

Aug. 25, 1925.

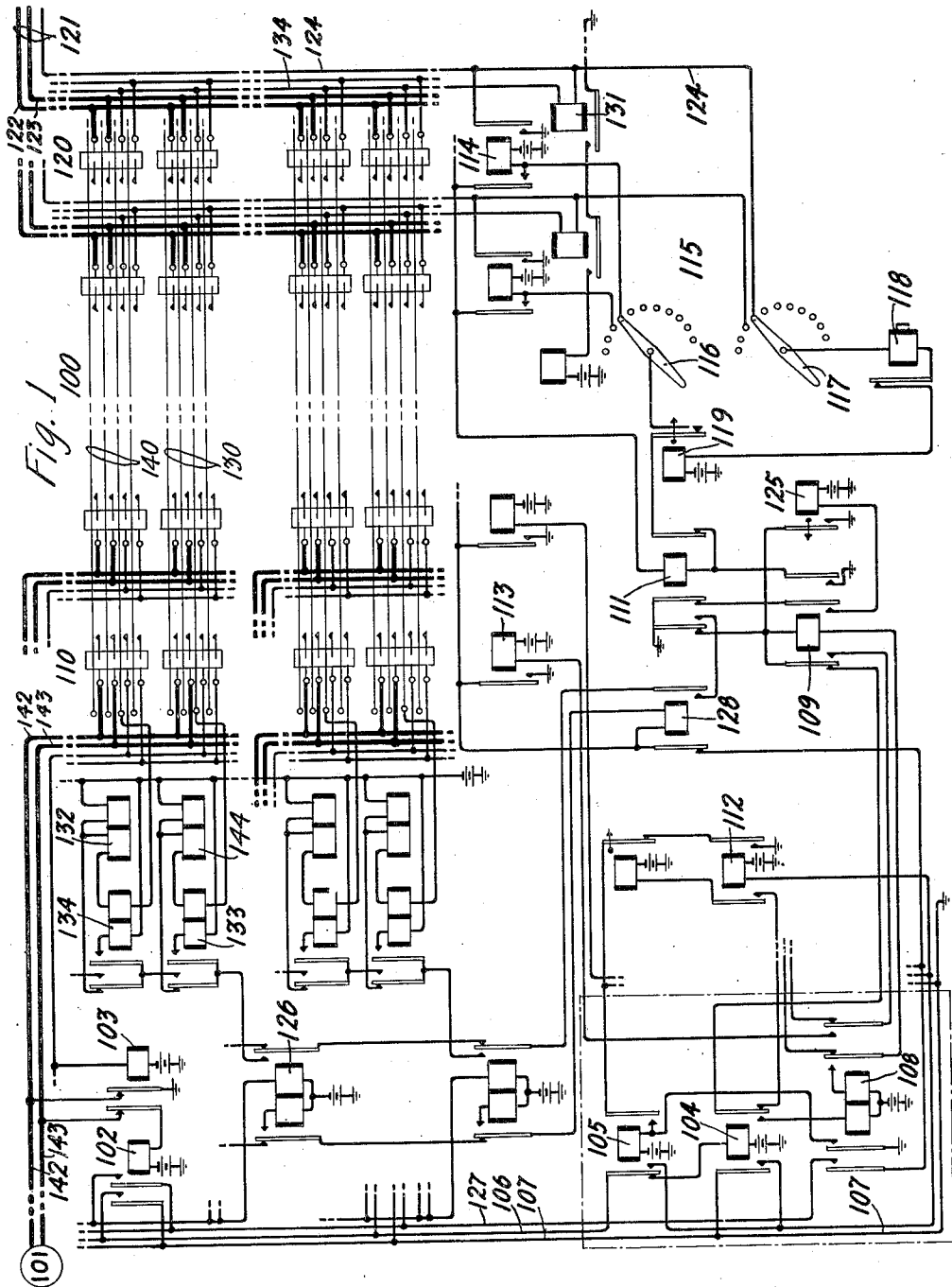
1,550,769

S. B. WILLIAMS

TELEPHONE EXCHANGE SYSTEM

Filed Sept. 26, 1923

14 Sheets-Sheet 1



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Aug. 25, 1925.

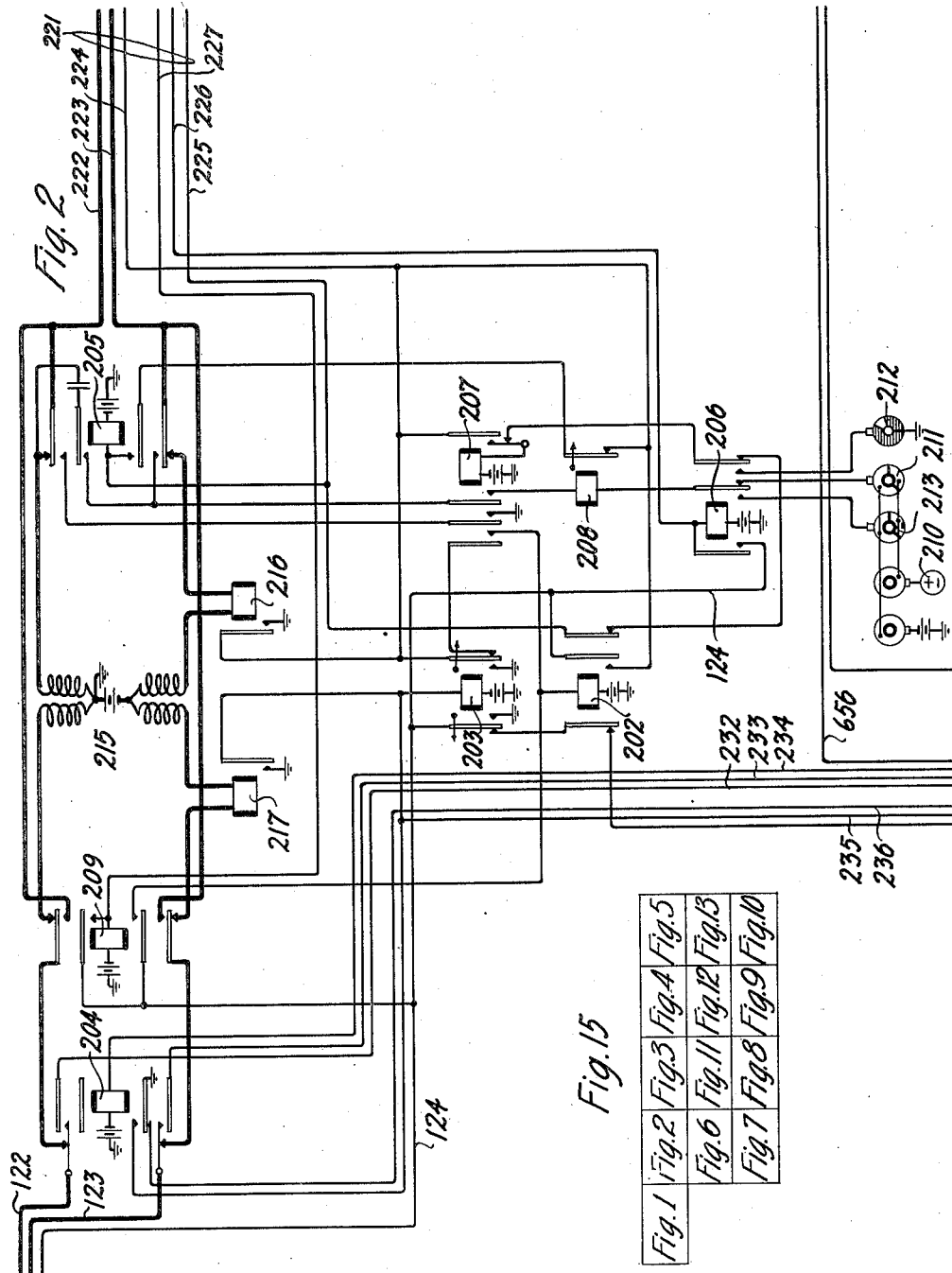
1,550,769

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TELEPHONE EXCHANGE SYSTEM

Filed Sept. 26, 1923

14 Sheets-Sheet 2



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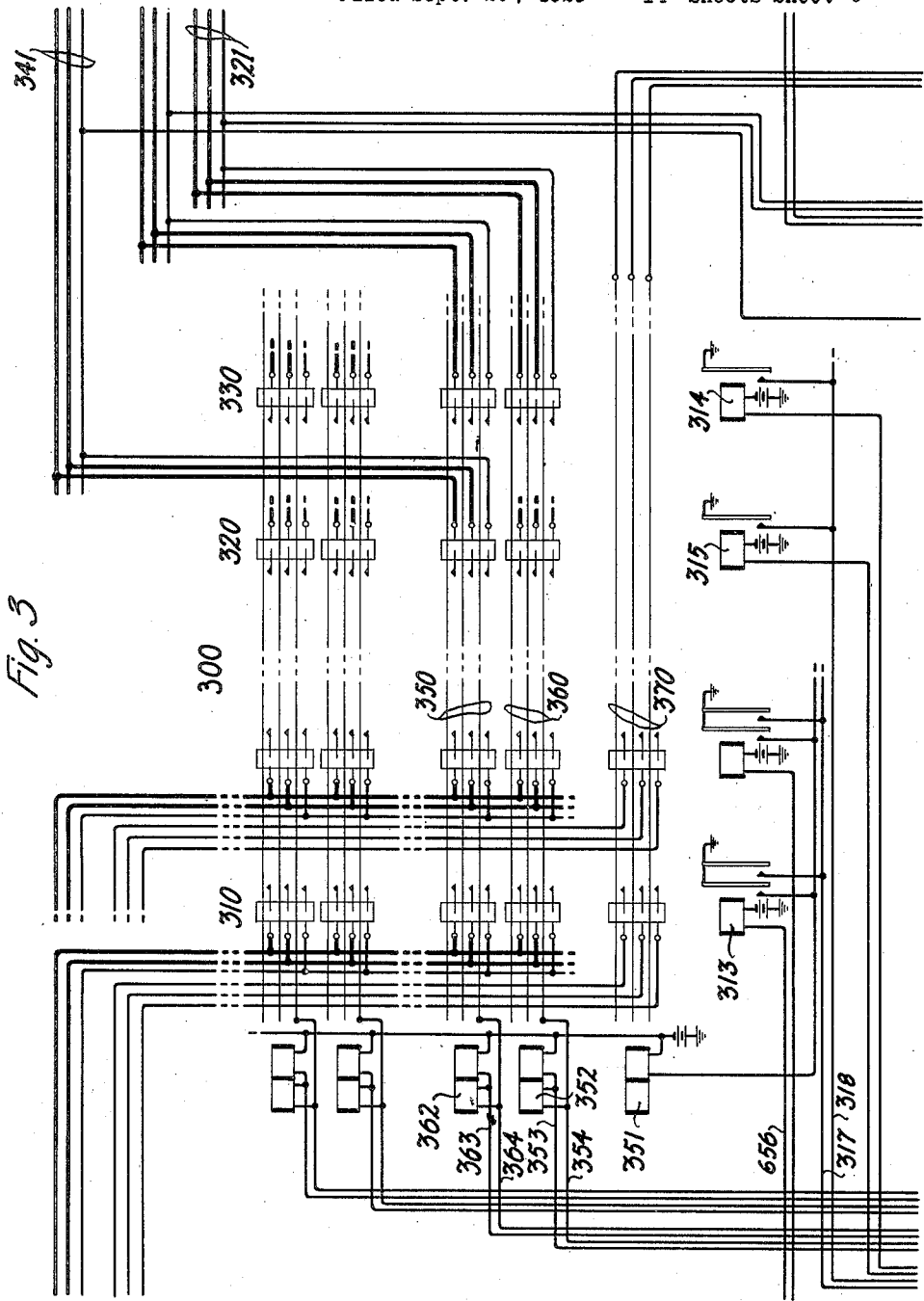
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1,550,769

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TELEPHONE EXCHANGE SYSTEM

Filed Sept. 26, 1923 14 Sheets-Sheet 3



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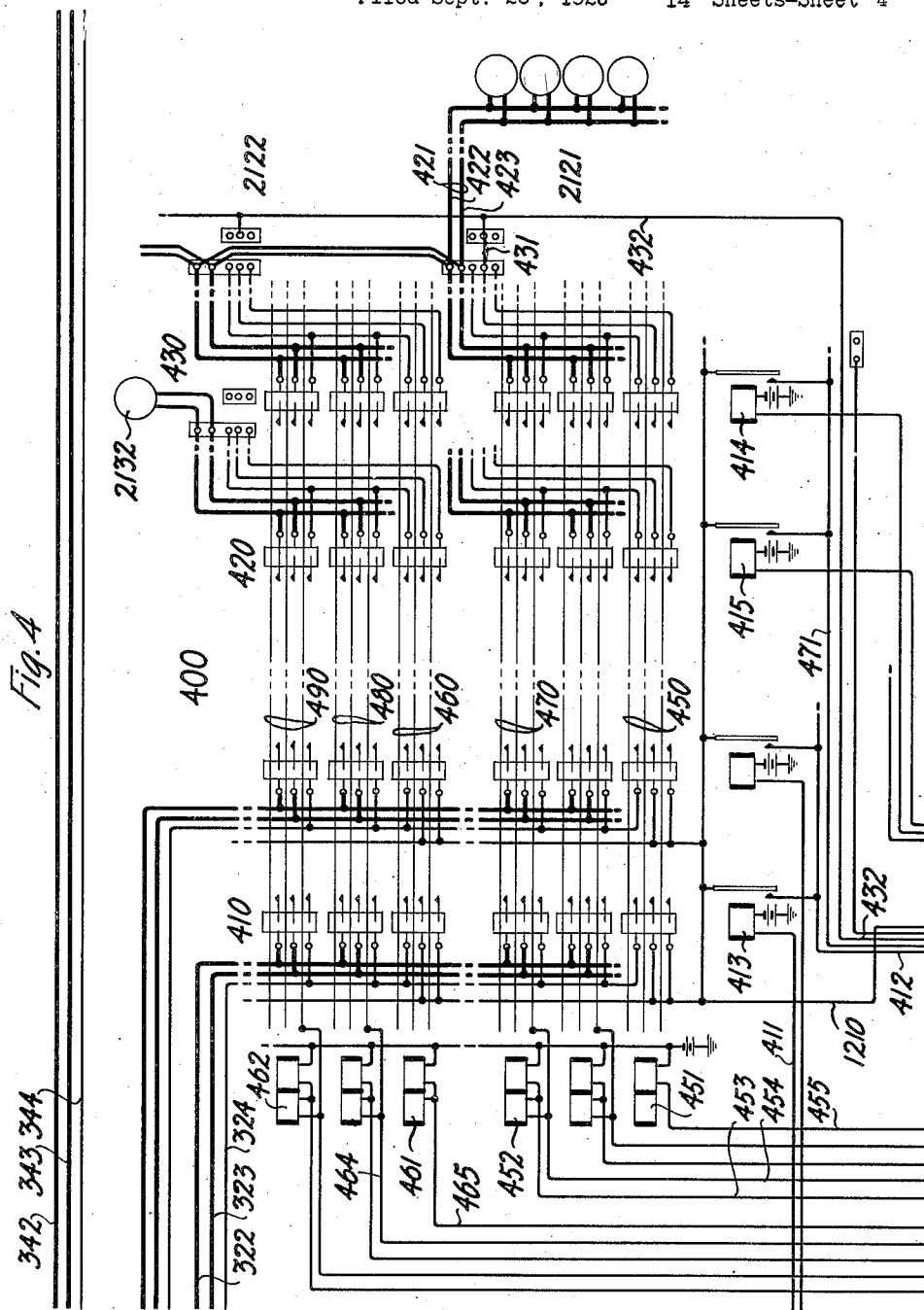
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TELEPHONE EXCHANGE SYSTEM

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14 Sheets-Sheet 4



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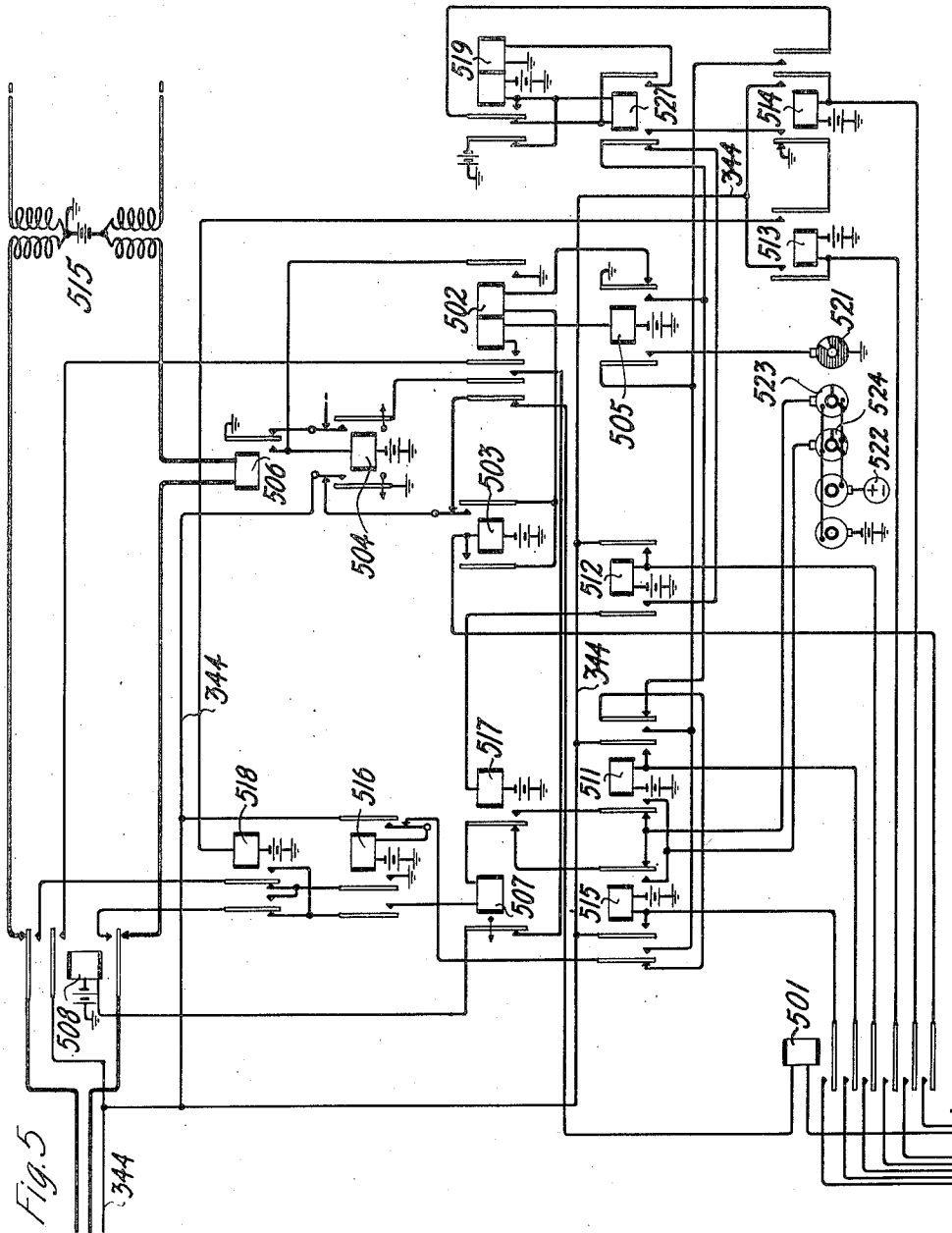
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TELEPHONE EXCHANGE SYSTEM

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14 Sheets-Sheet 5



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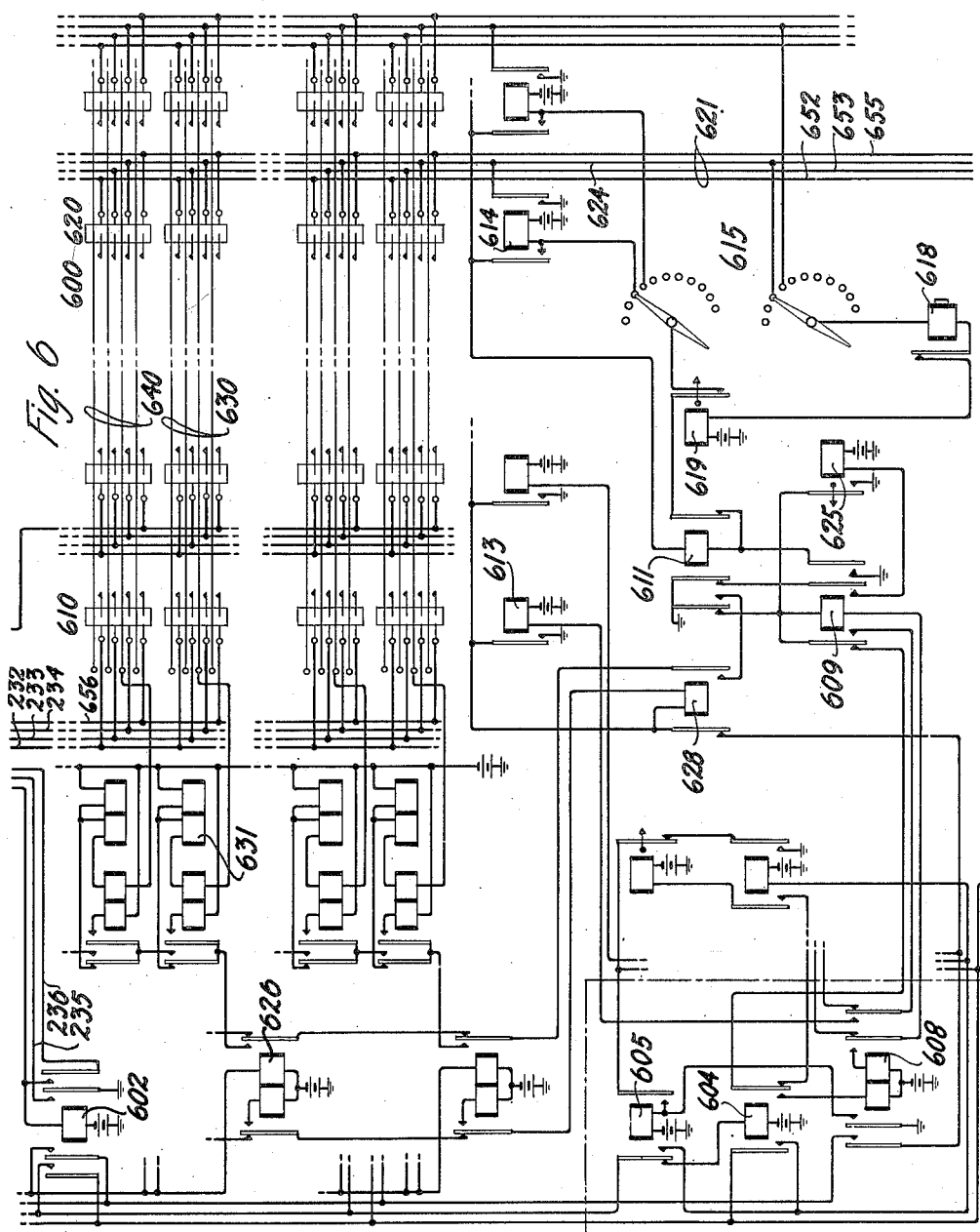
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TELEPHONE EXCHANGE SYSTEM

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14 Sheets-Sheet 6



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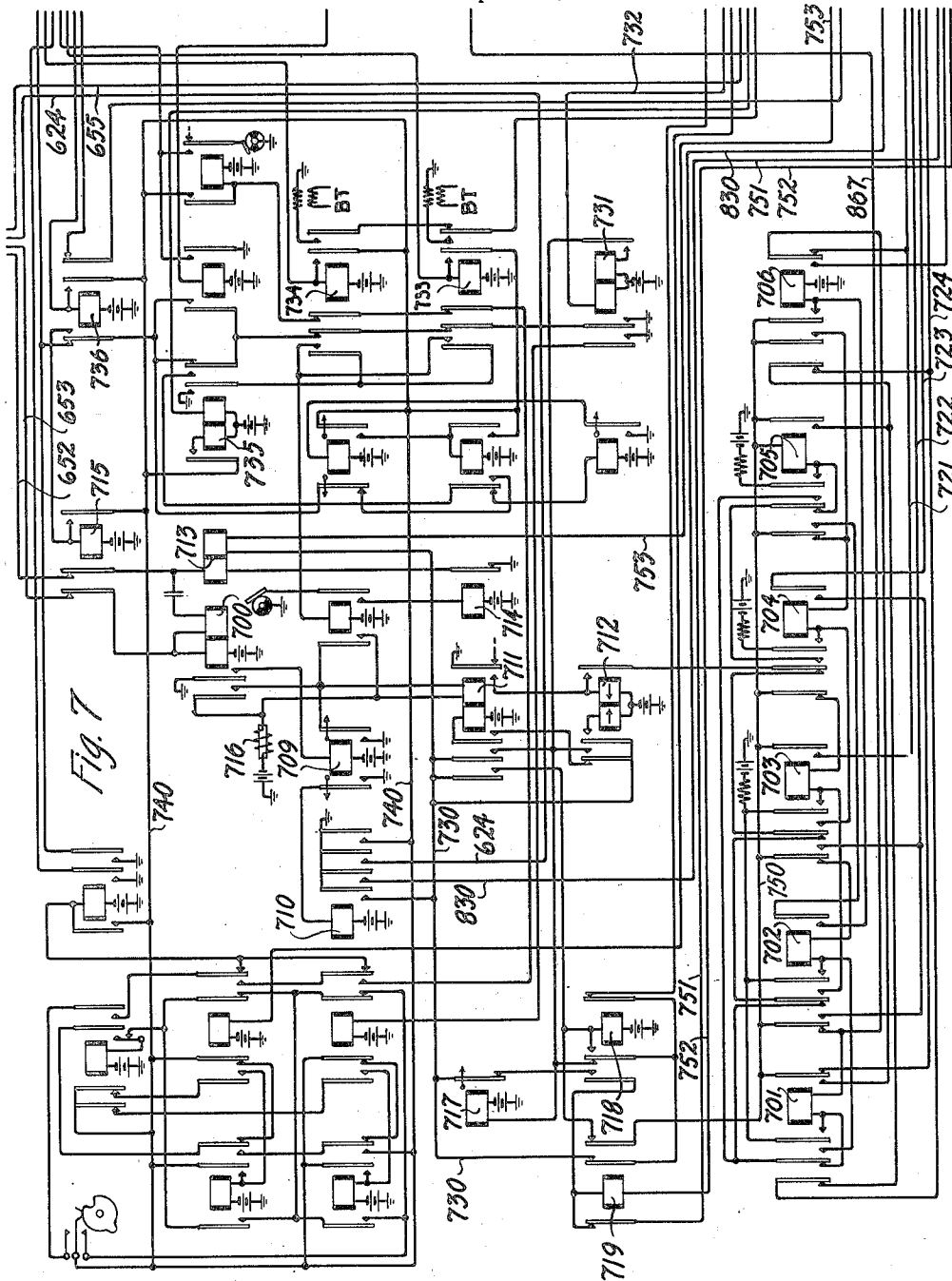
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TELEPHONE EXCHANGE SYSTEM

Filed Sept. 26, 1923

14 Sheets-Sheet 7



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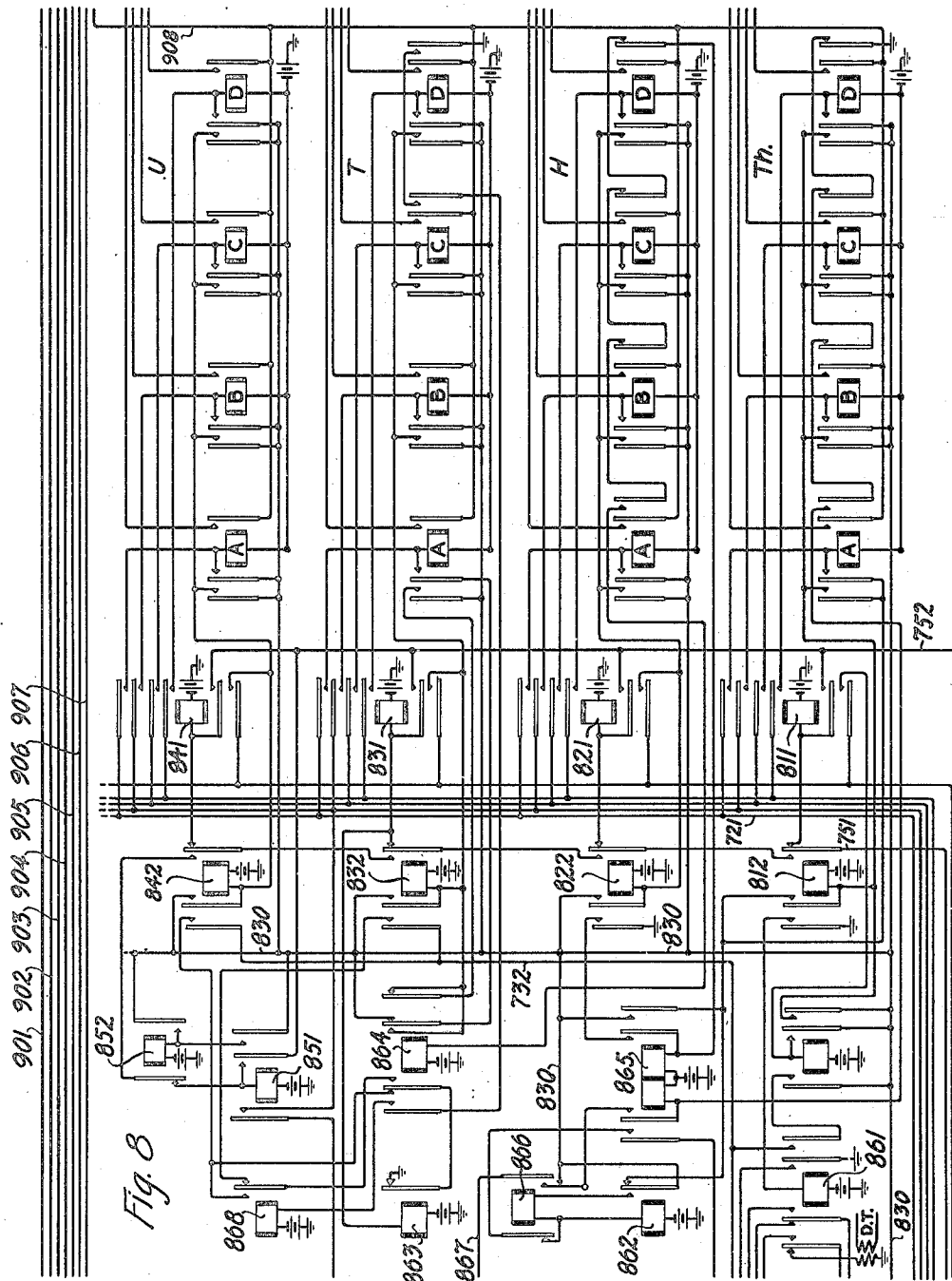
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1,550,769

TELEPHONE EXCHANGE SYSTEM

Filed Sept. 26, 1923

14 Sheets-Sheet 8



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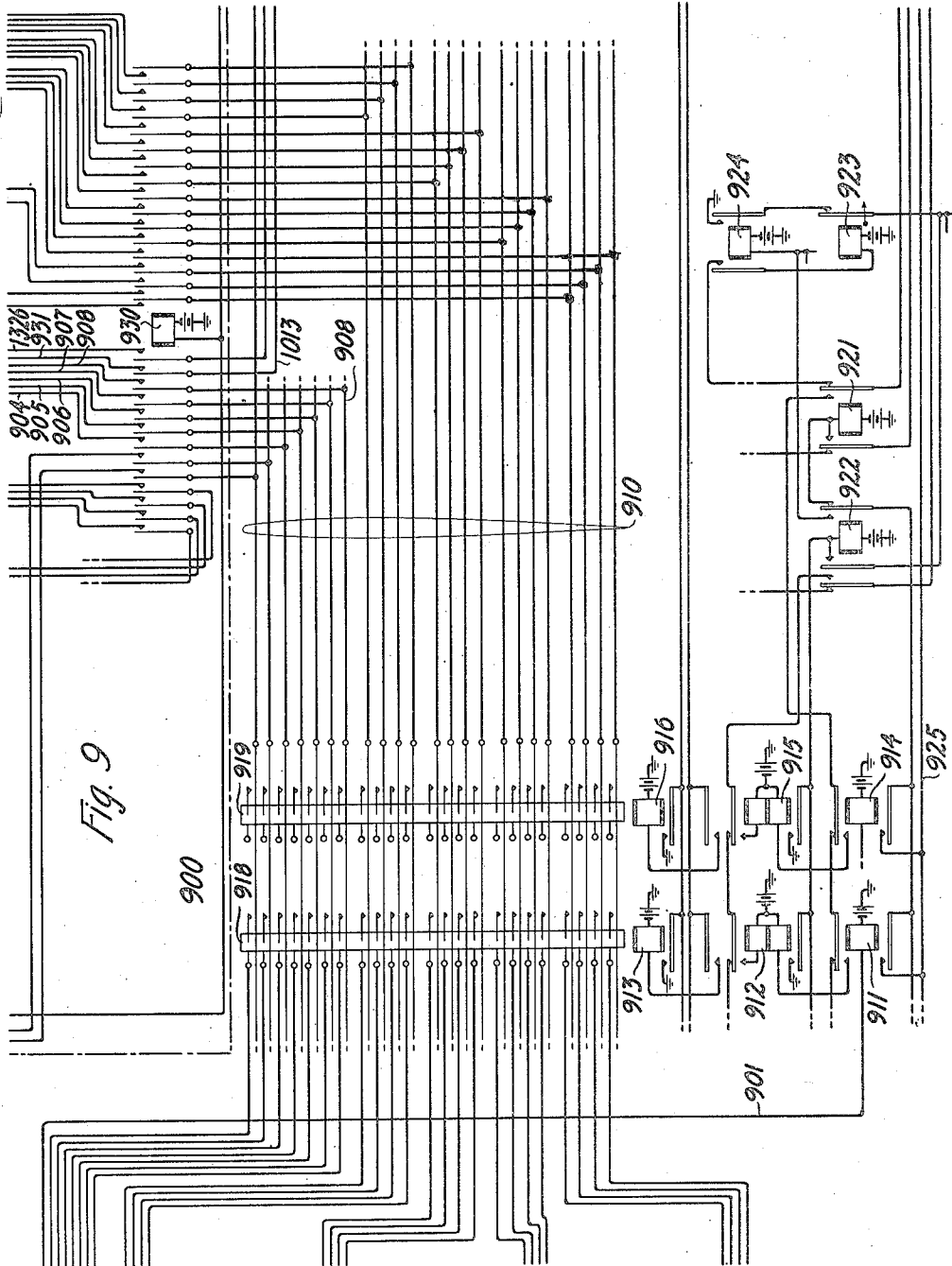
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TELEPHONE EXCHANGE SYSTEM

Filed Sept. 26, 1923

14 Sheets-Sheet 9



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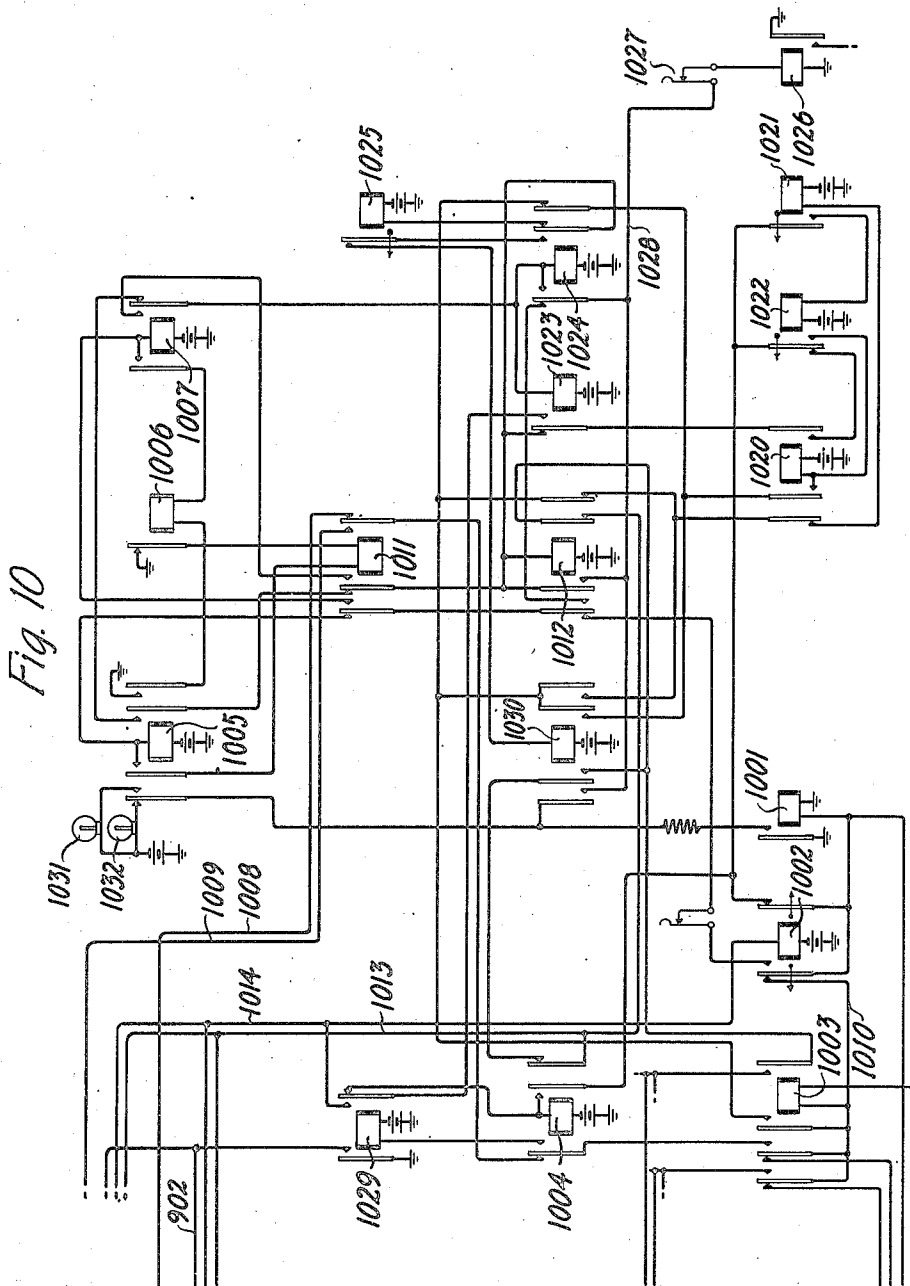
S. B. WILLIAMS

1,550,769

TELEPHONE EXCHANGE SYSTEM

Filed Sept. 26, 1923

14 Sheets-Sheet 10



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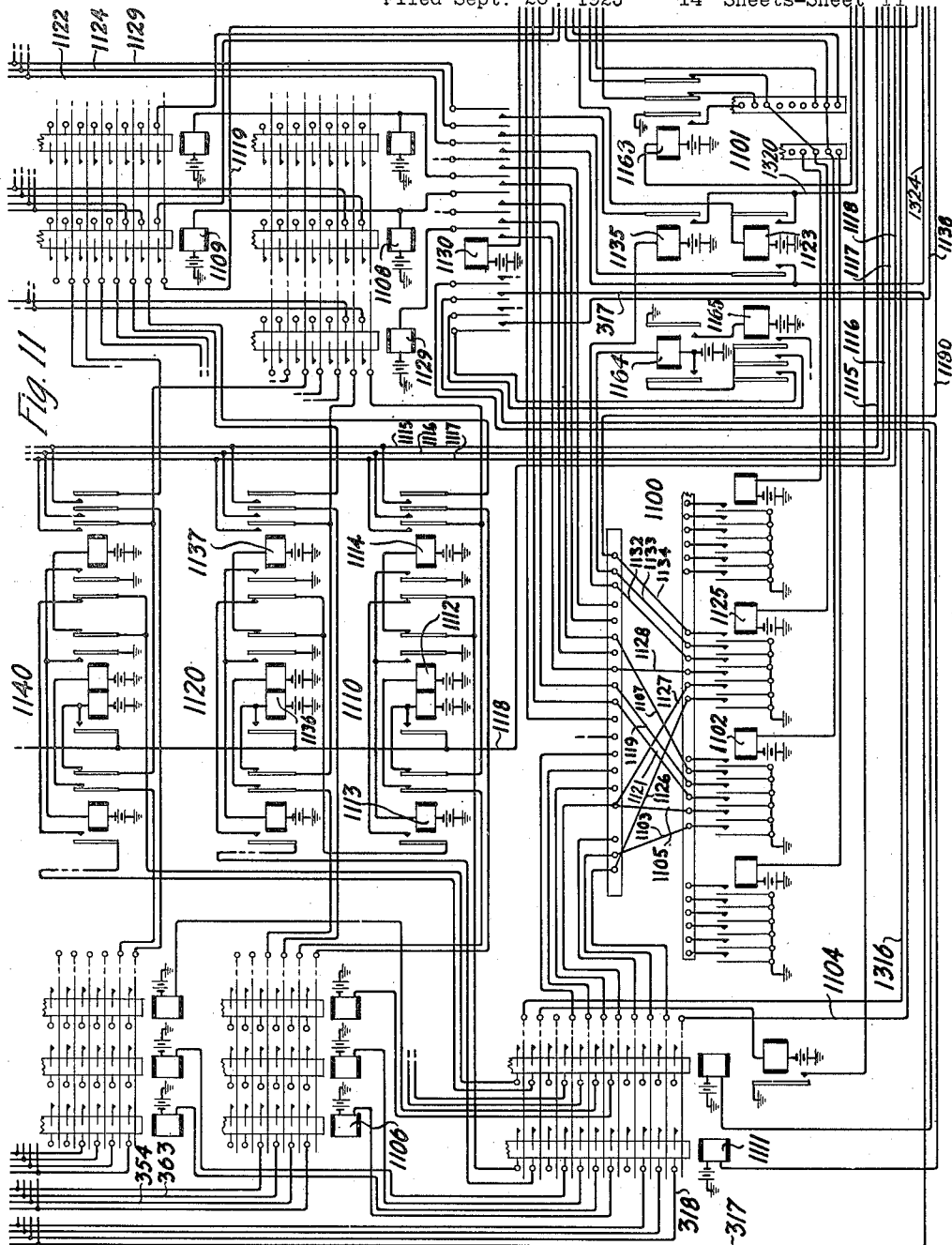
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TELEPHONE EXCHANGE SYSTEM

Filed Sept. 26, 1923

14 Sheets-Sheet 11



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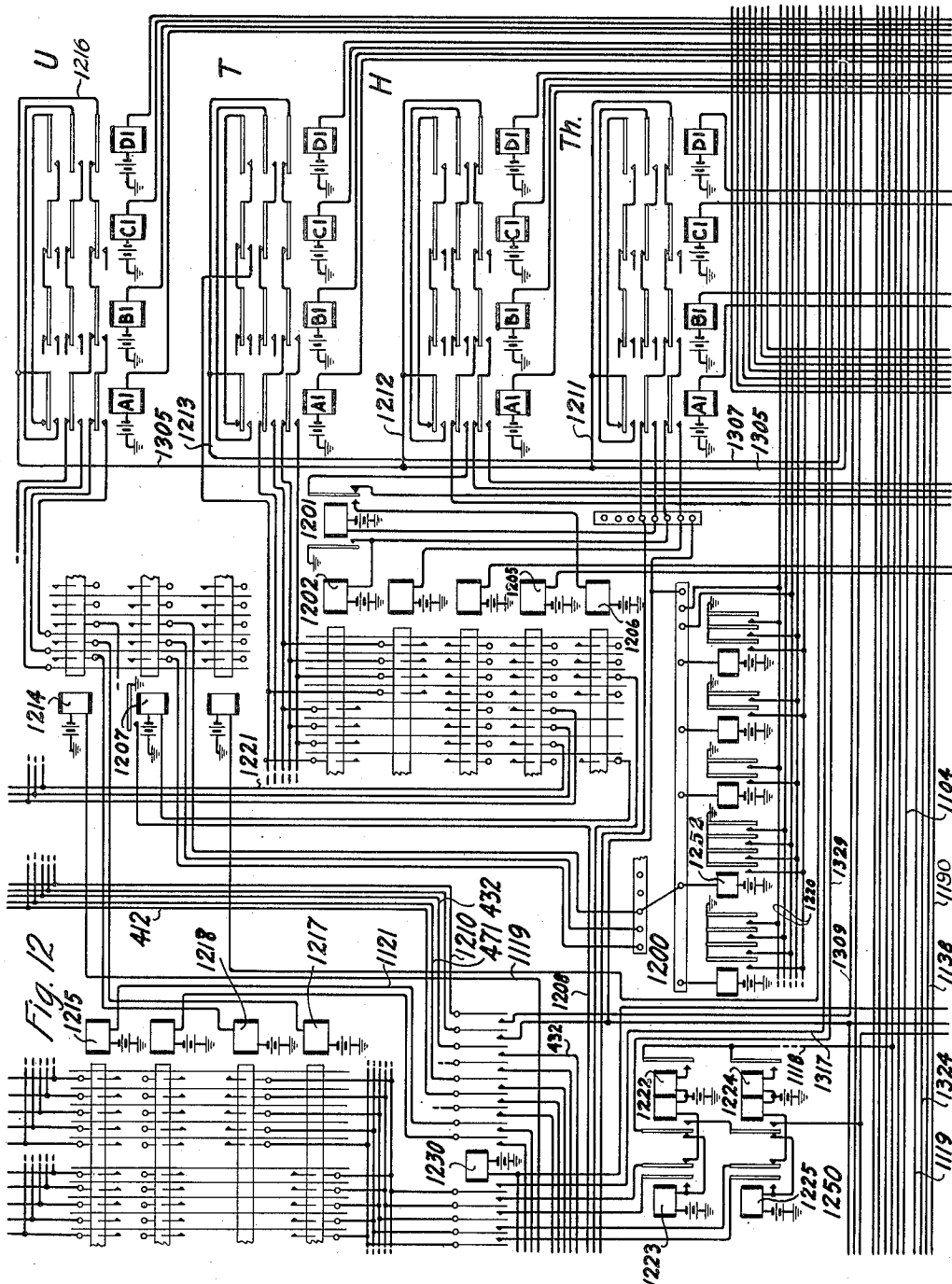
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TELEPHONE EXCHANGE SYSTEM

Filed Sept. 26, 1923

14 Sheets-Sheet 12



Inventor:
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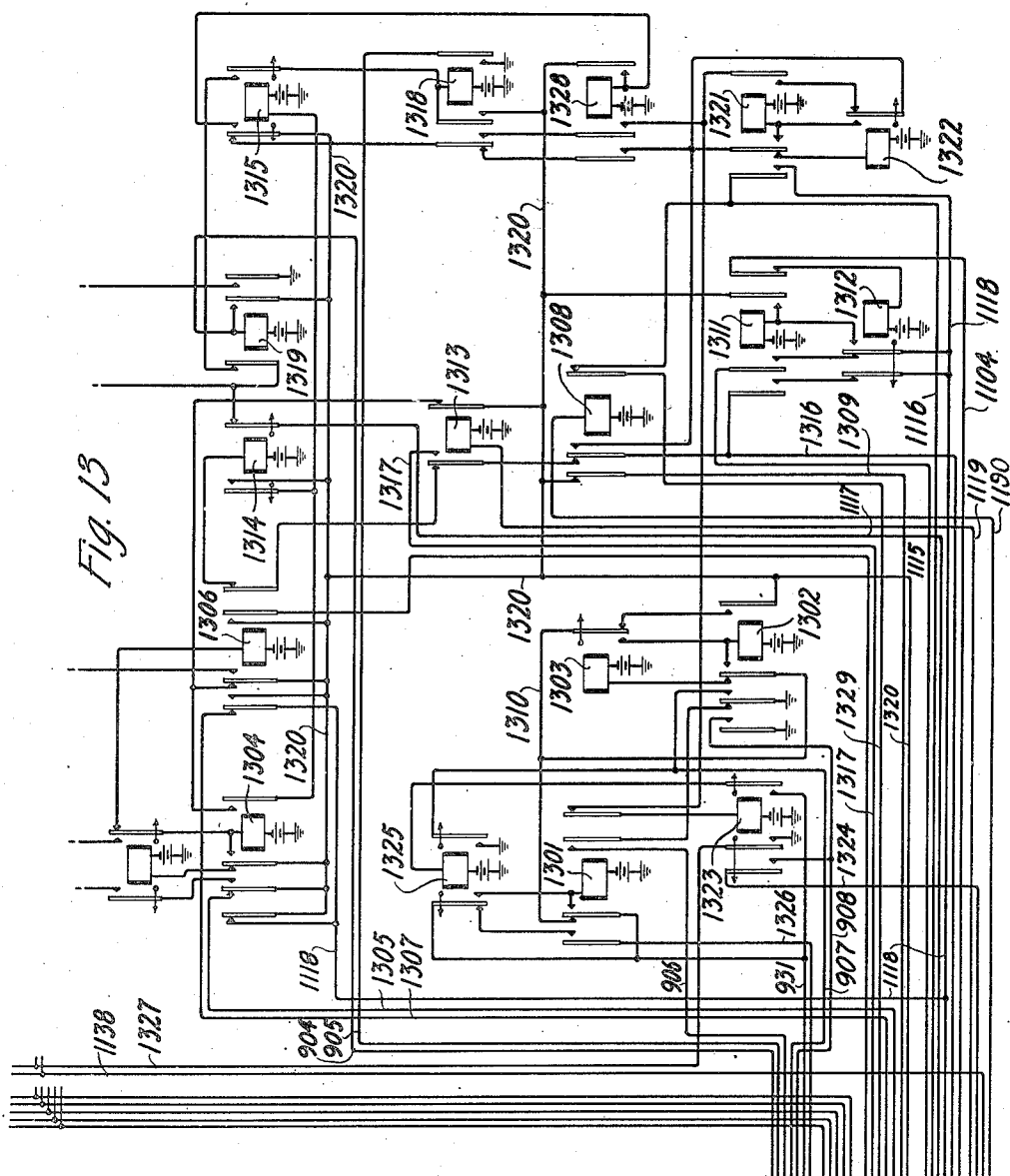
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S. B. WILLIAMS

TELEPHONE EXCHANGE SYSTEM

Filed Sept. 26, 1923

14 Sheets-Sheet 13



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S. B. WILLIAMS

TELEPHONE EXCHANGE SYSTEM

Filed Sept. 26, 1923

14 Sheets-Sheet 14

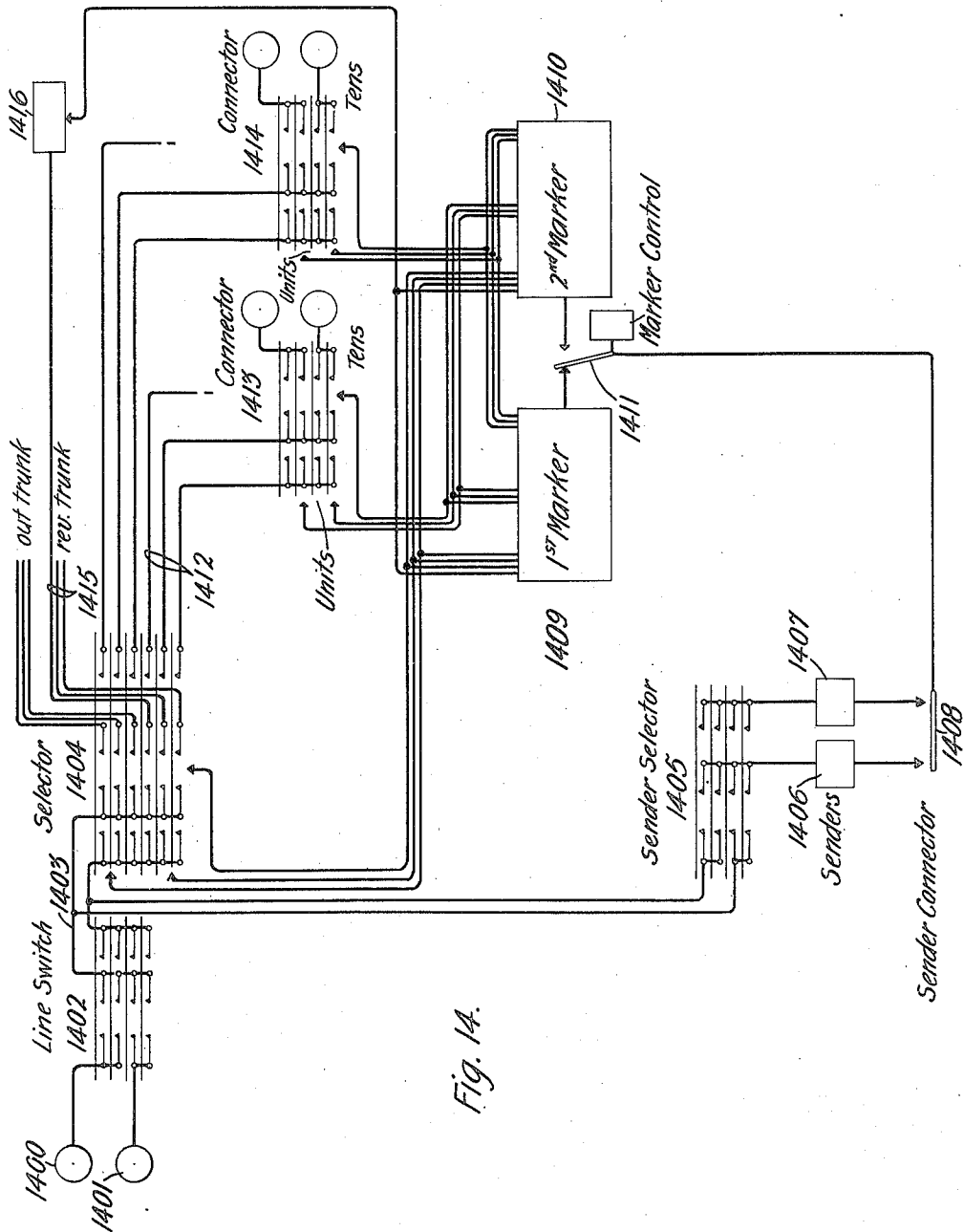


Fig. 14.

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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 September 26, 1923. Serial No. 664,825.

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.

This invention relates in general to telephone exchange systems and more particularly to exchange systems of the class wherein automatic switching apparatus is used for setting up conversational connections.

The principal object of the invention is to improve the organization of recording and controlling equipment for exercising a quick and reliable control over the selective switches in a telephone system.

A feature of the invention is to provide a plurality of equivalent switch controlling mechanisms, each associable with common recording devices, and also with any of a number of selector switches at a switching stage for selectively operating such switches.

Another feature relates to the provision, in a system of the foregoing character, of a plurality of switch controlling mechanism each associable with the selector switches at a number of stages for selectively operating a switch at each stage.

A further feature consists in so arranging the switch controlling mechanisms that when one of them is unserviceable another will handle its share of the calls until the disabled mechanism is restored to service.

Other features and advantages of the invention will be more clearly understood from the following detailed description and also from the appended claims.

Referring to the drawing, Figs. 1 to 13, inclusive, when arranged in the order illustrated in Fig. 15, disclose an automatic telephone exchange system embodying the features of the present invention.

Fig. 1 illustrates a line switch of the coordinate type for extending subscribers' lines to trunks.

Fig. 2 shows one of the trunk circuits in full leading from the line switch to the first group selector.

Fig. 3 illustrates a portion of one of a

number of first group selector switches of the coordinate type.

Fig. 4 illustrates one of a number of coordinate connector switches which serves to complete connections to the called subscribers' lines.

Fig. 5 illustrates a special circuit employed for reverting calls.

Fig. 6 shows a sender selector switch of the coordinate type which serves to associate the trunks with idle register senders.

Figs. 7 and 8 illustrate one of the recording devices or register senders as they will be termed hereinafter.

Fig. 9 shows a multicontact relay connecting device for associating the register senders with the switch controlling mechanisms or markers.

Fig. 10 illustrates a controlling circuit arrangement common to a number of the switch controlling markers.

Figs. 11, 12 and 13 disclose one of the switch controlling mechanisms or markers.

Fig. 14 is a schematic diagram of the system.

Fig. 15 is a diagram showing the manner in which the various figures of the drawing are to be arranged.

The line switch 100, the selector and connector switches 300 and 400 and the sender selector switch 600 are coordinate switches in which incoming circuits are connected to outgoing circuits through the medium of horizontal links. The operating contacts are actuated by means of coordinate vertical and horizontal bars. For a clear understanding of the construction and the operation of switches of this character reference is made to the patent to S. B. Williams, No. 1,517,331, issued Dec. 2, 1924.

General arrangement of the system.

It is believed that a better understanding may be had of the system and of the features of invention embodied therein by first considering the general plan illustrated in the diagram of Fig. 14. In this diagram the subscribers' lines, two of which, 1400 and 1401, are illustrated, enter the exchange and terminate in vertical rows of contacts on the line switch 1402. The line switch 1402 operating in response to the initiation of the call extends the calling

line over an idle trunk 1403 to the first selector switch 1404. At the same time the trunk 1403 is extended through a sender selector switch 1405 to one of a plurality of senders 1406, 1407, etc.

The subscriber now manipulates his sending transmitter and stores up in the selected sender, the record of the called subscriber's line. Thereafter, the sender through a connecting device 1408 is associated with one of two equivalent markers 1409 and 1410. The markers are arranged to be taken for use in alternation. If both are idle the marker 1409 will be taken for use when a call arrives. Thereupon, the switching device 1411 is adjusted to render the second marker 1410 available for the next call. If, while the second marker 1410 is in use, the first marker is released, the device 1411 will be readjusted so that the next succeeding call is handled by the first marker 1409. Should either of the markers become disabled for any reason, the switching device 1411 would throw the other marker into service permanently so that all incoming calls thereafter will be handled by the available marker until such time as the disabled marker is restored to service.

Following the attachment of the sender to the marker as above outlined, the record of the called subscriber's line is transferred from the sender into the associated marker. The marker, thereupon determines the selection of the vertical row of contacts which represents the group of called subscribers' lines containing the desired line. These called subscribers' lines appear in a number of coordinate connector switches 1413, 1414, etc. and each such switch accommodates a plurality of the groups of lines. Therefore, it is necessary for the marker not only to determine which of the connectors shall be taken for use, but also to determine the particular vertical group of contacts in that connector in which appears the called line. Having fixed the vertical row of contacts containing the called line in the connector switch 1413, the marker determines the selection of a group of trunks 1412 outgoing from the selector switch 1404 and terminating in the switch 1413.

Following this the marker determines the selection of an idle trunk in the group 1412 and also determines an idle horizontal link in each of the switches 1404 and 1413 and then operates the horizontal magnets to extend the calling line through the switches to the called subscriber's line. Upon the completion of the connection the marker is released and immediately thereafter the register sender is also disconnected.

Should the calling subscriber desire connection with a party line the marker is arranged to receive information as soon as

connection has progressed to a point where the called line is ascertained in the connector switch. This information in the marker is then transferred through the first selector switch 1404 to the trunk circuit incoming from the line switch 1402 where it serves to determine the selection of the proper code of ringing current to be applied to the party line. As will be seen hereinafter for four party lines a semi-selective ringing arrangement is employed in the present system. Each party line has four appearances in the connector switch, two of which are reversed as regards the tip and ring conductors. The ringing equipment in the trunk circuit is adapted to apply a code consisting of either one ring or two rings with the usual intervening intervals. By selecting one of two different codes by use of the marker and by reversing the tip and ring conductors of the connector switch terminals, two bells on the party line may be rung at a time either with one short ring or with two short rings. The parties at these two substations will differentiate their bells by means of the codes.

In the event that the subscriber on a party line wishes to make a reverting call, namely, one to another substation on the same line, the marker receives special information from the recording sender. By the use of this information the marker determines the operation of the first sector switch 1404 to select one of a number of special trunks 1415, each including a reverting ringing equipment 1416. In this case the connector switch 1413 is dispensed with entirely. Having selected a reverting ringing equipment 1416, the proper ringing condition is ascertained from the marker and is applied to the party line to ring both the called and calling subscribers' bells.

Detailed description of establishment of a connection—Local office call.

It will first be considered that the subscriber of line 101 wishes to converse with another subscriber whose call number is 2 1 3 2.

When the calling subscriber removes his receiver from the switchhook a circuit is closed from battery, through the winding of relay 102, outer back contact of relay 103, through the subscriber's loop, inner back contact of relay 103 to ground. Relay 102 operates and closes a circuit from battery through relay 104, left back contact of relay 105, conductor 106, outer contact of relay 102, conductor 107 to ground. Relays 104, 105 and 108 enclosed within the broken rectangle pertain to the vertical group of lines in the row 110 of switch 100. These relays are brought into action whenever one of the

lines of the corresponding group initiates a call.

Relay 104 now closes a circuit from battery through the left-hand winding of relay 108, right front contact of relay 104, left back contact of relay 109 to ground at the outer left back contact of relay 111. Relay 108 energizes and locks over its inner right front contact, winding of relay 109 to ground at relay 111. Relay 109 energizes and closes an obvious circuit for slow release relay 125. Relay 109 also closes a circuit from battery through the vertical operating magnet 113, outer right front contact of relay 108, left front contact of relay 109 to ground at relay 111.

Relay 108 closes a circuit for relay 105, which energizes. Relay 112 was operated over the left front contact of relay 104, conductor 107 to ground. Relay 105 now opens the circuit for relay 104 which releases and opens the operating circuit for relay 112, but this circuit was previously replaced by a multiple path over the left front contact of relay 105 and outer front contact of relay 102. Relay 112 closes a holding ground for relay 105.

Relay 109 also closes a circuit from battery through vertical operating magnet 114, terminal and switch arm 116 of allotter switch 115, back contact of relay 119, right contact of relay 111 to ground at outer right front contact of relay 109. The allotter switch 115 has a position for each of the several trunks which lead out from the line switch 100 to succeeding selector switches. The allotter switch 115 is operated by magnet 118 and will always take a position of rest corresponding to an idle trunk. Switch 115 is assumed to have been previously operated to find the idle trunk 121. Consequently, vertical operating magnet 114 is now operated and locks itself over the winding of relay 111 to ground at relay 109. Relay 111 being shunted at this time does not operate.

The magnets 113 and 114 operate and prepare the contacts in vertical rows 110 and 120, respectively. Magnet 114 closes a circuit which may be traced from battery through the winding of relay 602, left back contacts of relays 202 and 203, conductor 124 to ground at magnet 114. Relay 602 operates and at this time starts a series of operations in the circuit provided for the sender selector 600 in a manner similar to the operations described for the line switch 100. Magnet 114 also closes a circuit traceable from battery, winding of relay 119, contact and winding of stepping magnet 118, switch arm 117 and test-terminal of switch 115, conductor 124 to ground at magnet 114. Relay 119 is slow to release and keeps the circuit for switch arm 116 open during the stepping operation of switch 115. Magnet

118, in operating the switch 115, opens and closes its own circuit and advances the brushes 116 and 117 to a test-terminal to which no ground is applied by a vertical operating magnet or otherwise. Relay 119, in operating, opens the shunt around the winding of relay 111. Relay 111, therefore, operates in series with the winding of magnet 114. Relay 111 opens the circuit for relay 125 which is made slow to release in order to permit certain operations to take place before its armature is completely retracted.

When magnet 113 operated it closed a circuit which may be traced from battery, right-hand winding of relay 126, inner left front contact of relay 102, conductor 127, outer left contact of relay 108, contact of relay 128 to ground at magnet 113. Relay 126 is common to a group of horizontal operating magnets 144, 132, any one of which is able to connect the calling line to an outgoing trunk. With each horizontal operating magnet is associated a relay 133, 134 which will cause an incoming call to be extended to an idle link in the line switch 100. It will be assumed that the first link 130 of the group associated with the calling line is idle. Relay 126, in operating, closes a locking circuit for itself through the winding of relay 128 to ground at magnet 113. Relay 128 operates in this circuit. Relay 126 now extends a circuit for horizontal operating magnet 144 which may be traced from battery through the right-hand winding of magnet 144, left back contact of relay 133, right front contact of relay 126, front contact of relay 128 to ground at relay 111, when relay 111 operates as above described. Horizontal operating magnet 144 now operates and causes the connection to be established between the link 130 and a set of contacts in vertical row 110 and also with a set of contacts in vertical row 120. The subscriber's line is thereby extended through to the trunk 121.

Ground at magnet 114 now is extended through the winding of relay 131, conductor 134, contact in vertical row 120 and wire of link 130, through the right winding of relay 133, both windings in series of magnet 144 to battery, thus providing a holding circuit for magnet 144. The ground at magnet 114 is also extended from the wire of link 130, through contact in vertical row 110 and through the winding of cut-off relay 103 which now operates. Relay 102 deenergizes and causes the release of relay 112, provided that no other call is waiting.

Relay 602 in operating closed a locking circuit for itself over its outer right contact, conductor 236 to ground at the inner back contact of relay 204. Relay 602 also connects ground to conductor 235 through relay 203 to battery. Relay 203 energizes

and connects ground at its left front contact to conductor 124. The complete release of relay 125 can now take place and will cause the release of magnet 113, which in turn, opens the holding circuit for relays 128 and 126 which both release. Relay 125 also opens the holding circuit for relays 109 and 108. The release of relay 108 next causes the release of relay 105. The release of relay 109 opens the holding circuit for relay 111 and magnet 114. The release of relay 128 opens the operating circuit for horizontal magnet 144 which now holds up through the winding of relay 133 as previously traced to ground on conductor 124. The shunt is now removed from the operating winding of relay 133 and this relay energizes and in so doing shifts the operating circuit for magnet 144 on to magnet 132, which now will be ready to take the next call in the same horizontal group. With the magnets 113 and 114 deenergized and the allotter switch 115 at rest the line switch 100 is in readiness to extend another call.

Turning now to the operation of the sender selector 600, the operation of relay 602 closes circuits for relays 604, 605, 608 and 609, in the same manner as described for relay 102 in the line switch circuit. Vertical magnet 613 is operated over a circuit from battery through its own winding, outer right front contact of relay 608, left front contact of relay 609 to ground at relay 611. Vertical magnet 614 is operated from battery through its own winding, terminal and brush arm of the allotter switch 615, contacts of relays 619 and 611 to ground at relay 609. Vertical magnet 613 connects ground to horizontal group relay 626, which operates and locks in series with relay 628 and the operation of the horizontal magnet 631 takes place as soon as relay 611 energizes in the holding circuit for magnet 614. The vertical magnet 614 connects ground to the test bank of allotter switch 615 which will step forward to the set of terminals corresponding to the next idle vertical operating magnet. Relay 625 energized at the time relay 609 was energized and its release was subsequently started when relay 611 operated. Relay 625 is slow to release in order to provide time for certain operations to take place before its complete release.

With horizontal magnet 631 and vertical magnets 613 and 614 operated, contacts in vertical rows 610 and 620 will now close with the wires in horizontal link 630 and the connection is thus established between the circuit of trunk 121 and the sender shown in Figs. 7 and 8. Ground from magnet 614 is extended to hold horizontal magnet 631 in a manner similar to that described for magnet 144 of line switch 100.

The ground at the right contacts of magnet 614 is also connected by means of a contact in vertical row 610, conductor 234, winding of relay 204 to battery. Relay 204 energizes and connects the subscriber's loop through the sender selector 600 to the sender circuit in Fig. 7. A circuit is now completed from battery through the left winding of relay 700, outer left contact of relay 715, conductor 653, contacts and wire of link 630, conductor 233, lower front contact of relay 204, conductor 123, contacts and wire of link 130 of line switch 100, conductor 143, subscriber's loop, conductor 142, contacts and wire of link 130, conductor 122, upper front contact of relay 204, conductor 232, contacts and wire of link 630, conductor 652, inner left contact of relay 715, left winding of coil 713 to ground at relay 714. Relay 700 operates in this circuit and connects ground to relay 709. Relay 709, in turn, operates relay 710 and a holding ground is now extended from the second outer front contact of relay 710 to conductor 624. Slow-to-release relay 625 can now complete its release and the release of vertical magnets 613 and 614 of the sender selector will take place in a manner similar to the release of the vertical magnets of the line switch 100 as described above. Horizontal magnet 631 will be held energized by the holding ground just described on conductor 624. Relay 602 was released at the time relay 204 operated and the release of the remaining relays related to the sender selector will take place as described above for similar relays associated with the line switch 100, so that the sender selector 600 will again be in a position to extend a connection from another trunk to another sender.

The operations so far described were caused by the removal from the switchhook of the subscriber's receiver. At the time relay 710 operated a circuit was completed from ground at its innermost front contact, conductor 730, through the right winding of coil 713, conductor 753, outer left back contact of relay 861 to a source of dial tone. This tone is transferred by induction from the right to the left winding of coil 713, and may thus be heard by the subscriber who then will set his dial for the sending of the first digit. The circuit is in a condition to receive the first series of two impulses.

The first break in the line circuit causes relay 700 to release and open a short circuit across the right winding of relay 711 which will operate in a circuit from battery, through coil 716, right winding of relay 711 and right front contact of relay 709. Relay 711 energizes and operates relay 712 which locks over its inner left contact to conductor 730 which is grounded at relay

710. The complete operation of relay 712 is insured by the locking of relay 711 over the outer left back contact of relay 712 to grounded conductor 730. Relay 717 was operated over a circuit from battery through the winding of relay 717, left back contact of relay 718, inner right back contact of relay 719 to ground on conductor 730. Another circuit is now closed from battery through the winding of relay 717, middle left contact of relay 711 to grounded conductor 730. A circuit is also closed from battery through the winding of relay 718, outer left contact of relay 711 to conductor 730. Relay 718 energizes and locks over its inner left contact and inner right contact of relay 719 to conductor 730. Relay 712, in operating, extends a circuit from ground at right contact of relay 711, over the right contact of relay 712, left middle back contacts of relays 704, 703, 702 and 701, winding of relay 701, outer left back contact of relay 702 to the holding conductor 750, outer right contact of relay 719, outer left contact of relay 711 to grounded conductor 730. The winding of relay 701 is thus short circuited.

When the line circuit is again completed relay 700 energizes and again shunts the operating winding of relay 711 which, therefore, releases its holding circuit having been opened by the operation of relay 712. The ground at right contact of relay 711 is thereby removed from the circuit described for relay 701, which circuit now includes the right winding of relay 712 and battery. The first counting relay 701 therefore operates and locks itself to battery over its inner left contact, and thereby places a shunt around relay 712. Relay 712 is differentially wound and the current in the right-hand winding is now so much reduced that the relay will release, the release being accelerated by the left-hand winding. It will be noted that relays 709 and 717 are slow to release and, therefore, are maintained energized during the reception of impulses. Upon the second break in the line circuit relay 700 again deenergizes. Relays 711 and 712 again energize as just described. Ground from the right contact of relay 711 is now extended over the right contact of relay 712, middle left back contacts of relays 704, 703 and 702, middle left front contact of relay 701 through the winding of relay 702, outer left contact of relay 703 to the holding conductor 750. The second counting relay is now shunted and upon closure of the subscriber's line, relay 700 again energizes, relay 711 deenergizes and relay 702 will energize in series with the right winding of relay 712. Relay 702 locks to battery and shunts the winding of relay 712 which again releases. Relay 702 also opens the holding circuit for relay 701 at its outer

left front contact and relay 701 releases. It should be noted that the inner left contacts of the counting relays 701 to 706 are made to close slightly before the middle left front contacts open so that the holding circuits for these relays are sure to be closed before their operating circuits are opened.

The first series of impulses now having been completed an interval occurs, during which slow-to-release relay 717 will have time to completely release. Ground is thereby extended from conductor 730 over the contact of relay 717, outer left contact of relay 718, left contact of relay 719, conductor 751, right back contact of relay 812, winding of relay 811 to battery. Relay 811 energizes and locks over its lower front contact to conductor 752, through winding of relay 719, left outer contact of relay 718, contact of relay 717 to grounded conductor 730. Relay 719 does not operate in this circuit, being shunted by the previously described circuit. Relay 811 in energizing establishes a connection at its upper front contacts from the counting relays to the relays Th. in the thousands register over conductors 721, 722, 723 and 724. For the present setting of the counting relays a ground will be extended from the grounded conductor 750, over the outer left front contact of relay 702, conductor 722, contact of relay 811, winding of relay B of the thousands register Th. to battery. Relay B locks to conductor 830 which is grounded at relay 710. Relay B further closes a circuit from conductor 830, outer left contact of relay B, through the winding of relay 812 to battery, causing relay 812 to operate and lock over its inner left contact, back contact of relay 862 to conductor 830. Relay 812 closes a circuit for relay 861 which now removes the dial tone from the line circuit and prepares a circuit for the application of busy tone. Relay 812 also opens the energizing circuit for relay 811 and thus removes the short around relay 719 which therefore operates. Relay 719 opens the holding circuit of the counting relays at its outer right contact and at its right inner contact relay 719 opens the holding circuit of relay 718. The counting relay 702 releases and also relay 718, which in turn, opens the circuit for relays 719 and 811 at its outer left contact and relays 719 and 811 release.

Slow-to-release relay 717 now again energizes over the left back contact of relay 718 and the setting of the thousands register is thus completed.

The operation of this circuit in receiving the second digit is similar to that for the first digit as described above, but since only one impulse is sent out, relay 701 will remain energized at the time slow release relay 717 completes its release in the time interval be-

tween the second and third digit. Relay 717 now extends the ground from conductor 730, over its own contact, left outer contact of relay 718, left contact of relay 719, conductor 751, right front contact of relay 812, right back contact of relay 822, through the winding of relay 821 to battery. Relay 821 connects the counting relays to the H relays in the hundreds register and locks itself to conductor 752, through winding of relay 719, contact of relays 718 and 717 to conductor 730. Relay 719 is again shunted as described above. A circuit is now extended from conductor 750, inner right front contact of relay 701, right back contact of relay 706, conductor 721, contact of relay 821, winding of relay A of the hundreds register. Relay A energizes, locks to conductor 830 and closes a circuit at its outer left contact to relay 822 which, therefore, operates and locks. The operating circuit for relay 821 is now open and the shunt removed from relay 719, which operates and causes the release of the counting relay 701 and relay 718. Relays 719 and 821 release and, slow release relay 717 energizes as described for the first digit.

The setting of the hundreds register is thus completed and the circuit is ready to receive the third digit which, in this case, is assumed to consist of three impulses. The operations for the first two pulses will be the same as for the first digit. At the end of the third impulse when relay 711 deenergizes and the shunt is removed from relay 703, this relay energizes over a circuit traced from battery right winding and right front contact of relay 712, middle left back contact of relays 704 and 703, middle left front contact of relay 702, winding of relay 703, outer left contact of relay 704 to ground at conductor 750. Relay 703 operates and opens the circuit for relay 702 and in locking places a shunt around the winding of relay 712 which deenergizes as previously described. When now slow-to-release relay 717 completes its release, ground from conductor 730 is extended over its own contact, outer left front contact of relay 718, left contact of relay 719, conductor 751, right front contact of relays 812 and 822 and right back contact of relay 832, through the winding of relay 831 to battery. This circuit also extends from the right back contact of relay 832, through winding of relay 863. These two relays energize. Relay 863 temporarily removes ground from its armature for purposes as will be described later. Relay 831, in operating, connects the counting relays to the relays T of the tens register and two circuits are now extended by the counting relay 703, from the conductor 750, one to be traced over its outer left front contact, conductor 722, contact of relay 831, winding of relay B to battery. The other circuit

is closed at the right front contact of relay 703, conductor 721, contact of relay 831, through winding of relay A to battery. Relays A and B operate. Relay B locks directly to conductor 830, while A locks over its inner left front contact, inner right back contact of relay 864 to conductor 830. Relay 832 is now operated and locked by the operation of relays A and B. The operating circuit for relays 831 and 863 is opened and the shunt removed from relay 719. The subsequent release of relay 718, 719 and 831 takes place as previously described and slow-to-release relay 717 again energizes.

The circuit is now ready to receive the units digit, which in the case assumed, consists of two impulses. The operations in response to these two impulses are the same as described for the first digit and when relay 717 releases, a circuit is extended from conductor 730, contact of relays 717, 718 and 719, conductor 751, right front contacts of relays 812, 822, 832, right back contact of relay 842, winding of relay 841 to battery. Relay 841 now connects the counting relays to the relays U in the units register and the circuit from the second counting relay 702 will be extended through the winding of relay B which locks and furthermore operates the relay 842. This latter relay also locks and opens the shunt around the winding of relay 719 which operates. The operation of relay 719 and the subsequent release of relays 718, 719 and 841 take place, whereupon relay 717 energizes.

When relay 842 operated a circuit was completed from battery left winding of relay 731, conductor 732, outer left front contact of relay 842, inner left back contact of relay 864 to ground at contact of relay 863. Relay 731 energizes and locks over its own right contact, inner left back contact of relay 718, inner right back contact of relay 719 to conductor 730. Ground is now extended from the inner left front contact of relay 731, middle left contacts of relays 733 and 734, outer right back contact of relay 735, left back contact of relay 736, conductor 901, through relay 911 to battery. Relay 911 energizes and closes a circuit from battery through winding of relay 921, right back contact of relay 922, lower front contact of relay 911, conductor 925, through relay 1001 to ground. Relay 921 operates in this circuit and locks at its left front contact over back contacts of relays 1003 and 1002, through the winding of relay 1001 to ground. A circuit is now completed for the lower winding of relay 912 from battery over the upper front contact of relay 911, upper back contact of relay 914, right front contact of relay 921, through grounded conductor 1010. Relay 912 energizes and extends ground to relay 922 which energizes and closes a holding circuit for itself at its

inner left contact, over contacts of relays 923 and 924 provided relay 924 is operated. Relay 922 also closes a holding circuit for relay 912 from battery over the upper front contact of relay 912, back contact of relay 915, left front contact of relay 922, winding of relay 1003 to grounded conductor 1010. Relay 1003 operates in this circuit and in doing so connects ground from conductor 1010 over the upper front contact of relay 912, to the winding of multicontact relay 913. Relay 1003 at its middle back contact opens the holding circuit for relay 921 which deenergizes. Another circuit closed by relay 1003 extends from grounded conductor 1010, over the middle front contact of relay 1003, left back contact of relay 1004, right back contact of relay 1011, conductor 1008 to relays 930, 1230 and 1130 in multiple to battery in marker No. 1.

The multicontact relay device 900 serves the purpose of connecting various conductors from the several senders to corresponding conductors 910, which, as appears from Fig. 9 lead into the first marker shown in Figs. 11, 12 and 13, but which also connect at the extensions shown in Fig. 9 to the second marker. This marker is for the sake of simplicity not shown in this circuit, but is identical with the one shown. The connections from conductors 910 are shown brought up to armatures of relay 930 of the first marker. The extensions of the conductors 910 will connect to similar armatures of another relay for the second marker corresponding to relay 930.

On examination of the marker circuit shown on Figs. 11, 12 and 13, it will be found that numerous conductors extend from the marker and connect to various points at the selector switch 300 and the connector switch 400 and also the reverte ring trunk shown in Fig. 5. Other conductors are assumed to connect to other selectors and connectors (not shown in the drawing). Multiple taps on these conductors as shown in the upper part of Figs. 11, 12 and 13, lead to corresponding points in the second marker. Each marker will thus have access to all switches and trunks in the exchange.

The multicontact relay device 900 is provided with magnets 913, 916 and others which by means of pull bars 918 and 919, respectively, are able to close the various contacts for the senders. Thus all the conductors leading from the sender shown in Figs. 7 and 8 are now connected by the operation of relay 913 to the conductors 910 and by the operation of relay 930, further extended to various points in the first marker. The multicontact relays of the device 900 and their individual operating circuits may be grouped and each group controlled by common relays 922 and 921 for the pur-

pose of extending the operating leads from one group to another, in order that the particular sender selected by the sender selector may be connected to the conductors 910 and thus to the markers.

Returning now to the operation of relay 1003, a circuit was closed from ground at the lower contacts of relay 913, right contact of relay 1003, inner right contact of relay 1012, conductor 1013, contact of relay 930, conductor 931, inner left back contact of relay 1301, inner left back contact of relay 1302, winding of relay 1303 to battery. Relay 1303 operates and extends the circuit just traced over its front contact to relay 1302 which energizes and locks to the grounded circuit just traced. Relay 1303 is slow to release and will commence its release at this time allowing the following operations to take place before its complete release. Relay 1302 connects ground over its middle left front contact, conductor 907, leading over contacts of relay 930 and multicontact relay 913, conductor 907, outer right contact of relay 736, inner left front contact of relay 861, conductor 655, contacts and wire of link 630 of sender connector 600, conductor 656, through winding of vertical operating magnet 313 of selector 300. Magnet 313 operates and prepares the contacts in vertical row 310 associated with the trunk 221.

The selector frame 300 consists of two main sections. In the left-hand sections each incoming trunk from the line switches is multiplied to all contact wires in a corresponding vertical row. The right-hand section has a set of contact springs for each one of all the trunks leading to all connector frames in the exchange. The horizontal links are divided into a number of groups in such a manner that in general the trunks leading from a vertical row of such a group will all lead to one connector frame. One special group of trunks leads from one such group of contacts to a group of reverting ringing trunks, such as the one shown in Fig. 5. Other groups of trunks may lead to operators' positions etc. The selector 300 thus has access to all connector frames and all special trunks in the exchange. The outgoing trunks from the selector are furthermore multiplied to corresponding points in other selectors similar to selector 300. Each selector is provided with a special link 370 for temporarily connecting certain relays of the trunk circuit to the marker as will be described later. The horizontal operating magnet 351 for this link is operated immediately after the operation of magnet 313, thus establishing the above mentioned connection between the trunk circuit and the marker.

When relay 1302 operated it also extended ground over its outer left front contact, conductor 908 which leads over contacts of relay 930 and multicontact relay 900 to all right-

hand armatures of the register relays. These armatures are connected to sets of decoding register relays Th, H, T and U shown in Fig. 12 by the operation of multicontact relay 900 and relay 930. The ground extended from relay 1302 as just described will now be connected over contacts of such relays in the register which were set by the subscriber's dial impulses and will operate corresponding decoding relays. The register setting is thus transferred to the marker.

After a short interval slow-to-release relay 1303 completes its release and ground will be extended from grounded conductor 1310, over back contact of relay 1303, front contact of relay 1302, conductor 1320, left middle contact of relay 1304, conductor 1305 to armatures of decoding relays Th, H and U. Another circuit is also closed from conductor 1320, outer left contact of relay 1304, outer left contact of relay 1306, conductor 1307 to armatures of decoding relays T. Since relay B¹ of the thousands relays is operated ground is further extended from conductor 1305, conductor 1211, over back contacts of relays D¹ and C¹, lowermost front contact of relay B¹, back contact of relay A¹, winding of multicontact relay 1202 to battery. Since relay A¹ of the hundreds relays is operated, ground is also extended from conductor 1305, over conductor 1212, back contacts of relays D¹, C¹ and B¹, middle front contact of relay A¹, back contact of relay 1201, contact of relay 930, through winding of multicontact relay 1205 to battery. Multicontact relays 1202 and 1205 operate and with relays A¹ and B¹ operated in the tens decoding relays, ground will be extended from conductor 1307, over conductor 1213, lower back contacts of relays D¹ and C¹, lower front contact of relays B¹ and A¹, contacts of multicontact relays 1202 and 1205, conductor 1221, winding of vertical operating magnet 415 of connector switch 400 to battery.

The connector switch 400 is divided into two sections, each incoming trunk from the selectors is multiplied to all contacts in a vertical row in the left-hand portion of the switch. The switch is further divided in a number of horizontal groups and each outgoing line from the right-hand section of the switch is multiplied to a vertical row of contacts of such a group. An additional horizontal link is provided for each horizontal group for testing purposes. By the operation of magnet 415 the contacts of vertical row 420 are prepared, this being the row in which the called subscriber's line is found.

When relay 1303 released the grounded conductor 1310 was extended over outer left contact of relay 1308, conductor 1309, contact of relay 1230 to conductor 1210. This ground is now further extended over con-

tact of magnet 415 to conductor 471, contact of relay 1230, distributing frame 1101, relay 1102 to battery. The contacts of relay 1102 are cross connected at the cross connecting frame 1100 to a number of conductors for the purpose of locating such trunks which lead into the connector in which magnet 415 has been operated. The operation of relay 1102 thus completes a number of circuits, one of which may be traced from ground, contact of relay 1102, conductor 1103, contact of multicontact relay 1111, winding of magnet 314 of the selector switch to battery. It should be noted that contacts of multicontact relay 1111 were closed when this relay was operated from battery over its own winding, contact of relay 1130, conductor 317 to ground at magnet 313. Magnet 314 operates and prepares the contacts in vertical row 330 and also connects ground over conductor 318, contact of relay 1111, conductor 1104, right outer contact of relay 1311, winding of relay 1312 to battery. Relay 1312 is operated in this circuit and extends the grounded conductor 1118 over its left inner front contact, through winding of relay 1311 to battery. This relay now operates and locks to grounded conductor 1320, and opens the circuit for relay 1312 which is slow to release and at this time commences its release, allowing time for subsequent operations to take place.

Another circuit closed by relay 1102 extends from ground over conductor 1105, through multicontact relay 1106 to battery. Multicontact relay 1106, in operating, connects a group of testing relays 1110, 1120, etc. to the links of selector 300 at which the trunks from the connector selected appear. Another circuit closed by relay 1102 may be traced over conductor 1107, contact of relay 1130, through the windings of multicontact relays 1108 and 1109 in multiple to battery. These multicontact relays, in operating, connect the test relays 1110, 1120, etc. to the trunks leading from the selected connector switch and to the corresponding vertical operating magnets of said connector. The test relays serve the purpose of finding an idle link in the selector 300 and also an idle trunk from the connector 400.

Considering the operation of the set of test relays 1110, a circuit may be traced from battery through the right winding of relay 1112, inner right contact of relay 1113, contact of multicontact relay 1106, conductor 354 to the sleeve wire of link 360. Another circuit may be traced from battery over the left winding of relay 1112, outer right contact of relay 1113, contact of multicontact relay 1108, to the sleeve conductor 324 of trunk 321. It will be assumed that link 360 as well as trunk 321 are idle. Relay 1112 thus remains deenergized,

An interval after the testing operation has taken place, relay 1312 completes its release and the ground applied to conductor 1320 will now be extended over the outer left back contact of relay 1304, conductor 1118 the outer back contact of relay 1312, outer left contact of relay 1311, conductor 1316, contacts of multicontact relay 1111, outer right contact of relay 1112, winding of relay 1114 to battery. Relay 1114, in operating, connects ground to the winding of relay 1113 which operates and disconnects the operating circuits for relay 1112. Relay 1114, in operating, closes the following circuit from battery through magnet 413, conductor 411, contact of relay 1109, outer right contact of relay 1114, conductor 1115, inner left contacts of relays 1311 and 1312 to grounded conductor 1118. Vertical operating magnet 413 operates and prepares the contacts of vertical row 410. It also connects grounded conductor 1210 over its front contact to conductor 412, over contact of relay 1230, contacts of multicontact relay 1109, conductor 1119, winding of relay 1313 to battery. Relay 1313 operates.

It will be noted that at the time relay 1312 completed its release, a circuit was also established from conductor 1118, over outer left contacts of relay 1312 and 1311, inner left back contact of relays 1308 and 1313 outer right contact of relay 1306 to battery through relay 1314 which operates and in turn connects ground from conductor 1320 over its left front contact to operate relay 1315. This relay now connects grounded conductor 1320 over its left front contact through relay 1328 to battery. Relay 1328, in turn, operates and locks directly to grounded conductor 1320. The circuit for slow-to-release relay 1314 is now opened by the operation of relay 1313 and relay 1314 commences its release.

When relay 1102 operated two more circuits were closed from ground, one over conductor 1119, through multicontact relay 1214 to battery. The other over conductor 1121, leading over contact of relay 1230, through multicontact relay 1215 to battery. With relay B¹ of the units decoding relays operated a circuit was established from grounded conductor 1305, over conductor 1216, back contacts of relays D¹ and C¹, lower front contact of relay B¹, lower back contact of relay A¹, contacts of multicontact relay 1214, winding of multicontact relay 1217 to battery. The multicontact relays 1215 and 1217 serve to associate the units test relays 1250 with the group of links which are associated with the called line in order to determine an idle link. A circuit may now be traced from battery, left winding of test relay 1222, outer back contact of relay 1223, contacts of relay 1230 and multicontact relays 1217 and 1215, conductor 464 to the sleeve wire of link

480. Assuming that link 480 is busy, it will have ground applied to its sleeve wire and thus cause the operation of relay 1222. Relay 1222 locks over its right winding and contact to conductor 1118. A circuit for test relay 1224 similar to that described above is closed to the sleeve conductor of link 490. Assuming this link to be idle, relay 1224 remains deenergized.

When relay 1313 operated a circuit was closed from grounded conductor 1118, outer contacts of relays 1312 and 1311, inner back contact of relay 1308, left front contact of relay 1313, conductor 1317, contacts of relay 1230 and contacts of multicontact relays 1217 and 1215, conductor 465, through winding of horizontal operating magnet 461 to battery. Magnet 461 operates the test link 460 and establishes connection with the associated contacts in rows 410 and 420. When now relay 1314 completes its release a circuit is completed from battery through busy test relay 1318, right front contact of relay 1315, left back contact of relay 1319, right contact of relay 1314, conductor 1117, inner right front contact of relay 1114, contact of multicontact relay 1108 to the sleeve conductor 324 of trunk 321. It will be noticed that this conductor now is connected over contacts in vertical rows 410 and 420 of link 460 to the sleeve conductor of the called line. If the line is busy relay 1318 will operate. It will, however, be assumed that the line is idle and that relay 1318 remains deenergized. When relay 1314 released it opened the circuit at its left contact for relay 1315 which is slow to release. Relay 1315 commenced to release thus allowing time for the busy test.

After a short interval the release of relay 1315 will be completed and a circuit may then be traced from grounded conductor 1320, left back contact of relay 1315, outer left back contact of relay 1318, outer left front contact of relay 1328, inner left back contact of relay 1321, winding of relay 1322 to battery. Relay 1322 operates and extends the circuit just traced over its front contact through the winding of relay 1321 to battery. This relay in turn operates and locks itself over its inner left front contact, outer left contacts of relays 1328, 1318, 1315 to conductor 1320. Relay 1321 now closes two circuits at its outer left front contact from grounded conductor 1118. One of these may be traced over conductor 1116, middle right contact of relay 1114, contacts of multicontact relay 1106, conductor 353, right winding of horizontal operating magnet 352 to battery. Magnet 352 operates and establishes connections from the contacts of rows 310 and 330 to link 360, thus extending the trunk circuit shown in Fig. 2 to the trunk 321. The other circuit closed by relay 1321 may be traced from its outer left contact,

over right contact of relay 1308, conductor 1329, left front contact of relay 1222, left back contact of relay 1224, winding of relay 1225 to battery. Relay 1225 now operates and extends the circuit just traced over contacts of relay 1230, multicontacts of relays 1217 and 1215, conductor 463, right winding of horizontal operating magnet 462 of the connector 400. Magnet 462 operates and establishes connections from contacts of vertical rows 410 and 420 to the wires of link 490. The trunk circuit shown in Fig. 2 is thus extended to the called subscriber's line. Holding ground is now supplied over right front contact of relay 203, sleeve conductor 224, over contact of vertical row 310 to sleeve wire of link 360, through both windings in series of horizontal magnet 352 to battery and also from the sleeve wire of link 360, over contact of vertical row 330, sleeve conductor 324, contact of vertical row 410 of connector 400, through both windings in series of horizontal magnet 462 to battery.

When relay 1321 operated it opened at its inner back contact the circuit for slow-to-release relay 1322 which commenced to release, allowing time for the operations just described to take place. Relay 1322 now completes its release and closes a circuit which may be traced from battery through winding of relay 1323, outer right contact of relay 1301, right contacts of relay 1321 and relay 1322, outer left contact of relay 1328, outer left contact of relay 1318 and left contacts of relay 1315 to grounded conductor 1320. Relay 1323 now operates and closes a circuit from ground, outer left contact of relay 1302, outer left contact of relay 1323, conductor 1324, contact of relay 1130, conductor 1122, wire of link 370 and contact of vertical row 310, conductor 225, and from there it may be traced over two circuits, one through the winding of relay 205 to battery; the other, over outer right contact of relay 202, right contacts of relays 206 and 207, through the winding of relay 207 to battery. Relay 207 operates and locks to sleeve conductor 224 over its right front contact. Relay 205 also operates and locks itself over contacts of relay 208 to sleeve conductor 224.

Ring current is now applied to the called line from the source of ringing current 210, over segment of commutator 211, inner right back contact of relay 206, winding of relay 208, inner left front contact of relay 207, outer lower front contact of relay 205 to the ring conductor 223. From there it may be traced over contacts of selectors 300 and connector 400, over the loop of the called subscriber's line and back over a similar path by means of the tip conductor, over upper outer front contact of relay 205, through the middle left contact of relay 207 to ground. As the commutator 211 revolves,

ringing current and battery are alternately applied to this circuit and cause the usual intermittent ringing of the called subscriber's bell. When the calling subscriber answers the resistance of his loop circuit is reduced and relay 208 will operate and open the holding circuit for relay 205 which now deenergizes and disconnects ringing current from the trunk. Relay 205, in releasing, connects battery and repeating coil 215 to the tip and ring conductors of the trunk 221. Thereupon, relay 216 operates and supplies additional holding ground to sleeve conductor 224.

Returning now to the operation of relay 1323, it will be noted that a circuit was closed from grounded conductor 931, over right front contact of relay 1323, through winding of relay 1325 to battery. Relay 1325 operates and closes a circuit from grounded conductor 931 at its left front contact, through relay 1301 to battery. This relay now operates and locks directly to conductor 931. It now opens the circuit for slow to release relay 1323 which commences to release. Relay 1301 at its inner left back contact removes the ground from conductors 1310 and 1320, thus commencing the release of the marker. The holding circuit for relay 1302 is opened and this relay releases and connects ground over its middle left back contact, inner right front contact of relay 1301, conductor 906, leading over contacts of relay 930 and multicontact relay 913, through winding of relay 736 to battery. Relay 736 operates and locks to grounded conductor 740. Relay 736, in operating, opens the circuit for relay 911 at its left back contact and transfers the ground at relay 731, over its left front contact, through relay 715 to battery. Relay 715 now operates and locks to grounded conductor 740. It then opens at its left-hand contacts the impulse circuit for relay 700. This relay releases and causes the subsequent release of relays 709 and 710. Relay 710 removes holding ground from all relays in the sender and register circuits which hereby are restored to normal.

Relay 710 also removes ground from conductor 624 and thus causes the release of relay 204. Battery and repeating coil 215 are hereby connected over the tip and ring conductors of trunk 121 to the loop of the calling subscriber's line. Relay 204 removes the ground from slow to release relay 203. This ground is, however, shortly replaced by one from contact of relay 217, when this relay energizes upon the completion of the talking circuit.

When relay 1323 completed its release which occurred shortly after the operation of the ringing relays 205 and 207, it opened the operating circuit for these two relays and also that for slow-to-release relay 1325

which then commenced to release. When this relay finally releases, a circuit is closed from grounded conductor 931, over left back contact of relay 1325, outer left contact of relay 1301, conductor 1326, contact of relay 930, conductor 1014 to battery through relay 1002 which now operates and removes ground from conductor 1010 so that relay 1003 releases. The relays associated with device 900 are thus caused to release and ground is also removed from conductor 931 causing the release of relay 1301.

The circuit for vertical operating magnet 313 was opened at the outer right contact of relay 736. The circuits for vertical operating magnets 315, 413 and 415 were opened when ground was removed from conductor 1320 at the inner left back contact of relay 1301 when this relay operated. The release of multicontact relay 913 disconnects the sender from the marker. The release of relay 1003 opens the circuit for relays 930, 1320 and 1130. The further release of multicontact relays and other relays in the marker may readily be traced to the removal of ground from conductor 1320.

When relay 1002 energized a circuit was closed from battery through relay 1005, outer left contact of relays 1011 and 1012, left front contact of relay 1002, through the winding of relay 1001 to ground. Relay 1005 energized and locked over its inner left contact, winding of relay 1011 to ground at relay 1006. Relay 1011 operated and will together with relay 1005 remain energized until such time when a marker will again be required to set up a connection. The circuit for relay 1002 was opened when relay 1301 released. Relay 1002 is slow to release in order to allow time for the release of the connecting device 900. The circuits for sender selector 600, sender and register as well as the marker are now restored to normal and are ready to receive another call. When the conversation has been completed and the receivers have been restored to the switchhooks at both stations, relays 217 and 216 release. Relay 217 opens the circuit for slow-to-release relay 203, the release of which will be completed after an interval. Ground is hereby removed from sleeve conductors 124, 234 and 324 whereupon the horizontal operating magnets 131, 352 and 462 will be caused to release. The links 130, 360 and 490 are thus restored to normal.

When now another call is initiated and the operation of the sender and register has progressed to the time when relay 1003 energizes after the operation of connecting device 900, the circuit from ground through relay 1001, over left back contact of relay 1002 and conductor 1010 will then be extended over middle left front contact of relay 1003, left back contact of relay 1004,

right front contact of relay 1011 to conductor 1009 which leads to relays in the second marker similar to relays 930, 1230 and 1130, the relay 1011 now being operated. Conductors 910 from multicontact relay device 900 will now be connected to the second marker and the setting of this marker will proceed in a manner similar to that described for the first marker. After the completed operation of the second marker, relay 1002 will again be energized and a circuit closed from battery, through relay 1007, outer left front contact of relay 1011, outer left back contact of relay 1012, left front contact of relay 1002, winding of relay 1001 to ground. Relay 1007 operates and locks itself over its left front contact, winding of relay 1006, outer right contact of relay 1005 to ground. Relay 1006 operates in this circuit and opens the circuit for relays 1011 and 1005, which both release. Relay 1005, in turn, opens the circuit for relays 1006 and 1007, which also release. Relay 1011, in releasing, again prepares the first marker for the next call.

Assuming now that the called subscriber's line was busy as described above, relay 1318 would then have operated due to the presence of a ground on the wire of link 460 which is connected over contact in vertical row 420 to the sleeve conductor of the called line. Relay 1318 then closes a circuit from ground over its right front contact, conductor 905 which leads over contacts of relay 930, multicontact relay 900, through winding of relay 733 to battery. Relay 733 operates and locks over its inner right contact to conductor 740. Busy tone is now applied over right front contact of relay 733, outer left front contact of relay 861, conductor 753, right winding of coil 713 to grounded conductor 730. This tone is induced in the left winding of coil 713 and may thus be heard by the calling subscriber. When the subscriber hangs up relay 700 will release and cause the release of relays 709 and 710, which in turn will release the sender and register circuits. The release under this condition of the marker is commenced when relay 1315 completes its release. A circuit may then be traced from grounded conductor 1320, inner left back contact of relay 1315, outer left front contact of relay 1318, inner left front contact of relay 1328, outer right contact of relay 1301 to battery through relay 1323. The subsequent release of the marker and the multicontact relay 900 takes place as described above.

Party line call.

Assuming next that a call is desired to a four-party line, the call number of which is 2 1 2 2, the operation will take place in a manner as above described. In this case

the following relays will be operated in the register shown in Fig. 8 in response to the dialing by the subscriber: relay B of the thousands register, relay A of the hundreds register, relay B of the tens register and relay B of the units register. The corresponding relays will subsequently be operated in the decoding relays in Fig. 12. The setting of the thousands and hundreds decoding relays will connect the leads from the tens decoding relays to the same connector frame 400 as before. Relay B¹ only being operated in the tens decoding relays, a circuit may now be traced from grounded conductor 1307, over conductor 1213, back contacts of relays D¹ and C¹, front contact of relay B¹, back contacts of relay A¹, contacts of multicontact relays 1202, 1205 to battery through vertical operating magnet 414. The operation of this magnet prepares the contacts of vertical row 430 in which the called line appears. The operation of magnet 414 will cause the operation of relay 1102 as in the case described above. The subsequent test and marking operations of the marker will take place followed by the busy test and in time ringing current will be supplied to the trunk 221. As described above the ringing source 210 is connected to the ring conductor 223 of trunk 221 and is carried over the ring conductors of switches 300 and 400 while the ground is connected to the tip conductor 222 and continued over the tip conductors of switches 300 and 400 to the contact points in vertical row 430. The four-party line 421 is strapped to four positions in vertical row 430 of which only two have been shown in the drawing. Two of these positions are strapped in such a manner that the tip and ring conductors from the line 421 will be reversed with respect to the tip and ring contacts in the vertical row 430. In the case described the source of ringing current will thus be connected to the tip conductor 422 of the line 421, while the ground connection will be applied to the ring conductor 423. This will cause the bells of two of the parties to respond. Since only a single ring is applied to the line only the corresponding party whose call number is 2 1 2 2 will respond.

Assuming now that the called number is 2 1 2 1, the setting of the thousands, hundreds and tens registers will be the same as before, while relay A will be operated in the units register of the sender. The decoding relays will be operated correspondingly. The same vertical operating magnet 414 will be operated as before, but the A¹ relay of the decoding relays will now be operated. A circuit may be traced from grounded conductor 1305, over conductor 1216, back contacts of relays D¹, C¹ and B¹, middle front contact of relay A¹, contact of multicontact relay 1214 to battery through the

winding of multicontact relay 1218. The units test relays 1250 will thus be associated with the lower group of links shown in the drawing in connector switch 400. After the test operation of the trunk test relays magnet 413 will again operate, assuming that trunk 321 is idle. Magnet 413 closes a circuit for relay 1313 as described above. This, in turn, causes the operation of horizontal magnet 451. Contacts of vertical row 410 and 430 are thus connected to horizontal test link 450. A circuit may now be traced from grounded conductor 1210 over contacts of vertical rows 410 and 430, middle wire of link 450, over the strap 431, conductor 432, leading over contact relay 1230 to battery through relay 1123, which operates and locks to conductor 1320. Busy test will be made as described above and assuming the line to be idle, relay 1321 will in time operate and extend ground from conductor 1118, over the units test relays to operate horizontal magnet 452, it being assumed that the first link was busy. When relay 1323 now operates it closes the circuit over conductor 1324 to operate the ringing relays 205 and 207. A circuit may also be traced from conductor 1324, over left front contact of relay 1123, conductor 1124, middle wire of link 370, contact of vertical row 310, conductor 226 to battery, through relay 206. Relay 206 operates and locks to sleeve conductor 124. Relay 206 opens the operating circuit for relay 207 before relay 207 is able to establish a holding circuit for itself. Relay 207 thus remains deenergized until such time when the segment of pick-up interrupter 212 reaches the brush and connects ground over outer front contact of relay 206 to operate relay 207 which now locks to the conductor 224. This operation takes place at a time when ringing current is not applied to the line. Ringing current is applied shortly after over interrupter 213, inner right front contact of relay 206, winding of relay 208, inner left front contact of relay 207, outer lower front contact of relay 205 to ring conductor 223. Ground is at the same time supplied to the tip conductor 222 as described before. After passing the contact of vertical row 430 of the connector 400, the ringing current is connected to the ring 423 of line 421, ground being connected to the tip conductor 422. Thus the bells at two of the party station will respond, and the code being two rings, the corresponding party whose number is 2 1 2 1 will answer and cause relay 208 to operate as above.

Reverting party line call.

A call will now be described which is assumed to be originated by a party of a four-party line desiring to call another party on the same four-party line. It will be assumed that the called party may be called

by one ring on the tip conductor of the line, while the calling party may be called by a two ring code applied to the ring conductor of the line. The number to be dialed by the calling party under these conditions is assumed to be 1 1 9 3.

The line 101 will be assumed to represent the four-party line. The operation, in response to the removal of the calling party's receiver from the switchhook, of the line switch and the sender selector will take place exactly as described above. When the first digit 1 is dialed counting relay 701 will be operated. When relay 717 completes its release, relay 811 will operate as described above, followed by the operation of relay A of the thousands register Th, the operation of relay 812 and the release of relay 811. Relays A and 812 lock as described above over back contact of relay 862 to conductor 830. A circuit may now be traced from battery, through left winding of relay 865, outer right contacts of relays A, B, C and D of the thousands register to ground. Relay 865 operates in this circuit and locks over its inner left contact, right back contact of relay 866 to conductor 830. Relay 865 also establishes a new locking circuit for relay 812, over its outer right front contact. When now relays 719 and 718 release a circuit will be traced from battery through relay 862, over left back contact of relay 866, outer left contact of relay 865, right back contact of relays 718 and 719 to grounded conductor 730. Relay 862 completes a locking circuit for itself through winding of relay 866, over front contact of relay 862 to grounded conductor 830. Relay 866 does not operate being short circuited by the circuit just described.

When the next digit 1 is transmitted, relay 711 will energize and operate relay 718 which now removes the short for relay 866 at its right back contact. Relay 866, therefore, operates.

It should be noted that the holding circuit for relay 865 is now extended over its inner left front contact, right front contact of relay 866, conductor 867, outer left back contact of counting relay 702, through holding conductor 750. If, therefore, more than one impulse has been received by the counting relays, this holding circuit would have been opened at the contact of relay 702. Relay 865 would, therefore, have been released and in doing so would have opened the holding circuit for relay 812 and relay A of the thousands register. The setting of the thousands register in response to the first impulse as described above would thus have been obliterated and the impulse would have been absorbed as a preliminary impulse. In that case the thousands register would again be ready to register the digit which thus was the cause of the release of relay 865.

However, in the case assumed, only relay 701 is operated and relay 865 remains energized to maintain the holding circuit for relay 812 and relay A of the thousands register. When relay 717 now completes its release, relay 821 and, thereafter, relay A of the hundreds register operate and lock. The operation of relay A causes relay 822 to operate, whereupon relay 821 releases. Relay 822 provides a new holding circuit at its outer left contact for relay 865. A circuit may now be traced from battery through relay 864, over outer right contacts of relays A, B, C and D of the hundreds register, inner right front contact of relay 865, outer left contact of relay 822 to ground. Relay 864 operates in this circuit and prepares a number of circuits for the arrival of the third digit. Nine impulses will now be received by the counting relays, the first impulse will operate relay 701, the second impulse will operate relay 702, as described above, the third impulse operates relay 703 which extends the circuit from relays 711 and 712, through the middle left front contact to the winding of relay 704, which will thus operate in response to the fourth impulse. Relay 704 locks to battery at its inner left contact and extends the impulse circuit over its middle left front contact to relay 705 which will respond to the fifth impulse and lock itself to battery. The holding circuits for relays 703 and 704 were opened successively by the operation of succeeding relays. When relay 704 releases it extends the impulse circuit to relay 701 which will operate in response to the sixth impulse. Relay 705 locks to battery over its inner left front contact and is connected directly to conductor 750 and will thus remain energized until the completion of the series of impulses. Relay 702 closes a circuit from battery through relay 706, right front contact of relay 702, outer left front contact of relay 705 to holding conductor 750. Relay 706 operates and locks to conductor 750. In the meantime relay 703 will be operated by the eighth impulse and relay 704 by the ninth impulse, the circuit for relay 704 having been completed at the middle left contact of relay 706. Relays 704, 705 and 706 remain locked. When now relay 717 completes its release and operates relay 831, circuits may be traced from battery through windings of relays C and D of the tens register, contacts of relay 831, conductor 724, outer left contact of relay 701, right front contact of relay 705, to conductor 750 and also over conductor 723, right front contact of relay 704, right back contact of relay 701 to conductor 750. Relays C and D operate and lock and cause the operation of relay 832. A circuit is also closed from ground over outer right front contacts of relays D and C, outer left contact of relay 864 to battery,

through the winding of relay 868 which operates. It should be noted that relay 863 was operated simultaneously with relay 831. If the third digit had been any number from 2 to 8, relay 868 would not have been operated. In such a case when relays 863 and 831 release, ground is extended from the back contact of relay 863, through the inner front contact of relay 864, back contact of relay 868, outer left contact of relay 832, left winding of relay 731 to battery. The register would in such case have been satisfied and relay 731 would have caused the register to be connected to a marker over multicontact relay 900 as described above. In the present case, the ground from relay 863 will be extended when this relay releases over inner left front contact of relay 864, inner front contact of relay 868 to left front contact of relay 842, which, however, is opened and will not be closed until the fourth digit has been set up. When the last series of three pulses has been received, relay 703 remains energized and when relay 717 releases, causes the operation of relays A and B of the units register. These latter relays lock and operate relay 842 which now extends the ground from relay 863 over its outer left front contact, through left winding of relay 731 which now operates.

The operation of multicontact relay device 900 now takes place as described above. The operation of relay 1003 causes the operation of relays 930, 1230 and 1130, thereby the registers will be connected to the decoding relays in Fig. 12. The operation of relay 1003 also grounds conductor 931 and conductor 1310. In the meantime vertical magnet 313 is operated from ground at the middle left front contact of relay 1302, and in turn, causes the operation of horizontal magnet 351 and multicontact relay 1111, all as previously described. Ground on the outer left contact of relay 1302 passes over the right front contacts of the register relays, which have been set, to windings of corresponding decoding relays which operate. When now relay 1303 completes its release, ground is extended from conductor 1310, to conductor 1320 and further to conductors 1305 and 1307 to armatures of the decoding relays. Ground will now be traced from conductor 1305, over conductor 1211, back contacts of relays D¹, C¹ and B¹ of the thousands decoding relays, middle front contact of relay A¹, winding of relay 1201 to battery. This relay, in operating, operates multicontact relay 1202. Ground may also be traced from conductor 1305, over conductor 1212, back contacts of relays D¹, C¹ and B¹ of the hundreds decoding relays, middle front contact of relay A¹, right front contact of relay 1201 to battery through multicontact relay 1206. Ground may further be traced from con-

ductor 1307, over conductor 1213, upper back contact of relay A¹ of the tens decoding relays, upper front contacts of relays D¹ and C¹, contacts of multicontact relay 1206 to battery, through the winding of multicontact relay 1207 which operates. Ground from front contact of relay 1207 is now extended over conductor 1208, outer contact of relay 1163, cross-connecting rack 1101, through relay 1125. Contacts of relays 1125 are cross-connected at cross-connecting block 1100 in such a manner as to cause the association of a trunk circuit equipped with reverte ringing equipment with the trunk 221. Such a trunk circuit is shown in Fig. 5 and it will be noted that this is connected directly to a set of contacts in the lower group of vertical row 320 of the selector switch 300. Other similar trunk circuits may be connected to the remaining contacts of the same group in vertical row 320. Ground may finally be traced from conductor 1305, over conductor 1216, back contacts of relays D¹ and C¹ of the units decoding relays, lower front contacts of relays B¹ and A¹, contact of multicontact relay 1207, through the winding of relay 1252 to battery. Relay 1252 and other similar relays complete ground at different combinations on conductors 1220 leading to relays in the trunk circuit shown in Fig. 5, for the purpose of determining the ringing to be applied to the calling four-party line. Thus when relay 1252 operates, the operation of relay 1125 causes ground to be applied to a circuit over conductor 1126, contact of multicontact relay 1111, through vertical operating magnet 315 to battery. Magnet 315 connects ground to operate relay 1312 as previously described, which again causes the operation of relay 1311 followed by the release of relay 1312. Another circuit is closed from ground at relay 1125, over conductor 1127, through winding of multicontact relay 1106 to battery. This relay associates test relays 1110, 1120, etc. with the horizontal operating magnets in the lower group of selector 300 as before described. Ground is also extended over conductor 1128, contact of relay 1130 to battery, through the winding of multicontact relay 1129 which operates. Relay 1129 associates the test relays with the sleeve conductors of the reverte ringing trunks. Ground is further extended by relay 1125, over conductor 1132 to operate relay 1135. Another ground is extended over conductor 1133 to operate relay 1164 and still another ground is extended over conductors 1134 and 1135 to operate relay 1308. It will be assumed that link 360 of selector switch 300 is busy. Ground from the sleeve wire of this link may then be traced over conductor 354, contact of multicontact relay 1106, inner right contact of relay 1113,

through right winding of relay 1112 to battery. Relay 1112 operates, locks itself to grounded conductor 1118 and operates relay 1113 from ground at its inner right front contact. Link 350 will be assumed to be idle as well as trunk 341. Test relay 1136 will, therefore, remain deenergized so that when relay 1312 completes its release, ground is extended by means of conductor 1118, contact of relays 1312 and 1311, conductor 1316, contact of multicontact relay 1111, outer left contact of relay 1114, left contact of relay 1113, outer right back contact of relay 1136 to relay 1137 to battery. Ground was also extended from conductor 1118, over outer left contacts of relays 1312 and 1311, inner left front contact of relay 1308, inner left back contact of relay 1321 to operate relay 1322, which in turn, operates relay 1321. It further forces the release of relay 1322. Ground may now be traced from conductor 1118, over outer left contact of relay 1321, conductor 1116, middle right front contact of relay 1137, contact of relay 1106, conductor 363, right winding of horizontal operating magnet 362 to battery. This magnet operates and completes the connection between the trunk 221 and the revertive ringing trunk shown in Fig. 5.

When relay 1164 operated, relay 1165 was also operated and battery may be traced over left front contact of relay 1164, outer left contact of relay 1165, contact of relay 1130, conductor 1138, winding of relay 501, outer left contact of relay 502, right front contact of relay 503, left front contact of relay 504, to sleeve conductor 344 which is grounded at relay 203. The operation of relay 501 will thus take place as soon as the connection is completed over selector 300. Ground from relay 1252 may now readily be traced over conductors 1220, contacts of relay 501, through relays 511, 512, 513 and 514 to battery, causing these relays to operate and lock directly to sleeve conductor 344. At the time when relay 1322 completed its release, relay 1312 operates as previously described, in turn, causing the operation of relay 1325 followed by the operation of relay 1301. When relay 1323 operated a circuit was closed from ground over its inner left front contact, conductor 1327, contact of relay 501 to battery, through relay 503 which now operates and closes a locking circuit for itself over its own front contacts in series, left front contact of relay 504 to ground on sleeve conductor 344. The operating circuit for relay 501 is now opened, whereupon this relay releases and disconnects the marker from the revertive ringing trunk.

At the time horizontal operating magnet 351 operated a circuit was closed from the grounded conductor 1320, over front contact

of relay 1135, contact of relay 1130, conductor 1129, upper wire of link 370, contact of vertical row 310, conductor 227, winding of relay 209 to battery. Relay 209 operates and locks to conductor 124. Relay 202 operates in a circuit over inner lower front contact of relay 209 to sleeve conductor 124 and opens the operating circuit for relay 207. When, therefore, relay 1323 operates and extends ground over conductor 1324, relay 205 will operate as described before, but ringing current will not be supplied to the tip and ring conductors of trunk 221. The repeating coil and battery 215 are now completely disconnected from the trunk circuit by the operation of relays 209 and 205. Battery will be supplied through repeating coil 515 at the time the connection is cut through by selector 300.

The release of the sender takes place as soon as relay 1301 operates, as described above, ground being extended over middle left back contact of relay 1302, inner right front contact of relay 1301 to operate relay 736. When relay 715 operates it causes the release of relays 700, 709 and 710. Relay 710 removes ground from conductor 624 and thus releases relay 204 which cuts the line through and opens the circuit for relay 203 which relay now commences to release. When the line is cut through the circuit is completed from battery and repeating coil 515, through the subscriber's loop, whereupon relay 506 operates and causes relay 504 to operate. Relay 504 places a ground on the sleeve conductor 344 in order to replace the holding ground at relay 203, when this relay completes its release. Relay 504 also opens the previously traced holding circuit for relay 503. Another circuit may, however, be traced for relay 503, over its left front contact, right winding of relay 502, right back contact of relay 505 to ground. Relay 503 will remain energized over this circuit and relay 502 operates. The circuit will now remain in this condition until the subscriber hangs up in order to await the ringing signal. The release of the marker and register has taken place in the meantime as previously described.

When the calling subscriber hangs up his receiver, relay 506 releases and ground may be traced over its back contact, right front contact of slow-to-release relay 504, middle left contact of relay 502, contact of relay 507, through relay 508 to battery. Relay 508 operates and provides a locking circuit for relay 502 from conductor 344, upper inner contact of relay 508, inner left contact and left winding of relay 502, winding of relay 505 to battery. Relay 505 operates and opens the holding circuit for relay 503 which releases. Relay 504 is held by ground at right contact of relay 502. The circuit is now ready for ringing. When the

segment of interrupter 521 reaches the brush, ground is extended over left front contact of relay 505, outer right front contact of relay 511, outer left back contact of relay 515, right back contact and winding of relay 516 to battery. Relay 516 operates and locks to sleeve conductor 344. When ground was completed over the segment of interrupter 521, a circuit was also closed over the left front contact of relay 505, over outer right contact of relay 514, inner left back contact of relay 519, through winding of relay 527, outer left back contact of relay 519 to battery. Relay 527 operates and closes a locking circuit for itself over its right front contact and right winding of relay 519 to ground. As soon as the segment of commutator 521 leaves the brush, it removes the shunt from around the right winding of relay 519 and this relay operates, opens the direct battery at its outer left contact and replaces it by battery through its left winding. A circuit may now be traced from ground, over right front contact of relay 505, left front contacts of relays 527 and 514, right front contact of relay 513 through relay 518 to battery. Relay 518 operates. After a short interval ringing current will be supplied from ringing source 522, over commutator 523, right back contact of relay 515, back contact of relay 517, winding of relay 507, outer left contact of relay 516, inner front contact of relay 518, upper front contact of relay 508 to tip conductor 342, returning by means of the subscriber's loop, over the ring conductor 343, lower front contact of relay 508 and outer left front contact of relay 518 to ground at inner front contact of relay 516. A single ring is thus applied to the tip conductor of the four-party line and will serve to signal the called subscriber.

When now the segment of commutator 521 again reaches the brush, it extends ground over left front contact of relay 505, outer right contact of relay 514, inner left front contact and winding of relay 519 to battery. Relay 527 is thus shunted and releases and opens the ground circuit through the right winding of relay 519. Relay 519, therefore, releases as soon as the segment of interrupter 521 leaves the brush. Relay 527 opens the circuit for relay 518 which releases. At the same time a circuit is closed from ground over right front contact of relay 505, left back contact of relay 527, left front contact of relay 512, through relay 517 to battery. Relay 517 operates. When, after an interval ringing current is again applied, it may be traced from the source 522, over commutator 524, left front contact of relays 511 and 517, winding of relay 507, outer front contact of relay 516, outer left back contact of relay 518, lower front contact of relay 508 to the ring conductor 343, over the subscriber's loop, back over tip conductor 342, upper front contact of relay 508, inner back contact of relay 518, inner left front contact of relay 516 to ground. A two ring code is thus applied to the ring conductor of the four-party line and serves to signify to the calling party that ringing is taking place. The next time the segment of interrupter 521 reaches the brush, relays 527 and 519 again operate. Relay 517 is then released and relay 518 operated.

In this manner the two ringing codes will alternate until the called party answers. When the called party answers relay 507 operates due to the reduced resistance of the subscriber's loop. Relay 507 opens the circuit for relay 508 which releases and disconnects the ringing current from the line. Relay 518 also opens the holding circuit for relays 502 and 505 which release. The calling party observing that ringing current has been disconnected again removes his receiver and conversation will take place. After the conversation has been completed and both parties have restored their receivers, relay 506 releases. Shortly after, this relay 504 releases and removes ground from sleeve conductor 344, thus releasing all relays of the ringing trunk as well as those of trunk 221 and the holding magnets of selectors 300 and line switch 100, and the circuit is restored to normal.

Special features.

The markers are so arranged that one marker is able to take care of all calls, if the other marker fails to operate. Such failure is indicated by a prolongation of the ordinary operating time as measured from the time relay 1003 operates and starts the operation of the marker and until such time when relay 1002 operates in response to the release of the marker. Assuming that the first marker has been taken to set up a call by the operation of relay 1003, a circuit may be traced from ground, through relay 1001, left back contact of relay 1002, conductor 1010, inner left front contact of relay 1003, outer right back contact of relay 1012, outer left contact of relay 1020, winding of relay 1021 to battery. Relay 1021 operates and closes a circuit for relay 1022, over its front contact and over right back contact of relay 1002 to ground through relay 1001. Relay 1022 now operates and closes an obvious circuit for relay 1020 which now operates and locks itself over outer right contact of relay 1024, inner left contact of relay 1003 to grounded conductor 1010. Relay 1020 opens the operating circuit for relay 1021 which is slow to release and which will open the operating circuit for relay 1022 when it completes its release. Relay 1022 is slow to release and together with relay 1021 pro-

vides a time measure which is sufficient for the normal operation of the marker.

Assuming now that the release of the first marker is delayed for some reason so that the release of relay 1022 will be completed before relay 1002 has been operated, a circuit may then be traced from ground through winding of relay 1001, right contact of relay 1002, back contact of relay 1022, right front contact of relay 1020, back contact of relay 1023, from which point it may be traced through two paths, one through the winding of relay 1012 to battery, the other over inner back contact of relay 1024, winding of relay 1025 to battery. The relays 1012 and 1025 operate. Relay 1002 having failed to operate, relays 1005 and 1011 will now be operated due to the operation of relay 1012, ground being extended through relay 1026, over contacts of key 1027, conductor 1028, left back contact of relay 1024, outer left front contact of relay 1012, outer left back contact of relay 1011, winding of relay 1005 to battery. Relay 1005 operates and locks itself through relay 1011 which also operates. Relay 1011 thus shifts the starter circuit from the first marker to the second marker. Before relay 1011 operated a circuit was completed from grounded conductor 1028, over inner left contact of relay 1012, inner left back contact of relay 1011, inner right contact of relay 1005, right back contact of relay 1007, through the windings of relays 1023 and 1024 to battery. These two relays now operate and a circuit is closed from battery through relay 1004, right back contact of relay 1029, front contact of relay 1023, right contact of relay 1020, back contact of relays 1022 and 1002 to relay 1001 to ground. Relay 1004 operates and locks to ground over right contact of relay 1002 and closes a circuit at its left front contact for the operation of relay 1029. Relay 1029 now connects ground at its left front contact to conductor 902 which leads over contacts of multicontact relay 912, through the winding of relay 734 which operates and connects busy tone to the subscriber's line. Relay 1029 also closes a circuit from battery through relay 1002, right front contact of relay 1029, front contact of relays 1023, 1020, etc. to ground. Relay 1020 operates and opens the circuits extending through windings and contacts of relay 1003, thus causing the release of the multicontact relay 900 and of such relays which may have been operated in the first marker. When relay 1024 operated it opened a circuit for relay 1025 which commenced to release. When this relay finally releases, it closes a circuit from conductor 1028, inner left front contact of relay 1012, inner right front contact of relay 1024, back contact of relay 1025, through relay 1030 to battery. This relay

now operates and reestablishes circuits which were opened by relay 1012. The holding circuits for relays 1020 and 1004 are also opened. Relays 1012, 1023 and 1024 now remain locked to grounded conductor 1028.

When the marker is again called upon to set up a connection and relay 1003 has been operated, ground will be extended over the middle left front contact of relay 1003, left back contact of relay 1004, right front contact of relay 1011, over conductor 1009, into the second marker. Relay 1003 also closes the circuit for the operation of the timing relays 1020, 1021 and 1022. It also closes the circuit for the marker ground from relay 913, over right front contact of relay 1003, inner left contact of relay 1030, outer right back contact of relay 1004, conductor 1013 and into the marker. The control circuit shown in Fig. 10 is thus set for extending all calls to the second marker. The ordinary operation of relays 1007 and 1006 at the time the second marker releases and due to the operation of relay 1002 is now prevented, the circuit for relay 1007 being opened at the outer left back contact of relay 1012.

Trouble in the markers may be indicated by the lighting of lamp 1031 or 1032, and when the failing marker has been repaired, opening of key 1027 will cause the release of relays 1012, 1023 and 1024, whereupon the markers will again operate alternately.

What is claimed is:

1. In a telephone system, a selective switch, means for extending a connection to said switch, a recording device responsive to impulses sent over said connection for storing designations, a plurality of equivalent switch controlling mechanisms, means independent of the extended connection for connecting any one of said mechanisms with the recording device, and means controlled by such mechanism for selectively operating the switch.

2. In a telephone system, a line, a selective switch, means for extending a connection from said line to said switch, a recording device controlled over said line for storing designations, a plurality of equivalent switch controlling mechanisms, means independent of the extended connection for connecting any one of said mechanisms with the recording device, means for connecting such mechanism with the switch, and means controlled by the connected mechanism for selectively operating the switch.

3. In a telephone system, a selective switch, means for extending a connection to said switch, a plurality of recording senders, means for sending impulses over the extended connection to set said senders, a plurality of equivalent switch controlling markers, means independent of the extended connection for connecting any one of said markers with any one of said senders, and

means controlled by the connected marker for selectively operating said switch.

4. In a telephone system, a selective switch, automatic means for extending a connection to said switch, a plurality of senders for recording line designations, a plurality of equivalent switch controlling markers for cooperating with said senders, a multicontact relay device for connecting any sender to any one of said markers, and means controlled by the connected marker for selectively operating the switch to further extend the connection.

5. In a telephone system, a plurality of equivalent switches at a selective switching stage, means for extending a telephone connection to one of said switches, a plurality of recording senders each controlled over the extended connection for storing designations, a plurality of switch controlling markers, means independent of the extended connection for connecting any one of said markers to one of the senders, and means controlled by the marker for selectively operating the particular switch to which said connection has been extended.

6. In a telephone system, a selective switching stage having a plurality of switches thereat, means for extending a connection to said switches, a plurality of recording senders, a plurality of equivalent switch controlling markers, a multi-contact relay device for connecting any sender to any marker, a multi-contact relay device for connecting the particular marker taken for use to the particular switch to which a connection has been extended, and means controlled by the marker for selectively operating said switch.

7. In a telephone system, a selective switch, a plurality of trunk groups outgoing therefrom, means for extending a connection to the switch, a recording sender, a plurality of equivalent switch controlling markers, means independent of the extended connection for connecting any one of said markers to the recording sender, and means in said marker for selecting a group of trunks, for selecting an idle trunk in the group, and for operating said switch to extend the connection to the selected idle trunk.

8. In a telephone system, a selective switch, incoming lines, outgoing lines, a plurality of links in said switch for interconnecting the incoming and outgoing lines, a recording sender for receiving designations, a plurality of equivalent switch controlling markers, and means for connecting any one of said markers to a sender, said marker serving to test said links and outgoing lines and for operating said switch to extend the connection.

9. In a telephone system, a plurality of succeeding switches for building up a con-

nection, means for extending a connection to the first of said switches, a recording sender responsive to impulses sent over the extended connection for recording designations, a plurality of equivalent switch controlling markers, means independent of the extended connection for connecting any one of said markers to the recording sender, and means controlled by such marker for selectively operating each of said switches to further extend the connection.

10. In a telephone system, a number of successive switching stages, each having a plurality of selective switches thereat, a registering sender, a plurality of equivalent markers, means independent of the extended connection for connecting the register sender to one of said markers, and means controlled by the connected marker for operating simultaneously a switch at each of said stages to further extend the connection.

11. In a telephone system, a selective switch, means for extending a connection to said switch, a recording device, a pair of equivalent markers arranged to be taken for use in alternation, means independent of the extended connection for connecting said recording device to one of said markers if idle and a succeeding marker if the first marker is busy, and means controlled by the connected marker for selectively operating said switch.

12. In a telephone system, a selective switch, means for extending a connection to the switch, a recording device, a pair of equivalent switch controlling markers arranged for use in alternation, means for connecting said markers to the recording device, means when either marker is disabled for rendering it unconnectable and for rendering the other marker continually available, and means controlled by the markers for selectively operating said switch.

13. In a telephone system, a selective switching stage having a plurality of switches thereat, means for extending connections to said switches, a number of recording senders, a plurality of equivalent switch controlling markers, means for connecting any sender to any marker, means separate from the extended connection for connecting any marker to any one of said switches, and means controlled by the marker for selectively operating the switch to which it is connected.

14. In a telephone system, a plurality of selective switches, means for extending a connection to said switches, a plurality of recording senders, a plurality of equivalent switch controlling markers, means separate from the extended connection for connecting any one of said markers to any one of said senders, means separate from the

extended connection for connecting any one of said markers which is connected to a sender to any one of said switches, and means controlled by the connected marker for operating the switch.

15. In a telephone system, selective switches, means for extending connections to said switches, a plurality of senders, a plurality of equivalent switch controlling markers, means for connecting any sender to any marker, means separate from the extended connection for connecting any marker which is connected to a sender to any one of said switches, means controlled by the marker for selectively operating the switch to which it is connected for further extending the connection and means for releasing the marker and sender after the connection has been extended.

16. The combination in a telephone system of a number of selective switches, groups of trunks outgoing from said switches, means for extending connections to said switches, a plurality of recording senders, a plurality of equivalent switch controlling markers, means for connecting any marker to any sender, means for connecting any marker so connected to any one of said

switches, said marker serving to test the trunks in any group outgoing from the switch to which it is connected, and means controlled by the marker for operating the switch to extend the connection over one of said trunks.

17. The combination in a telephone system of selective switches, groups of trunks outgoing therefrom, means for extending connections to said switches, a plurality of recording senders, a plurality of equivalent switch controlling markers, each having a testing device therein, means for associating any sender with any marker, means for connecting the associated marker to the particular one of said switches to which a connection has been extended, said testing device in the connected marker serving to make a simultaneous test of all trunks in any group outgoing from the switch, and means controlled by the marker for operating the switch to extend the connection over one of said trunks.

In witness whereof, I hereunto subscribe my name this 25th day of September A. D., 1923.

SAMUEL B. WILLIAMS.

1,550,769.—*Samuel B. Williams*, Brooklyn, N. Y. TELEPHONE-EXCHANGE SYSTEM. Patent dated August 25, 1925. Disclaimer filed April 19, 1930, by the assignee, *Western Electric Company, Incorporated*.

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

"1. In a telephone system, a selective switch, means for extending a connection to said switch, a recording device responsive to impulses sent over said connection for storing designations, a plurality of equivalent switch controlling mechanisms, means independent of the extended connection for connecting any one of said mechanisms with the recording device, and means controlled by such mechanism for selectively operating the switch.

"2. In a telephone system, a line, a selective switch, means for extending a connection from said line to said switch, a recording device controlled over said line for storing designations, a plurality of equivalent switch controlling mechanisms, means independent of the extended connection for connecting any one of said mechanisms with the recording device, means for connecting such mechanism with the switch, and means controlled by the connected mechanism for selectively operating the switch.

"3. In a telephone system, a selective switch, means for extending a connection to said switch, a plurality of recording senders, means for sending impulses over the extended connection to set said senders, a plurality of equivalent switch controlling markers, means independent of the extended connection for connecting any one of said markers with any one of said senders, and means controlled by the connected marker for selectively operating said switch.

"4. In a telephone system, a selective switch, automatic means for extending a connection to said switch, a plurality of senders for recording line designations, a plurality of equivalent switch controlling markers for cooperating with said senders, a multi-contact relay device for connecting any sender to any one of said markers, and means controlled by the connected marker for selectively operating the switch to further extend the connection.

"5. In a telephone system, a plurality of equivalent switches at a selective switching stage, means for extending a telephone connection to one of said switches, a plurality of recording senders each controlled over the extended connection for storing designations, a plurality of switch controlling markers, means independent of the extended connection for connecting any one of said markers to one of the senders, and means controlled by the marker for selectively operating the particular switch to which said connection has been extended."

"9. In a telephone system, a plurality of succeeding switches for building up a connection, means for extending a connection to the first of said switches, a recording sender responsive to impulses sent over the extended connection for recording designations, a plurality of equivalent switch controlling markers, means independent of the extended connection for connecting any one of said markers to the recording sender, and means controlled by such marker for selectively operating each of said switches to further extend the connection."

"11. In a telephone system, a selective switch, means for extending a connection to said switch, a recording device, a pair of equivalent markers arranged to be taken for use in alternation, means independent of the extended connection for connecting said recording device to one of said markers if idle and a succeeding marker if the first marker is busy, and means controlled by the connected marker for selectively operating said switch."

"13. In a telephone system, a selective switching stage having a plurality of switches thereat, means for extending connections to said switches, a number of recording senders, a plurality of equivalent switch controlling markers, means for connecting any sender to any marker, means separate from the extended connection for connecting any marker to any one of said switches, and means controlled by the marker for selectively operating the switch to which it is connected.

"14. In a telephone system, a plurality of selective switches, means for extending a connection to said switches, a plurality of recording senders, a plurality of equivalent switch controlling markers, means separate from the extended connection for connecting any one of said markers to any one of said senders, means separate from the extended connection for connecting any one of said markers which is connected to a sender to any one of said switches, and means controlled by the connected marker for operating the switch."

[*Official Gazette*, May 6, 1930.]