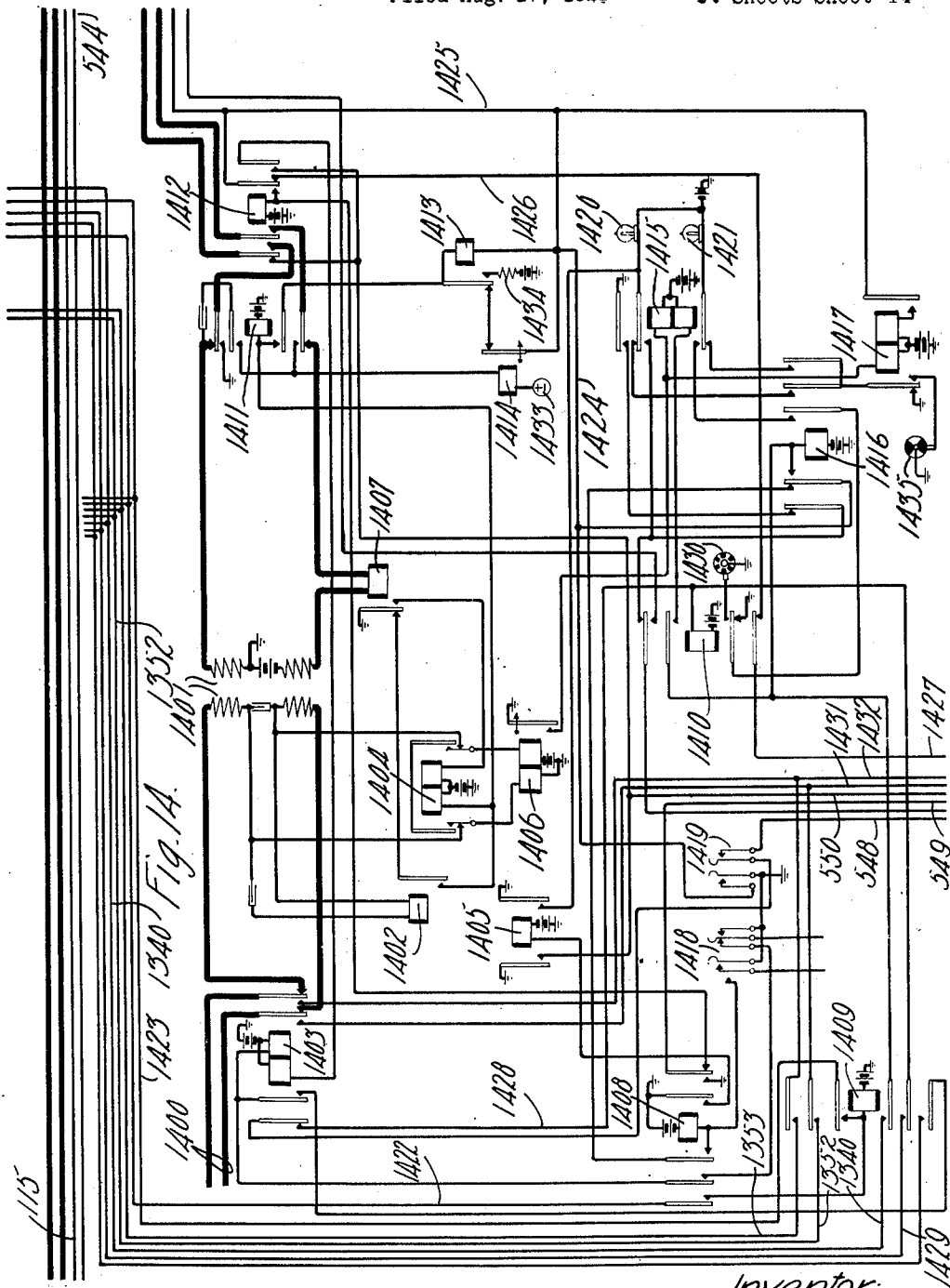
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TELEPHONE EXCHANGE SYSTEM

Filed Aug. 17, 1923

14 Sheets-Sheet 14



Inventor:
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UNITED STATES PATENT OFFICE.

SAMUEL B. WILLIAMS, OF BROOKLYN, NEW YORK, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed August 17, 1923. Serial No. 657,839.

To all whom it may concern:

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

10 This invention relates to telephone exchange systems and more particularly to systems involving machine switching apparatus for the establishment of conversational connections.

15 The object of this invention is an improved telephone system wherein the selective switches, which serve to establish connections of different classes, are under the control of the same selection controlling mechanism.

20 A feature of the invention relates to a system wherein calls extended automatically and calls extended by operators are further extended by automatic switches under the control of a register sender mechanism which may receive its records either over the automatically extended connections or from the operator's positions.

25 Another feature relates to a register controlling sender which is adapted to receive code impulses sent either from another register sender or from an operator's position for the purpose of controlling selective switches.

30 A further feature relates to a system having incoming trunks from automatic offices and trunks from operators' positions and a sender selector for associating senders with any of these trunks, together with means for sending records either over the incoming trunks from the automatic offices or from the operators' positions through said sender selector to the senders.

35 Other features and advantages contemplated by the invention will be taken up in detail hereinafter and pointed out in the appended claims.

40 Considering the drawing, Figs. 1 to 14, inclusive, taken in the order illustrated in Fig. 15 disclose the details of a telephone system incorporating the features of the present invention.

Fig. 1 shows a trunk circuit incoming to

the central office from a distant mechanical office.

Fig. 2 illustrates an incoming selector switch of the coordinate type in which terminate trunks incoming from the mechanical office.

Fig. 3 shows a second group selector switch to which connections are extended from the incoming switch in Fig. 2.

Fig. 4 illustrates a final or connector switch of the coordinate type employed for completing connections to the called subscribers' lines.

Fig. 5 shows a coordinate sender selector switch serving to extend the incoming trunks into connection with one of the number of register sender mechanisms.

Figs. 6, 7 and 8 illustrate details of one of the register senders. Figs. 7 and 8 constitute the relay registers of the sender upon which the designation records are established.

Fig. 9 shows a sender connector, device consisting of multicontact relays for associating the senders with the incoming marker together with certain control relays.

Fig. 10 shows the incoming marker mechanism which controls a plurality of incoming selectors to which it is common and associable.

In the lower part of Fig. 11 there is illustrated a multicontact relay sender connector device for connecting the senders with the line marker.

In the remainder of Fig. 11 and in Fig. 12 there is shown the line marker which is associable with the group selectors and connectors of Figs. 3 and 4 for controlling these switches to complete connections.

Fig. 13 discloses an operator's keyboard and impulse sending mechanism located in the same office with the switches shown in Figs. 2, 3 and 4.

Fig. 14 shows a trunk circuit incoming to the operator's position from a distant office which trunk terminates in the incoming selector switch of Fig. 2 together with the other trunks incoming from the distant mechanical offices.

There is disclosed in the drawings illustrating this invention a terminating central office to which connections of different types are extended for completion to called sub-

scribers' lines therein. This office is arranged to cooperate with distant full mechanical offices, one of which is illustrated diagrammatically at the left of Fig. 1. The connections after being extended from the mechanical office by means of automatic switches to the terminating office here represented appear first in incoming selector switches shown in Fig. 2. Following the extension of the connection to the incoming selector switch an idle register sender is associated with the incoming trunk and receives the record by means of code impulses which are transmitted over the incoming trunk from the automatic sending mechanism in the distant mechanical office.

After the record is established on the sender the markers are attached to the sender in the proper order and control the switches in the terminating office to complete the connection to the desired line.

Calls of another type handled by the terminating office are those originating in distant manual offices, for instance, and destined for some subscriber's line in the terminating office which can only be reached through the medium of the automatic selector switches. To attend to this type of service the terminating office is equipped with cordless operators' positions at which keyboards are installed for setting up the records pertaining to the called lines.

The incoming trunks from the manual originating offices terminate in any suitable manner in the same incoming automatic switches with the trunks above mentioned which arrive from the mechanical offices. These incoming trunks are under the control and supervision of the cordless operators, whose duty it is to make the necessary assignments orally to the distant operators and bring about release at the proper times. The cordless operators, on receiving the designations orally, set them up on a keyboard with the result that these records are transferred by code impulses from the operator's position to the same register senders which are employed in connection with calls originated or extended from the full mechanical offices.

According to the foregoing outline of the arrangement of the apparatus in the terminating office a number of register sender mechanisms and marker controlling devices are placed at the universal disposal of connections of a full mechanical nature and also of connections which are partially established through the medium of operators. Another desirable advantage is that with the particular type of switching medium employed for completing the connections in the terminating office, the varying types of incoming trunks, including those from mechanical offices and those from manual offices, are distributed in the same switching mechanism

and are extended therethrough and through the same succeeding switches into connection with the wanted lines. Furthermore, these incoming trunks are all associated through the same selecting apparatus to any of the common sender controlling mechanisms.

General description of the system and apparatus.

The selective switches including the incoming selectors 200, group selectors 300, connectors 400, sender selectors 500 and the other selector switches employed in this system are of the coordinate type such as shown and described in the patent to S. B. Williams No. 1,517,331, issued December 2, 1924.

The trunk 100 incoming from the mechanical office to the terminating office appears in the vertical row of contacts 202 of the incoming selector switch 200 and has access to all horizontal links 205, 206, etc. This incoming selector is shown in schematic form, only a limited number of the vertical rows of contacts and a limited number of the horizontal links being illustrated. It should be understood, of course, that this switch may have any desired capacity. The incoming trunk 1400 from the distant manual office also appears in the same incoming switch 200 in the vertical row of contacts 201, likewise, having access to all horizontal links. In a similar manner other trunks incoming from different offices would appear in this and other equivalent incoming selector switches.

The incoming selector switch 200 also has a plurality of groups of outgoing trunks appearing in rows 203, 204, etc. Each outgoing trunk is shown having an appearance before a single horizontal link such as the links 205, 206. These trunks are multiplied in order to appear before corresponding horizontal links in all of the remaining incoming selector switches controlled by the same marker mechanism. The trunks outgoing from the incoming selector switch are distributed among the different group selectors 300, one of these trunks 211 being shown in full.

A convenient manner of arranging the group selector and connector switches is to make a division of the exchange into terminal line groups. For a ten thousand line office each terminal line group, for example, would have access to two thousand different lines and would comprise a number of group selector and connector switches 300 and 400 and a single controlling line marker common to all of these switches. Each of the remaining four terminal line groups would likewise comprise a proper number of group selector and connector switches and a line marker for controlling said switches. According to this plan the trunks outgoing

from the incoming switches 200 would be distributed among the group selectors 300 in each of the five terminal line groups in order that any one of the ten thousand lines might be accessible.

Considering the terminal line group, the group selectors 300 are equipped with a number of groups of outgoing trunks which lead to the various connector switches 400 of that particular group. One such trunk 319 is illustrated in full.

The called subscribers' lines appear in the connector switches in groups. For instance, each of the vertical rows 417 and 418 represents a group of subscribers' lines. Each line is accessible over a group of horizontal links. The line 416 appears in the group occupying the vertical row 418 and is accessible by a group of links, two of which 401 and 402 are shown. A second line 426 in the same group is accessible to another group of horizontal links 404 and 405. Similarly, other lines in the same row (not shown in the disclosure) would be accessible to other groups of horizontal links. Each group of horizontal links is provided with a common test link for the purpose of testing the condition of the called lines to which that group of links has access. The common test link 403 serves with respect to the group of horizontal links containing the links 401 and 402. The link 406 likewise is common to the second group of horizontal links shown. As will be seen hereinafter, these test links are only operated for a brief interval at the proper time when conditions are favorable to make a test of the called subscriber's line.

The incoming marker shown in Fig. 10 includes a series of testing relays 1000 which serve to test the horizontal links in any of the incoming selector switches to which this marker is common and also to test the outgoing trunks which have access to those horizontal links. The connecting device 1002 which comprises a number of multicontact relays 1004, 1005, 1006, 1007, etc. serves to connect the set of test relays 1000 with the proper group of outgoing trunks, the multicontact relays each being individual to a different group. Also a connecting device 1001 consisting of multicontact relays 1008, 1009, 1010, 1020, 1021, 1022, etc. serves to connect the marker testing relays with the individual incoming switches. Relays 1008, 1009, and 1010, for instance, are individual to the particular incoming switch 200 illustrated in the drawing. Similarly, relays 1020, 1021 and 1022 are individual to a second incoming switch (not shown).

The line marker shown in Figs. 11 and 12 includes a plurality of registers 1200, 1201, and 1202 which receive numerical records from the controlling sender. It also includes the multicontact relay translating

device 1204 which is operated according to the settings of the registers to select the magnets 414, 415 individual to the different vertical rows of outgoing lines in the connector switches. Moreover the line marker includes a multicontact relay translating device 1203 which operates to associate the register 1201 with a connecting device 410 individual to the proper connector switch 400. The device 410 consisting of relays 411, 412, etc. serves to associate certain test relays with the horizontal links of the group having access to the called lines of the desired units designation. In Fig. 11 a set of testing relays of the marker are shown and these relays are associable through the multicontact relay connecting device 301 and 302 with the groups of trunks outgoing from the selector switch 400 and other switches and also with the horizontal links of these group selectors.

The sender selector switches 500 comprise a plurality of rows of contacts 501, 502, etc. together with horizontal links 505, 507 and 508. These horizontal links are arranged in groups, one group being represented by the single link 505 and another group being illustrated by the two links 507 and 508. The trunks incoming from the distant offices each appear in the sender selector switches as illustrated. The trunk 100, for instance, incoming from the mechanical office appears in the vertical row 501 and before all horizontal links belonging to the particular group which contains the link 505. The trunk 1400 incoming from the distant manual office also appears in the vertical row 501 and before all horizontal links of the group containing the links 507 and 508. In any similar and suitable fashion other trunks incoming may be distributed to appear in the different groups of horizontal links at the sender selector and at other sender selector switches.

In addition the sender selector 500 has a number of rows of contacts 503, 504, etc., in each of which appears a circuit leading to a register sender. The circuit 532, for instance, represents the register sender shown in full in Figs. 6, 7 and 8 and appears in the vertical row 504 and has access to all horizontal links in all groups. A second circuit 533 is illustrated which leads to another register sender (not shown in the drawing) and appears in the vertical row 503 of the sender selector switch. The step-by-step switch 526 associated with the sender selector serves for the purpose of allotting the different senders for use in succession according to whether they are busy or idle.

The operator's position illustrated in Figs. 13 and 14 is equipped with a number of sets of keys 1300, 1301, 1302 and 1303 for recording the four digits of the called subscriber's number. Moreover, the position is equipped with certain impulse generating

mechanism whereby code impulses are originated in accordance with the record on the keyboard and transmitted through the sender selector switch 500 to the associated register sender in order to record upon such sender the registration of the wanted number. The operator's keyboard is further provided with assignment and release keys for each trunk incoming to her position from a distant manual operator. The assignment key 1418 and the release key 1419 are individual to the particular trunk 1400 shown.

Detailed description of the system—establishment of a full mechanical connection.

Consider that a connection is extended from a distant mechanical office illustrated at the left of Fig. 1 over a trunk 100 to the terminating office. Assume, also that the party originating this call desires to converse with the subscriber of line 416 in the terminating office and that the number of this called line is 1 3 2 6. In any well-known manner the connection is extended over automatic switches such as the switch 110 in the originating mechanical office by way of the interoffice trunk 100 to the incoming selector switch 200 in the terminating office. Upon the extension of the connection over the trunk 100 a circuit is closed from battery, through the left-hand winding of relay 104, left normal contact of relay 103, upper left winding of repeating coil 101, outer right back contact of relay 102, thence over the tip of the trunk 100, through a closed bridge at the mechanical office and returning over the ring of trunk 100, inner right back contact of relay 102, lower left-hand winding of coil 101, right normal contact of relay 103, right-hand winding of relay 104 to ground. Relay 104 operates and closes a circuit from ground through its contact through the winding of relay 107. Relay 107 closes a circuit from ground over conductor 115, back contact of relay 106, conductor 114, inner left back contact of relay 102, winding of relay 513 to battery.

Relay 513 operates and a circuit is completed from battery through the winding of relay 515, right back contact of relay 514, conductor 535, inner right contact of relay 513, conductor 536, winding of relay 537 to ground.

Relays 514, 515 and 516 enclosed within the broken rectangle pertain to the vertical group of contacts in the row 501 in the switch 500. These relays are brought into action whenever one of the trunks appearing in this row is seeking to be attached to one of the register senders.

Relay 515 completes a circuit from battery through the winding of relay 519, left contact of relay 515, conductor 536, to ground through the winding of relay 537. Relay

515 also closes a circuit from battery through the left-hand winding of relay 516, right front contact of relay 515, left back contact of relay 517, outer right contact of relay 523 to ground through the winding of relay 537. Relay 516 at its outer left contact closes a circuit for relay 514. Relay 514 locks in a circuit through its winding and left contact, left front contact of relay 519 to ground at the contact of slow release relay 520. Relay 516 also closes a circuit from battery through its right winding and right contact, winding of relay 517, outer right contact of relay 523 to ground through the winding of relay 537. Relay 517 operates and closes a circuit from battery through the winding of slow-to-release relay 522, outer right contact of relay 517, inner right back contact of relay 523 to ground through the winding of relay 537. Relay 522 closes a substitute holding circuit for relays 516 and 517 independent of the relay 523.

With relay 517 operated a circuit is closed from battery through the winding of the vertical operating magnet 529, outer right front contact of relay 516, left front contact of relay 517, outer right contact of relay 523 to ground through the winding of relay 537. The magnet 529 operates and prepares the contacts of the vertical row 501. Magnet 529 also closes a circuit from ground through its contact, conductor 552, left contact of relay 521, inner left contact of relay 516, outer right contact of relay 513, left-hand winding of relay 512 to battery. Relay 512 is a group relay individual to the group of horizontal links including the link 505. Similarly, relay 538 is a group relay individual to the group of links containing the links 507 and 508.

Relay 512 operates and closes a circuit from battery through its right-hand winding and right contact, right back contact of relay 538, assuming the relay 538 to be de-energized at this time, winding of relay 521, conductor 552, to ground, at the contact of magnet 529. Relay 521 operates in this circuit.

Another circuit is closed from battery through the winding of the vertical operating magnet 531, brush 527 of the allotter 526, contact of slow release relay 525, left contact of relay 523, inner right contact of relay 517 to ground through the winding of relay 537. It is assumed that the first sender, to which the circuit 532 leads, is idle and that the allotter switch 526 is standing in a position to allot this particular sender as shown in the drawing. The allotter switch 526 has a position for each of the several senders appearing in the sender selector switch 500. Consequently, the vertical operating magnet 531 relative to the idle sender operates and prepares the contacts in the vertical row 504. Magnet 531,

in operating, completes a circuit from battery through its winding and inner contact, conductor 539, winding of relay 523, inner right contact of relay 517 to ground through
 5 the winding of relay 537. Relay 523, however, being shunted by the circuit above traced does not operate at this time. Magnet 531, furthermore, closes a circuit from
 10 ground through its outer contact, conductor 540, brush 528 of the allotter switch, contact and winding of the stepping magnet 524, through the winding of relay 525 to battery. The magnet 524 operates, interrupts
 15 its own circuit and advances the brushes 527 and 528 to the next set of terminals. If the following sender is idle, the allotter switch comes to rest, but if it is busy the switch continues until an idle sender is found. When the switch leaves the position
 20 shown, it opens the shunt around the relay 523 and this relay operates in series with magnet 531. The relay 523 opens the circuit of relay 522 which commences to de-energize. The relay 522 being slow holds
 25 its armatures for an interval after the operation of relay 523 which is sufficient for certain operations to take place as will be presently described.

During the interval measured by the release of relay 522, a circuit is closed from
 30 ground through the winding of relay 537, inner right front contact of relay 523, right contact of relay 521, left back contact of relay 538, left front contact of relay 512, back contact of relay 509, winding of the horizontal operating magnet 510, individual
 35 to the link 505, to battery. The magnet 510 operates and effects a connection between the link 505 and the incoming circuit and also between the link and the outgoing circuit 532.

At the time the vertical operating magnet 531 operates a circuit is closed from
 40 ground through the outer contact of said magnet, conductor 540, inner left back contact of relay 605, winding of slow-to-release relay 600 to battery. Relay 600 operates and closes a circuit for relay 605. Relay 600 also locks in a circuit from battery
 45 through its winding and right contact, conductor 637, outer left contact of relay 638, outer left back contact of relay 632, conductor 639, outermost right contact of relay 604, inner right contact of relay 605 to
 50 ground at the left front contact of relay 600.

Immediately that the connection is established through the sender selector switch 500 a circuit is closed from battery to the
 55 winding of the horizontal magnet 510, winding of relay 509, contacts of the switch 500, conductor 540, inner left front contact of relay 605, winding of relay 601 to ground at the inner left contact of relay 603. The
 60 magnet 510 is held energized in this circuit

under the control of the sender after the above traced energizing circuit has been opened. Relay 509, however, being shunted for the time being remains deenergized to
 70 prevent the extension of the start circuit through to the next link in the group.

After the necessary interval has elapsed slow relay 522 releases and in so doing opens the circuit of relays 516 and 517. Relay 517
 75 opens the circuit of relay 523 which releases and opens the original operating circuit through the winding of relay 509 and the winding of magnet 510. Thereupon, relay 509 operates in series with the magnet 510 in the substitute holding circuit. Relay 517 opens the circuit of the vertical
 80 operating magnet 529 and also the circuit of the vertical operating magnet 531. These two magnets release and restore the associated rods to their normal positions. The connection is now held solely by the
 85 maintained energization of the horizontal magnet 510.

At the time the sender selector switch operates, another circuit is completed from the
 90 grounded conductor 540, through contacts of the switch 500 by way of link 505, conductor 541, winding of relay 102 to battery. The relay 102 operates and extends the tip and ring conductors of the incoming trunk
 95 100 through the sender selector switch 500 to the selected idle sender. Relay 102 opens the circuit of relay 104 which releases. Relay 107, however, is now held in a circuit through its winding to ground at the
 100 outer left front contact of relay 102.

The relay 601 which is included in the circuit of conductor 540 for holding the magnet 510 and the relays 509 and 102 operated after the actuation of the sender selector also
 105 becomes energized. The relay 601 closes a circuit for relay 602 and this latter relay operates and locks through its make before break contact, conductor 640 to ground at the middle right contact of relay 605. The
 110 trunk 100 is now extended to the selected idle sender and an impulse circuit is traceable as follows: over the tip conductor of the trunk 100, outer right front contact of relay 102, conductor 116, through contacts
 115 of the selector 500, conductor 542, right normal contact of relay 606, conductor 641, windings of relays 634, 633 and 627, conductor 642, left normal contacts of relay 606, conductor 543, contacts of the switch 500,
 120 conductor 117, inner right front contact of relay 102, and thence over the ring side of the trunk 100 to the mechanical switching office.

At the distant mechanical switching office
 125 illustrated at the left of Fig. 1 there is shown diagrammatically a selector switch 110 by means of which the connection has been extended to the trunk 100 leading to the terminating office. Moreover there is shown in
 130

diagram a sender 111 and a marker 112 for controlling the switches in the originating office. The sender 111 after having cooperated with the marker 112 to extend the connection to the trunk 100 may further become effective to transmit codes of impulses from the mechanical office over the trunk 100 to the sender at the incoming office for the purpose of setting up a record on the registers shown in Figs. 7 and 8. For a more detailed description of the method in which the switches at the distant mechanical office may be positioned and the method in which the code impulses are created and transmitted by the controlling mechanism in said office, reference is made to the patent to S. B. Williams, No. 1,517,331, issued Dec. 2, 1924. The operation of the relay 102 on extending the trunk 100 through to the sender to complete the impulse circuit above traced may be disconnected the windings of relay 104 from said trunk serve as a signal to the mechanical office that the apparatus at the incoming office is in condition to receive the code impulses from the sender mechanism 111. Hence the equipment is in condition for transmitting code impulses over the line circuit for setting the registers in Figs. 7 and 8.

The code impulses are sent over a full metallic circuit comprising both the tip and ring side of the line in series. These impulses may be of either positive or negative polarities dependent upon the pole of battery that is connected to a given side of the line circuit. They may also be weak or strong dependent upon whether a high or low resistance is included in the circuit. The relay 634 at the incoming office is polarized in such a manner as to respond only when current of positive polarity flows over the ring side of the line; that is, over the conductor 543 and conductor 642. The relay 633 is polarized in such a manner as to respond to current of the opposite polarity. Both relays 634 and 633 respond to strong or weak impulses provided the polarity is proper. Relay 627 responds to strong impulses of either positive or negative polarity, but being marginal will not operate on weak impulses.

Since the number of the called subscriber's line is 1 3 2 6, the sender 111 at the distant office transmits a number of codes of impulses representing this number. For the first digit 1 it transmits a code as follows: first a weak positive impulse, second a weak negative impulse, third no impulse and fourth a weak negative impulse. The second digit 3 is represented by a weak positive impulse, a heavy negative impulse, no impulse, and a weak negative impulse. The third digit 2 is represented by a code beginning with no impulse and followed by a heavy negative impulse, then by a period

in which no impulse is sent and, lastly, by a weak negative impulse. The last digit 6 is represented by a weak positive impulse, a weak negative impulse, no impulse and a strong negative impulse. The manner in which these impulses are created and transmitted is fully explained in the patent to S. B. Williams No. 1,517,331.

In response to the first which is a weak positive impulse, the polarized relay 634 operates and relays 633 and 627 remain inert. Relay 634 completes a circuit from ground through the outer right contact of relay 605, conductor 643, contact of relay 634, left back contact of relay 635, left back contact of relay 703, winding of register relay 711 to battery. Relay 711 operates and locks to the grounded conductor 643. Relay 633 responds to the next impulse which is negative and a circuit is closed from ground over conductor 643 through the contact of relay 633, left back contact of relay 636, left-hand winding of relay 635, left-hand winding of relay 636 to battery. Relay 635 operates in this circuit but relay 636 being marginal does not become energized. Relay 635 completes a circuit from battery through the left-hand winding of relay 636, left-hand winding of relay 635, right-hand winding of relay 636, inner right contact of relay 635 to grounded conductor 643. Although the right-hand winding of relay 636 is included in this circuit, it is shunted by the circuit previously traced and, therefore, relay 636 still remains deenergized. Relay 635, in operating, completes a circuit from ground over conductor 643, outer right contact of relay 635, outer left back contact of relay 702, winding of relay 703 to battery. Relay 703 operates and closes a circuit from battery through its winding and the winding of relay 702, inner right front contact of relay 703 to the grounded conductor 643. Relay 702, however, is shunted by the circuit above traced through the contact of relay 635 and remains deenergized. At the end of the second impulse, relay 633 releases and in so doing removes the shunt from around the winding of relay 636 and this relay operates in series with relay 635. In response to the next and last impulse representing the first digit which is a negative impulse, the relay 633 operates and connects ground potential directly to the left-hand winding of relay 636. This results in shunting the relay 635 which releases its armatures. Relay 635 opens the shunt around the winding of relay 702, but another shunt is maintained around this relay through the inner right contact of relay 636. At the end of the last impulse, relay 633 releases and opens the circuit of relay 636, whereby relay 702 operates in series with relay 703. Thus, for the first digit 1, a code of impulses is transmitted resulting in the

operation of the register relay 711 of the first register 700.

Next a positive impulse is transmitted over the line, the first impulse of the code representing the second digit 3, causing the operation of relay 634. Relay 634 closes a circuit from ground over conductor 643 through its contact and thence through the left back contact of relay 635, left front contact of relay 703, outer left back contact of relay 705, winding of register relay 713 to battery. Relay 713 operates and locks to the grounded conductor 643. In response to the next impulse, which is negative and heavy, relays 633 and 627 operate. Relay 633 causes the operation of relay 635, which in turn, closes a circuit from ground over conductor 643, through the outer right contact of relay 635, outer right front contact of relay 742, outer right contact of relay 704, winding of relay 705 to battery. Relay 705 operates and prepares a holding circuit for itself in series with relay 704, but relay 704 being shunted does not operate. Relay 627, in operating, closes a circuit from ground over conductor 643, thence through the outer right back contact of relay 636, outer right front contact of relay 702, inner right back contact of relay 704, winding of relay 714 to battery. Relay 714 operates and locks to the grounded conductor 643. At the end of this impulse, relay 633 releases and relay 636 operates in series with relay 635.

Finally, a weak negative impulse is transmitted, which is the last impulse of the code representing the second digit, and relay 633 operates shunting the relay 635. At the end of this impulse, relay 633 releases and relay 636 deenergizes to permit relay 704 to operate in series with relay 705. Thus, at the end of the second series, relays 713 and 714 of the register 701 have been energized and locked.

The first impulse representing the third digit 2 being negative and heavy causes the operation of relays 633 and 627. Relay 633 causes the operation of relay 635 which closes the above traced circuit over the outer left front contacts of relays 702 and 704, thence through the outer left back contact of relay 802, winding of relay 803 to battery. Relay 803 operates and prepares a circuit for relay 802, but this latter relay being shunted remains inert. Relay 627, in operating, completes a circuit over conductor 643, through the contact of said relay, outer right back contact of relay 636, outer right front contact of relay 702, inner right front contact of relay 704, inner right back contact of relay 802, winding of relay 807 to battery. Relay 807 operates and locks over conductors 810, 811 and 643 to ground. At the end of this impulse relays 623 and 627 release and relay 636 operates. The last

impulse for the third digit is weak and negative, and consequently, relay 633 operates causing the relay 635 to release. At the end of this impulse relay 633 releases opening the circuit of relay 636, which deenergizes and opens the shunt around the relay 802. Relay 802 operates in series with relay 803 to the grounded conductor 811. Thus, for the third digit the register relay 807 is operated and locked.

The first impulse representing the last digit 6 is positive and causes the operation of relay 634. This relay closes a circuit over grounded conductor 643 through the contact of said relay, left back contact of relay 635, thence through the left front contacts of relays 703, 705 and 803, left back contact of relay 805, winding of register relay 808 to battery. Relay 808 operates and locks over conductors 812 and 811 to ground. The next impulse in order is weak and negative causing the operation of relay 633 and the consequent operation of relay 635. Relay 635 completes a circuit in an obvious manner for relay 805. Relay 805 operates and prepares a circuit for relay 804. This latter relay being shunted remains deenergized. At the end of this negative impulse, relay 633 releases and relay 636 operates. Finally a heavy negative impulse is transmitted causing the operation of relays 633 and 627. Relay 633 shunts the relay 635. Relay 627 closes a circuit from grounded conductor 643 to the contact of relay 627, outer right front contact of relay 636, inner left front contact of relays 702, 704 and 802, outer right back contact of relay 804, winding of relay 809 to battery. Register relay 809 operates and locks to the grounded conductor 812. At the end of the impulse, relays 627 and 633 release, causing the release of relay 636 and the operation of relay 804 in series with relay 805. Thus, in response to the code of impulses representing the last digit, register relays 808 and 809 are operated and locked.

At the time the sender is first seized and relay 605 operates a circuit is closed from battery through the winding of slow-to-release relay 625, conductor 644, inner right back contact of relay 804, conductors 812, 811 and 643 to ground. Relay 625 operates and completes a circuit from battery through the winding of relay 624, left contact of relay 625, conductors 645, 646 and 647 to ground at the middle right contact of relay 605. Relay 624 operates and places a substitute holding ground on conductor 637. After the record has been received as above described and recorded on the registers in Figs. 7 and 8, relay 804 operates and opens the circuit of relay 625. While relay 625 is holding its armatures attracted, however, a circuit is closed from battery, through the winding of relay 632, right front contact of

relay 625, conductor 648, inner right front contact of relay 804 to the grounded conductor 812. Relay 632 operates and locks through its inner left contact to the grounded conductor 643. After an interval relay 625 releases and in so doing opens the holding circuit of relay 624. Before relay 624 can release to open the locking circuit of relay 600, a substitute holding circuit is provided for said relay 600. At the time relay 632 operates a circuit is closed from battery through the winding of relay 606, right contact of relay 632, right back contact of relay 625, conductor 648 and thence as traced to ground over conductor 812. Relay 606 operates and at its continuity contacts extends the tip and ring conductors of the incoming trunk through to the windings of relay 618. This extended circuit may be followed from battery through the left-hand winding of relay 618, conductor 649, normal right contacts of relay 610, right-hand front contact of relay 606, thence over the tip conductor 542 to the distant office and returning over the ring conductor 543, inner left front contact of relay 606, left normal contacts of relay 610, conductor 650, right-hand winding of relay 618 to ground. Relay 618 operates in this circuit and closes a circuit from ground through its contact, conductor 651, right contact of relay 603, winding of slow relay 600 to battery. Thus, the relay 600 and relay 605 are held under the control of the distant office.

The apparatus is now in condition to associate the sender with the incoming marker shown in Fig. 10. As a matter of fact this association takes place immediately that the second digit has been received and recorded on the hundreds register 701. Following the receipt of the second digit a circuit is completed from ground over conductor 643, conductor 811, inner left front contact of relay 705, conductor 715, outer right contact of relay 629, conductor 652, winding of relay 904 to battery. Relay 904 operates and closes a circuit from ground through its right contact, outer right back contact of relay 907, winding of relay 908 to battery. Relay 908 operates and locks through its right contact, outer right back contact of relay 911, conductor 920, contact of relay 914 to ground. Another circuit is closed from battery through the right-hand winding of relay 903, left front contact of relay 904, left back contact of relay 906, left front contact of relay 908, outer right back contact of relay 911 to ground over conductor 920. Relay 903 operates and closes an obvious circuit for relay 907. With relay 907 energized a circuit is closed from battery through the left-hand winding and contact of relay 903, left back contact of relay 905, left contact of relay 907, winding

of relay 911 to the grounded conductor 920. Relay 903 locks and relay 911 operates in this circuit. Relay 911 opens the locking circuit of relay 908. The multicontact relay 901 which is individual to the sender illustrated is energized to extend the conductors from the sender into the marker. The circuit for this relay may be traced from battery through its winding, inner right contact of relay 903, inner left contact of relay 911, conductor 920 to ground. Relay 901, in operating, also closes a circuit from ground through its contact, conductor 921, outer left contact of relay 911, inner left back contact of relay 913, winding of relay 912 to battery.

The connecting device 900 is made up of a plurality of multicontact relays each individual to a different sender. Another of these relays 902 is illustrated together with relays 905 and 906 pertaining thereto.

Relay 912, in operating, completes a circuit from ground over conductor 920, through its inner left contact, conductor 922, outer left back contact of relay 1046, winding of slow release relay 1048 to battery. Relay 1048 operates and closes a circuit for the slow release relay 1047.

At this time a circuit is completed for the vertical operating magnet 213 which controls the row of contacts 202 of the incoming selector switch 200 in which appears the incoming trunk 100. This circuit may be traced from ground through the right contact of relay 912, conductor 923, contacts of relay 901, conductor 924, inner right back contact of relay 629, conductor 653, outer right contact of relay 609, conductor 654, contacts of the switch 500, conductor 544, winding of vertical operating magnet 213 to battery. The magnet 213 operates, rotates the associated rod and prepares all contacts in the vertical row 202. The magnet 213 also completes a circuit from ground through its contact, conductor 214, through the windings of multicontact relays 1008, 1009 and 1010 to battery. These relays which are individual to the switch 200 operate and associate the incoming marker with said switch.

It will be noted that the marker shown in Fig. 10 is provided with a number of relays, three of which 1023, 1024 and 1025 are shown. These relays are individual to groups of trunks appearing in the contacts of the different incoming switches. They are selected in accordance with the registration of the thousands register 700 in the sender in order to determine which group of outgoing trunks is needed for extending the connection through the incoming switch. While only three of these relays are shown it is understood that as many may be provided as are necessary. The relay 1025, for instance, is individual to the group of trunks

containing the trunk 211 appearing in the vertical row 204 of the selector 200 and in corresponding rows of other selectors. This group of trunks is identified by the thousands digit 1 which, it will be recalled, is the digit recorded upon the register 700 of the sender. Therefore the register 700 prepares a circuit for the selection of the group relay 1025 due to fact that relays 712, 716 and 717 are released. This circuit may be traced from ground over conductor 920 to the outer right front contact of relay 911, outer left contact of relay 912, conductor 925, contacts of relay 900, conductor 926, inner back contact of relay 709, left back contact of relay 717, outer right back contact of relay 716, inner left back contact of relay 712, outermost back contact of relay 707, conductor 718, contacts of relay 901, conductor 927, conductor 1026, winding of relay 1025 to battery.

With relay 1025 operated a circuit is closed from ground through the lowermost contact of said relay, conductor 1027, winding of relay 1046 to battery. Relay 1046 operates and opens the circuit of relay 1048, but this latter relay requires an interval in which to release its armatures. Relay 1046 in operating completes a circuit from ground through its inner left contact, right front contact of relay 1047, inner upper contact of relay 1025, conductor 1028, contacts of relay 1010, conductor 1029, winding of the vertical operating magnet 208 to battery. Magnet 208 operates and prepares the contacts in the vertical row 204 representing the selected outgoing group of trunks. Magnet 208 also closes a circuit from ground through its contact, conductor 215, contacts of relay 1010, conductor 1030, winding of relay 1049 to battery. With relay 1046 operated a circuit is completed from ground over conductor 922, outer left front contact of said relay, left contact of relay 1047, conductor 1031, contacts of relay 1010, conductor 1032, middle lower contact of relay 1025, winding of multicontact relay 1007 to battery. Relay 1007 is individual to the group of trunks appearing in the row 204 and series to associate the testing relays of the marker with these trunks.

The equipment is now in condition to make a test of the trunks outgoing from the switch 200 and also of the corresponding horizontal links. For this purpose a series of double wound test relays 1011, 1014, 1017, etc. is provided, each being individual to an outgoing trunk in any group with which the marker may be associated and also associable with the corresponding horizontal links on any incoming switch 200. The relay 1011, for instance is associable with the trunk 216 and if this trunk is busy a circuit is closed from the grounded sleeve conductor 217, thence over conductor 218, contacts of relay

1007, right contact of relay 1013, right-hand winding of relay 1011 to battery. Should the horizontal link 206, which has access to the trunk 216, be busy, a circuit is closed from the grounded sleeve conductor of said link, thence over conductor 219, contacts of relay 1009, outer left back contact of relay 1013, left-hand winding of relay 1011 to battery. Relay 1011 operates when either of its windings is energized or when both are energized simultaneously. Relay 1011, in operating, locks through its right winding and right contact, conductor 1033 to ground at the outer right front contact of relay 1046. Relay 1011 closes a circuit for relay 1012 through the grounded conductor 1033. In this manner the test relays associable with all busy trunks or busy links are operated.

If it is assumed that the next trunk 211 in the group is idle and that the link 205 is also idle, the corresponding test relay 1014 remains deenergized. After an interval the slow relay 1048 becomes deenergized and a circuit is completed from ground over conductor 922, right contact of relay 1049, right contact of relay 1048, inner right contact of relay 1046, conductor 1034, contacts of relay 1007, inner left front contact of relay 1012, inner left back contact of relay 1015, winding of relay 1016 to battery. With relay 1016 operated a circuit is completed from ground through the left contact of relay 1049, conductor 1035, contacts of relay 1007, right front contact of relay 1012, right back contact of relay 1015, left contacts of relay 1016, through contacts of relay 1009, thence over conductors 1036 and 1037, through the left and right-hand windings, respectively of the horizontal operating magnet 209 to battery. Magnet 209 rotates the associated rod and completes the connection through the selector switch 200 whereby the incoming trunk 100 is connected to the link 205 and the link 205 is connected to the outgoing trunk 211 leading to the group selector switch 300. Immediately that the connection is effected a circuit is completed from battery through the right-hand winding of magnet 209, through contacts of the switch 200, over the sleeve conductor 115 of the trunk 100 to ground at the contact of relay 107. The magnet 209 is held energized in this circuit after the incoming marker has released.

After an interval has elapsed following the release of relay 1048, the slow relay 1047 becomes deenergized and opens the circuit of relay 1007. Relay 1047 also opens the circuit of the vertical operating magnet 208, which in turn, releases and opens the circuit of relay 1049. With relay 1047 deenergized a circuit is closed from ground over the inner left contact of relay 1046, right back contact of relay 1047, conductor 1039, winding of release relay 913 to battery.

Relay 913 operates and locks temporarily through its inner left contact and the outer left contact of relay 911 to the conductor 921. Relay 913 at its outer left contact
 5 closes a circuit for the relay 914. Relay 914 is slow to operate and slow to release and, therefore, requires an appreciable interval of time to attract its armature and remove ground from conductor 920. During this
 10 interval a circuit is established from ground over the conductor 920, through the outer right contact of relay 913, conductor 928, contacts of relay 901, conductor 929, winding of relay 629 to battery. Relay 629 operates and locks through its inner left contact
 15 to ground over conductor 647.

After the necessary interval relay 914 operates to remove ground from conductor 920 whereby the operated relays of Fig. 9
 20 become deenergized and the sender is disconnected from the marker and the remaining energized relays in the marker and the vertical operating magnet 207 of the switch 200 are restored to normal.

The next operation to take place is the connection of the line marker shown in Figs. 11 and 12 with the register sender through the medium of the connective device 1101. At the time relay 629 operates a circuit is
 30 closed from ground through the left front contact of relay 600, inner right contact of relay 605, outermost right contact of relay 604, conductor 639, outer left front contact of relay 632, outer left contact of relay 629,
 35 outer left back contact of relay 630, conductor 655, thence in parallel through the windings of relay 706, 707 and 709 to battery.

It was hereinbefore explained that the exchange is divided into five terminal line
 40 groups each serving 2000 lines and each provided with a single line marker. It is, therefore, necessary to determine which one of these terminal line groups is to be taken for use in completing the connection to the called
 45 line. This is done by means of the thousands register 700 upon which is recorded the thousands digit. In the present instance, the digit being 1, that means that the called line occurs in the first group of 2000 lines.
 50 Accordingly, the setting of the thousands register 700 will determine that the line marker pertaining to the first terminal line group shall be taken into use. Therefore, a circuit is traceable from ground over conductor 655, as previously described, through
 55 the inner left front contact of relay 709, left back contact of relay 717, outer right back contact of relay 716, inner left back contact of relay 712, outer left front contact of relay 707, conductor 719, thence to the relay 1112 associated with the connecting device 1101. Relay 1112 operates and closes a circuit for relay 1116. Relay 1116 locks
 60 through its right contact, outer right back contact of relay 1114, conductor 1140 to

ground through the contact of slow relay 1117. Relay 1116 closes a circuit from battery through the right-hand winding of relay 1110, left contacts of relays 1112 and 1113, left-hand contact of relay 1116, outer
 70 right back contact of relay 1114 to ground over conductor 1140. Relay 1110 closes an obvious circuit for relay 1115. Relay 1115 closes a circuit from battery through the left-hand winding and contact of relay 1110,
 75 left back contact of relay 1111, left contact of relay 1115, winding of relay 1114 to the grounded conductor 1140. Relay 1110 locks and relay 1114 operates in this circuit. A circuit is now established from battery
 80 through the winding of multicontact relay 1108, which is individual to the sender shown in the disclosure, outer right contact of relay 1110, inner left contact of relay 1114 to ground over conductor 1140. Relay 1108
 85 operates and connects the sender to the line marker. Relay 1108 also closes a circuit through its contact, outer left contact of relay 1114, outer left back contact of relay 1119, winding of relay 1118 to battery.

One of the first things to take place upon the connection of the line marker to the sender is the closure of a circuit for the vertical operating magnet 306 of the group selector 300 in which terminates the selected
 90 trunk 211 outgoing from the incoming switch 200. This circuit may be traced from the grounded conductor 1140, inner right contact of relay 1114, contact of relay 1118, conductor 1141, contact of relay 1108, conductor
 95 1142, lowermost contact of relay 706, conductor 720, inner right contact of relay 630, conductor 656, inner right back contact of relay 609, conductor 657, conductor 545, outer left back contact of relay 106, over the tip
 100 conductor of trunk 100, through contacts of the switch 200, thence over the tip conductor of trunk 211, contact of relay 318, winding of the vertical operating magnet 306 to battery. Magnet 306 operates and prepares the
 105 contacts in the vertical row in which appears the incoming trunk 211 in the group selector switch 300. Magnet 306 also closes a circuit for the multicontact relay 312. Relay 312 connects the test relays of the line marker
 110 with the horizontal links of the switch 300 for testing purposes.

The record of the thousands, hundreds, tens of units digits is now transferred from the registers of the sender to the line marker.
 120 Relays 1218 and 1219 serve to determine whether the thousands digit is even or odd according to the combination in which they are operated. In the present case the digit being 1 and odd, the relay 708 in the sender
 125 is operated. It will be noted that this relay is energized in parallel with the register relay 711 at the time the latter relay is operated. Accordingly a circuit is completed from ground over conductor 1142 as 130

previously traced through the outermost contact of relay 708, conductor 721, contacts of relay 1108, conductor 1144, winding of relay 1218 to battery. A circuit is now
 5 closed from battery through the winding of multicontact relay 1228, left front contact of relay 1218, back contact of relay 1219, conductor 1141, contact of relay 1118, inner
 10 right contact of relay 1114 to the grounded conductor 1140.

Another circuit may be traced from ground over conductor 1142, through the outermost contact of relay 713, conductor 722, contacts of relay 1108, conductor 1145,
 15 winding of relay 1214 to battery. Still another circuit may be traced over the grounded conductor 1142 to the outermost contact of relay 714, conductor 723, contacts of relay 1108, conductor 1146, winding
 20 of relay 1215 to battery. Another circuit may be traced over the grounded conductor 1142, through the outermost contact of relay 807, conductor 813, contacts of relay 1108, conductor 1147, winding of relay 1207 to
 25 battery. Other circuits are completed over the grounded conductor 1142, through the contacts of relays 808 and 809, conductors 814 and 815, contacts of relay 1108, conductors 1148 and 1149, relays 1210 and 1213,
 30 respectively to battery.

With relays 1214 and 1215 operated a circuit is completed over the grounded conductor 1141, conductors 1150, 1151, inner right contact of relays 1217 and 1216, inner
 35 right front contact of relay 1215, inner left front contact of relay 1214, winding of multicontact relay 1240 to battery. A circuit is now completed from battery through the winding of relay 1230, contact of relay
 40 1228, contact of relay 1240, conductor 1150 to the grounded conductor 1141. Relay 1230 operates and a circuit is established from ground over conductor 1150, contact of relay 1230, inner right back contacts of relays
 45 1209 and 1208, inner right contact of relay 1207, inner left back contact of relay 1206, conductor 1241, contacts of relay 1228, contacts of relay 1240, conductor 1242 to the winding of the vertical operating magnet
 50 415 to battery. Magnet 415 operates and prepares the contacts in the vertical row 418 in which appears the called line 416. Magnet 415 also closes a circuit from ground through its contact, conductor 419, thence
 55 in parallel through the windings of multicontact relays 1220 and 316 to battery.

Relay 316 connects the common test relays of the marker with the group of trunks leading from the switch 300 to the connector
 60 switch 400 and also closes a circuit for the vertical operating magnet 308. Magnet 308 prepares the contacts in the associated row and closes a circuit from ground through its contact, contacts of relay 312, conductor
 65 320, winding of slow-to-release relay 1121 to battery. Relay 1121 closes a circuit from battery through the winding of slow-to-release relay 1138, back contact of relay
 1137, conductor 1152, outer contact of relay 1121 to ground over conductor 1141. Relay 70
 1138 closes a circuit from ground over conductor 1141, through the inner front contact of said relay, conductor 1153, winding of slow-to-release relay 1123 to battery. Relay
 75 1123 operates and closes a circuit from battery through the winding of slow-to-release relay 1124, right front contact of relay 1123 to the grounded conductor 1141. Relay
 1124, in turn, completes a circuit from battery through the winding of relay 1125, 80
 front contact of relay 1124, conductor 1154, outer right contact of relay 1114 to the grounded conductor 1140. Relay 1125 operates and locks through its inner right contact to the grounded conductor 1154. 85
 The multicontact relay 1220 operates and connects the register 1201 to the connecting device 410. Relay 1220 also closes a circuit from battery through the winding of relay 1235, contact of relay 1220 to ground over
 90 conductor 1150. Relay 1235 completes a circuit from the grounded conductor 1151, contact of relay 1235, outer right contact of relay 1210, outer right contact of relay 1213,
 95 outer right contacts of relays 1212 and 1211, conductor 1243, contacts of relay 1220, conductor 1244, winding of multicontact relay 411 to battery. Relay 411 connects the test relays 1222, 1224, etc. with the horizontal
 100 links of the group having access to the called subscriber's line 416.
 The testing operation will now be explained. If the first trunk 321 in the selected group is busy, a circuit is closed from battery, through the right-hand winding of
 105 test relay 1134, inner right contact of relay 1136, conductor 1155, contacts of relay 316 to the busy test conductor 324 of the trunk 321. If the link 303 associated with the trunk 321 is busy, a circuit is closed from
 110 battery through the left-hand winding of relay 1134, outer left back contact of relay 1136, contacts of relay 312 to the sleeve conductor of the busy link 303. Either winding of the relay 1134 is sufficient to operate the
 115 same. If the next trunk 322 or its associated link is busy, or both are busy, the corresponding test relay 1131 is operated in the same manner. Assuming, however, that the next trunk 323 and the link 305 are idle, the
 120 relay 1128 remains deenergized. Relays 1134 and 1131, in operating, lock through their right windings and contacts, conductor 1156, conductor 1152, outer contact of relay
 125 1121 to the grounded conductor 1141. Relay 1134 closes a circuit from battery through the winding of relay 1135, left contact of relay 1134 to the grounded conductor 1156. In a similar manner relay 1131 closes a circuit for relay 1132. 130

Another circuit may be traced from ground over conductor 1141, through the inner contact of relay 1121, conductor 1157, inner left front contacts of relays 1135 and 1132, inner left back contact of relay 1129, winding of relay 1130 to battery. A circuit is now completed for the vertical operating magnet 413 of the connector switch 400. This circuit leads from ground over conductor 1141 to the outer contact of relay 1121, conductor 1152, outermost contact of relay 1130, middle contact of relay 1129, contacts of relay 316, conductor 325, winding of vertical operating magnet 413 to battery. Magnet 413 prepares the associated contacts and also closes a circuit from ground through its contact, conductor 420, contacts of relay 316, conductor 326, winding of relay 1137 to battery. Relay 1137 operates and opens the circuit of relay 1138. This latter relay, however, being slow requires an interval before it retracts its armatures. Relay 1137 also closes a circuit from battery through the winding of the horizontal test magnet 409, contacts of relay 411, conductor 421, front contact of relay 1137 to the grounded conductor 1152. Magnet 409 operates the test link 403 connecting the test conductor of the incoming trunk 319 to the test conductor of the called subscriber's line 416.

While the foregoing operations are taking place a test is made of the links 401, 402, etc. to determine an idle one thereof. Assuming the link 401 is busy a circuit is completed from battery through the right-hand winding of relay 1222, left contact of relay 1221, contact of relay 411 to the grounded sleeve conductor of the busy link 401. Relay 1222 operates and locks through its left-hand winding to the grounded conductor 1141. If the next link 402 is idle the corresponding test relay 1224 remains de-energized.

After the necessary interval, relay 1138 releases and opens the holding circuit of relay 1123. While relay 1123 is holding its armatures attracted a test circuit is closed from battery, through the winding of test relay 1122, left contact of relay 1123, conductor 1158, outer contact of relay 1138, middle right contact of relay 1130, outermost right contact of relay 1129, contacts of relay 316, conductor 327, over the sleeve conductor of the trunk 319, through the test link 403 to the test conductor of the called line 416. Assuming the line 416 to be idle no potential is found on the test conductor, and consequently, the relay 1122 fails to operate. After an interval relay 1123 releases and opens the circuit of relay 1124. While relay 1124, which is slow to release, is de-energizing, a circuit is closed from ground over conductor 1141, right back contact of relay 1123, right contact of relay 1122,

outer left contact of relay 1125, conductor 1159, innermost right front contacts of relays 1135 and 1132, innermost right back contact of relay 1129, left front contacts of relay 1130, thence over conductors 1160 and 1161, contacts of relay 312, through the windings of the horizontal operating magnet 311 to battery. Magnet 311 operates the selector switch 300 and immediately that the connection is effected, a circuit is closed from battery through the winding of relay 317, through contacts of the switch 300, thence to the grounded conductor 1141, over the path just traced. Relay 317 operates and locks to the grounded sleeve conductor of the incoming trunk 211. Relay 317 closes a circuit for relay 318 which opens the circuit of the magnet 306. Magnet 306, in turn, opens the circuit of multicontact relay 312. The connection through the switch 300 is now held by the horizontal magnet 311 which is locked in a circuit through its right winding, contacts of the switch 300, contact of relay 317 to the grounded sleeve conductor of the trunk 211.

Another branch of the above mentioned circuit leads through the inner left contact of relay 1125, conductor 1162, right front contact of relay 1222, right back contact of relay 1224, winding of relay 1223 to battery. Relay 1223 operates and the grounded conductor 1162 is extended through the right contact of said relay, thence over conductor 1245, contact of relay 411, left-hand winding of the horizontal operating magnet 408 to battery. Magnet 408 operates the connector switch 400 and locks through the right winding and contacts of the switch 400 to the grounded sleeve conductor of the trunk 319.

After an interval has elapsed relay 1124 releases. Relay 1125 remains energized and a circuit is established from the grounded conductor 1154, back contact of relay 1124, outer right contact of relay 1125, winding of release relay 1119 to battery. Relay 1119 closes a circuit for the relay 1117 which being slow to operate requires an interval in which to retract its armature. Relay 1119 opens the circuit of relay 1118 which removes ground from the conductor 1141, bringing about the release of the several relays which have been held in circuits depending upon this grounded conductor. While relay 1117 is operating a circuit is closed from ground through its contact, conductor 1140, right contact of relay 1119, conductor 1153, contacts of relay 1108, conductor 1163, winding of relay 630 to battery. Relay 630 operates and locks through its inner left contact to the grounded conductor 647. After an interval relay 1117 operates and removes ground from conductor 1140 causing the release of the remaining operated relays and magnets. Relay 1108

is also released to disconnect the register sender from the line marker. The horizontal test magnet 409 releases and disconnects the test link 403 from the subscriber's line and from the trunk 319. With the vertical magnets 306, 308, 413 and 415 deenergized the connection is held through the switches 300 and 400 by the maintained operation of magnets 311 and 408.

When relay 630 operates a circuit is closed from battery through the windings of relay 621, outer left front contact of relay 630, outer left contact of relay 629, outer left front contact of relay 632, conductor 639 to ground as above traced. Relay 621 operates and locks temporarily through its inner right contact to the grounded conductor 639. Relay 621 completes a circuit from battery through the winding of slow relay 603, left front contact of relay 621, conductor 640 to ground at the middle right contact of relay 605. Relay 603, in operating at its right contact, opens the holding circuit of slow relay 600. As this is the only circuit by which relay 600 can be held at this time, said relay releases and in so doing opens the circuit of relay 605 which also releases. The release of these relays causes the removal of ground from the several holding conductors and the consequent restoration of the register sender and its associated relays. The removal of ground from the holding conductor 540 causes the release of the sender selector switch 500 for the purpose of disassociating the sender from the incoming trunk 100.

Prior to the time the sender selector switch 500 releases to disconnect the sender a circuit is closed from ground through the outer right front contact of relay 630, conductor 658, outer left contact of relay 609, conductor 659, contacts of the switch 500, conductor 546, winding of relay 106 to battery. Relay 106 operates and locks through its right front contact to ground at the contact of slow relay 107. When, a short time later, the circuit of relay 102 is opened and this relay deenergizes it opens the holding circuit of relay 107. Before relay 107, however, can restore, trunk 100 is extended through to the windings of the relay 104 and this relay operates in series with the trunk which at this time may be under the control of the subscriber's receiver at the calling end. Relay 104, in operating, recloses the holding circuit for the relay 107 and this relay remains energized to hold ground potential on the sleeve conductor 115.

In any well-known manner ringing current may be applied to the called subscriber's line and when in response to the ringing of his bell the called party removes his receiver, relay 105 is included in circuit with the called line. This relay

operates the relay 103, which in the well-known manner, reverses the flow of current back over the trunk 100 which may be used for any desired purpose.

After conversation is completed the subscribers replace their receivers on the switch-hooks and relays 104, 105 and 103 become deenergized. Relay 104 opens the circuit of relay 107, which in turn, releases and removes ground from the holding conductor 115. This results in the release of the horizontal operating magnets of the incoming switch 200, the group selector 300 and the connector switch 400, whereby these switches release to break down the connection.

It will next be assumed that the called subscriber's line is busy at the time a test is made thereof. Since the called line is busy a ground potential exists on the sleeve conductor thereof and the test relay 1122 is operated in the circuit above traced. Relay 1122 closes a circuit from the grounded conductor 1141, through its outer left contact, conductor 1170, contacts of relay 1108, conductor 1171, winding of relays 604 and 608 in parallel to battery. These relays operate and lock through the innermost right contact of relay 604 to the grounded conductor 640. Relay 608 at its left contacts connects the busy tone apparatus 607 across the tip and ring conductors of the incoming trunk. A busy tone is, therefore, transmitted back over the calling line to notify the calling subscriber that connection cannot be obtained.

After an interval relay 1123 releases, but since relay 1122 is now operated, the above traced circuits for operating the selector switch 300 and the connector switch 500 are not completed. In the manner described relay 1124 releases and operates the release relay 1119 which brings about a disconnection of the sender from the line marker. In this case, however, relay 621 remains deenergized since the operating circuit therefor is opened at the outer right back contact of relay 604. Consequently the sender remains connected to the incoming trunk until the calling subscriber recognizes the significance of the busy tone and hangs up his receiver to release the relay 618. Relay 618 opens the holding circuit of relay 600 which brings about a release of the sender, sender selector and other apparatus in the incoming office.

Establishment of a semi-mechanical connection.

It will now be considered that a connection is to be established between trunk 1400 incoming from a distant operator's position, through the switches 200, 300 and 400 to a called subscriber's line in the terminating office. For simplification in the description, the assumption will be made that the same

subscriber's line 416 is desired having the number 1 3 2 6. In this case the operator in the distant office receiving the call communicates with the cordless operator whose position is shown in Figs. 13 and 14 over an order wire which is not illustrated herein. The originating or distant operator requests the assignment of an idle trunk by the cordless operator and also communicates to her the number of the called subscriber's line. Complying with this request the cordless operator assigns the trunk 1400 for use and at the same time depresses the assignment key 1418. The depression of the assignment key 1418 causes the contacts of the associated release key 1419 to close, these contacts being normally opened. When key 1418 is depressed a circuit is completed from battery through the winding of relay 1408, left contacts of key 1418 to ground. Relay 1408 closes a circuit from ground through its inner right contact, winding of relay 1405 to battery. Relay 1405 completes a circuit for lamp 1420 which burns steadily. Relay 1408 locks in a circuit through the inner left contact of relay 1408, inner left back contact of relay 1416, conductor 1424, left contacts of key 1419 to ground.

Relay 1408 also closes a circuit from battery through the winding of relay 1409, outer left contact of relay 1408, conductor 1422, outer left contact of relay 1310, resistance 1331, right back contact of relay 1309 to ground at the right back contact of slow-release relay 1308. Relay 1409 operates in this circuit and associates the operator's keyboard and equipment shown in Fig. 13 with the trunk 1400, the keyboard being common to a number of these trunks. Relay 1409 locks through its inner upper contact, conductor 1423, winding of relay 1309 to ground at the right back contact of relay 1308. Relay 1309 operates and relay 1409 locks in this circuit.

The operation of the key 1418 and the closing of the contacts of key 1419 results in the closure of a circuit for operating the sender selector switch 500 to associate the trunk 1400 with an idle register sender. This circuit may be traced from ground through the left contacts of key 1419, conductor 1424, conductor 1425, inner right back contact of relay 1412, conductor 1426, lowermost back contact of relay 1410, conductor 1427, winding of relay 547 to battery. Relay 547 is individual to the trunk 1400 in the sender selector switch and serves in identically the same manner as the relay 513 to bring about an operation of the sender selector to connect the trunk 1400 to an idle register sender. Since this operation has already been described, it will not be repeated at this time. As soon as the sender is attached to the trunk a circuit is completed from ground over the conductor 540 as previously de-

scribed, through the contacts of the sender selector switch 500 involving the link 508, for instance, thence over conductor 548, right contacts of key 1419, outer left contact of relay 1403, conductor 1428, winding of relay 1410 to battery and in parallel through the middle lower contact of relay 1409, conductor 1429, winding of relay 1310 to battery. Relay 1410 at its lowermost contact opens the circuit of relay 547 resulting in the release of the operating relays in the selector switch 500. The sender selector is held from the sender over the grounded conductor 540.

When the cordless operator receives the designation of the called subscriber's line, which in the present case is number 1 3 2 6, she proceeds to set this number up on her keyboard. Accordingly, she depresses the No. 1 key 1332 in the row 1300, the No. 3 key 1333 in the row 1301, the No. 2 key 1334 in the row 1302 and the No. 6 key 1335 in the row 1303. These keys are of the locking type and remain depressed until they are released by the key release magnets 1304, 1305, 1306 and 1307. The contacts 1336, 1337, 1338 and 1339 are common to the rows 1300, 1301, 1302 and 1303, respectively, and operate whenever any key of these rows is depressed. When a key in each row has been depressed as above mentioned a circuit is completed from ground through the contacts 1336, 1337, 1338 and 1339, through the inner right front contact of relay 1310, conductor 1340, inner lower contact of relay 1409, thence through the winding of relay 1416 and in parallel through the inner upper contact of relay 1410 and the lower winding of relay 1415 to battery. Relay 1415 completes a circuit from battery through the lamp 1421, inner lower front contact of relay 1415, inner right contact of relay 1416, inner lower contact of relay 1410, through the interrupter 1430, to ground. The interrupter 1430 causes the lamp 1421 to flicker. Relay 1416 releases relays 1408 and 1405 and the latter opens the circuit of lamp 1420.

Another circuit is completed from ground through the contacts 1336, 1337, etc., thence through the left contact of relay 1309, winding of relay 1329 to battery. Relay 1329 operates and prepares the mechanism in Fig. 13 for transmitting codes of impulses in accordance with the depressed keys to establish the record of the called line on the registers of the associated sender. Relay 1329 completes a circuit from ground through the right back contact of relay 1308, right front contact of relay 1309, inner left front contact of relay 1310, conductor 1341, middle right contact of relay 1329, inner right back contact of relay 1327, outer right contact of relay 1326, inner right contact of relay 1325, left back contact of relay 1327,

left-hand windings of relays 1328 and 1327 to battery. Relay 1328 operates in this circuit, but relay 1327 being marginal does not receive sufficient current to attract its armatures. Relay 1328, in operating, completes a circuit from battery through the left-hand winding of relays 1327 and 1328, right-hand winding of relay 1327, inner right contact of relay 1328 to the grounded conductor 1341. The right-hand winding of relay 1327, however, being shunted by the above traced circuit, this relay does not operate. Relay 1328 completes a circuit from ground through its outer right contact, conductor 1342, back contact of relay 1321, outer right back contact of relay 1313, winding of relay 1312 to battery. Relay 1312 operates and closes a circuit from battery through its winding and inner left contact, winding of relay 1321 to ground over conductor 1342. Relay 1321, however, being shunted by the circuit above traced, does not operate at this time.

Relay 1329 also completes a circuit from ground through the outer right contact of relay 1310, conductor 1343, inner right contact of relay 1329, conductor 1344, left back contact of relay 1324, winding of relay 1323 to battery. The relays 1323 and 1324 are constructed to operate and release slowly and in conjunction with each other they serve to measure intervals of time for the purpose of creating and transmitting impulses in accordance with the setting of the keys on the operator's keyboard to represent the different digits of the wanted subscriber's line. Relay 1323, therefore, operates slowly in the above traced circuit and on completing its operation closes a circuit from battery through the winding of relay 1324, inner left contact of relay 1323 to the grounded conductor 1344. Relay 1324 energizes in this circuit and operates slowly. When relay 1324 is fully operated a circuit is closed from battery through the winding and normal contact of relay 1322, outermost right front contact of relay 1324 to the grounded conductor 1344. Relay 1322 operates and locks through its inner left front contact to ground over conductor 1344. When relay 1324 completes its operation it closes a circuit from battery through a resistance, through its middle right contact directly to the grounded conductor 1344. This circuit being in shunt of the relay 1323, the latter relay commences to release slowly. When relay 1323 is fully released it closes a circuit from battery through a resistance, through its right back contact directly to the grounded conductor 1344 in shunt of the winding of relay 1324. Therefore relay 1323 commences to deenergize slowly. In this manner the relays 1323 and 1324 operate in succession and release in succession to measure intervals of time.

While the relays 1323 and 1324 are releas-

ing a circuit is completed from ground or the positive pole of battery, through the outer right contact of relay 1322, conductor 1350, outer left contact of relay 1329, conductor 1351, right normal contacts of relay 1330, conductor 1352, middle upper contact of relay 1409, conductor 1431, contacts of the sender selector 500, conductor 543, thence as above traced through the windings of relays 627, 633 and 634 and returning over conductor 542, through the sender selector switch 500, conductor 1432, uppermost contact of relay 1409, conductor 1353, left normal contacts of relay 1330, left back contact of relay 1326, outer right contact of relay 1329, left back contact of relay 1313, contacts of key 1332, high resistance 1354 to the opposite pole of battery. After the relays 1323 and 1324 have fully released as above explained, a circuit is closed from the grounded conductor 1344, through the outer right back contact of relay 1324, outer left contact of relay 1322, conductor 1345, left back contact of relay 1325, left-hand winding of relays 1326 and 1325 to battery. When relay 1326 operates it opens the shunt circuit around the right-hand winding of relay 1327 and this relay operates in series with relay 1328. Relay 1327, in operating, completes a circuit from battery through the winding of relay 1313, outer left contact of relay 1312, conductor 1346 outer right contact of relay 1327, conductor 1347 to the grounded conductor 1341. Relay 1313 operates and locks directly to the conductor 1347. Relay 1313 at its outer right contact opens the shunt around the winding of relay 1321 and this relay operates in series with relay 1312. Another circuit is completed from battery through the resistance 1348, conductor 1349, winding of relay 1330, outer left contact of relay 1323, inner right contact of relay 1324, inner right contact of relay 1322 to the grounded conductor 1344. Relay 1330 operates and locks in a circuit from battery through resistance 1348, conductor 1349, winding and inner left contact of relay 1330 to the grounded conductor 1344.

Next the relays 1323 and 1324 operate in succession. Relay 1324, in operating, removes ground from conductor 1345, whereupon relay 1325 is permitted to operate in series with relay 1326. While relays 1323 and 1324 are operating at this time a circuit is closed from the positive pole of battery over conductor 1350, outer left contact of relay 1329, conductor 1351, left front contacts of relay 1330, thence over the conductor 1353, through the polarized relays in the sender, as explained, and returning over conductor 1352, through the right front contacts of relay 1330, conductor 1356, through the high resistance 1354 to the opposite pole of battery.

After the relays have fully operated a

circuit is closed from battery through the resistance 1348, middle left contact of relay 1322, outer right front contact of relay 1324 directly to the grounded conductor 1344.

5 This circuit shunts the relay 1330 which releases and interrupts the impulse being transmitted to the sender.

Next the time measuring relays 1323 and 1324 release in succession, at the end of 10 which period a circuit is closed from the grounded conductor 1344, outer right contact of relay 1324, outer left contact of relay 1322, conductor 1345, left front contact and left-hand winding of relay 1325 to battery. 15 This circuit shunts the relay 1326 which releases. Moreover, the above traced circuit is closed for the operation of relay 1330.

Next the relays 1323 and 1324 operate in succession and during this period a circuit 20 is closed from positive pole of battery over conductor 1351, thence through the left front contacts of relay 1330, over conductor 1353 as traced through the sender and returning over conductor 1352 through the right front 25 contacts of relay 1330, conductor 1356 and resistance 1354 to battery. Thus another impulse of negative polarity and weak in character is transmitted from the operator's keyboard to the sender. At the end of this 30 impulse period ground is removed from conductor 1345 whereupon relay 1325 releases. A circuit is now closed from battery through the left-hand winding and left front contact of relay 1327, inner right contact of 35 relay 1325, outer right contact of relay 1326, inner right front contacts of relays 1327 and 1328 to the grounded conductor 1341. This circuit shunts the relay 1328, which releases, and opens the circuit of relay 1327 which 40 also deenergizes. Moreover, the relay 1330 is shunted as above explained and retracts its armatures. Thus the necessary code impulses have been transmitted from the operator's keyboard through the sender selector switch to the sender for recording on 45 the registers of the sender the first digit of the wanted subscriber's line. When relay 1328 releases it opens the holding circuit of relays 1312 and 1321. Relay 1312 at its 50 right contact disconnects the control conductors from the first set of keys 1300.

Immediately that the timing relays have been restored as above explained, relay 1328 55 is reenergized as previously explained. Relay 1328 closes a circuit from ground through its outer right contact, conductor 1342, contact of relay 1341, outer right front contact of relay 1313, outer right back contact of relay 1315, winding of relay 1314 to bat- 60 tery. Relay 1314 operates and closes a holding circuit for itself in series with relay 1321, but this latter relay being shunted does not operate. Next the relays 1323 and 1324 undergo release. During this period 65 a circuit is closed from the positive pole of

battery over conductor 1351, thence through contacts of relay 1330, over conductor 1352 as traced and returning over conductor 1353 through the normal contacts of relay 1330, 70 left back contact of relay 1326, outer right contact of relay 1329, left front contact of relay 1313, left back contact of relay 1315 contacts of key 1333, conductor 1356, high resistance 1354 to the opposite pole of bat- 75 tery. After relays 1323 and 1324 have released, relays 1326, 1327 and 1330 are operated as heretofore explained. Relay 1330, in operating, interrupts the impulse being transmitted to the sender. Relay 1327, in 80 operating, closes a circuit from ground over conductor 1347, through the outer right contact of relay 1327, conductor 1346, left contact of relay 1314, winding of relay 1315 to battery. Relay 1315 operates and locks and 85 also permits relay 1321 to operate in series with relay 1314.

Next the relays 1323 and 1324 undergo operation and during this period a circuit 90 is closed from positive pole of battery over conductor 1351, and thence as traced over conductor 1353 to the sender and returning over conductor 1352, front contacts of relay 1330, outer right back contact of relay 1325, conductor 1357, inner right contact of relay 95 1314, left contacts of key 1333, low resistance 1355 to battery. In this case a heavy impulse of negative polarity is transmitted to the sender. Relay 1325 operates and relay 1330 releases.

Next the relays 1323 and 1324 release at 100 the end of which time relay 1326 releases and relay 1330 operates.

Next the relays 1323 and 1324 operate. During this period a weak negative impulse 105 is transmitted to the sender in the manner above explained. At the end of the period relays 1325, 1328, 1327 and 1330 become deenergized.

When relay 1328 again operates it closes 110 a circuit from ground through its outer right contact, conductor 1342, contact of relay 1321, right front contacts of relays 1313 and 1315, outer right back contact of relay 1317, winding of relay 1316 to battery. Relay 1316 operates and prepares a circuit 115 for itself and relay 1321, but the latter relay being shunted remains deenergized. The apparatus is now ready to transmit code impulses representing the third digit.

When relays 1323 and 1324 have released, 120 relays 1326, 1327 and 1330 become operated. Relay 1327, in operating connects ground over conductor 1346, through the outer left contact of relay 1316, winding of relay 1317 to battery. Relay 1317 locks to conductor 125 1347 and opens the shunt to permit relay 1321 to operate in series with relay 1316.

Next relays 1323 and 1324 operate and during this period a circuit is closed from 130 the positive pole of battery over conduc-

tors 1350 and 1351, thence over conductor 1353 to the sender and returning over conductor 1352, through the right front contact of relay 1330, outer right back contact of relay 1325, conductor 1357, inner right contact of relay 1316, left contacts of key 1334, low resistance 1355 to battery. A heavy negative impulse is transmitted in this circuit. Following the impulse period relay 1325 operates and relay 1330 releases to interrupt the impulse.

Next the relays 1323 and 1324 release, at the end of which time, relay 1326 releases and relay 1330 operates.

Following this relays 1323 and 1324 operate and during the period of their operation a light negative impulse is transmitted to the sender in the manner above described. After relays 1323 and 1324 have fully operated relays 1325, 1328, 1327 and 1330 become deenergized.

Relay 1328 immediately operates again and in so doing ground potential is connected over conductor 1342, through the contact of relay 1321, outer right front contacts of relays 1313, 1315 and 1317, outer right back contact of relay 1319, winding of relay 1318 to battery. Relay 1318 operates and prepares a circuit for itself and relay 1321. Next the relays 1323 and 1324 release and during this interval a circuit is closed from positive pole of battery, over conductor 1351, normal contact of relay 1330, conductor 1552 to the sender and returning over the conductor 1353, left normal contacts of relay 1330, left back contact of relay 1326, outer right contact of relay 1329, left front contacts of relays 1313, 1315 and 1317, left back contact of relay 1319, contacts of key 1335, conductor 1356, high resistance 1354 to the opposite pole of battery. A light positive impulse is transmitted to the sender in this circuit. When relays 1323 and 1324 have released relays 1326, 1327, 1330 become operated. Relay 1337 in the manner above explained completes a circuit for relay 1319 and relay 1321 operates in series with relay 1318.

Next the relays 1323 and 1324 are operated and during the interval they are being operated, a light negative impulse is transmitted over the circuit to the sender. When these relays have operated relay 1325 energizes and relay 1330 releases to interrupt the impulse.

Next relays 1323 and 1324 become deenergized, following which, relay 1326 releases and relay 1330 operates.

Lastly, relays 1323 and 1324 operate and during this period a circuit is closed from positive pole of battery over conductor 1351, left front contact of relay 1330, over conductor 1353 to the sender and returning over the conductor 1352, right front contacts of relay 1330, right front contact of

relay 1325, outer right contact of relay 1318, left contacts of key 1335, low resistance 1355 to the opposite pole of battery. A heavy negative impulse is transmitted over this circuit to the sender.

Thus, the record set up on the operator's keyboard has been transmitted to the registers 700, 701, 800 and 801 of the sender. These registers take identically the same settings as in the case previously described since the number of the wanted number is the same. Immediately following the transmission of the last code impulse, relay 1328 operates in the manner above described and completes a circuit from ground over its outer right contact, conductor 1342, contact of relay 1321, outer right front contacts of relays 1313, 1315, 1317 and 1319, outer right back contact of relay 1320, winding of relay 1311 to battery. Relay 1311 operates and prepares a circuit for itself in series with the winding of relay 1321. When subsequently, relay 1327 operates a circuit is closed from battery through the winding of relay 1320, outer contact of relay 1311, conductor 1346, outer right contact of relay 1327 to the grounded conductor 1347. Relay 1320 operates and removing the shunt permits relay 1321 to operate in series with relay 1311. When relay 1328 releases it opens the circuit of relays 1311 and 1321. The next time relay 1328 operates the circuit extending over conductor 1342 now leads through the contacts of relays 1321, 1313, 1315, 1317, 1319, through the outer right front contact of relay 1320, winding of relay 1308 to battery. Relay 1308 operates and locks through its left contact and thence in parallel through contacts of the operated keys 1332, 1333, etc. to ground. Relay 1308 opens the circuits of relays 1309 and 1329. Relay 1329 renders the impulse sending mechanism ineffective to transmit further impulses. Relay 1308 at its right front contact closes parallel circuits for the key release magnets 1304, 1305, 1306, 1307 and 1358. These magnets energize and restore the operated keys in their respective rows. After the last key has been restored all parallel branches of the operating circuit of relay 1308 are opened and this relay releases. Relay 1308 being slow to release, maintains its armatures attracted for an appreciable interval. While relay 1308 is operated to open the holding circuit of relay 1309 it also opens the circuit of relay 1409. Relay 1308 also removes ground from conductor 1341 whereby all energized relays depending upon this conductor are restored to normal.

Relay 1409, in releasing, disconnects the operator's keyboard from the trunk circuit 1400 whereby the relay 1310 becomes deenergized.

If at this time the operator at the origi-

nating office has inserted her plug in the
 jack of the trunk 1400 outgoing therefrom,
 a circuit is completed from battery through
 the right-hand winding of relay 1406, right
 5 normal contacts of relay 1404, lower left
 winding of repeating relay 1401, inner right
 back contact of relay 1403, over the ring side
 of the trunk 1400 and returning over the tip
 side of the trunk to the outer right back con-
 10 tact of relay 1400, upper right winding of re-
 peating coil 1401, left normal contacts of re-
 lay 1404, left-hand winding of relay 1406
 to ground. Relay 1406 operates and closes
 circuits for the upper and left hand wind-
 15 ings of relays 1415 and 1417 respectively.
 Relay 1417 locks through its right winding
 to the grounded conductor 1425.

In the manner fully explained hereinbe-
 fore the register sender is attached to the
 20 incoming and line markers and these de-
 vices operate to control the selective actuation
 of the switches 200, 300 and 400 to extend
 the trunk 1400 to the called subscriber's line
 416. After the line marker has performed
 25 its functions and relay 630 operates as above
 described a circuit is completed from ground
 through the outer right contact of said re-
 lay thence over conductors 658, left back con-
 tact of relay 609 conductor 659, through the
 30 switch 500, conductor 549, outer right back
 contact of relay 1408, winding of relay 1412
 to battery. Relay 1412 operates and locks
 to the grounded sleeve conductor 1425. It
 will be noted that the relay 1408 and relay
 35 1405 are released at this time since the op-
 erator has released the assignment key 1418
 and since relay 1416 is operated. The con-
 tacts of the release key 1419, however, still
 remain closed. Relay 1412 at its left con-
 40 tacts completes the tip and ring conductors
 of the trunk through to the right-hand wind-
 ings of the repeating coil 1401.

In the manner fully described hereinbe-
 fore the register sender and sender selector
 45 switch 500 are restored to their normal po-
 sitions following the completion of the func-
 tions of the line marker. When the sender
 and sender selector switch are released,
 ground potential is removed from the con-
 50 ductor 548 and, consequently, relay 1410 re-
 leases. Relay 1410 disconnects the lamp
 1421 from interrupter 1430 and connects the
 same to ground. The lamp 1421 discontinues
 flickering and burns steadily.

55 Ringing current is now applied to the
 called subscriber's line. To accomplish
 this the operator in the distant office by any
 well-known device transmits ringing current
 over the trunk 1400. This results in the
 60 operation of the ringing current responsive
 relay 1402. When relay 1402 operates a
 circuit is closed from battery through the
 winding of relay 1411, contact of relay 1402
 to ground at the back contact of relay 1407.
 65 Relay 1411 locks through its inner lower

contact, contacts of relays 1413 and 1414 to
 grounded conductor 1424. The circuit for
 applying ringing current to the called line
 may be traced from the ringing source 1433
 to the winding of relay 1414, lower front
 70 contact of relay 1411, inner left contact of
 relay 1412, thence over the ring side of the
 line through the subscriber's station and
 returning over the tip side of the line
 through the outer left front contact of re-
 75 lay 1412 to ground at the uppermost front
 contact of relay 1411. When the called
 subscriber answers relay 1414, which nor-
 mally remains inert, operates and opens
 the following shunt circuit which has up to
 80 this time existed around the winding of re-
 lay 1413: battery through the winding of
 relay 1411, inner lower contact of said relay,
 back contact of relay 1413, contact of relay
 1414 to the grounded conductor 1424. Relay
 85 1413 thereupon operates and a circuit is
 closed from battery through resistance 1434,
 front contact and winding of relay 1413 to
 the grounded conductor 1425. Relay 1413
 locks and shunts out the relay 1411 which
 90 releases and disconnects ringing current
 from the line. When relay 1411 releases
 relay 1407 is included in series with the
 called line and operates to close a circuit for
 relay 1404. This relay disconnects the
 95 supervisory battery supply from the incom-
 ing end of the trunk 1400, and talking cur-
 rent is supplied from the distant office in
 the usual manner.

When conversation is completed the called
 100 subscriber in hanging up his receiver opens
 the circuit of relay 1407. This relay opens
 the circuit of relay 1404 which reconnects
 the windings of relay 1406 to the incoming
 tip and ring conductors of the trunk 1400.
 105 If the operator at the distant office has
 disconnected at this time or when she does
 disconnect, relay 1406 releases and opens the
 circuit of relay 1415. Relay 1415 releases
 and closes a circuit through the supervisory
 110 lamp 1420, inner upper back contact of relay
 1415, middle right contact of relay 1416,
 left front contact of relay 1417, interrupter,
 1435 to ground. A similar circuit is also
 closed for the lamp 1421. These lamps flash
 115 to advise the cordless operator that the con-
 nection is no longer required and accord-
 ingly she manipulates the key 1419 to release
 the connection. Key 1419 disconnects
 ground potential from the conductors 1424
 120 and 1425 whereupon the operated switches
 are restored to their normal positions.

A description will now be given of the
 manner in which the apparatus operates in
 case the called line is found busy when a
 125 connection of the foregoing class is being
 established. At the time the sender is first
 connected to the incoming trunk and the
 ground potential is placed on conductor 643
 a circuit is completed from battery through
 130

the winding of relay 609, conductor 661, inner right back contact of relay 703 to ground, on conductor 643. Relay 609 completes a circuit from battery through the winding of relay 623, conductor 662, left front contact of relay 609, conductor 659, through the sender selector switch 500, conductor 549, outer right front contact of relay 1408 to ground. Relay 623 operates and closes a circuit from battery through the winding of relay 619, outer right front contact of relay 623 to ground on conductor 646. Relay 619 operates and locks directly to the grounded conductor 640. Another circuit is closed from battery through relay 626, inner right front contact of relay 609, conductor 657, through switch 500, conductor 550, left front contact of relay 1405 to ground. Relays 623 and 626 complete a circuit from battery through the winding of relays 628, left front contact of relay 626, inner right front contact of relay 623 to the grounded conductor 646. A circuit is now closed through relay 611, right front contact of relay 623 to grounded conductor 647. Relay 611 operates and locks to the grounded conductor 647.

Since the called line is busy when the test is made relays 604 and 608 are operated in the manner above described. A circuit is now closed from ground through the outer left contact of relay 619, conductor 663, innermost right contact of relay 608, left back contact of relay 609, conductor 659, through the sender selector 500, conductor 549, outer right back contact of relay 1408, winding of relay 1412 to battery. Relay 1412 operates and locks to the grounded sleeve conductor 1425. It will be noted that relay 609 has released by this time since its circuit is opened by the relay 703 which operates when the first digit is transferred from the operator's keyboard to the sender. It will also be noted that the relay 1408 is released since the operator has, previously to this time released her assignment key 1418. Still another circuit is closed from ground over conductor 663, through the middle right contact of relay 608, inner right back contact of relay 609, conductor 657, through the sender selector switch 500, conductor 550, outer right front contact of relay 1412, left-hand winding of relay 1403 to battery. Relay 1403 operates and extends the tip and ring conductors of the incoming trunk 1400 over conductors 1431 and 1432, through the sender selector 500 to conductors 543 and 542, front contacts of relay 606, left-hand armatures of relay 608 to the busy tone apparatus 607.

It will also be noted that relay 610 is operated in a circuit through its winding to ground at the outer right contact of relay 611. Relay 610 at its front contacts extends the tip and ring conductors of the incoming

trunk through the left contacts of relay 611 to the windings of relay 615. The busy tone apparatus 607 being connected across to the tip and ring conductors a tone is transmitted back over the incoming trunk to the distant office. While this condition prevails, relay 617 is intermittently operated and released in a circuit from battery through its winding, through the middle right contact of relay 604, interrupter 660, to ground. Relay 617 at its left contact opens and closes a circuit through contact of relay 611, winding of relay 614. Relay 614 holds relay 615 but removes battery and ground from the trunk to control supervision at the distant office. This expedient may be used in any well-known manner to cause an intermittent signal at the distant office to advise that the called subscriber's line has been found busy.

During this period relay 615 applies ground to conductor 651 to hold relay 600 to prevent the sender from releasing.

When the operator at the distant office disconnects the relay 615 releases and removes ground at its left contact from conductor 651 and causes the sender to release in the manner above described. The switches and other apparatus taken in connection with the unsuccessful call may be released by the operators as previously explained.

What is claimed is:

1. In a telephone system, a selective switch having a plurality of link circuits, trunks terminating in said switch serving for the extension of connections automatically to said switch, other trunks terminating in said switch serving for the extension of connections manually to said switch, and a register sender mechanism for controlling said switch to further extend any of said trunks over one of said links.

2. In a telephone system, a selective switch, trunks terminating in said switch serving for the extension of connections automatically to said switch, other trunks terminating in said switch serving for the extension of connections manually to said switch, said switch having a plurality of links for interconnecting said first mentioned trunks with said outgoing trunks, and a register sender mechanism for controlling said switch to extend any of said automatic or manual trunks over one of said outgoing trunks.

3. In a telephone system, selective switches, an automatic device for extending connections to said switches, means including an operator's position for extending other connections to said switches, a plurality of senders, a marker controlling mechanism associable with any one of said senders, means for connecting any one of said senders to any one of said extended connections, and means controlled by said

marker for operating said switches to further extend such connections.

4. In a telephone system, a series of selective switches, means for extending connections in the direction of said switches automatically, means including an operator's position for extending other connections in the direction of said switches, a register sender a plurality of marker mechanisms each associable with a different switch in said series, means for connecting said sender to any of said connections, and means for connecting said sender to said markers in succession for controlling said switches to further extend the connection.

5. In a telephone system, a selective switch, trunks of different classes incoming to said switch, automatic means for extending connections over trunks of one class, means under the control of an operator for extending connections over trunks of another class to said switch, and a register sender mechanism automatically associable with any of said trunks over which a connection is extended for controlling said automatic switch to further extend the connection.

6. In a telephone system, a single automatic selective switch, a trunk over which connections are extended automatically terminating in said switch, a second trunk over which connections are extended under the control of an operator terminating in said switch, and a register sender mechanism for controlling the selective operation of said switch to further extend said trunks.

7. In a telephone system, a coordinate selective switch, a number of trunks, of one class terminating in said switch, a number of trunks of another class also terminating in said switch, and a common register controlling mechanism for governing the operation of said switch to extend any of said trunks.

8. In a telephone system, a selective switch, an operator's trunk incoming to said switch, a plurality of register senders, a sender selector for connecting said trunk to any of said senders, an operator's position, means controlled by the operator for sending code impulses from her position through the sender selector to set the connected sender, and means controlled by

said sender for selectively operating said selective switch.

9. In a telephone system, selective switches, a circuit incoming to said switches over which connections are extended automatically, another circuit incoming to said switches over which connections are extended under the control of an operator, a register sender, an automatic switch for connecting said sender to either of said incoming circuits, means controlled over circuits extending through said automatic switch for setting said sender, and means controlled by said sender for operating said selective switches to further extend the incoming circuits.

10. In a telephone system, selective switches, a circuit incoming to said switches over which connections are extended automatically, another circuit incoming to said switches over which connections are extended under the control of an operator, a plurality of register senders, an automatic switch for connecting one of said senders to either of said incoming circuits in response to the extension of a connection thereover, means for sending code impulses through said automatic switch for setting said senders, and means under the control of a sender taken for use for operating said selective switches to further extend either of said incoming circuits.

11. In a telephone system, selective switches, a circuit incoming to said switches over which connections are extended automatically, an operator's position having a keyboard thereat, another circuit incoming to said switches over which connections are extended under the control of the operator, a register sender device, an automatic switch for connecting said sender device to either of said incoming circuits, means for transmitting impulses either over said first incoming circuit or from said operator's keyboard through said automatic switch to position said sender, and means controlled by the sender for operating said selective switches to further extend either of said incoming circuits.

In witness whereof, I hereunto subscribe my name this 14th day of August A. D., 1923.

SAMUEL B. WILLIAMS.