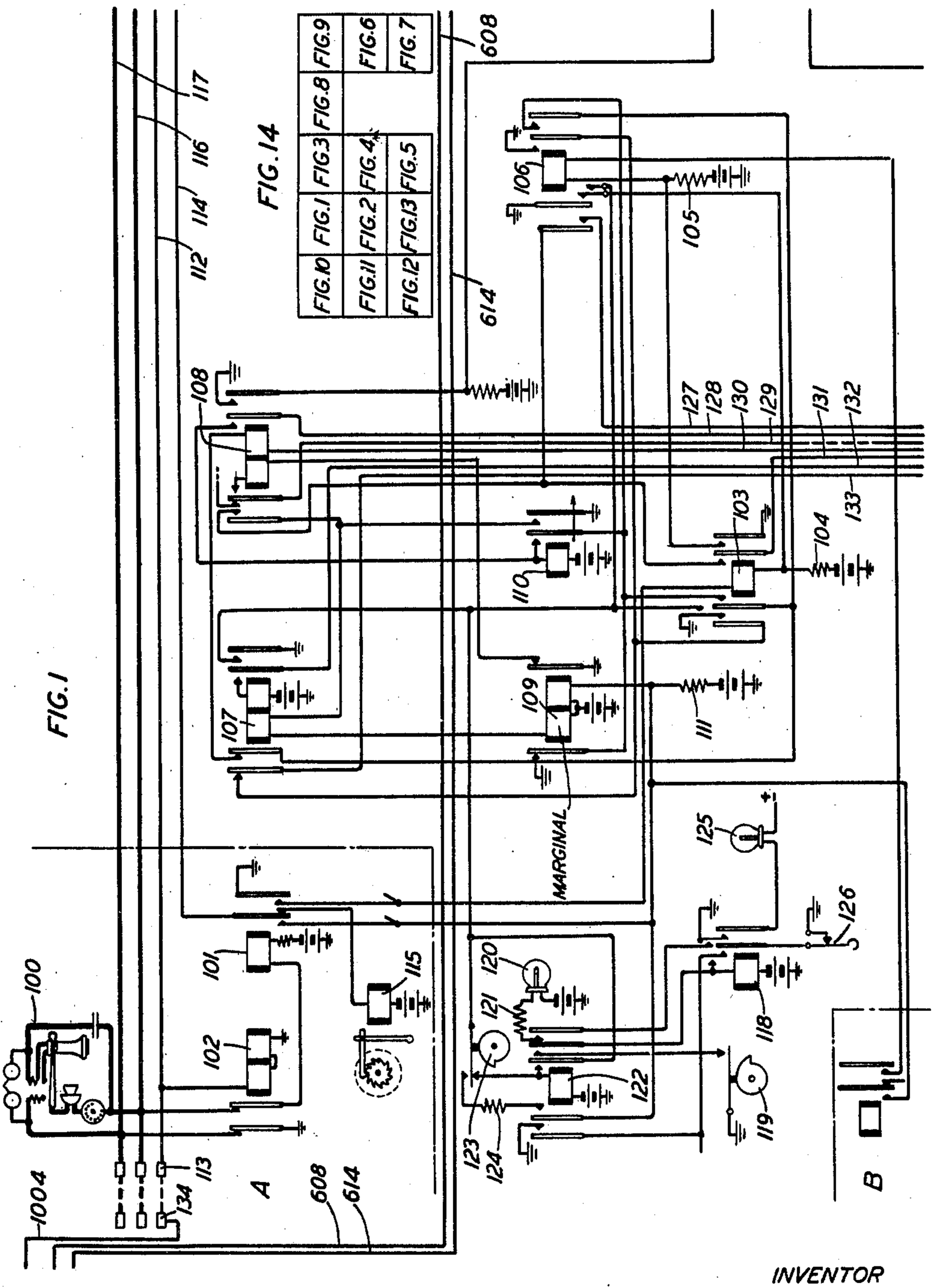
Feb. 23, 1932. W. T. HAINES 1,846,516

TELEPHONE SYSTEM

Filed June 5, 1931 13 Sheets-Sheet 1

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TELEPHONE SYSTEM

Filed June 5, 1931 13 Sheets-Sheet 2

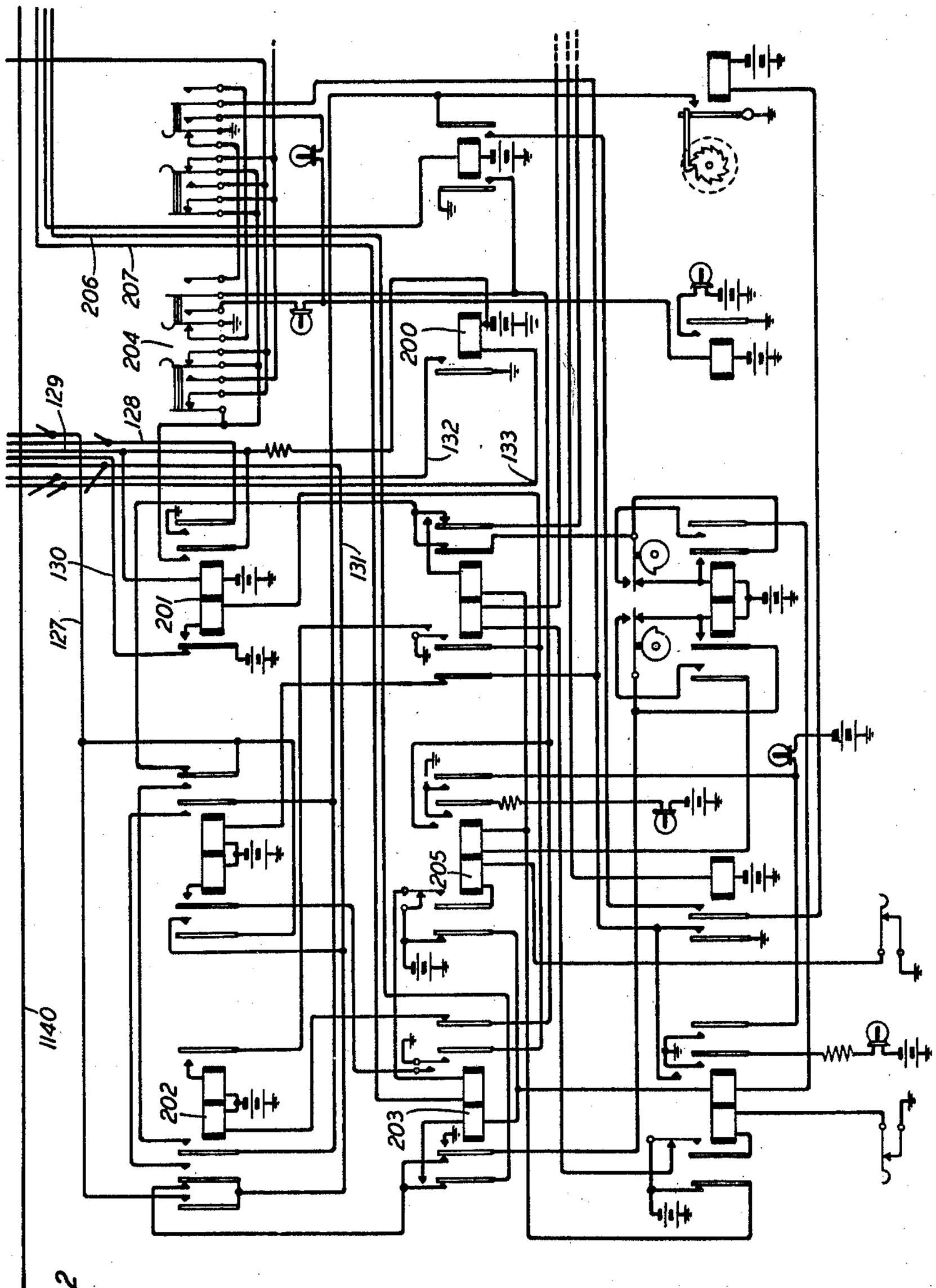


FIG. 2

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TELEPHONE SYSTEM

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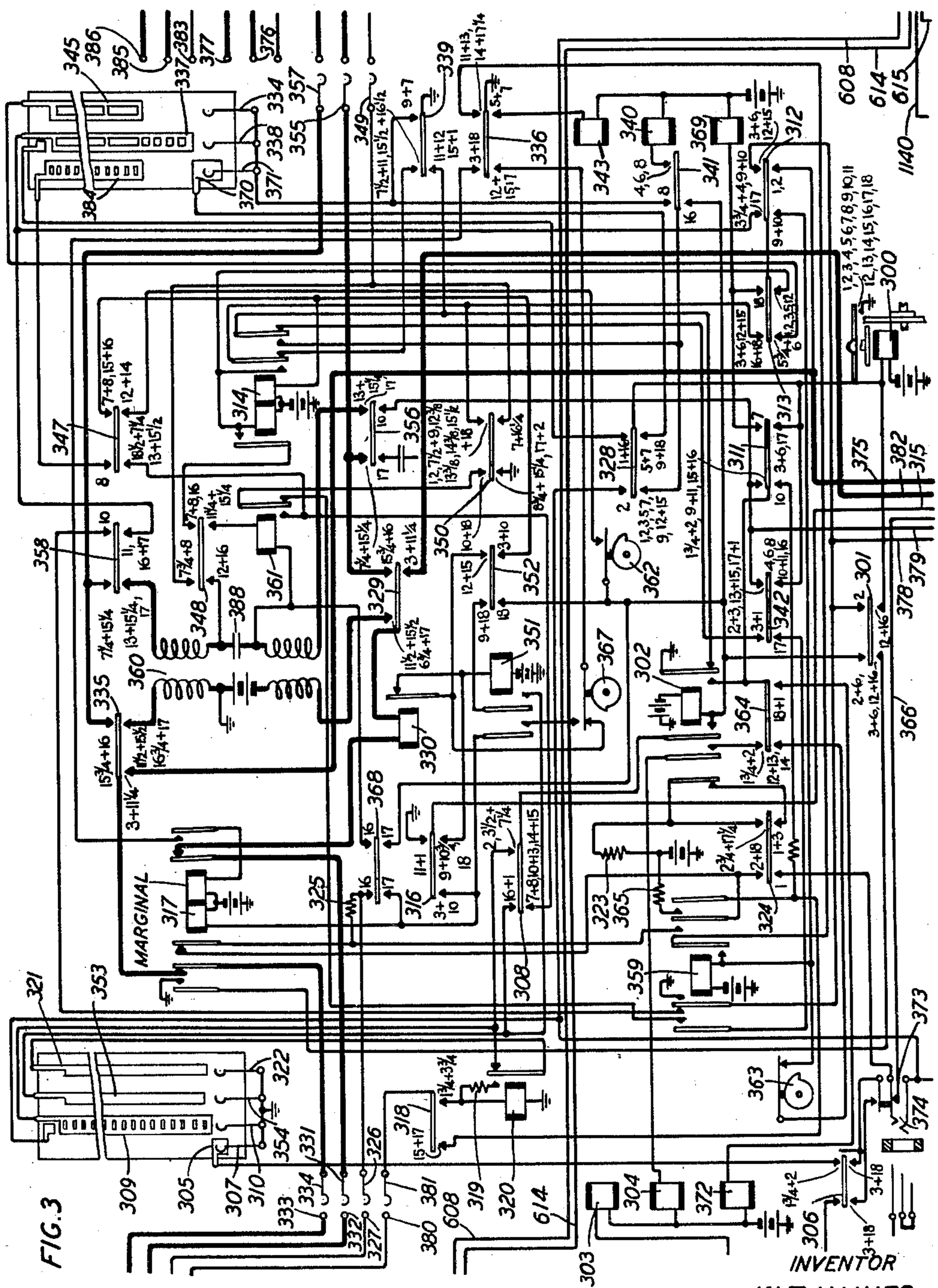


FIG. 3

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TELEPHONE SYSTEM

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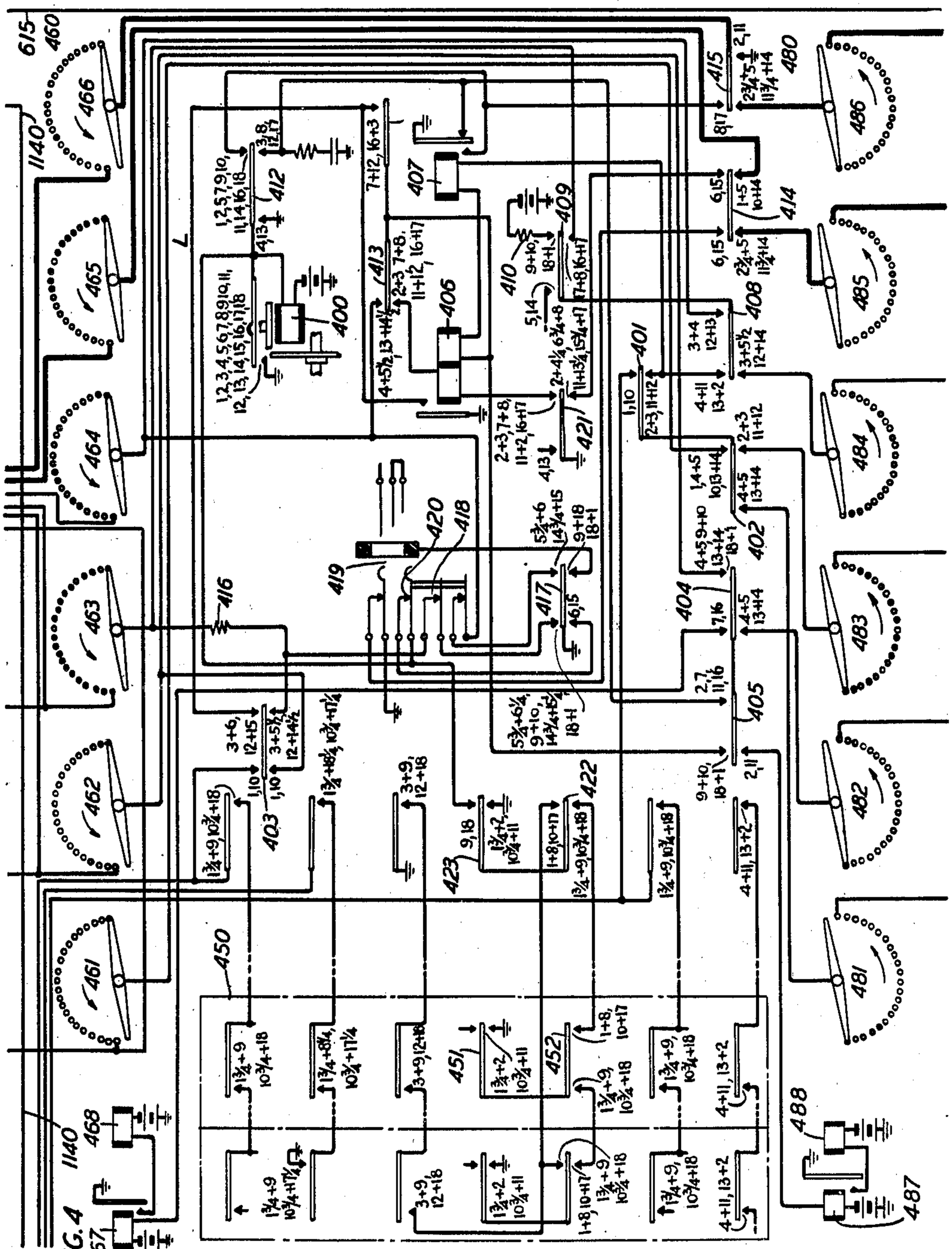


FIG. 4

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TELEPHONE SYSTEM

Filed June 5, 1931 13 Sheets-Sheet 5

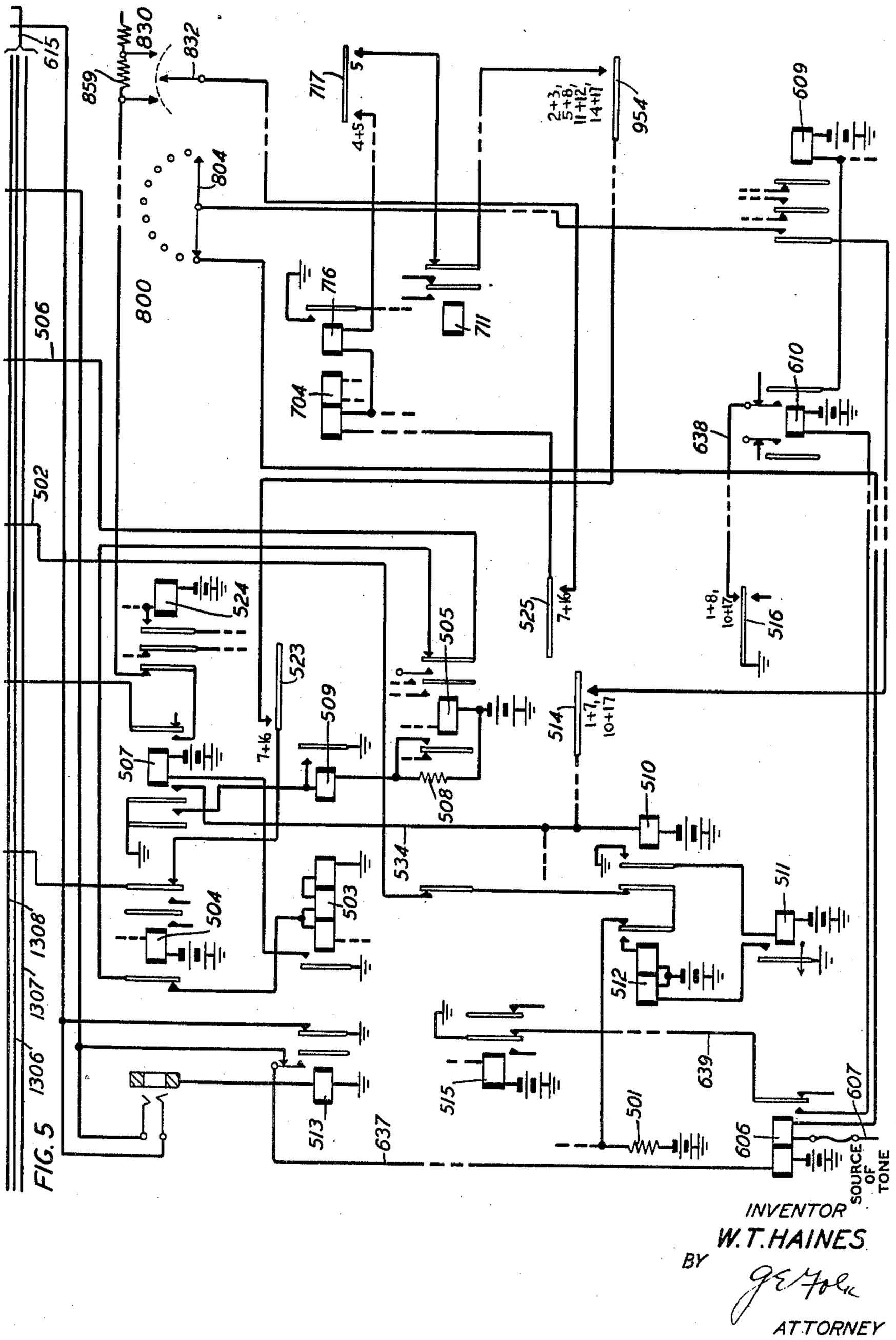


FIG. 5

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TELEPHONE SYSTEM

Filed June 5, 1931 13 Sheets-Sheet 6

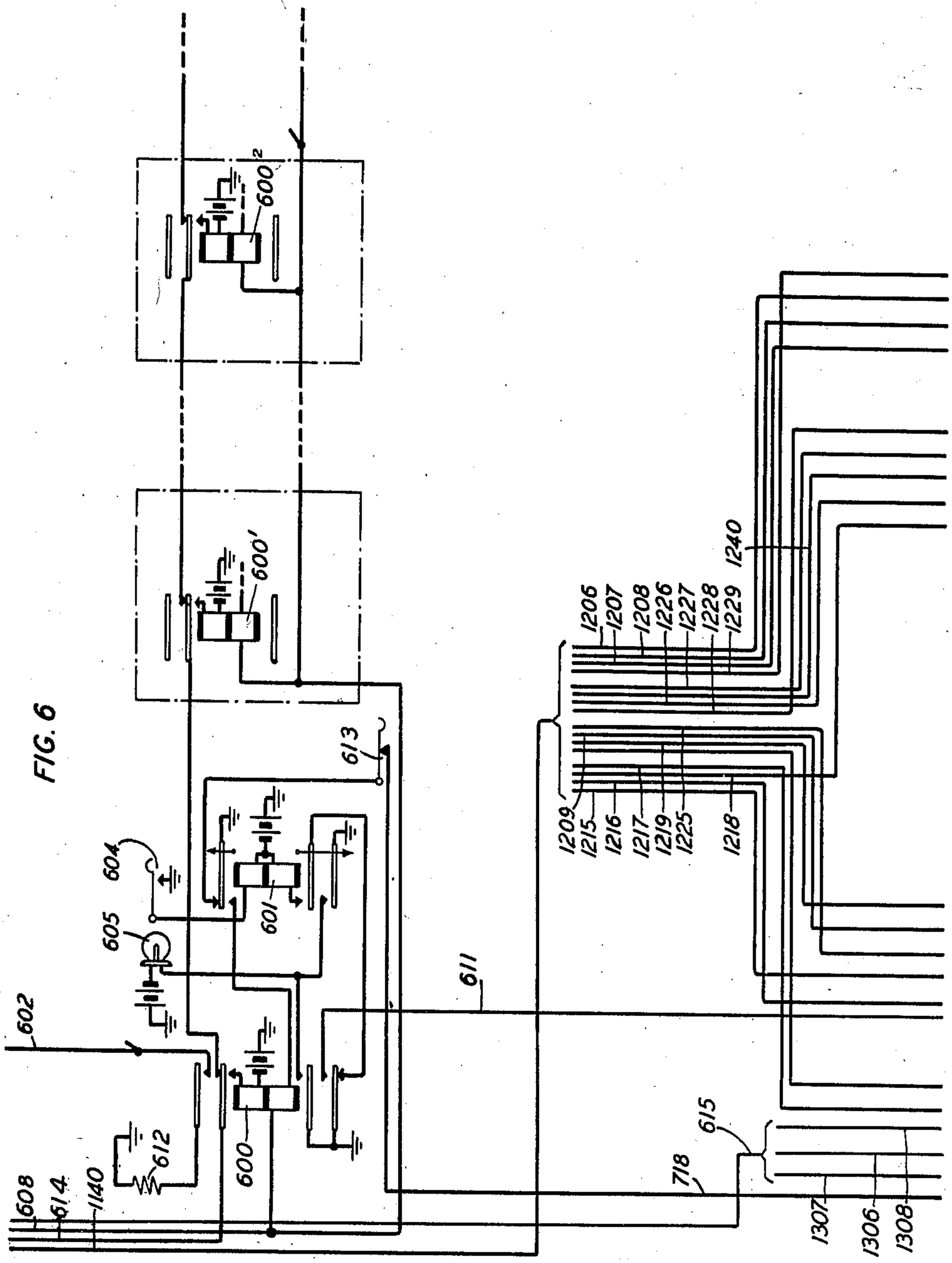


FIG. 6

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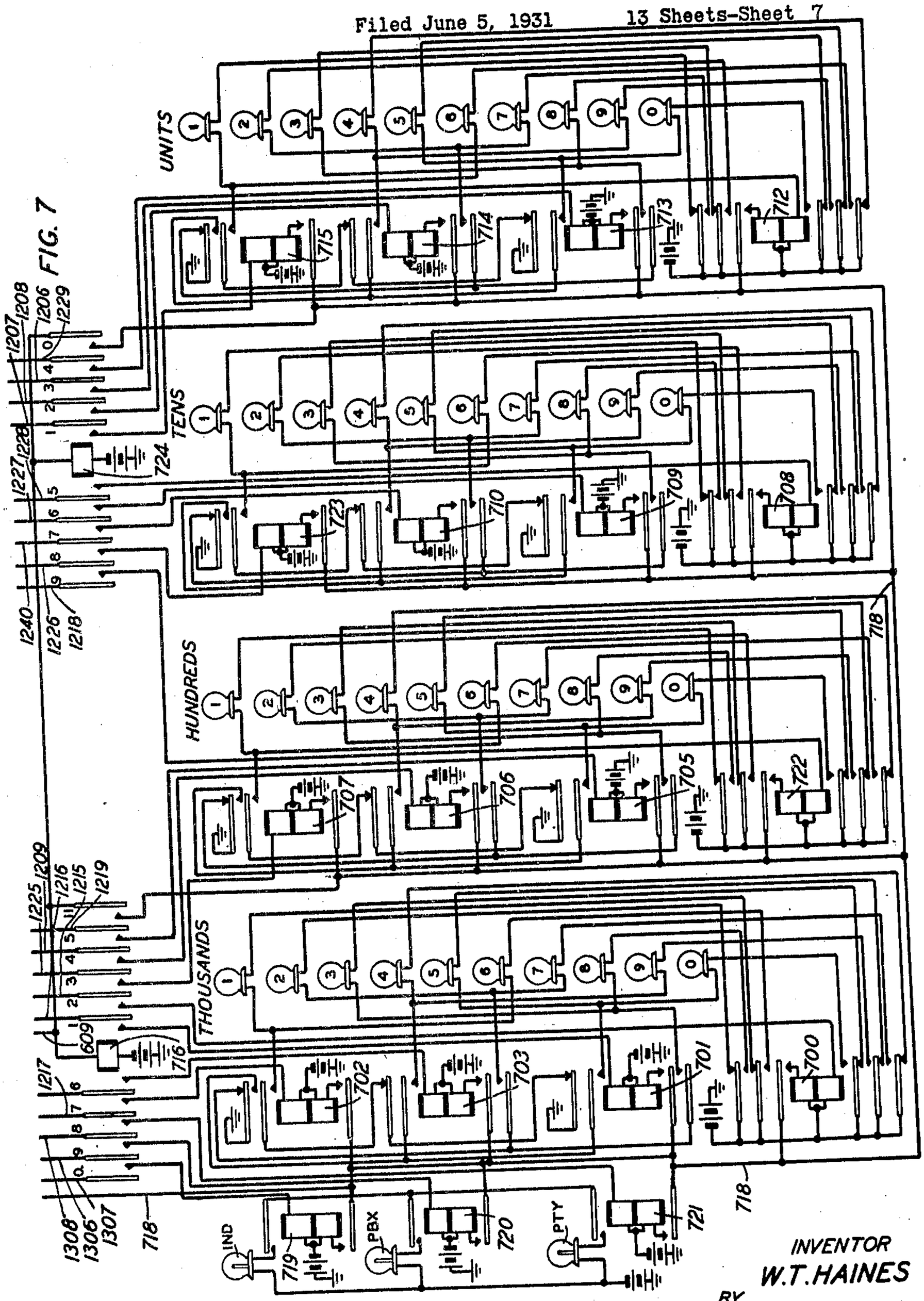
TELEPHONE SYSTEM

Filed June 5, 1931 13 Sheets-Sheet 7

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TELEPHONE SYSTEM

Filed June 5, 1931 13 Sheets-Sheet 8

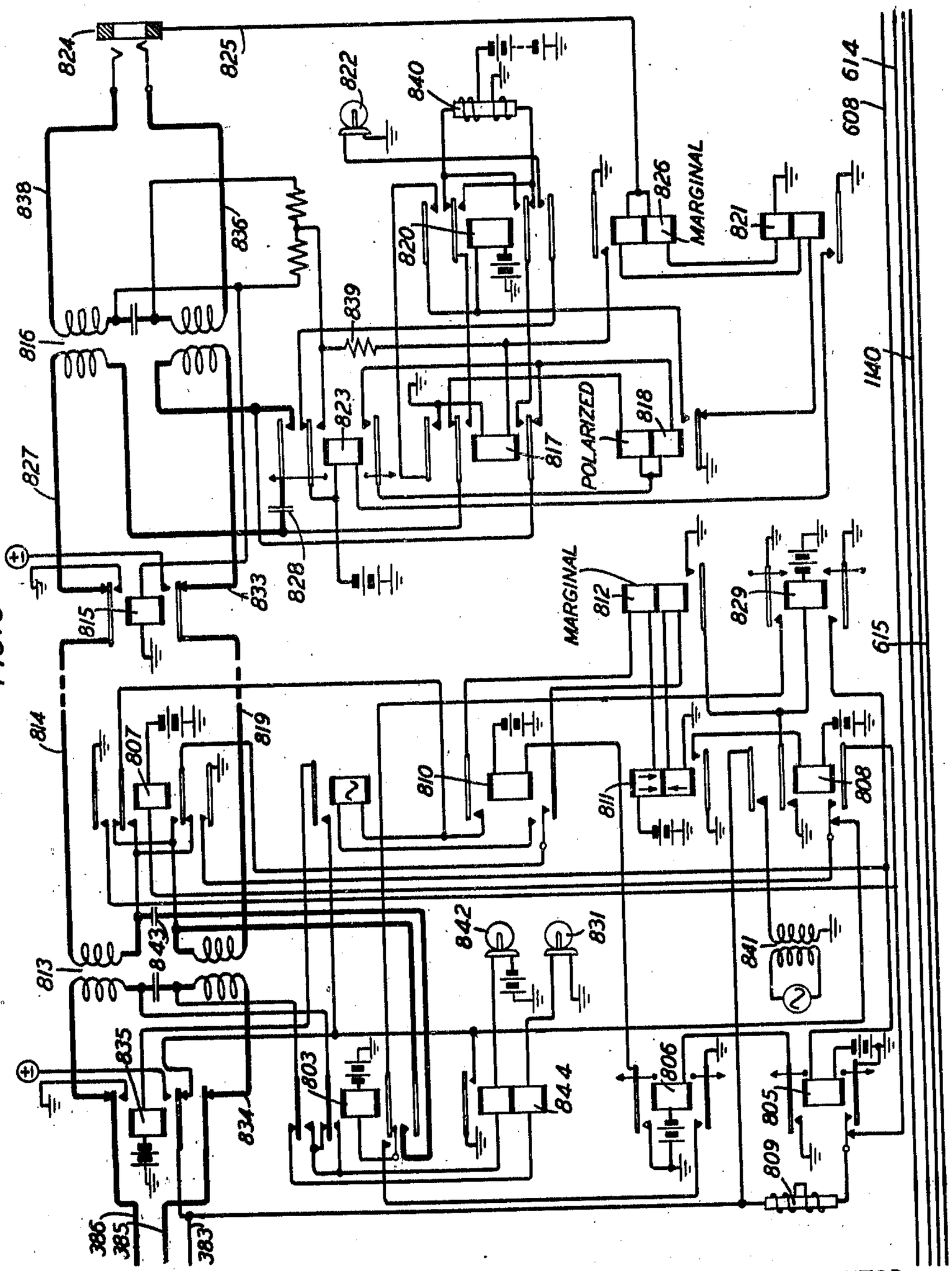


FIG. 8

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TELEPHONE SYSTEM

Filed June 5, 1931 13 Sheets-Sheet 9

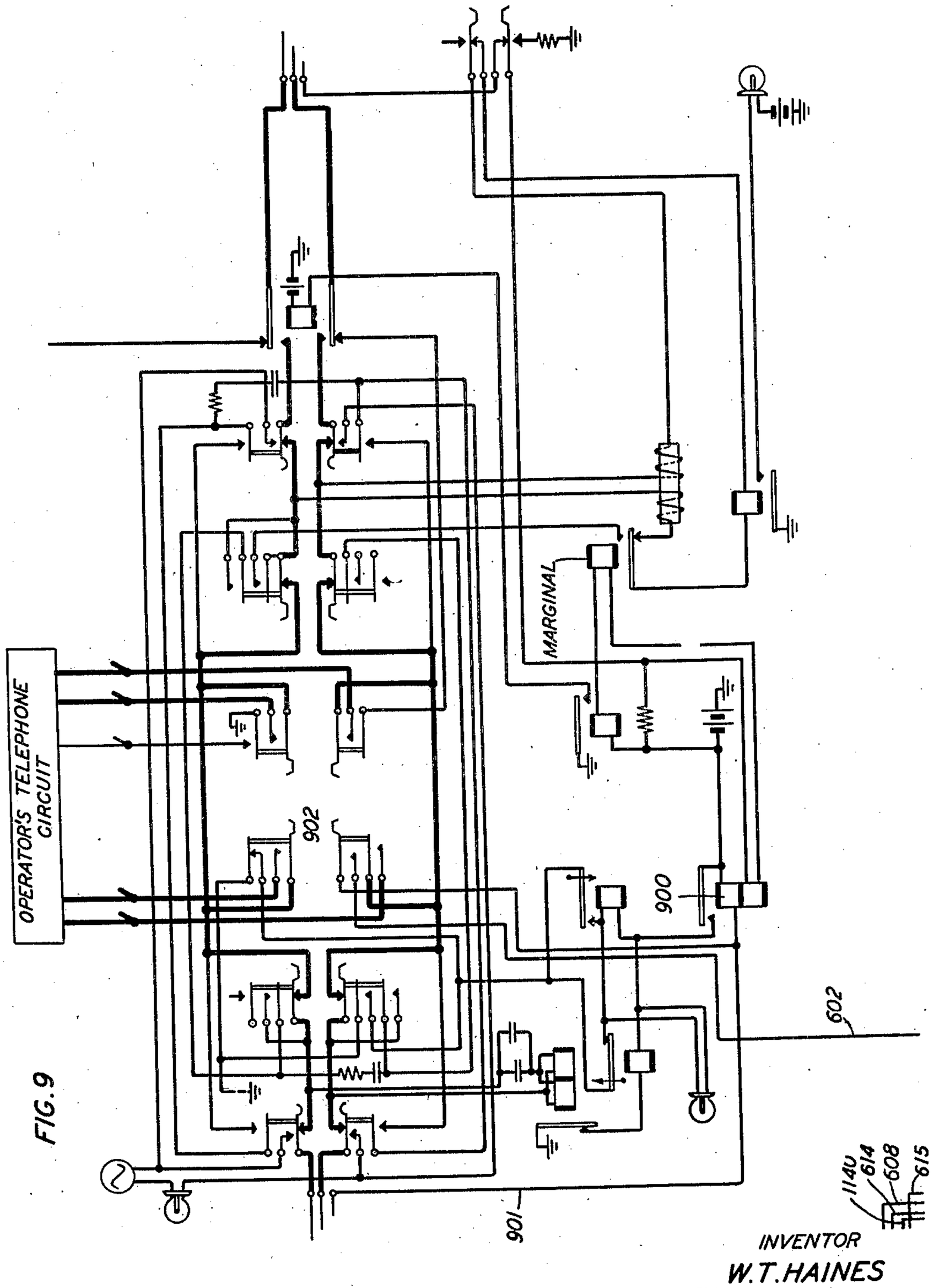


FIG. 9

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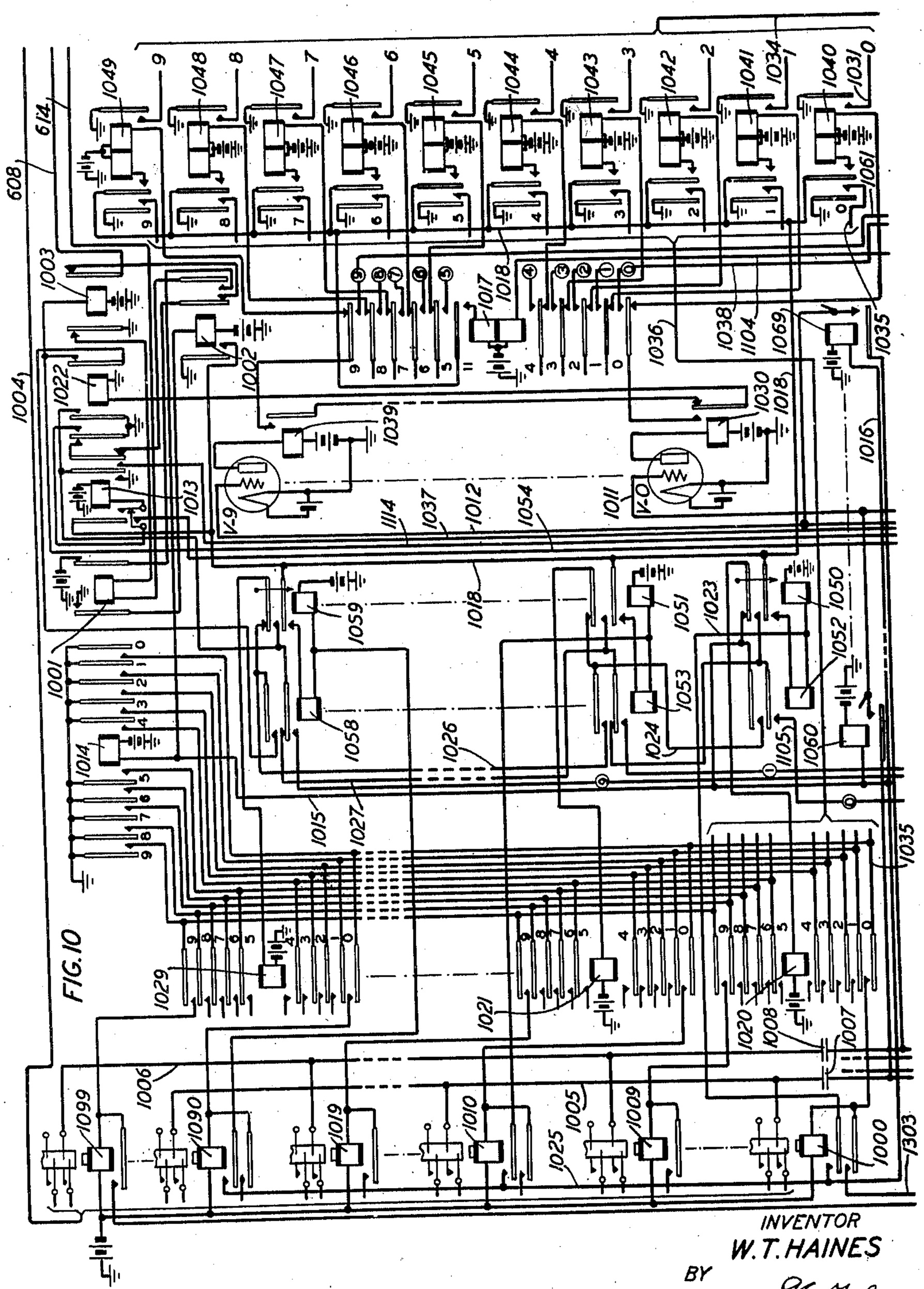
TELEPHONE SYSTEM

Filed June 5, 1931 13 Sheets-Sheet 10

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TELEPHONE SYSTEM

Filed June 5, 1931 13 Sheets-Sheet 11

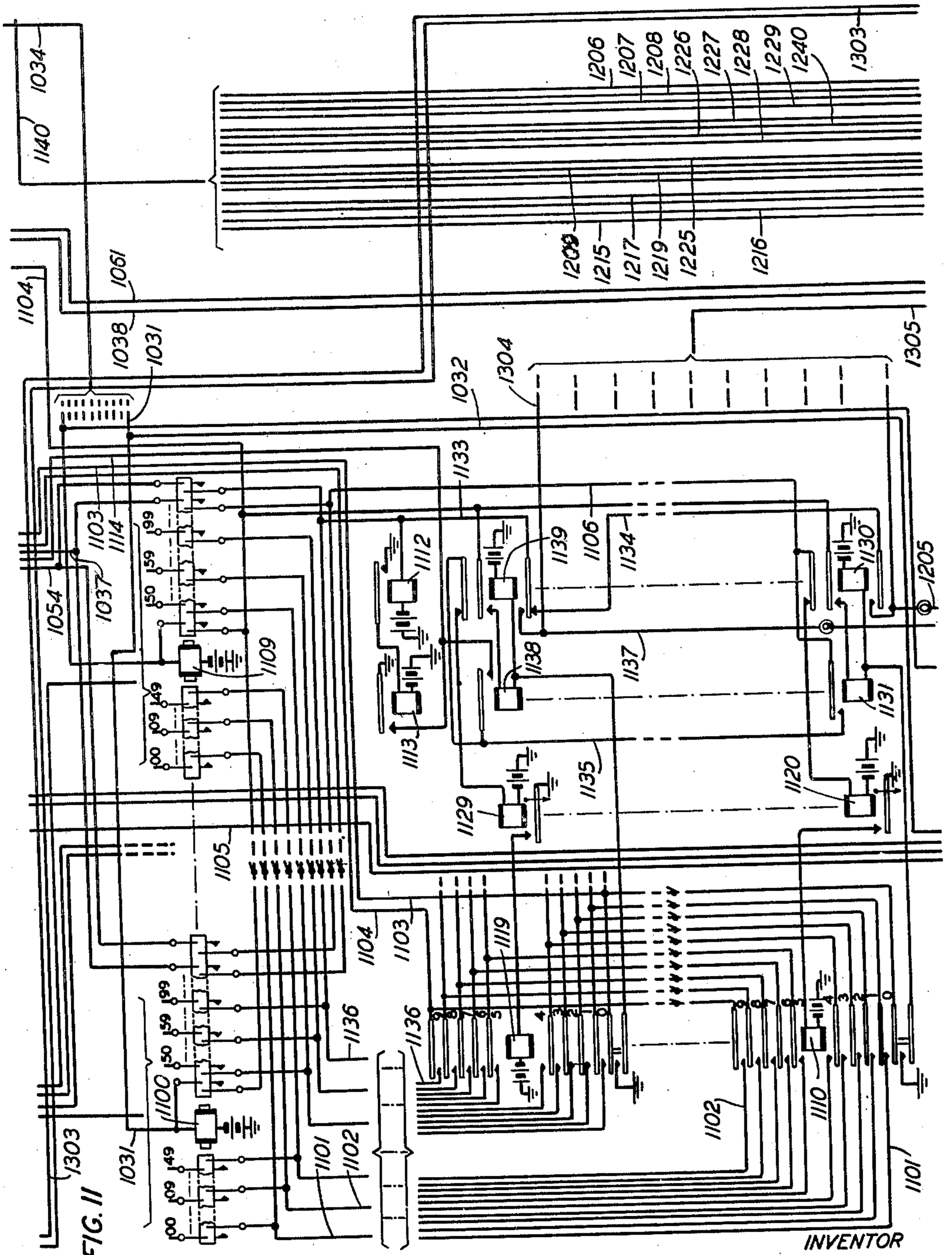


FIG. 11

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TELEPHONE SYSTEM

Filed June 5, 1931 13 Sheets-Sheet 12

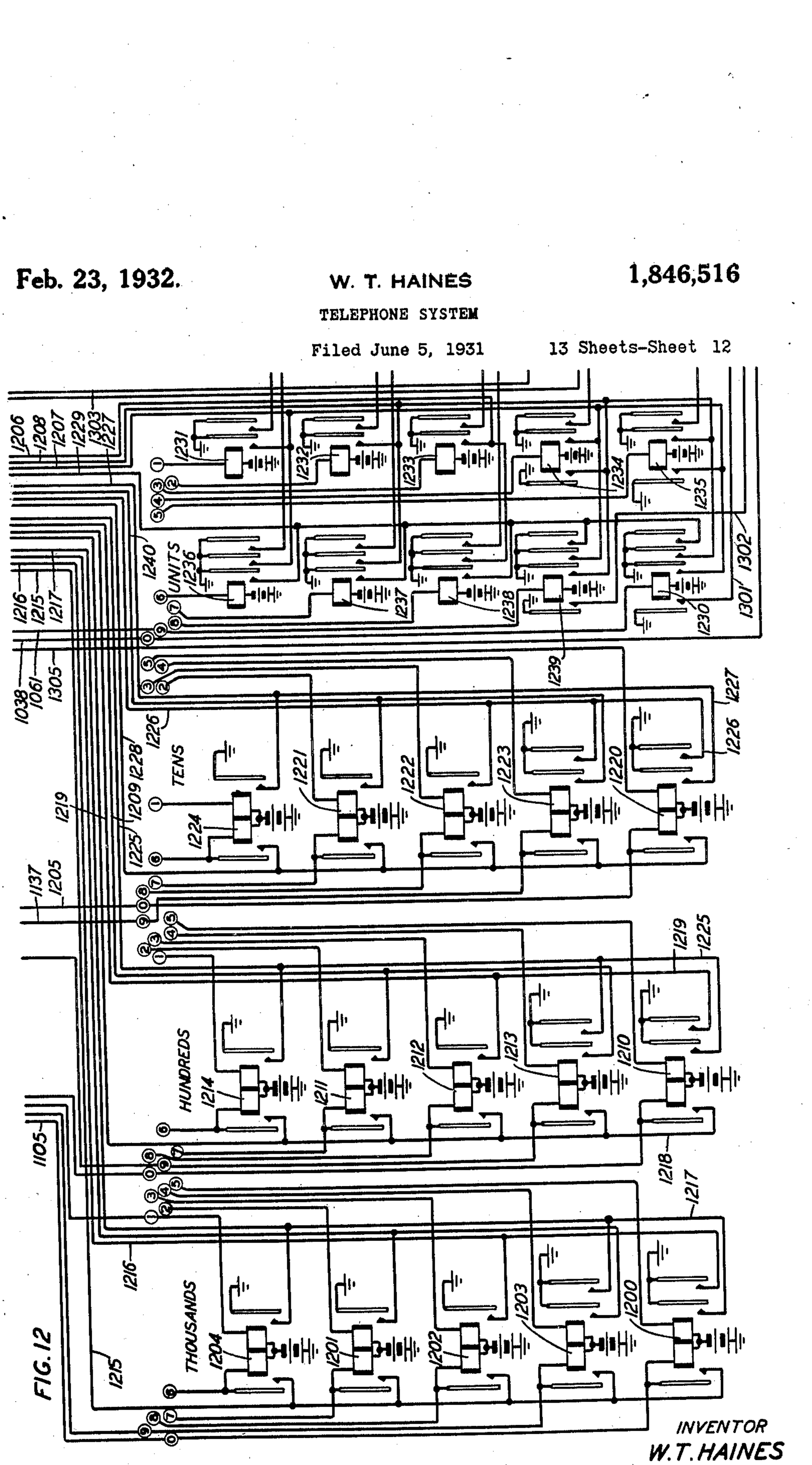


FIG. 12

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TELEPHONE SYSTEM

Filed June 5, 1931 13 Sheets-Sheet 13

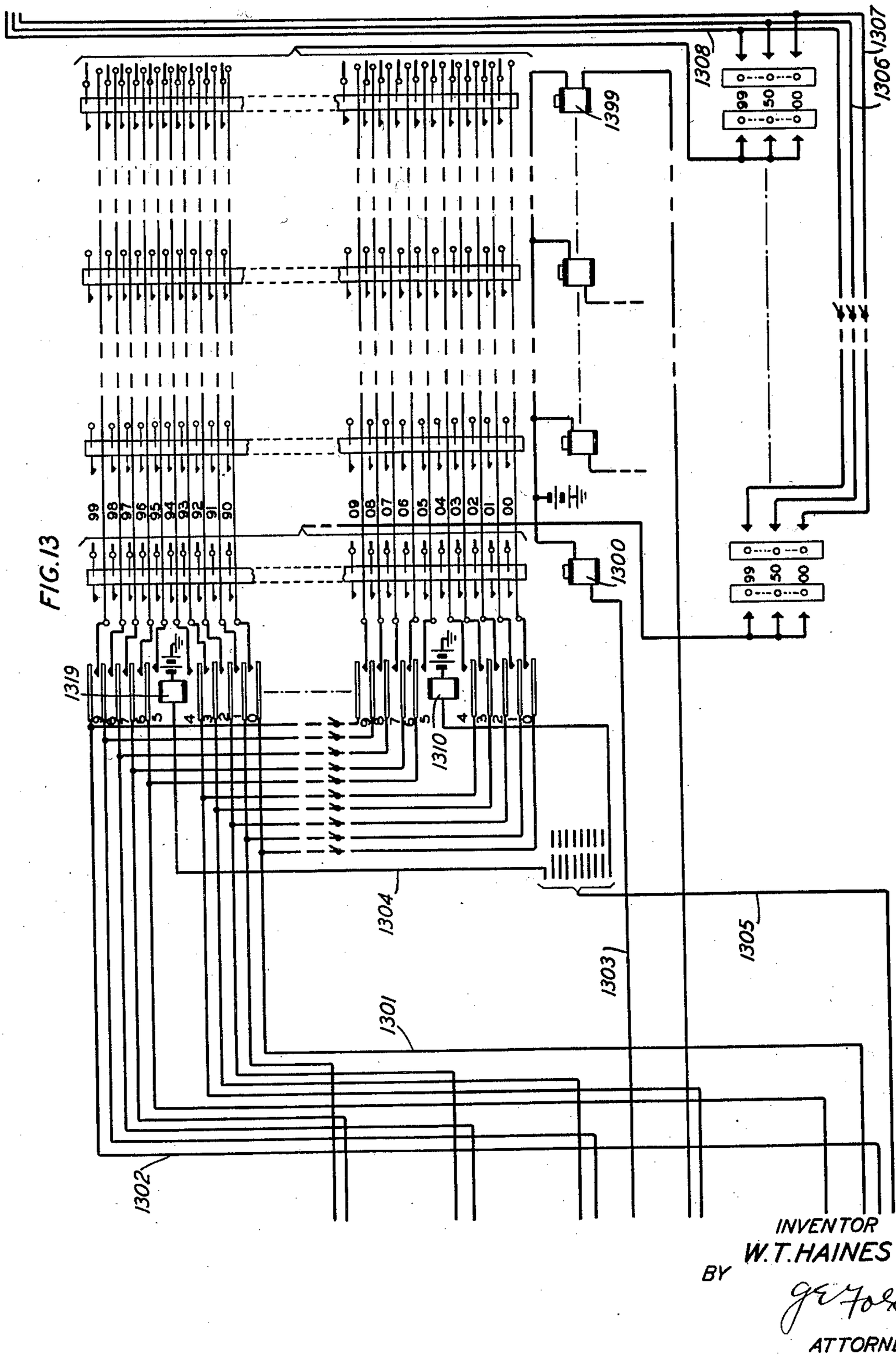


FIG. 13

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Patented Feb. 23, 1932

1,846,516

# UNITED STATES PATENT OFFICE

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## TELEPHONE SYSTEM

Application filed June 5, 1931. Serial No. 542,436.

This invention relates to telephone systems and more particularly to line indicating devices used in such systems.

In telephone systems employing line extending switches for completing a part of a telephone connection, it becomes necessary on certain types of calls, such as a toll call, to supply the operating company with information as to the identity of the calling line number. Under such circumstances the line extending switches, controlled by the calling subscriber, serve to connect the line to an operator's position where facilities exist for further extending the connection after the operator has been apprised by the calling subscriber of the identity of the calling line number. This information is necessary in order to permit the operating company to bill the calling station for the toll call. Facilities are usually provided for verifying the line number as given by the calling subscriber, so that the operating company will make no error in properly charging the toll call to the station from which the call is made.

At the present time number checking is being accomplished in divers ways, among which there is the well known checking multiple method whereby the operator, upon being apprised of the calling line number, applies the tip conductor of a cord to a sleeve conductor of the calling line in the checking multiple in which all the lines in the office terminate; the method whereby the operator, after having been given the number by the subscriber, sets a train of switches to select the calling line as given by the subscriber and thereafter impresses a tone over the sleeve conductor of the extended connection, the tone circuit being closed over the switches set by the operator and returning by way of the switches set by the subscriber so that, if the line number as given by the subscriber checks with the line terminal to which the operator has set the switches, the operator will hear the tone which was impressed over the line conductor; and other methods for causing a lamp display of the calling line number, the lamp display circuit being set by trains of impulses characteristic of the calling line.

These and other means have been used with varying degrees of success but either require the operator to obtain the line designation from the calling subscriber thereby slowing down the service or involving a large amount of equipment of a character difficult to maintain. The object of the invention is, therefore, to provide a more direct and efficient method for determining the calling subscriber's line numbers; the said means being of a structure which is both reliable in operation and economical to maintain.

The apparatus and organization of circuits described in the present invention is a means for number checking based upon the use of a positive hunting circuit for locating an identified conductor of the calling line and thereafter causing a corresponding display of the line number on an indicating device before the operator. In accordance with the invention, therefore, one specific embodiment of which is disclosed herein by way of illustration this is accomplished in the following improved manner: Each operator's position capable of extending calling subscribers' lines to toll points and for which a verification of the calling line number is necessary, is provided with four sets of relays and lamps for the display of a four-digit number and an additional set for displaying the class of line. A testing circuit which is common to all such positions and to all the subscribers' lines in the office is used. By the use of a lock-out circuit under the control of a key at each such position only one position at a time has accessibility to the testing circuit. Under such circumstances, it is necessary that the speed of operation be high, that is, the holding time of the common test circuit should be very small so as to provide all operators with facilities for using the common test circuit as fast as possible.

The testing circuit comprises an organization of groups of multi-contact relays arranged in a cascade formation and other controlling relays. Each subscriber's line of the office is provided with a multiple con-

nection from its sleeve conductor which extends as a test conductor to a particular contact of a multi-contact relay in the first group of the cascade. Through the operation of the controlling relays the multi-contact relays are so operated as to select the thousands, hundreds and tens groups in which is included the test conductor of a calling line and finally the test conductor of the calling line itself.

When a subscriber has extended a connection to the recording operator's position the operator, in response to the call, depresses a position checking key and if the test circuit is available at the time, it is taken into use and all other operator's positions are locked out from access thereto. A source of alternating current is then connected over the connection established from the subscriber's line and extended to the multiple test conductor of the calling line, establishing thereon a test potential which is instrumental in causing the test circuit to select that particular calling line. When the test circuit has functioned to select the calling line, registers at the operator's position are selectively operated to indicate on banks of lamps controlled thereby the thousands, hundreds, tens and units digits of the calling line and the indication of the class of service to which the calling line is entitled. The operator after noting the displayed line number operates a release key which, in turn, extinguishes the lamps which have displayed the line number, the test circuit having automatically restored to normal.

Since the quantity of alternating current which may be applied over the sleeve conductor of the established connection to the multiple test conductor is limited by impedance drains shunted at a number of points in the circuit extending from the calling subscriber's line to the operator's position, the energy available at the test conductor of the calling line in the test circuit is not sufficient to operate a test relay when its winding is directly connected to the sleeve conductor of such a line. For this reason, the test relays used in the test circuit of the present invention to detect the alternating current are each connected through a thermionic amplifier and operate over a circuit controlled through the space current thereof when the grid element responds to the alternating potential.

A clearer conception of the scope and purpose of the invention can be obtained from a consideration of the following description and attached drawings in which,

Fig. 1 shows one of a group of subscribers' lines together with the line and trip circuit common to the group of lines which serve to control a start circuit;

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

Fig. 3 shows a line finder-district selector circuit for extending the calling line to subsequent selectors and other types of outgoing trunks, such as a trunk to the recording operator's position;

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

Fig. 5 shows such parts of the circuits of the sender disclosed in Patent 1,589,402 granted to O. H. Kopp and dated June 22, 1926, as is necessary for an understanding of the present invention. The designation of the apparatus in Fig. 5 is identical with that of the same apparatus in the sender of the above mentioned patent;

Fig. 6 is the calling line test circuit lockout control circuit at one of the recording positions;

Fig. 7 is the line display circuit at a recording operator's position;

Fig. 8 shows a trunk from the district selector frame to the recording position;

Fig. 9 shows the toll cord and cooperating operator's telephone circuit, schematically shown, at such position;

Figs. 10, 11, 12 and 13 show the common calling line test circuit;

Fig. 14 shows the manner in which Figs. 1 to 13 inclusive should be arranged with respect to each other in order to disclose the invention completely.

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

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

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

contact of relay 109, left winding and inner left contact of relay 108, over the inner left back contact of the trip relays of the other groups of lines, conductor 129, right winding of start relay 201 to battery. Relay 201 operates in this circuit. A circuit is now closed for relay 110 extending from battery through the winding of relay 110, inner right contact of relay 108, conductor 128, to ground at the outer right contact of relay 201. Relay 110 locks in an obvious circuit to ground at the left back contact of relay 109. Relay 108, together with relay 103 prepares a circuit from ground on the outer contact of relay 110, outer left front contact of relay 108, inner right contact of relay 103, conductor 131, left back contact of relay 202, outer left back contact of relay 203, conductor 206, upper contact of cam 401, upper contact of cam 402, brush 461 and its associated terminal, conductor 378, upper contacts of cam 301, winding of relay 302, to battery, assuming that the line finder of Fig. 3 had been allotted for use by the switch 460 and the sequence switch 300 is therefore standing in position 2.

The operation of relay 108 also closes a circuit from ground over its outer right contact, through the winding of the trip magnet 303, serving the group of lines in which line 100 appears on the line finder frame, to battery. Relay 110, upon energizing, closes a circuit from battery, through the left winding of relay 109, left winding of relay 107, outer contact of relay 110 to ground. Relay 107 operates and locks through its right winding and inner right contact, conductor 132 to the contact of relay 200.

The operation of relay 302 closes a circuit from battery, through the winding of updrive magnet 304, middle left contact of relay 302, upper left contact of cam 364, right front contact of relay 302 to ground. Under the control of the updrive magnet 304 the line finder shaft is moved upwards. Due to the operation of the trip magnet 303 the set of brushes serving the group of lines to which line 100 belongs is tripped. When the switch shaft leaves the tripping zone a circuit is closed from ground over brush 307, through commutator segment 305, upper contacts of cam 306, outer left normal contact of key 204, inner right contact and right winding of relay 201 to battery. Relay 201 is held operated in this circuit but the circuit through the locking winding of relay 108 is shunted and that relay releases, in turn releasing the trip magnet 303. As soon as brush 307 leaves segment 305 the circuit of relay 201 is opened and that relay releases again connecting battery to the operating windings of relay 108 and the corresponding relays in other trip circuits, so that subsequent calls may be served.

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

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

In position 2 ground is connected from the right contact of cam 415 to brush 466 and its associated contact, conductor 375, lower right contact of cam 312, lower right contact of cam 313, left winding of relay 314 to battery. Relay 314 operates, but performs no function until the calling line has been found. Ground from the front contact of relay 406 is also extended over the contact of cam 411, upper left contact of cam 405, upper right contact of cam 404, left contacts of cam 403, conductor 207, right winding of relay 203, inner left contact of relay 205 to battery, holding relay 203 operated until the link cir-

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

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

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

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

In the meantime the line finder shaft continues to move upwards until it reaches the terminals corresponding to the calling subscriber's line. When these terminals are encountered a circuit is completed from battery, through the right winding of relay 109 in parallel with resistance 111, inner front contact of line relay 101, conductor 114, terminal 380, brush 381, right contact of cam 318, winding of relay 320 to ground. Relay 320 operates and closes a circuit in shunt of its winding through resistance 319, right front contact of relay 320, commutator segment 321, brush 322 to ground. Relay 109, which is marginal, is so adjusted as not to operate in the circuit previously traced in series with relay 107 or in the circuit traced for the winding of relay 320. With resistance 319 in parallel with relay 320, however, relay 109 does operate. The operation of relay 109 opens the locking circuit of relay 110 and relay 110 releases after an interval due to the fact that it is slow to release.

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

When sequence switch 300 leaves position 2 the circuit of relay 314 is opened and that relay releases. When the sequence switch 300 reaches position 3, the previously traced circuit for relays 503 and 317 is completed. Relay 317, being marginal, does not operate at this time. Relay 503 operates and closes an obvious circuit for relay 507 which, in turn, closes a circuit from battery, through resistance 508, winding of relay 509, outer left front contact of relay 507 to ground. Relay 509 operates and locks over its inner right front contact. Relay 507 closes a circuit for relay 510 from battery, winding of relay 510, conductor 534, to ground, at the inner left front contact of relay 507. The operation of relay 510 closes an obvious circuit for relay 511 which, in turn, closes a circuit through the right winding of relay 512.

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

it is moved to position 5 by means of ground over the lower left contact of cam 412.

In position 5 of the link sequence switch the dialing leads and the fundamental circuit leads are cut through directly from the district to the sender circuit. The dialing circuit may be traced from battery, through the left winding of relay 606, conductor 637, normally made contacts of relay 513, sender selector brush 485 and its corresponding terminal, lower contacts of cam 414, district finder brush 465 and its corresponding terminal, conductor 382, lower contact of cam 329, winding of relay 330, right back contact of relay 317, line finder brush 331, terminal 332, conductor 116 through the subscriber's substation, conductor 117, terminal 333, brush 334, middle left back contacts of relay 317, left contact of cam 335, conductor 375, brush 466 and its associated terminal, lower left contact of cam 415, brush 486 and its associated terminal, outer right back contact of relay 515, to ground. When the dialing circuit above traced is completed, relay 606 operates and closes a circuit from battery through the winding of relay 610, front contacts of relay 606, conductor 639, inner right back contact of relay 515 to ground. Relay 610 operates and closes a circuit from battery through the winding of relay 609, right front contacts of relay 610, conductor 638, upper left contact of cam 516 to ground. As soon as relay 609 operates the dialing tone circuit is completed as follows: from source of tone 607, right winding of relay 606, normal terminal and brush 804 of switch 800, outermost left contacts of relay 609, lower contact of cam 514, to ground at the inner left front contacts of relay 507.

Due to the closure of this circuit a tone is induced in the left winding of relay 606, Fig. 5 and over the dialing circuit to the receiver of the subscriber's telephone to indicate that dialing may be started. The subscriber now dials the assigned long distance code number as the first step in extending his connection to the proper operator's position, from which position the connection is then further extended to the wanted long distance subscriber.

The operation of the sender in response to the manipulation of the subscriber's dial and its consequent operation in causing the district selector to hunt for and connect with an idle trunk to the operator's position, are no part of the present invention, are completely described in the above identified patent to Kopp, and hence are not included as a part of this description, but reference is made to that patent for a complete description of these omitted operations.

When, in accordance with the operation described in the above patent, the district selector has connected with an idle trunk extending the operator's position, the district sequence switch 300 is advanced to position 10 and a trunk closure test is made of the trunk from the sender. The circuit for this test extends from ground, ballast lamp 831, Fig. 8, lower winding of relay 844, top outer back contacts of relay 803, lower left winding of repeating coil 813, bottom outer back contacts of relay 835, conductor 385 and cooperating terminal to brush 355, left upper and right lower contacts of cam 356, conductor 379, brush 462, right upper and lower contacts of cam 404, brush 482 and cooperating terminal, right front contacts of relay 507, left outer back contacts of relay 524, compensating resistance 859, brush 832 of translator 830, contact of cam 525, left winding of relay 704, winding of relay 716, lower contacts of cam 717, outer back contacts of relay 711, right contact of cam 954, left contact of cam 523, right outer back contacts of relay 504, brush 481 and cooperating terminal, left lower and upper right contacts of cam 402, brush 461 and cooperating terminal, conductor 378, left inner back contacts of relay 359, upper contacts of cam 358, brush 357, conductor 386 and connected terminal, upper back contacts of relay 835, Fig. 8, left upper winding of repeating coil 813, top inner back contacts of relay 803, upper winding of relay 844, ballast lamp 842 to battery. Relay 716 operates in this circuit but relays 844 and 704 do not. The operation of relay 716 functions to advance the sender to make the proper talking selection in the district, advancing the district selector sequence switch to position 15 and thereafter to dismiss the sender, all in accordance with the manner disclosed in the above mentioned patent.

With the district selector sequence switch 300 in position 15 a circuit is closed over the above traced battery and ground path in the operator's trunk circuit to brushes 357 and 355, respectively, left contacts of cam 358, upper right winding of repeating coil 360, lower contacts of cam 348, winding of relay 361, lower right winding of repeating coil 360, upper contacts of cam 356, brush 355 and thence through the above traced circuit at the operator's position, including relay 844. The resistance of this circuit is such that the quantity of current flowing through it is sufficient to operate relay 844, but its direction is opposite to that necessary to operate relay 361. Relay 844 operates and closes a circuit for relay 807 from ground on the contacts of relay 844, bottom normally made contacts of relay 808, winding of relay 807, to battery. Relay 807 causes the operation of relay 805 over an obvious circuit and relay 805 in turn causes the operation of relay 806. Relay 805, over its bottom front contacts, connects ground through retard coil 809 to conductor 383 and cooperating terminal in order to hold the district selector should the calling subscriber flash his receiver before the toll oper-

ator answers. Relay 806, in operating, causes the operation of relay 810. Relay 810 closes a circuit from battery through the upper winding of relay 811, upper winding of relay 812, top contacts of relay 810, top inner front contacts of relay 807, right upper winding of repeating coil 813, conductor 814, top back contacts of relay 815, conductor 827, upper left winding of repeating coil 816, top inner back contacts of relay 817, both windings in series of polarized relay 818, bottom back contacts of relay 817, left lower winding of repeating coil 816, conductor 833, bottom back contacts of relay 815, conductor 819, right lower winding of repeating coil 813, bottom inner front contacts of relay 807, bottom contacts of relay 810, lower winding of relay 812, lower winding of relay 811 to ground. Relay 818 operates in this circuit but relay 812 does not operate because the resistance of the circuit is too high and relay 811 does not operate because its windings are differential in respect to the current flowing through the circuit. Relay 818 causes the operation of relay 820 over an obvious circuit and opens, at its back contacts, the lower winding of relay 821. The operation of relay 820 closes a circuit from battery on the top back contacts of relay 823, bottom outer contacts of relay 820, lamp 822 to ground. Lamp 822 lights as an indication that a call is waiting on the trunk.

When the toll operator answers by inserting the plug of a toll cord circuit, such as is shown in Fig. 9 in the trunk answering jack 824, a circuit is closed from battery through the upper winding of relay 900, conductor 901, sleeves of plug and jack, conductor 825, bottom winding of relay 826, upper winding of relay 821 to ground. Relays 821 and 826 operate in the above circuit. Relay 821 causes the operation of relay 823 over an obvious circuit and this latter relay opens the circuit of lamp 822 thereby extinguishing it. Relay 823, by closing its top outer contacts, connects the left lower winding of repeating coil 816 through condenser 828 and thence to the left upper winding of the said repeating coil and short circuits, through its bottom contacts, the high resistance lower winding of relay 818. Due to the corresponding increase of current in the circuit above traced and including relays 811, 812 and 818, relay 812 operates. Relay 812 in turn causes the operation of relay 829. Relay 829 causes the operation of relay 803 over a circuit from ground on the top contacts of relay 829, bottom inner normally made contacts of relay 803, winding of relay 803 to battery. Relay 803, in operating locks through its bottom inner make contacts to ground on the bottom contacts of relay 806, reverses the direction of current flow in the trunk circuit path above traced and including relay 361 in the district selector. The current flow is now in the proper direction to operate relay 361, which, on operating, closes a circuit for relay 314 from ground over the left contacts of cam 350, front contacts of relay 361, left lower and right upper contacts of cam 347, right winding of relay 314 to battery. Relay 314 operates and closes a circuit from ground over cam 339 and the left lower contact thereof, right outer front contacts of relay 314, left lower contact and cam 328, winding of magnet 300 to battery. The switch magnet operates and advances the sequence switch to position 16 which is the "talking to operator" position. The operation of relay 803 also closes the talking circuit by connecting condenser 843 over its bottom outer contacts, to the two right windings of repeating coil 813.

In position 16 of the district selector sequence switch, the repeating coil is removed from the trunk loop and talking battery is supplied to the calling subscriber from battery through the ballast lamp 842, upper winding of relay 844, thence as traced to the upper right contact of cam 329, thence as traced over the calling loop to cam 335 and the upper contact thereof, thence as traced through the lower winding of relay 844 to ground. Relay 844 now holds over the said loop. In position 16, relay 314 is held locked over a circuit from ground on the bottom front contacts of relay 805, through retard coil 809 to conductor 383 and cooperating terminal, previously described, brush 349, right contacts of cam 350, right inner front contacts of relay 314, left winding of relay 314 to battery. The operation of relay 803 also completes, over its bottom outer contacts, the talking circuit by connecting condenser 843 to the right windings of repeating coil 813 as previously described.

The toll operator now operates talking key 902 and learns from the subscriber that a toll connection is desired. It is then necessary, before proceeding with steps to extend the subscriber's line to the toll area, to check and learn the identity of the calling line number. In order to do this number checking key 604 is operated. Key 604 closes a circuit to operate relay 601. Relay 601 locks over its bottom winding and bottom inner contacts to ground on the bottom outer back contacts of relay 600 and, over its top front contacts, prepares a circuit to operate relay 600 over its bottom winding. It also closes an obvious circuit for lamp 605 which lights. If the common calling line test circuit is idle at this time then the circuit for relay 600 is completed from battery, back contacts of relay 1001, right inner back contacts of relay 1002, right back contacts of relay 1003, conductor 608, bottom winding of relay 600, to ground on the top front contacts of relay 601. Relay 600 operates and closes a locking path from battery through its top wind-

ing and top inner front contacts, conductor 614, winding of relay 1001, left back contacts of relay 1003 to ground. Relay 600 locks and relay 1001 operates in the locking circuit just traced. Relay 1001 disconnects the operating battery for relay 600 and similar relays at other recording or toll positions the lower windings of whose lock-in relays are all connected in parallel to conductor 608. Should an operator at another recording or toll position at this time depress the position checking key to verify a calling line number, then, while the consequent operation of the position relay 601 prepares a path to operate the position cut-in relay 600, yet so long as the test circuit has been locked in with another position by the operation of relay 600 at that position, relay 1001 will be operated in series with the locking winding of relay 600 of that position and operating battery for the cut-in relays at all other positions is removed at its contacts. Relay 600 of the position to which the test circuit is connected also cuts off the locking circuit of other relays 600 over its top inner back contacts and, over its bottom outer front contacts, connects ground to conductor 611, operating relays 716 and 724 in parallel. Relay 716 locks over its No. 11 contacts to conductor 718 while relay 724 locks over its No. 0 contacts to conductor 718. Conductor 718 is connected through the contacts of release key 607 to ground on the top outer back contacts of relay 601.

The operated relay 600 closes an additional circuit for lamp 605 which continues to glow as long as the test circuit remains connected to the position. The lamp circuit at relay 600 replaces that at relay 601 which releases when relay 600 operates. Over its top outer contacts, relay 600 connects ground through low resistance 612 to conductor 602 which is connected in parallel to a conductor in each of the position toll cords connecting with a bottom inner contact on talking key 902. If the calling line number is being checked, key 902 is operated and the low resistance ground is connected in parallel to the sleeve conductor 901. The shunting parallel circuit reduces the current through the circuit of relays 826 and 821 and, relay 826 being marginal, releases. The release of relay 826 removes the shunt around the winding of relay 817 and this relay now operates in a circuit from battery through the top inner front contacts of relay 823, resistance 839, winding of relay 817 to ground. The operation of relay 817 disconnects the winding of relay 818 from the trunk conductors, causing it to release. Relay 820, however, does not release when relay 818 releases since it is held locked over its top outer contacts to ground on the top outer contacts of relay 817. The operation of relay 817 connects a battery of a higher voltage to the trunk conductors over a path from battery through the upper winding of retard coil 840, bottom inner front contacts of relay 820, bottom front contacts of relay 817, left lower winding of repeating coil 816, conductor 833, bottom back contacts of relay 815, conductor 819, right lower winding of relay 813, bottom inner front contacts of relay 807, bottom contacts of relay 810, bottom winding of relay 812, bottom winding of relay 811 to ground. another circuit is also closed from ground through the bottom winding of retard coil 840, top inner front contacts of relay 820, top inner front contacts of relay 817, left upper winding of repeating coil 816, conductor 827, top back contacts of relay 815, conductor 814, right upper winding of repeating coil 813, top inner front contacts of relay 807, top contacts of relay 810, top winding of relay 812, top winding of relay 811 to battery. Due to the difference in curent flow between the upper and lower windings of relay 811, caused by circuits of different battery potentials, the opposing characteristics of the windings of relay 811 are overcome and sufficient current flows through the lower winding to overcome the opposing current through the upper winding to cause relay 811 to operate. Relay 811, in turn, causes the operation of relay 808. The operation of relay 808 closes a circuit from ground through the secondary winding of a transformer 841 whose primary is connected to a source of alternating current preferably of high frequency, top outer contacts of relay 808, sleeve conductor 383 and cooperating terminal, brush 349, right contacts of cam 350, right inner front contacts of relay 314, left contacts of relay 314, right upper and left lower contacts of cam 348, condenser 388, top contacts of cam 368, brush 326, terminal 327, sleeve conductor 112, sleeve terminal 113, corresponding cross connecting terminal 134, to conductor 1004. Conductor 1004 is the test conductor connecting the sleeve circuit of a subscriber's line with the calling line test circuit. There is one such conductor from the sleeve terminal of each subscriber's line to the test circuit and the distribution of all the said conductors within the test circuit as well as the effects of an alternating potential on the said test conductor of the calling line whose number is being verified will hereinafter be described.

It will be noted that the trunk circuit above described and connecting the district selector with the operator's position is one of a well known type which is used when the operator's position is located at a distance from the originating central office and in which but two trunk conductors, namely 814 and 819, extend from the said office to the said position. Consequently the method of signaling the outgoing end of the trunk from the said position to connect an alternating potential to the sleeve conductor of the connection is one specifically adapted to the type of trunk dis-

closed. However, it is to be understood that the invention is not limited to any particular kind of trunk as it is realized that the connection between the first switching stage and the operator's position may be accomplished in a variety of ways, all of which would be satisfactory for use with the present invention provided that the trunk contains facilities or can be modified to contain facilities which are responsive to an operation at the operator's position for connecting an alternating potential to the sleeve conductor of the extended connection.

Each subscriber's line test conductor, such as conductor 1004, is connected to the contact of a multi-contact relay belonging to one of a plurality of groups of such relays. In a 10,000 line office there are ten such groups, one group for each thousand, and, in Fig. 10, three of these groups are represented by three abbreviated groups of relays; viz., a zero group of ten multi-contact relays represented by relays 1000 and 1009, the No. 1 group of ten multi-contact relays represented by relays 1010 and 1019, and the last or No. 9 group of ten multi-contact relays represented by relays 1090 and 1099. In each of the said groups, the first mentioned relay is the first relay and the last mentioned relay is the last relay in each of the respective groups. The remaining seven intermediary groups are not shown. Now each relay in each group has 100 pairs of contacts for connection with the test conductors of 100 subscribers' lines and also other miscellaneous contacts for circuit control purposes as more completely described hereinafter. The contacts in each relay connecting with the test conductors are arranged in a numerical order consistent with the numerical designation of the subscribers' lines. Thus, the contacts of first relay 1000 of the zero group are connected to the sleeve conductors of subscribers' lines whose numerical designations are from 0000 to 0099; the contacts of the first relay 1010 of the No. 1 group are connected to subscribers' lines whose numerical designations are from 1000 to 1099 and so on up to the contacts of the ninth relay 1099 in the No. 9 thousand group which are connected to the sleeve conductors of subscribers' lines whose numerical designations are from 9900 to 9999. Consequently, conductor 1004 of subscriber's line 100 in Fig. 1 would be connected to a contact on one of the ten multi-contact relays of the particular thousand lines group to which the subscriber's line belongs and, further, to the particular multi-contact relay of that group which contains the one hundred line subdivision in which the line under consideration belongs. The actual contact in the 100 contact pairs of the relay to which the test contact is connected is, of course, determined by the tens and units designation of the line, the 100 contact pairs being further subdivided in ten groups of ten contact pairs each.

The cooperating armature contact of each contact pair of the multi-contact relays in one entire thousands group is multipled to the corresponding contact in the corresponding hundreds relay in each of the other thousand groups and finally connected to a common conductor. In a 10,000 line office, therefore, there would be 10,000 multi-contact relay contacts connected to as many subscribers' lines test conductors and 1000 common conductors. For example, the contacts of relay 1000 contain the test conductors of subscribers' lines having designations from 0000 to 0099; the contacts of relay 1010 contain the conductors of subscribers' lines having designations from 1000 to 1099, while the contacts of relay 1090 contain the conductors of subscribers' lines having designations 9000 to 9099. In the same way the contacts of corresponding relays in the intermediary groups, not shown, are wired to test conductors of all other subscribers' lines whose hundreds numerical designation is 0. The cooperating armatures of these contacts in all the relays in similar hundreds in all the thousand groups are strapped to a common conductor such as, for example, conductor 1005. Likewise the contacts of relay 1009 are wired to the test conductors of subscribers' lines whose numerical designations are from 0900 to 0999, relay 1019 to test conductors of subscribers' lines whose numerical designations are from 1900 to 1999 and relay 1099 to test conductors of subscribers' lines whose numerical designations are from 9900 to 9999. The cooperating armature contacts of these relays, as well as those of relays in the intermediary groups are strapped together and connected to common conductors, such as conductor 1006. For the entire ten groups of hundreds relays, there are, therefore, 1000 common conductors and each of these conductors is connected in series with a condenser, such as condensers 1007 and 1008 connected in series with conductors 1005 and 1006, respectively.

On the other side of the condensers the extension of these conductors are multipled to contacts of the group of ten multi-contact relays represented by relays 1060 and 1069. As regards the extension of the conductors to the group of ten multi-contact relays represented by relays 1060 and 1069, conductor 1005, as already explained, is representative of the group of 100 conductors which are connected to the armatures of those multi-contact relays in each thousand group, whose cooperating contacts are connected to subscribers' lines having 0 hundreds designation. This group of 100 conductors is connected to the 100 armatures of relay 1060. Only one pair of contacts for this relay is shown in the drawings. The cooperating contacts making with these armatures are all strapped to-

gether and connected by way of conductor 1011 to the grid element of the thermionic amplifying circuit V—0 the plate circuit of which is in series with the winding of relay 1030. Likewise, every other group of 100 conductors connected to the armatures of those multi-contact relays whose cooperating contacts are connected to subscribers' lines having a particular hundreds designation are multipled to the 100 armatures of a corresponding relay in the group of relays represented by relays 1060 and 1069. The contacts making with these armatures are, in turn, strapped together and connected to the grid element of the corresponding thermionic amplifying circuit, the plate circuit of which is in series with the winding of a relay similar to relay 1030. In the illustration of Fig. 10, only two of the ten thermionic circuits are shown, namely, the one above referred to having to do with the group of 100 conductors relating subscribers' lines having a zero hundreds designation and the other group of 100 conductors, represented by conductor 1006, relating to subscribers' lines having a 9 hundreds designation. These last conductors are multipled to the 100 armatures of relay 1069. The contacts making with these armatures are multipled together and connected by way of conductor 1012 to the grid element of the thermionic amplifying circuit V—9, the plate circuit of which is in series with the winding of relay 1039.

The above conductors, that is, the 1000 common conductors connected to the armatures of multi-contact relays 1000 etc. are further multipled to another group of ten multi-contact relays, the first and last of which are represented by relays 1100 and 1109, respectively. Each group of 100 conductors common to all the hundreds groups of subscribers lines is wired to the armatures of one of the relays of the group, each relay designating one of the said hundreds groups. For example, the group of conductors represented by conductor 1005 and cooperating with those subscribers' line test conductors whose hundreds numerical designation is 0, are wired to corresponding armatures of relay 1100, while the group of conductors represented by conductor 1006 and cooperating with contacts connected to subscribers' lines having nine for their hundreds numerical designation are wired to corresponding armatures of relay 1109. All intermediate groups are wired to the armatures of similar intermediate relays but are not shown in the drawings. In connecting the individual conductors of the groups to the armatures of the separate group relays, the same subdivision in smaller groups of ten and the same numerical order of connecting the individual conductors in each group of ten is followed as was the case with connecting the multiple of the said conductors to the armatures of the relay group represented by relays 1060 and 1069 described above. For example, if it is assumed that conductor 1005 is wired to the respective first or zero armatures in each of the multi-contact relays 1000, 1010, 1090, etc. making with contacts connecting with the test conductors of subscribers lines bearing, respectively, the numerical designations 0000, 1000, 2000, etc., then conductor 1005 is connected to armature 00 of relay 1100, which relay has connected to its armatures all the common conductors connected to the multi-contact relays 1000, 1010, 1090 etc., whose cooperating contacts are connected to subscribers' lines test conductors having 0 for their hundreds numerical designation. On the other hand if conductor 1005 were connected to the respective armature of those relays whose cooperating contacts are connected to the test conductors of subscribers' lines having numerical designation 0049, 1049, 2049, etc., then conductor 1005 would be connected to armature 49 of relay 1100. The same order of wiring is followed with the remaining 100 conductors connected to the armatures of the multi-contact relays whose contacts are wired to the test conductors of subscribers' lines having 0 for their hundreds numerical designation. In the same way the 100 conductors of each group of subscribers with the same hundreds designation will be wired to correspondingly numbered armatures on the appropriate one of the ten relays of the group represented by relays 1100 and 1109. Conductor 1006, on the other hand, represents one of the group of 100 conductors connected to the armatures of relays 1009, 1019, 1099, etc. whose contacts are connected to subscribers' lines having numerical designations 0900, 1900, 9900, etc. and it is, in turn, connected to the corresponding contact of relay 1109 in the same numerical order as the group represented by conductor 1005 described above.

The corresponding contacts of each relay in the group represented by relay 1100 and 1109 are all multipled to each other and a common conductor from each of the multipled contacts is carried to a contact of a relay in yet another group of ten relays each having ten sets of contacts. This group is represented by relays 1110 and 1119 wherein relay 1110 represents the first and relay 1119 the last of the group. All conductors connected to contacts whose armatures bear the same tens designation are carried to corresponding contacts of one relay. For example, conductor 1101 multipled to those contacts whose cooperating armatures bear the designation 00 is connected to contact 0 on relay 1100. Conductor 1102, multipled to contacts cooperating with armatures 09 of the same tens group is connected to contact 9 of relay 1110. In the same manner each group of ten conductors connected to arma-

tures bearing identical numerical designations is wired to the appropriate contacts of all the other relays in the group of relays represented by relays 1110 and 1119. The correspondingly numbered armatures of all the relays in this group are all multipled to each other, making a group of ten conductors in all, and these, in turn, are each multipled to a grid conductor of the ten thermionic amplifiers V0—V9 in Fig. 11. Conductor 1103, multipled to armature contact 0 of relays 1110, 1119 etc. is connected to conductor 1011 of the thermionic amplifier V—0 while conductor 1104 multipled to armatures of the No. 9 contact combination, is multipled to conductor 1012 of the thermionic amplifier V—9. Other intermediate conductors are likewise multipled to the appropriate thermionic amplifier; these being not shown in the drawings.

It will be recalled that the depression of the number checking key 604 at the operator's position resulted in the operation of relay 1001. Relay 1001 causes the operation of relay 1002. The operation of relay 1002 starts the calling line testing circuit in a series of testing operations to determine the numerical designation of the calling line by testing for the sleeve conductor to which the source of alternating current was applied. Relay 1002, over its right outer contacts, closes a circuit from ground on the left outer back contacts of relay 1022, right outer back contacts of relay 1013, right outer contacts of relay 1002, winding of relay 1014 to battery and, in parallel to the said winding, conductor 1015, conductor 1016, to the winding of each of the ten relays in the group represented by relays 1060 and 1069. Another circuit also branches from conductor 1015 through the top outer back contacts of relay 1050, winding of relay 1020 to battery. All the relays in the above traced circuits operate; that is, relay 1014, the group of ten relays represented by relays 1060 and 1069, and relay 1020. Relay 1014 connects ground through each of its ten contacts to the correspondingly numbered armatures of relay 1020. The armatures of relay 1020 are in turn, multipled to correspondingly numbered armatures of nine other relays, the entire group of ten being represented in the drawings by relays 1020, 1021 and 1029. Each of these relays has ten sets of contacts, and the contacts cooperating with the said armatures are connected to the windings of the 100 multi-contact relays represented by relays 1000, 1009, 1010, 1019, 1090 and 1099. Each group of ten multi-contact relays whose contacts are connected to the line test conductors therefore, is controlled by one of the ten relays represented by relays 1020, 1021 and 1029 and the operation of relay 1020, in turn, causes the operation of the ten corresponding multi-contact relays, represented by relays 1000 and 1009, controlled through its contacts. The operation of relay 1000 closes a circuit for multi-contact relay 1300 from battery through the winding of relay 1300, conductor 1303, bottom outer contacts of relay 1000, in parallel with the winding of relay 1000 to the same operating ground on the contacts of relay 1014. Relay 1300 operates but performs no function at this time and subsequently releases when, as explained hereinafter, relay 1000 releases. As already explained, the contacts of the group of multi-contact relays represented by relays 1000 and 1009 are connected to the line test conductors of the first or 0 thousands group of subscribers' lines, so that, with the operation of these relays, the zero thousand conductors are connected into the test circuit to participate in the test to be made for the conductor to which the alternating current has been applied. Relay 1021 represents the second control relay and closes the circuit to the winding of the second group of ten multi-contact relays to whose contacts are connected the sleeve conductors of subscribers' lines of the first thousand group, while relay 1029 is the ninth control relay and closes the circuit to the winding of the last group of 10 multi-contact relays to whose contacts are connected the sleeve conductors of the subscribers' lines of the last or ninth thousand group in the office.

In seeking to identify the calling line to whose sleeve conductor an alternating current source has been applied, a test is progressively made in each group of 1000 lines of the entire 10,000 lines commencing with the lowest or 0 group. Since the controlling relays represented by relays 1020, 1021 and 1029 are arranged to control the operation of the subscriber test conductor relays in groups of a thousand at a time and in a numerically serial order, the operation of relay 1020 causes the operation of the ten relays represented by relays 1000 and 1009 to close through the 1000 test conductors in the 0 thousand. The relays represented by the group 1000 and 1009, in operating, close through the 1000 test conductors of subscribers' lines designated 0000 to 0999 inclusive to the 1000 common conductors represented by conductors 1005 and 1006. Now if the subscriber's line to whose test conductor the alternating current source was connected is located in the 0 thousands group, then that conductor is connected to a contact in one of the relays represented by the group 1000 and 1009, the particular relay depending on which further subdivision of one hundred lines of the thousand it belongs. If it belongs in the first hundred, that is, if it is connected to a contact in relay 1000, and remembering that the 100 of the 1000 common conductors connected to the armatures of this relay are, in turn, multipled to the armatures of relay 1060, the alternating current circuit

path previously traced to the test conductor 1004, would now be completed through the particular armature making with the contact connected to the subscriber's test conductor relay 1000, the common conductor connected to the said armature, corresponding armature on relay 1060, contact making with said armature, conductor 1011, to the grid element of thermionic amplifier V—0. The space current resulting from the operation of the said amplifier results in the operation of relay 1030. Relay 1030 closes a circuit from battery through the right winding of relay 1040, back contacts of the No. 0 contacts of relay 1017, front contacts of relay 1030, winding of relay 1022 to ground. Relays 1022 and 1040 both operate in this circuit. Relay 1040 locks over its left winding and contact, conductor 1018, to ground on the left contacts of relay 1002.

If the calling line test conductor 1004 is not in the zero hundreds group but in any other of the remaining hundreds groups of the 0 thousand, the above alternating current circuit would be traced from the contact and armature in the appropriate hundreds multicontact relay of the group represented by relays 1000 and 1009, through one of the 100 common conductors multipled to the armatures of the corresponding hundreds relay of the group represented by relays 1060 and 1069, the armature and contact in the said relay, to a conductor, similar to conductor 1011, connected to the grid element of the thermionic amplifier having the same hundreds designation as the relay to the contacts of which its grid element is connected. The space current resulting from the operation of the thermionic amplifier would operate a relay corresponding to relay 1030 which, in operating, would close a circuit from ground through the winding of relay 1022, the back contacts in a series chain of all space current relays, like relay 1030, of all thermionic amplifiers of lower numerical designation than the one which operated, front contacts of the space current relay of the thermionic amplifier which has operated, the back contacts of the correspondingly numbered contact combination of relay 1017, to the right winding of the corresponding relay of the series 1040–1049, inclusive. This last mentioned relay locks over its left winding in the same manner as relay 1040, previously described in connection with the operations based on the assumption that the calling line test conductor was located in the zero hundreds group.

During the time that the operations above described are taking place and when the group of relays represented by relays 1000 and 1009 are operated, a path is closed for slow-to-operate relay 1050 from battery through the winding of relay 1050, conductor 1023, bottom inner contacts of relay 1000, conductor 1015 to a previously traced ground on the contacts of relay 1022. Relay 1050 operates after an interval and closes a locking path for itself through the winding of relay 1052, inner contacts of relay 1050, conductor 1018 to ground on the left contacts of relay 1002. Relay 1052, however, does not operate in this locking circuit since the operating ground for relay 1050 on conductor 1023 is still connected to the other side of its winding. When, however, relay 1022 operated in series with relay 1040, or some other relay of the group 1040–1049 inclusive, as a result of finding the calling line test conductor in the 0 thousands group, ground is removed from conductor 1015, causing relays 1014, 1020, the group of relays represented by relays 1060 and 1069, and the group represented by relays 1000 and 1009, to release. The release of relay 1000 removes the short circuit around the winding of relay 1052 causing it to operate in the locking circuit of relay 1050. With the operation and locking of relay 1052 the test of the 0 thousands group is terminated. Relay 1050 and others in the same group, as more clearly explained hereinafter, are made slow to operate in order to allow sufficient time to operate the thermionic amplifier circuit should the calling line test conductor be found in the thousands group under test. With relay 1050 made slow to operate, the circuit of relay 1020 is not cut off immediately and the group of multi-contact relays connected to the 1000 test conductors under test is not disturbed for an interval until relay 1030 which, having but one pair of contacts is fast in operating, has had an opportunity to operate.

The termination of the test of the 0 thousands group of test conductors and the consequent finding therein of the calling line test conductor 1004 results in the operation and locking of the pair of counting relays 1050 and 1052 as already described and also the operation and locking of relay 1040 or some other relay in the group 1040–1049, inclusive. The operation and locking of the counting relay 1050 and 1052 registers the fact that the calling subscriber's line whose number is to be verified is located in the first or 0 thousands group while the locking of relay 1040 registers the fact that the calling line is located in the 0 hundreds of the 0 thousands group. If any other relay of the group 1040–1049 inclusive had been operated and locked, that relay and not relay 1040 would have indicated the particular hundreds in the 0 thousands group in which the calling line test conductor is located.

Should it come to pass, however, that the calling line test conductor 1004 is not in the 0 thousands group, then there is no alternating current circuit for operating the thermionic amplifier V—0, relay 1030 does not op-

erate and therefore no circuit is closed for relays 1040 and 1022. Under such circumstances the succeeding thousands groups are progressively tested to locate the test conductor of the calling line and this is accomplished in the following way:

If relay 1022 does not operate as a result of finding the calling line test conductor, then ground is not removed from conductor 1015 but relay 1020 releases when relay 1050 operates. The release of relay 1020 releases the multi-contact relays represented by relays 1000 and 1009 and the release of relay 1000 causes the operation of relay 1052 in the locking circuit of relay 1050 as previously described. A circuit is now closed for control relay 1021 from battery through the winding of relay 1021, top outer back contacts of relay 1051, conductor 1024, top outer contacts of relay 1052 to ground on conductor 1015. Relay 1021 operates and closes circuits through its various contacts to operate the multi-contact relays of the No. 1 thousand group which relays are represented by multi-contact relays 1010 and 1019. The operation of relay 1010 closes a circuit path for relay 1051 from battery through the winding of relay 1051, bottom inner contacts of relay 1010, conductor 1025 to ground on conductor 1015. Relay 1051 operates and closes a locking circuit for itself through the winding of relay 1053 and inner contacts of relay 1051, conductor 1018 to ground on the left contacts of relay 1002. Relay 1053, however, does not operate in the locking circuit just traced due to the fact that the operating ground for relay 1051 is still connected to one side of its winding. The fact that the multi-contact relays connected to the subscribers' line test conductors of the first thousands group are operated serves to connect the test conductors of these lines to the 1000 common conductors represented by conductors 1005 or 1006. As in the case of the test of the 0 thousand group, the test conductors in the No. 1 thousand group are now connected by way of the thousand common conductors to the armatures of each of the ten relays in the group represented by relays 1060 and 1069. If the calling line test conductor 1004 is located in the No. 1 thousand group, then the alternating current circuit previously traced to the said conductor will be completed to the one of the ten thermionic amplifiers V—0–V—9, inclusive, whose grid element is connected to the multipled contacts of a relay in the group represented by relays 1060 and 1069 and the armatures of which relay are connected to the common conductors multipled to the contacts of that multi-contact relay which contains the test conductor 1004 of the calling line. The operation of the space current relay of the responding amplifier will then close a circuit for relay 1041 in series with relay 1022 and the latter relay will release relays 1014, 1021, the group of relays represented by relays 1010 and 1019, and the release of relay 1010 will cause the operation of relay 1053 as previously described for relay 1052. Under such circumstances, ground on conductor 1015 is connected through the outer contacts of relay 1052, outer contacts of relay 1053 to conductor 1026 which, in turn, is connected to the back contacts of a counting relay similar to relay 1051 controlling the No. 2 thousand group and connected also to the winding of a control relay similar to relay 1021 which controls the operation of the No. 2 thousand group of multi-contact relays.

It is not thought necessary to describe the repetition of the test in each of the remaining thousands groups beyond stating that there is a pair of counting relays for each thousands group which controls the operation of the control relay for that group; the test stopping when relay 1022 operates as a result of the operation of one of the ten thermionic amplifiers V—0–V—9 inclusive when the calling line test conductor is found. As each thousand lines are tested a pair of counting relays is locked up. The last counting relay pair to be locked prior to the operation of relay 1022 represents the thousands line group in which the calling line test conductor is located, while the operation of one of the relays in the group 1040 to 1049, inclusive, indicates the particular hundreds group in the thousand in which the calling line test conductor is to be found.

It is evident from the foregoing that in the test for the thousands and hundreds designation of the calling line, the test conductor 1004 to which alternating current was applied, must be found. Should it come to pass, however, that in the meanwhile, the operator has released the circuit or, for other reasons, the connection of alternating current to the test conductor is disrupted, there is no reason for conducting further tests for the tens and units designation. There being but one test circuit for the office under ordinary circumstances, it is of advantage to release the test circuit immediately it becomes known that there is no test conductor in the whole office which has an alternating potential applied to it. When, therefore, counting relays 1058 and 1059 have operated and none of the thermionic amplifiers have responded as each thousand lines were tested, a circuit is closed from ground on conductor 1015, through the series chain of top outer contacts of all the relays beginning with relay 1052, conductor 1026, outer contacts of relay 1058, right back contacts of relay 1022, winding of relay 1003 to battery. Relay 1003 operates and functions to release the test circuit in a manner described hereinafter.

It will also be noted that the thermionic

amplifiers used for responding to an alternating current impressed on a test conductor, are desirable because the sleeve conductor of the trunk connection to which the test conductor is extended is shunted along its path by the holding relays of the various selectors which are or may be connected together at every switching stage from the subscriber's line to the operator's position. The quantity of electrical energy which may be available at the contact of the multi-contact relay to which the test conductor is wired is very small and consequently a sensitive detecting instrument is desirable, under such circumstances, to respond to the small quantity of electrical energy at the conductor. It is evident, however, that if the connection is made up of a sleeve conductor whose shunting relay paths along the line of the connections have very high impedances, it is not necessary to use thermionic amplifiers as detectors but any other less sensitive responsive device may be used as well. In other words, the essence of this feature of the invention is the use of a detecting instrument at the test conductor whose sensitivity is consistent with the quantity of electrical energy available at that conductor to operate the detecting device.

With the operation of relay 1022 the testing of remaining thousands group is stopped and the further functioning of the test circuit is concerned with registering the thousands and hundreds designation of the subscriber's line on a group of registers, determining and registering the tens and units designation of that number and determining, also, the class of service to which the subscriber's line is entitled, which information is likewise registered on a group of registers.

For the purpose of illustration and in order to follow the further operation of the circuit more clearly, it will be assumed that the calling line number is 0099. In such a case the 0 thousands designation will be indicated by the operation and locking of counting relays 1050 and 1052 and the 0 hundreds by the operation and locking of relay 1040. When relay 1022 operates a circuit is closed from ground over its inner left contacts, inner back contacts of relay 1058, conductor 1027, through the inner back contacts of the counting prime relays belonging to the thousands groups which have not been tested, including relay 1053 of the No. 1 thousand group, inner contacts of relay 1052, conductor 1105, right winding of relay 1200 to battery. Relay 1200 operates and registers the fact that the subscriber's thousands numerical designation is 0. Now relay 1200 is one of a group of five relays comprising the thousands register. Each of the windings of each relay is connected to a terminal marked with a circle and the number within the circle indicates the relay of the counting relay pair to the inner front contact of which the terminal is wired. Since the intermediate counting relay pairs are not shown in Fig. 10, the conductors connecting the said terminals and said contacts are not shown. The further function of relay 1200 will be described hereinafter.

Relay 1022 closes another circuit from ground on its outer front contacts, left normally made contacts of relay 1013, winding of relay 1013 to battery. Relay 1013 operates and locks over its left front contacts to ground on the left contacts of relay 1002.

Relay 1040, on operating, closes a circuit from ground on its right contacts, conductor 1031 within bracket 1034, conductor 1031 in Fig. 11, winding of relay 1100 to battery. The circuit described for conductor 1031 is also extended in parallel to conductor 1032 to the left winding of relay 1210, operating relay 1210 and registering the fact that the subscriber's line hundreds numerical designation is 0. Relay 1210 is one of a group of five relays comprising the hundreds register. Each of the windings of each relay is connected to a terminal marked with a circle and the number within the circle indicates the front contact of the similarly marked contact on relays 1040 to 1049 to which the said terminals are wired. Only the Nos. 0 and 9 terminals are shown cross-connected. As in the case of relay 1200, the further fuction of relay 1210 will be described hereinafter.

Relay 1100 operates and extends its operating ground over its right innermost contacts to conductor 1104 and bottom winding of relay 1017, thereby operating this relay. Relay 1017 locks over its top winding and No. 11 contacts to ground on conductor 1018. The operation of relay 1017 transfers the contacts of the thermionic space current relays, represented by relays 1030 and 1039 and connected to the armatures of relay 1017 in the same numerical order as the V-designation of each of the amplifiers, from the windings of the group of ten relays 1040–1049, inclusive, to the winding of the group of ten relays 1230–1239, inclusive; the circle on the front contacts of the contact sets of relay 1017 being connected to correspondingly numbered circles of the conductors connecting with the winding of the relays 1230–1239, inclusive. With the operation of relay 1017 relay 1022 releases but due to the fact that relay 1013 has operated and locked, the circuit for relay 1200 is maintained over conductors 1105 and 1027 to the right inner front contacts of relay 1013. Relay 1210 also will not release since relay 1040 is locked to ground on conductor 1018.

Relay 1040 closes another circuit from ground on its left outer contacts, conductor 1035 within bracket 1036 to the No. 0 contacts of relay 1020. Now due to the fact that re-

lay 1050 is operated because the calling line test conductor 1004 is located in the No. 0-thousand group and all counting relay pairs of other thousand groups are normal because the test of further thousand groups was stopped, relay 1020 is operated once again over a circuit from battery through its winding, outer front contacts of relay 1050, inner back contacts of relay 1053, conductor 1027, through the inner back contacts of intermediate counting prime relays, back contacts of relay 1058, to ground on the right inner front contacts of relay 1013. Relay 1020 operates and the ground on conductor 1035, above traced, causes the operation of relay 1000. The operation of this last relay reconnects the subscriber's line test conductors of the 0-hundreds group once again into the test circuit for a further examination of that group to determine the tens and units designation of the calling line test conductor 1004. Had it been that the hundreds group of the calling line had been other than the 0-hundreds assumed in the illustration, then the consequent operation of the appropriate relay in the group 1040–1049 inclusive would have closed a circuit from ground on the left inner contacts of that relay to the conductor included within the bracket 1036 which is connected to the corresponding multipled contacts of the control relays represented by relays 1020, 1021 and 1029, and from thence to operate the particular hundreds group multi-contact relay indicated by the operated relay of the group 1040–1049, inclusive. The further scanning of the hundred test conductors would then take place in this latter group and not in the one controlled by relay 1000 as assumed. Further, if the calling line test conductor were located in a thousand group other than the 0-thousand group assumed, then the counting relay pair of that group would be the last pair operated, counting the 0-group pair as the first, and a circuit for the appropriate control relay in the group represented by relays 1020, 1021 and 1029, would then be closed over the outer front contact of the counting relay of the designated thousand group in the same manner as the circuit closed for control relay 1020 of the 0-thousand. The above described circuit from the left inner contacts of the hundreds indicating relay of the group 1040–1049, inclusive, would then be closed through the correspondingly numbered contacts of the selected thousands group control relay to operate the hundreds multi-contact relay in that thousands group for a further examination of the hundred test conductors in order to determine the tens and units designation of the calling line test conductor.

Referring back to the line designation 0099 taken for the purpose of illustration, the test for the tens and units designation 99 of the calling line begins with the operation of relay 1120 at the time relay 1013 operates. The circuit path of relay 1120 may be traced as follows: battery through the winding of relay 1120, top outer contacts of counting relay 1130, conductor 1106, next to the right outermost contacts of relay 1100, conductor 1037, right outer front contacts of relay 1013 to ground on the outer back contacts of relay 1022. Relay 1120 causes the operation of relay 1110. Relay 1110, over its No. 11 contacts, closes a circuit for counting relay 1130. Relay 1130 operates and closes a locking path for itself through the winding of relay 1131 and the top inner contacts of relay 1130, right innermost contacts of relay 1100, conductor 1031, to ground on the right contacts of relay 1040. Relay 1131 does not operate in this locking circuit due to the presence of operating ground for relay 1130 on the other side of its winding and relay 1120 does not release immediately with the operation of relay 1130 because it is of the slow releasing type. Relay 1110, in operating, closes through its contacts the first ten common conductors of the group of 100 which are connected to the first ten test conductors of the 100 test conductors terminating in contacts of relay 1000 and which have been further extended through the cooperating contacts on relay 1100 and designated 00–09, inclusive. The said common conductors are, of course, also connected to other corresponding hundreds groups of multi-contact relays in the other thousands groups as already explained, but since relay 1000 is the only one operated at this time, the fact of such connection to other relays is of no consequence.

Now test conductor 1004, as already indicated, is connected to the first contact in the last or No. 9 group of tens of the 100 test conductors connected to the contacts of relay 1000 and particularly on the 9th contact of that tens group so that, with the operation of relays 1100 and 1110, no circuit is closed which depends upon the alternating current available on the calling line test conductor 1004 since the said conductor is not located in the 0-tens group. Consequently with the operation of relay 1130, relay 1120 releases after an interval, in turn, releasing relay 1110 but without any further tests taking place during the time that relay 1110 is in an operated position. The release of relay 1110 removes the short circuit around relay 1131 allowing this relay to operate in the locking path of relay 1130, above described.

Relay 1131 operates and closes its contacts to a conductor 1135 which connects with the top outer back contacts of the counting relay similar to relay 1130 next in the sequence and from thence to the winding of the next control relay in the group represented by relays 1120 and 1129. As in the case of the counting relay pairs for the thousands

groups, there are likewise a pair of counting relays for each of the tens groups, one pair for each group. In the drawing of Fig. 11 counting relay pair 1130 and 1131 is associated with the 0-tens group while counting relay pair 1138 and 1139 is associated with the last or 9th group. Each counting relay controls the operation of its associated control relay like relay 1120 or 1129. Intermediate counting relay pairs and their associated control relays are not shown but it is not difficult to see that conductor 1135 would be connected to the top outer back contacts of the counting relay of the No. 1 tens group and paralleled from there to the operated contacts of the associated relay of that pair. From thence it connects with the top outer back contacts of the next counting relay in the sequence and so on to the contacts of the last counting relay 1139 of the No. 9 group. Consequently the operation of relay 1131 closes a circuit from ground on conductor 1106, front contacts of relay 1131, conductor 1135, top back contacts of the counting relay of the No. 1 tens group, not shown, to the winding of the control relay, similar to relay 1120, of that group, also not shown. The control relay operates the cut-in relay of the No. 1 tens groups in the group of relays represented by relays 1110 and 1119. The operation of this relay connects the next group of ten common conductors of the hundred which are connected to multi-contact relay 1000 and similar relays. Since calling line conductor 1004 is not located in this group, the same operations which have been described in connection with the pair of counting relays 1130 and 1131 and the relays they control, will now take place with the counting relay pair of the No. 1 group and the relays they control, that is, the local control relay similar to relay 1120 and the cut-in relay similar to relay 1110.

It is not thought necessary to describe the operation of further progressive tests in determining the tens group of the calling line test conductor. It is believed sufficient to note that as each tens group is examined and the calling line test conductor is not found therein, the operation of the relay of that group operates to advance the test to the next group tens.

When the test has progressed to the No. 9 group, relay 1129 operates over a circuit path including the top outer back contacts of relay 1139, conductor 1135, the series chain circuit of intermediate relays, top contacts of relay 1131 to ground on conductor 1106. Relay 1129 operates the No. 9 tens group cut-in relay 1119 and connects through the last ten common conductors which are connected to the last or 9th group of ten subscribers' line test conductors in relay 1000 and other 0-hundreds group relays in each thousands group. Now it has been assumed that the calling line tens and units designation is 99 which means that conductor 1004 of that line is contained in the No. 9 group of contacts in relay 1000 and is connected to the 9th contact in that group. Consequently when relay 1119 is operated and before it has time to release by the operation of relays 1139 and 1129, a circuit is closed from the alternating current available on conductor 1004, common conductor connected to the 9th armature in the 9th group in relay 1000, similar to conductor 1005 or 1006, condenser in series therewith, like condenser 1007 or 1008, contacts No. 99 of relay 1100, conductor 1136, No. 9 contacts of relay 1119, conductor 1104, conductor 1012, to the grid element of thermionic amplifier V–9. The space current relay 1039 operates and closes a circuit from ground through the winding of relay 1022, back contacts in a series chain of all other space current relays, front contacts of relay 1039, No. 9 front contacts of relay 1017, conductor 1061, winding of relay 1239 to battery. Another circuit is also closed from ground on the outer front contacts of relay 1022, left outer make contacts of relay 1013, conductor 1054, right outermost contacts of relay 1100, conductor 1133, winding of relay 1112, and in parallel, through the front contacts of relay 1139, conductor 1137, left winding of relay 1223 to battery. Relays 1112 and 1223 operate; relay 1223 registering the fact that the calling line tens designation is 9 and relay 1239, when operated, registering the further fact that the units designation of the said line is 9. The function of relay 1112 will be designed hereinafter.

It will be noted from the operations and registrations thus far carried out with the calling line test circuit that the operation of a pair of counting relays determines the thousands designation, the operation of one of ten relays locally controlled from the space current relay of one of ten thermionic amplifiers determines the hundreds, the operation of another pair of counting relays determines the tens while the operation of one of another group of ten relays, also locally controlled from the same space current relays through a transfer relay, determines the units designation.

With the operation of a relay in each of the registers of Fig. 12, the numerical designation of the subscriber's line is registered and, for offices where the class of service is uniform for all subscribers and no discriminatory indication is necessary in respect to the type of service accorded to each line, the registration in the calling line test circuit registers of the calling line numerical designation completes the test.

However, in most offices a further identification is desirable to apprise the operator of the type of service to which the calling line is entitled. There may be in the same office, for example, individual message rate lines,

party lines, P. B. X. lines, each group being entitled to a different class of service in accordance with the rates established for the separate groups. Under such circumstances the operator must know the class in which the calling line belongs in order to determine whether or not the call should be completed to its ultimate destination and what rate should be charged for the service. The present invention is designed to provide the designation of the class of the calling line. In Fig. 13 is shown the flexible means for registering as many classes or subdivisions of subscribers' lines as there are in the office. The apparatus, for a 10,000 line office, consists of 100 multi-contact relays of 100 contacts each, each multi-contact relay operating locally from the contacts of each multi-contact relay in Fig. 10 whose contacts are connected to the subscribers' line test conductors. Thus relay 1300, the first hundreds group relay in the class of line designating circuit, is controlled by relay 1000, while relay 1399, the last or 99th hundreds group relay in the said circuit, is controlled by relay 1099. The contacts of all the 100 relays are strapped together while the armatures of each relay are each connected to a terminal in one of a pair of terminal blocks; there being one such pair of terminal blocks for each of the hundred relays. There are also ten ten-contact set relays, represented by relays 1310 and 1319, whose contacts are connected to the said multiple contacts of the multi-contact relays. The corresponding armatures of these relays are strapped together and each of them is connected to a contact of one of the units register relays in the order of numerical succession. Thus, the No. 0 armature contacts of all ten relays connect by way of conductor 1301 to the left contact on the 0 units register relay 1230, while contact No. 9 of the said relays is connected by way of conductor 1302 to the left contact on the No. 9 units register relay 1239. All the intermediate contacts are connected to the intermediate units register relays as shown.

The operation of the class of line indicating circuit of Fig. 13 is as follows: Assuming for illustration that the subscriber's line 0099 is the one for which a class of line indication is to be given, then at the time relay 1000 operates for determining the tens and units designation of said line as previously described, a path is closed for relay 1300 from battery through the winding of relay 1300, conductor 1303, bottom outer contacts of relay 1000, No. 0 contacts of relay 1020, bracket 1036, conductor 1035, to ground on the left contacts of relay 1040. Relay 1300 operates and closes its 100 contacts which are connected to the terminals of the left punching block for relay 1300 to the common switching wires formed by the multipled contacts of all 100 relays. It will be noted at this point that relay 1300 also operated once before at the time relay 1000 was operated to determine the thousands group, but due to the fact the tens cut-in relays, represented by the group of relays 1310—1319, were not operated at that time nothing further happened. At the time when the last or 9th pair of counting relays in Fig. 11 operated and thereby designated the tens group designation of the calling subscriber's line, a path was likewise closed for relay 1319 from battery, through the winding of relay 1319, conductor 1304 within the bracket 1305, conductor 1304 within bracket 1305 in Fig. 11, bottom front contacts of counting relay 1139, right outermost contacts of relay 1100, conductor 1054, left outer front contacts of relay 1013 to the outer front contacts of relay 1022 which is operated at this time. Relay 1319 operates and closes a group of ten contacts to the last or No. 9 group of contacts of the multi-contact relay 1300. Finally, the operation of the units indicating relay 1239 closes a circuit from ground on its left contacts, conductor 1302, No. 9 contacts of relay 1319 to armature contact 99 of relay 1300. Armature 99 is connected to the 99th terminal on the punching block associated with relay 1300 and ground is therefore connected on this terminal. The method of identifying the class of calling line therefore is to ground a terminal individual to that line. To this terminal may be connected any one of a group of signals characterizing each of the subscriber classes. Conductors 1306, 1307 and 1308 are each connected to the winding of a relay controlling a signal, and each of these signals represents a class of subscribers' lines, as for example, one may signify an individual line, another a party line and yet another a P. B. X. line. Others may be added if desired. The conductors connecting with these signal relays are extended to the right terminal block of each of the 100 cross connecting blocks as shown in Fig. 13. Cross connections between the left blocks representing subscribers' lines and right blocks representing class of line signals, are then made in accordance with the particular class to which each subscriber's line belongs.

Recapitulating the registration of all indications of the calling line 0099, the operation of relay 1200 indicates the 0 thousands designation, the operation of relay 1210 the 0 hundreds designation, the operation of relay 1223 the No. 9 tens group designation and the operation of relay 1239 the No. 9 units designation. Finally the ground on terminal 99 of the cross connecting rack associated with relay 1300 will indicate the class of the calling line when the said terminal is cross connected to the appropriate conductors 1306, 1307, 1308, or any other conductor which controls the signal for that particular class.

The designation of the calling line num-

ber being thus registered in the calling line test circuit it is further transmitted over a group of conductors to a corresponding register and display circuit at the recording operator's position wherein, by the operation of relays responsive to the said registration in the test circuit lamps will be lighted to display to the operator the designation of said calling line.

The operator's register and display circuit is shown in Fig. 7 and consists of a group of relays and associated lamps for each numerical designation as well as another group of relays and associated lamps for the class of line indication. It will be recalled that in the case under illustration the subscriber's thousands designation is zero and resulted in the operation of relay 1200. When this relay operated a circuit is closed from ground on the right outer contacts of said relay, conductor 1216 within bracket 1140 of Fig. 11, conductor 1216 within bracket 1140 of Fig. 6, No. 1 contacts of relay 716, top winding of relay 701 to battery. Relay 701 operates and locks over its bottom winding and bottom inner contacts, conductor 718, contacts of key 613 to ground on the top back contacts of relay 601. Another circuit is closed from ground on the right inner contacts of relay 1200, conductor 1217 within bracket 1140 of Fig. 11, conductor 1217 within bracket 1140 of Fig. 6, No. 7 contacts of relay 716, top winding of relay 702 to battery, operating relay 702. This relay locks over its bottom winding and contacts to ground on conductor 718. Also another circuit is closed by way of ground on conductor 1105, left contacts of relay 1200, conductor 1215 within bracket 1140 of Fig. 11, conductor 1215 within bracket 1140 of Fig. 6, No. 2 contacts of relay 716, bottom winding of relay 700 to battery operating relay 700. This relay also locks over its top winding and top inner contacts to ground on conductor 718. The locking of relays 700, 701 and 702 closes a circuit for lamp 0 of the thousands register from battery on the bottom inner front contacts of relay 700 through lamp 0, top inner contacts of relay 701, top outer front contacts of relay 702 to ground, thereby lighting the lamp 0 as an indication that the calling subscriber's line thousands designation is 0. In the same way the operation of relay 1210 closes a circuit from ground on the right inner contacts of the said relay, conductor 1225 within bracket 1140 of Fig. 11, conductor 1225 within bracket 1140 of Fig. 6, No. 3 contacts of relay 716, top winding of relay 707 to battery, operating this relay and locking it over its bottom winding and contacts to ground on conductor 718. Another circuit is also closed from ground on the right outer contacts of relay 1210, conductor 1219 within bracket 1140 of Fig. 11, conductor 1219 within bracket 1140 of Fig. 6, No. 5 contacts of relay 716, top winding of relay 705 to battery, operating this relay and locking it over its bottom winding and bottom inner contacts to ground on conductor 718. Also another circuit is closed from ground on conductor 1032, left contacts of relay 1210, conductor 1218 within bracket 1131 of Fig. 11, conductor 1218 within bracket 1140 of Fig. 6, No. 9 contacts of relay 724, bottom winding of relay 722 to battery, operating this relay and locking it over its top winding and top inner contacts to ground on conductor 718. The operation of relays 704, 705 and 707 closes a circuit for the 0-lamp of the hundreds register from battery on the bottom inner front contacts of relay 704 through the 0 lamp, top inner contacts of relay 705, top outer front contacts of relay 707 to ground thereby operating lamp 0 and displaying 0 in the hundreds register as the hundreds designation of the calling line. Since the tens designation of the calling line is 9, relay 1223 was operated in consequence, as explained, and therefore a circuit is closed from ground on the right inner contacts of relay 1223, conductor 1240 within bracket 1140 of Fig. 11, conductor 1240 within bracket 1140 of Fig. 6, No. 7 contacts of relay 724 to the top winding of relay 710, operating this relay and locking it over its bottom winding and bottom inner contacts to ground on conductor 718. Another circuit is closed from ground on the right outer contacts of relay 1223, conductor 1226 within bracket 1140 of Fig. 11, conductor 1226 within bracket 1140 of Fig. 6, No. 8 contacts of relay 724 to the top winding of relay 723, operating this relay and locking it over its bottom winding and bottom inner contacts to ground on conductor 718. Another circuit is also closed from ground on conductor 1137, left contacts of relay 1223, conductor 1228 within bracket 1140 of Fig. 11, conductor 1228 within bracket 1140 of Fig. 6, No. 5 contacts of relay 724 to the bottom winding of relay 708 operating this relay and locking it over its top winding and top inner contacts to ground on conductor 718. The operation of relays 708, 710 and 723 closes a circuit for the No. 9 lamp in the tens row of lamps from battery on the bottom middle front contact of relay 708 through the lamp No. 9, top inner contacts of relay 710, to ground on the top outer front contacts of relay 723, thereby lighting the No. 9 tens lamp as the tens designation of the subscriber's number. The No. 9 units designation resulted in the operation of relay 1239 and consequently a circuit is closed from ground on the right inner contacts of relay 1239, conductor 1208 in bracket 1140 of Fig. 11, conductor 1208 within bracket 1140 of Fig. 6, No. 2 contacts of relay 724 to the top winding of relay 714, operating relay 714 and locking it over its bottom winding and bottom

inner contacts to ground on conductor 718. Another circuit is also closed from ground on the right middle contacts of relay 1239, conductor 1207 within bracket 1140 of Fig. 11, conductor 1207 within bracket 1140 of Fig. 6, No. 1 contacts of relay 724 to the top winding of relay 715, operating this relay and locking it over its bottom winding and contacts to ground on conductor 718. Likewise another circuit is closed from ground on the right outer contacts of relay 1239, conductor 1229 within bracket 1140 of Fig. 11, conductor 1229 within bracket 1140 of Fig. 6, No. 4 contacts of relay 724, bottom winding of relay 712 operating this relay and locking it over its top winding and top inner contacts to ground on conductor 718. The operation of relays 715, 714 and 712 closes a circuit for the No. 9 units lamp from battery through the bottom middle front contacts of relay 712, No. 9 lamp, top inner contacts of relay 714, top outer front contacts of relay 715 to ground thereby lighting lamp No. 9 for the units indication of the calling line. The ground on terminal 99 of the cross connecting block associated with relay 1300 will likewise close a circuit to conductor 1306, 1307 or 1308 depending upon which of these conductors is cross connected to that terminal, thence from bracket 615, Fig. 5, to bracket 615, Fig. 6, and operate either relay 719, if cross connected to conductor 1307, relay 720 if cross connected to conductor 1306, and 721 if cross connected to conductor 1308. One of these relays, when operated, will lock over its bottom winding to conductor 718 and light the lamp it controls to indicate the class of the calling line. Thus the display 0099 and the class of line indication is given to the operator at her position as the result of tests made by the calling line test circuit to locate the calling line test conductor having the alternating current applied to it by the operation of talking key 902 of the cord connecting with the trunk which extends the calling line to the operator's position.

It will be recalled that where a circuit was closed for relays 1239 and 1319, relay 1112 was operated in parallel. Relay 1112 causes the operation of relay 1113 and relay 1113 closes a circuit from ground on its contacts, conductor 1114, winding of relay 1003 to battery. Relay 1003 operates and opens the circuit of relay 1001 allowing the said relay to release. Relay 1001 opens its left contacts and releases relay 1002. Relay 1002 releases relay 1013, and opens another contact in the operating circuit of relay 600 at the operator's position causing relay 600 to release. The release of relay 1002 disconnects ground from all of the counting relays as well as the register and counting relays of the calling line test circuit and associated register circuit shown in Figs. 10, 11, 12 and 13 thereby restoring the calling line test circuit to normal so as to make it available for another call.

The release of relay 600 at the operator's position reconnects the calling line test circuit to the various cut-in circuits at the operator's position and also releases the ground through resistance 612 and sleeve conductor 901. The removal of resistance ground on the sleeve of the cord conductor 901 increases the current which flows through the bottom winding of relay 826 and top winding of relay 821 causing the said relay 826 to operate again. The operation of relay 826 short circuits relay 817 which releases. Relay 817 now releases relay 820 and the release of relay 820 removes high potential battery through retard coil 840 from the trunk line. The removal of the said high potential battery reestablishes the differential condition for relay 811 which thereby releases and, in turn, releases 808. The release of relay 808 opens the alternating current circuit to conductor 383 and hence to the calling line test conductor 1004. As soon as the test circuit has performed its function and releases, it is seen that it automatically removes a condition originally established by the operator for identifying the calling line.

The operator after noting the display operates key 613 which, on operating, removes ground from conductor 718, extinguishes the lamp display, releases relay 716 and 724 and restores to normal the locked numerical registers.

At the time relay 811 releases it releases relay 808 as already described. The common line test circuit is now normal and the connection established to the operator's position is now in the same condition as it would be for the operator to complete the connection to the distant office by means of the calling part of the cord shown in Fig. 9. This invention, however, is not concerned with the operating features of the connections subsequent to the display of the calling line number, the connection being established in the well known manner. Reference is further made to the above identified patent to Kopp for a further description of the operation and release of the district selector and associated line finder since these features are the same, the district selector having been modified over that shown in the above patent only to include necessary features for the operation of the present invention.

What is claimed is:

1. In a telephone system, a calling line having an arbitrary multi-symbol designation, an identifying conductor for said line, means for impressing an electric potential thereon, and a calling line test circuit for selecting said calling line through said identifying conductor comprising a plurality of circuits responsive to said electric potential, and

means responsive to each of said circuits for recording each of said symbols of said arbitrary designation.

2. In a telephone system, a plurality of telephone lines each having an arbitrary designation, a plurality of operators' positions, means for connecting a calling telephone line to one of said operators' positions, a calling line test circuit for selecting said calling telephone line, means for connecting said test circuit with any one of said operators' positions, and means responsive to the connection of said calling telephone line with said operator's position to the connection of said calling line test circuit with said position and the selection of said calling telephone line by said calling line test circuit for visibly indicating the arbitrary designation of said calling line at said position.

3. In a telephone system, a plurality of telephone lines each having an arbitrary designation, a plurality of operator's positions, means for connecting a calling telephone line to one of said operators' positions, a calling line test circuit for selecting said calling telephone line, means for connecting said test circuit with any one of said operators' positions, and means responsive to the selection of said calling telephone line by said calling line test circuit and to the connection of said calling line test circuit with said position to which said calling line was extended for indicating the arbitrary designation of said calling line.

4. In a telephone system, a plurality of telephone lines each having a multi-digit designation and a class of line designation, an identifying conductor for each of said lines, means for impressing an electric potential on the associated identifying conductor of a calling line, and a calling line test circuit comprising a plurality of circuits responsive to said electric potential and a register responsive to each of said circuits for recording therein each of the digits and the class of line designation of said calling line.

5. In a telephone system, a plurality of telephone lines each having a numerical designation, an identifying conductor for each calling line, means for impressing an electric potential on the associated identifying conductor of a calling line, a calling line test circuit to which said identifying conductors extend, said conductors being distributed and arranged in said calling line test circuit in groups and subdivisions thereof in accordance with each digit of said numerical designations, a plurality of circuits in said calling line test circuit responsive to said electric potential for selecting the one of said groups and subdivisions thereof which contain said calling line, and a register in said calling line test circuit responsive to each of said circuits for recording the numerical designation of said group and subdivisions thereof to record the numerical designation of said calling line.

6. In a telephone system, a calling line having an arbitrary multi-symbol designation, an identifying conductor for said line, means for impressing an electric potential thereon, a calling line test circuit for selecting said calling line through said identifying conductor comprising a plurality of circuits responsive to said electric potential, and registers responsive respectively to each of said circuits for recording each of the symbols of said arbitrary designation, an operator's position, means for connecting said test circuit to said position, a register indicating circuit at said position, and means responsive to an operative connection between said test circuit and said operator's position for operating said register indicating circuit in accordance with the setting of said registers in said calling line test circuit.

7. In a telephone system, a plurality of telephone lines, a calling line test circuit for selecting a calling line, a plurality of operators' positions, means for extending a calling line to one of said positions and means responsive to an operation of said operator's position for causing said calling line test circuit to select said calling line and to render said calling line test circuit unresponsive from other of said operators' positions while selecting said calling line.

8. In a telephone system, a calling line having an arbitrary multi-symbol designation, an identifying conductor for said line, means for impressing an electric potential thereon, a calling line test circuit comprising a plurality of circuits each responsive to said electric potential, and registers responsive respectively to each of said circuits for recording each of the symbols of said arbitrary designation, a plurality of operators' positions, a register indicating circuit at each of said positions, means for operatively connecting said calling line test circuit to any one of said positions, means responsive to the operative connection of said calling line test circuit to one of said positions for operating said register indicating circuit at said position in accordance with the setting of said registers in said calling line test circuit and means responsive to said operative connection between said calling line test circuit and said position for rendering said calling line test circuit non-available at any other of said positions.

9. In a telephone system, a plurality of telephone lines each having a numerical designation, an identifying conductor for each calling line, means for impressing an electric potential thereon, a calling line test circuit to which said identifying conductors extend, said conductors being distributed and arranged in said calling line test circuit in groups and subdivisions thereof, each of said groups and subdivisions corresponding to a

digit in said numerical designations, a plurality of relays each responsive to said electric potential on said identifying conductor for identifying subdivisions corresponding to the second and fourth digits of the numerical designations of said calling line, two groups of pairs of counting relay circuits, means responsive to each of said relays when said subdivisions are identified for operating pairs of said counting relay circuits in each of said groups for identifying said line subdivisions corresponding to the first and third digits, respectively of the numerical designation of said calling line, means for restoring said calling line test circuit to normal and means responsive to the operation of all the counting relay circuits in one of said groups when identifying the test conductor subdivisions corresponding to the second digit of the numerical designation of said calling line for operating said means for restoring said calling line test circuit to normal.

10. In a telephone system, a plurality of telephone lines each having a numerical designation, an identifying conductor for each, a calling line, means for impressing an electric potential on the associated identifying conductor of a calling line, a calling line test circuit to which said identifying conductors extend, said conductors being distributed and arranged in said calling line test circuit in groups and subdivisions thereof, each of said groups and subdivisions corresponding to a digit of said numerical designations, a plurality of relays each responsive to said electric potential for identifying said line subdivisions corresponding to the second and fourth digits of the numerical designation of said calling line, a plurality of pairs of counting relay circuits, means responsive to each of said relays when said subdivisions are identified for operating pairs of said counting relay circuits for identifying said line subdivisions corresponding to the first and third digits of the numerical designation of said calling line, and registers in said calling line test circuit responsive to said operated relays and said operated counting relay circuits for recording the numerical designation of said calling line.

11. In a telephone system, a plurality of telephone lines each having an arbitrary designation, a calling line test circuit comprising a plurality of multi-contact relays, a test conductor for each of said plurality of telephone lines extending to contacts of said multi-contact relays, an operator's position, means for connecting a calling telephone line to said operator's position, means for operatively connecting said calling line test circuit with said position, and means responsive to the connection of said calling line with said operator's position and said calling line test circuit with said position for operating the multi-contact relay in said calling line test circuit which contains the test conductor of said calling line for visibly indicating the arbitrary designation of said calling line at said operator's position.

12. In a telephone system, a plurality of telephone lines each having an arbitrary designation, a calling line test circuit comprising a plurality of multi-contact relays, a test conductor for each of said plurality of telephone lines extending to the contacts of said multi-contact relays, an operator's position, means for connecting a calling telephone line to said operator's position, a lamp indicating device at said operator's position, and means responsive to the connection of said calling line with said operator's position and the selection of said calling line by said calling line test circuit through the identification of its associated test conductor for operating said lamp indicating device for indicating the arbitrary designation of said calling telephone line at said operator's position.

13. In a telephone system, a plurality of telephone lines each having an arbitrary designation, a calling line test circuit comprising a plurality of multi-contact relays, a test conductor for each of said plurality of telephone lines extending to contacts of said multi-contact relays, an operator's position having a connecting cord, an indicating device at said operator's position, a trunk line for connecting a calling telephone line with said operator's position, said trunk line having a source of alternating current, and means responsive to a connection of said calling line over said trunk line with said connecting cord and the application thereover of said alternating current source to said test conductor for operating said calling line test circuit to select said calling line and to operate said indicating device thereafter for indicating the arbitrary designation of said calling line.

14. In a telephone system, a plurality of telephone lines each having an arbitrary designation, a line, a plurality of operators' positions, a calling line test circuit capable of selecting a calling telephone line, means for operatively connecting said calling line test circuit with each of said plurality of operators' positions, a lock-out circuit connecting all of said positions and said calling line test circuit, means at each of said positions for causing said look-out circuit to operatively associate said calling line test circuit with said position and to lock out other positions from said calling line test circuit, means for connecting a calling telephone line with any of said operators' positions, a lamp indicating device at each of said operators' positions, and means responsive to the selection of said calling line by said calling line test circuit and to the operative connection of said calling line test circuit with the operator's position to which said calling line has been extended, for operating

said lamp indicating device at said position for displaying the arbitrary designation of said calling line.

15. In a telephone system, a plurality of telephone lines each having a multi-digit designation, an identitfying conductor for each, a calling telephone line, means for impressing an electric potential on the associated identifying conductor of a calling line, and a calling line test circuit comprising means for connection to said identifying conductors, means for testing for said calling line identifying conductor having said electric potential impressed thereon and means responsive to the removal of said electric potential during the operation of said tests for restoring said calling line test circuit to normal.

16. In a telephone system, a plurality of telephone lines each having a numerical designation, an identifying conductor for each of said lines, an operator's position, a register indicating circuit at said position, means for extending a calling line to said operator's position, means at said position for impressing an electric potential on the identifying conductor of said calling line, a calling line test circuit to which said identifying conductors extend, said conductors being distributed and arranged in said calling line test circuit in groups and subdivisions thereof in accordance with each digit of the numerical designation of said telephone lines, a plurality of circuits in said calling line test circuit responsive to said electric potential for selecting the one of said groups and subdivisions thereof which contains the test conductor of said calling line, a register in said calling line test circuit responsive to each of said circuits for recording the numerical designations of said group and subdivisions thereof, means for operatively connecting said calling line test circuit with the operator's position to which said calling line has been extended, and means responsive to such an operative connection for operating said register indicating circuit at said position from the operated registers of said calling line test circuit for indicating at said position the numerical designation of said calling line.

17. In a telephone system, a plurality of telephone lines each having a four-digit numerical designation, an identifying conductor for each calling line, a calling line test circuit comprising a plurality of multi-contact relays to the contacts of which extends said identifying conductors, said multi-contact relays being arranged in as many groups as there are major divisions of said plurality of telephone lines as indicated by the various first digits of all of said numerical designations, and each of said multi-contact relays in each of said divisions containing minor subdivisions of 100 identifying conductors in accordance with the second digit of all of said numerical designations while the order of said identifying conductors on the contacts of each of said multi-contact relays is in accordance with the tens and units digits of the numerical designation of the lines associated with said identifying conductors, means for applying an alternating potential to the identifying conductor of a calling line, a plurality of circuits responsive to said alternating potential for selecting the major and minor subdivisions and tens and units divisions of said calling line and a register responsive to each of said plurality of circuits for recording said major division and minor division and said tens and units designation as the four-digit numerical designation of said calling line.

In testimony whereof I have signed my name to this specification this 3rd day of June, 1931.

WILLIAM T. HAINES.