

April 26, 1932.

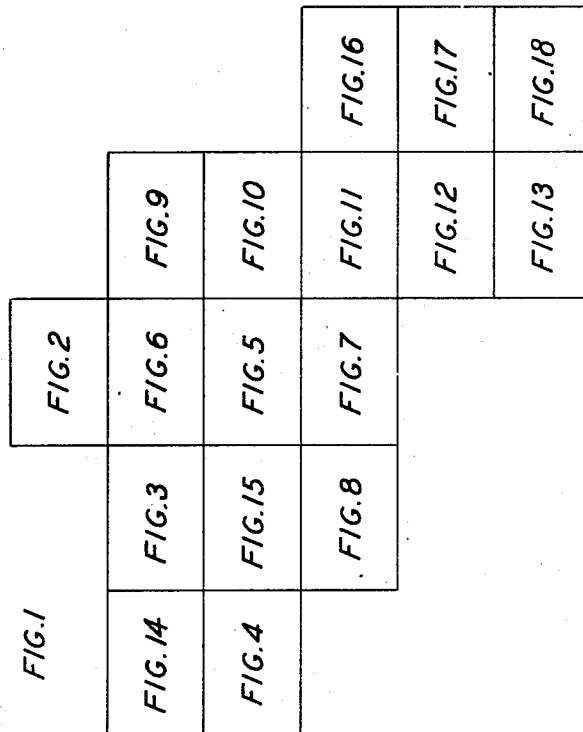
W. E. STEVENS

1,855,616

TELEPHONE SYSTEM

Filed Dec. 31, 1930

18 Sheets-Sheet 1



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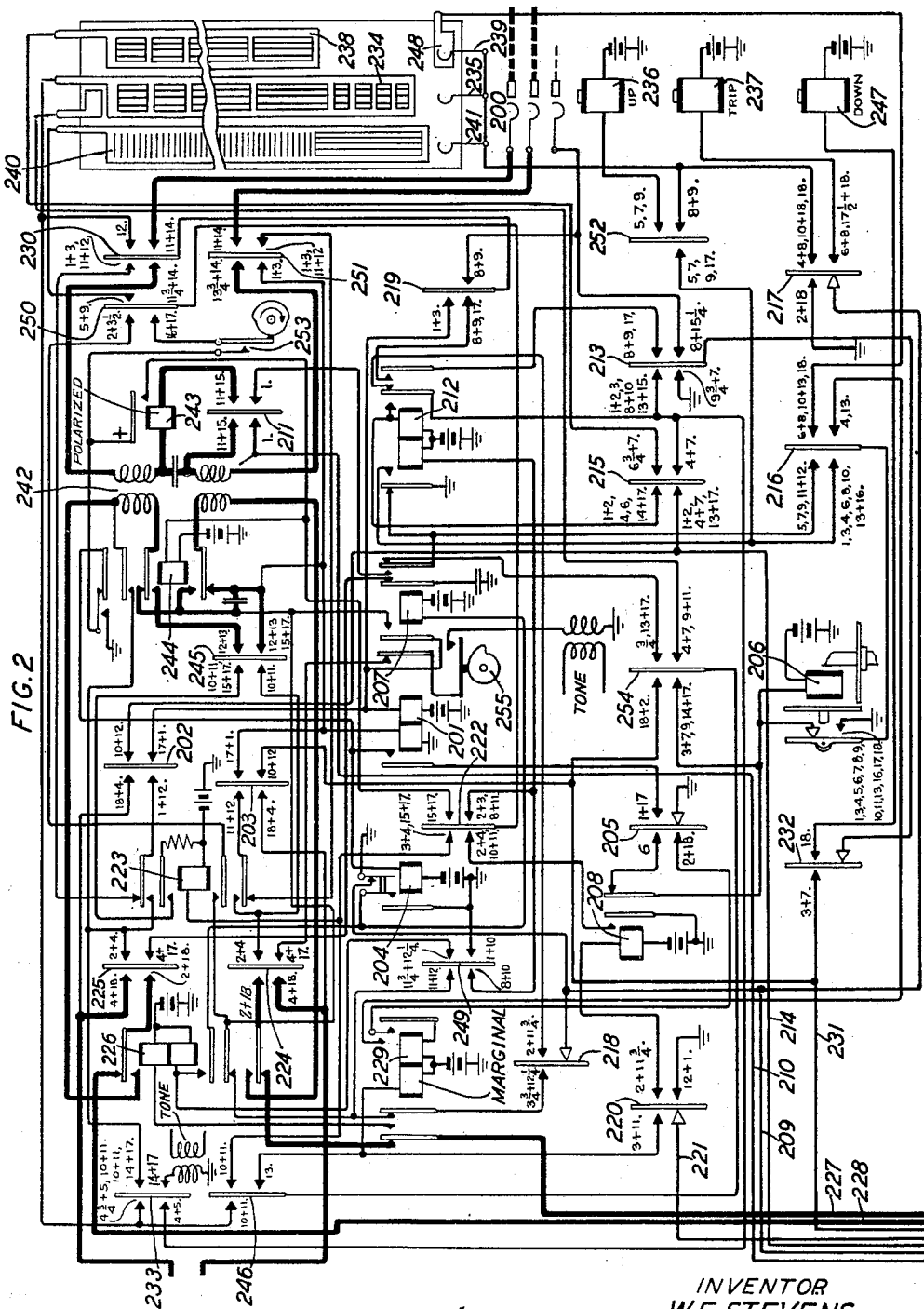
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18 Sheets-Sheet 2



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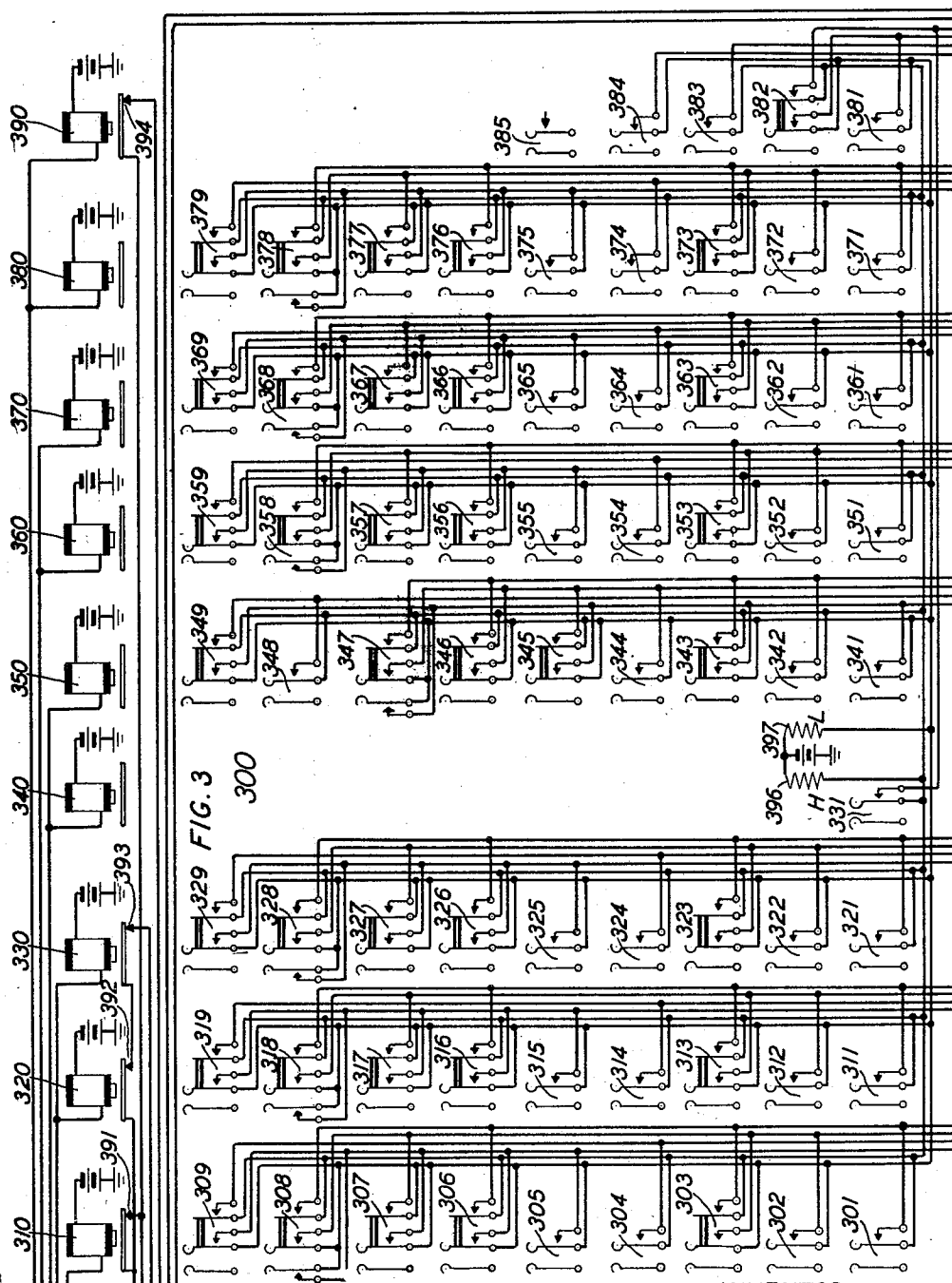
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18 Sheets-Sheet 3



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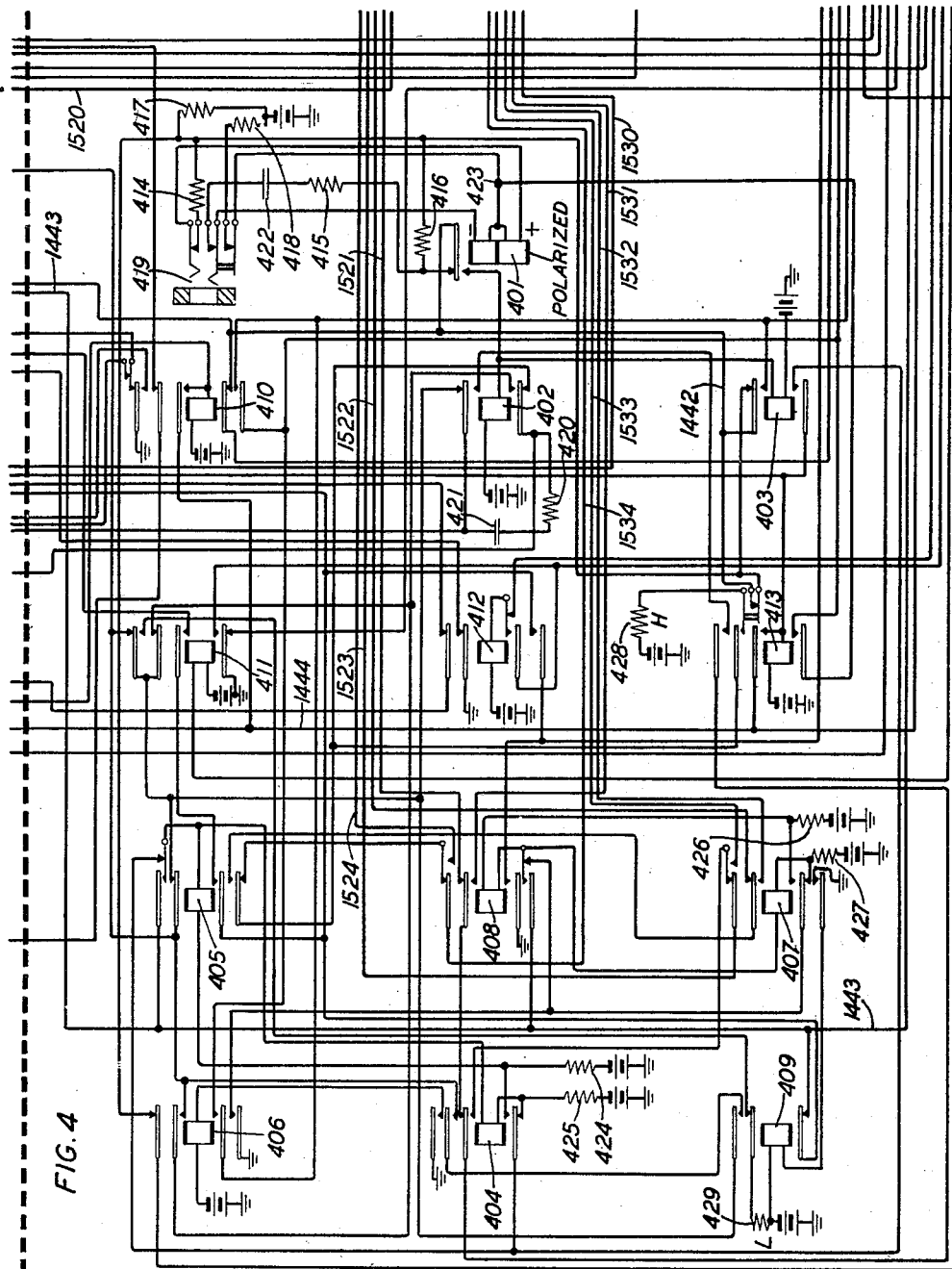
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18 Sheets-Sheet 4



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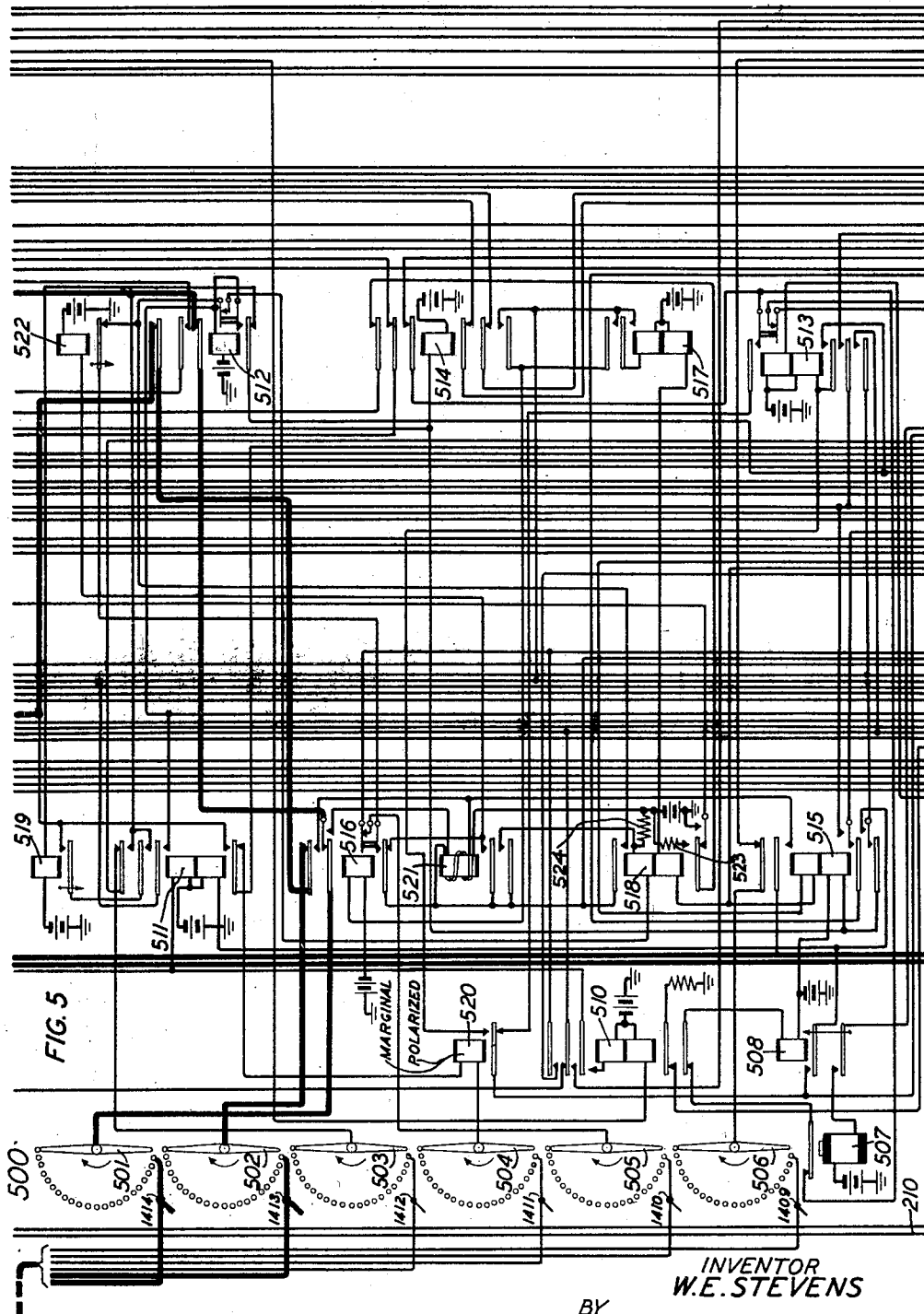
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18 Sheets-Sheet 5



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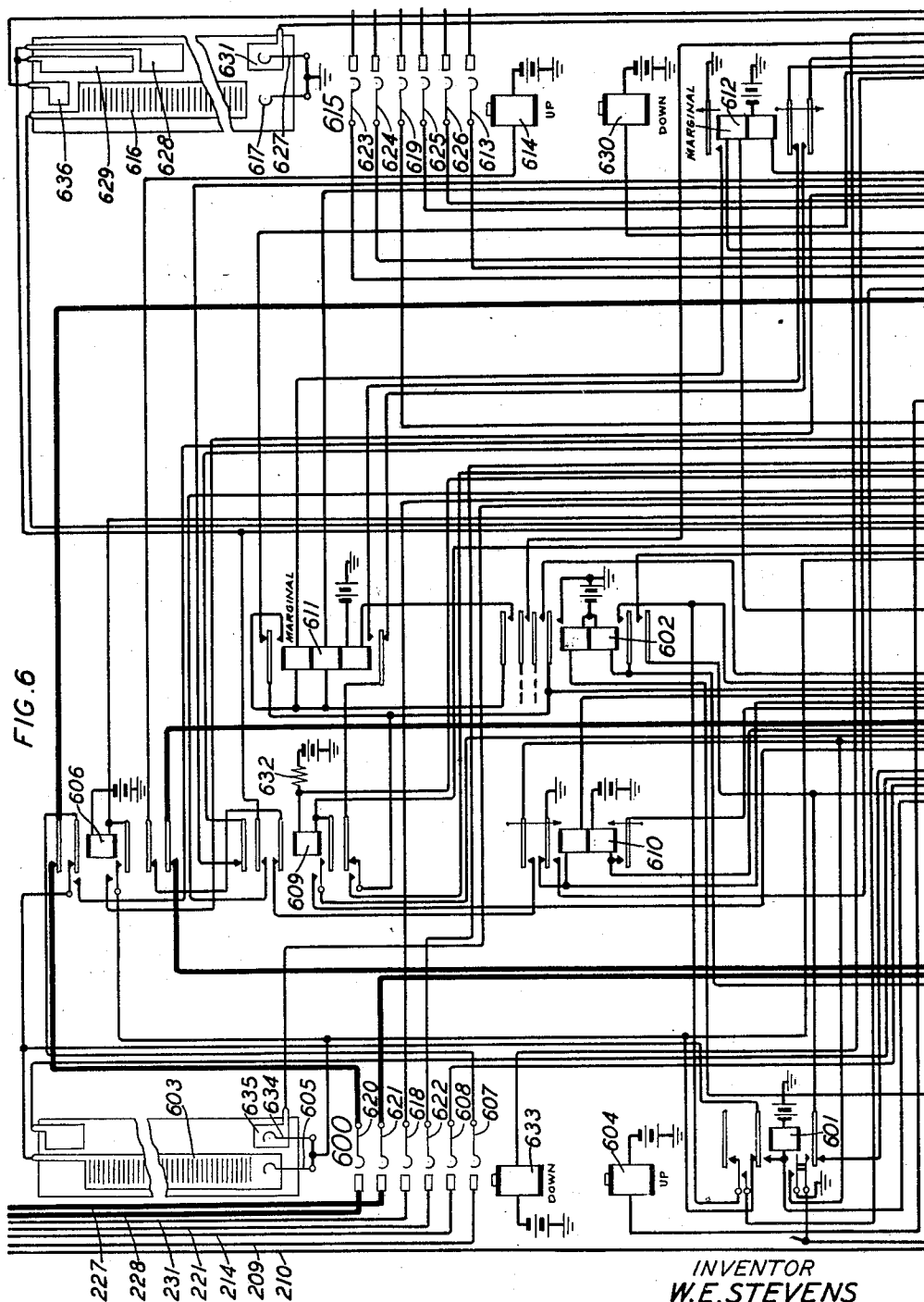
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18 Sheets-Sheet 6



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18 Sheets-Sheet 7

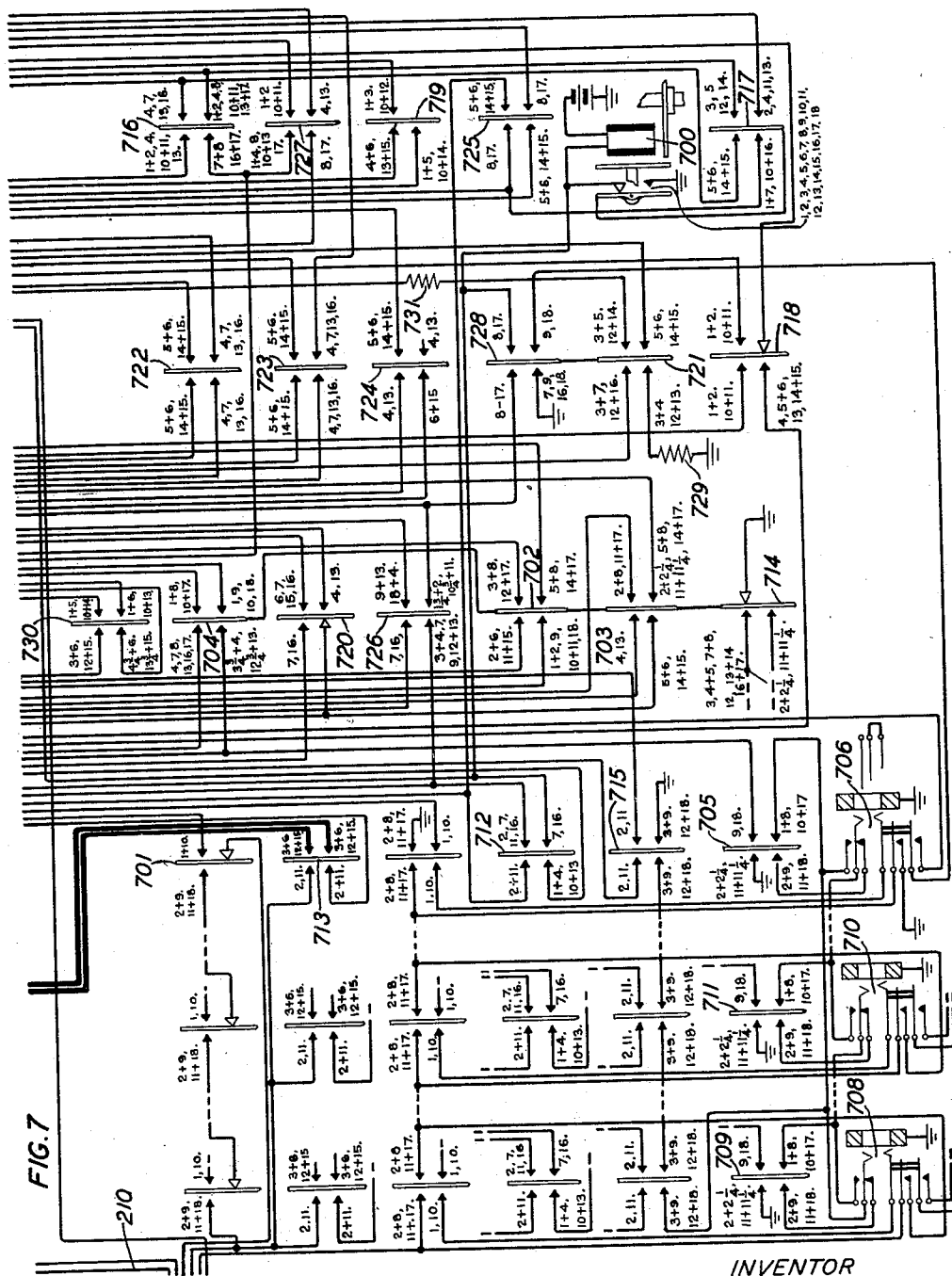


FIG. 7

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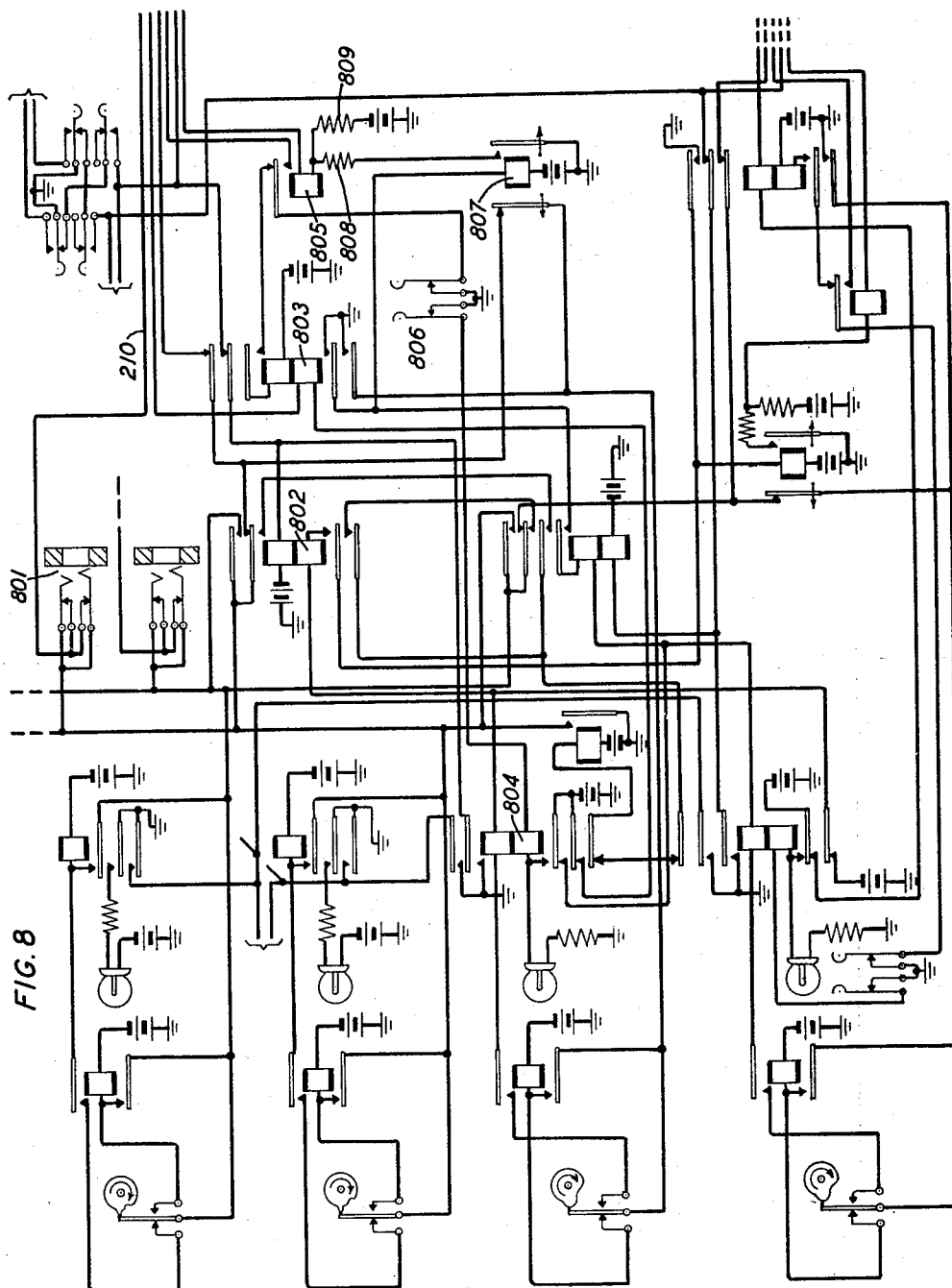
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18 Sheets-Sheet 8



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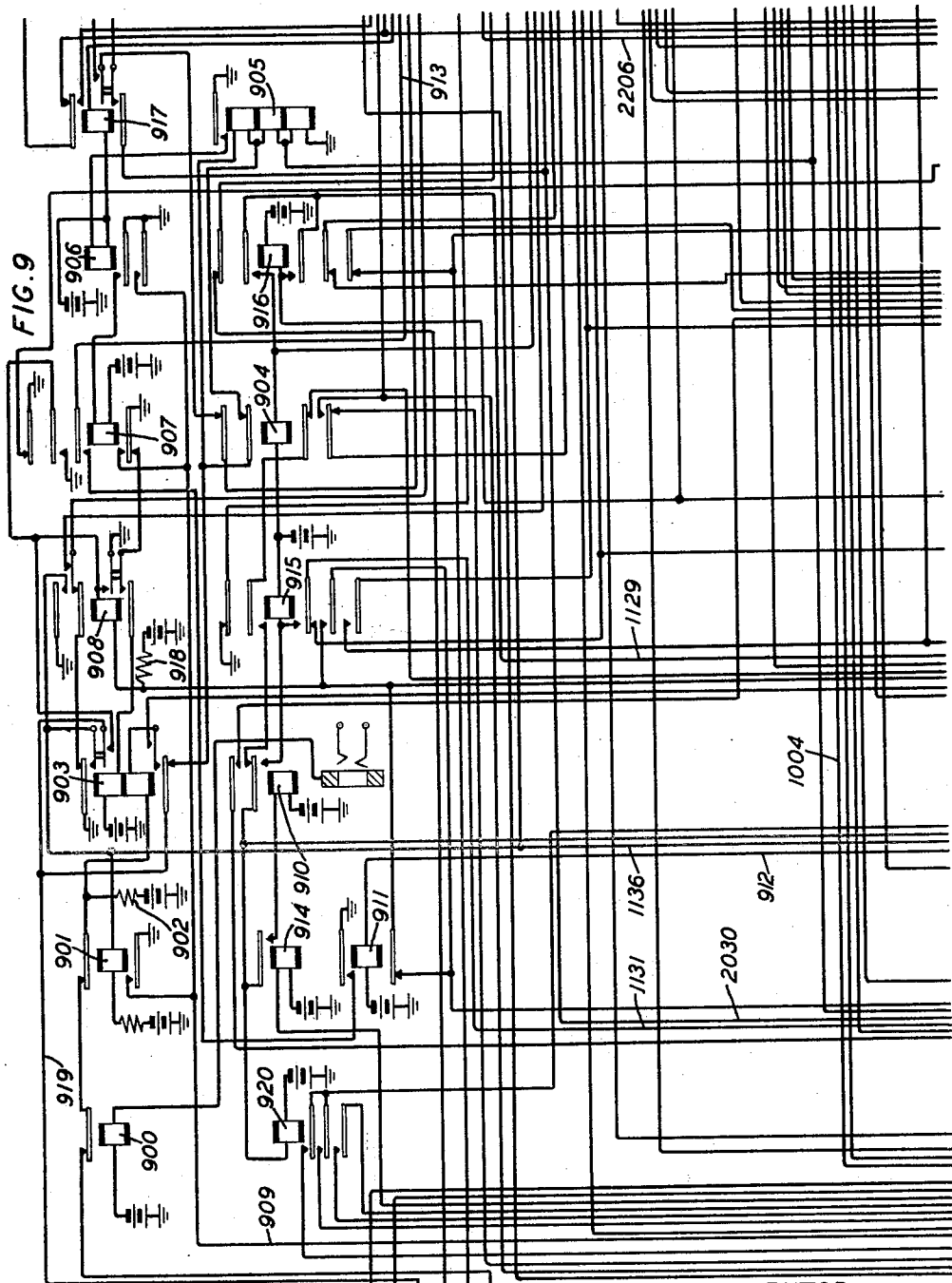
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18 Sheets-Sheet 9



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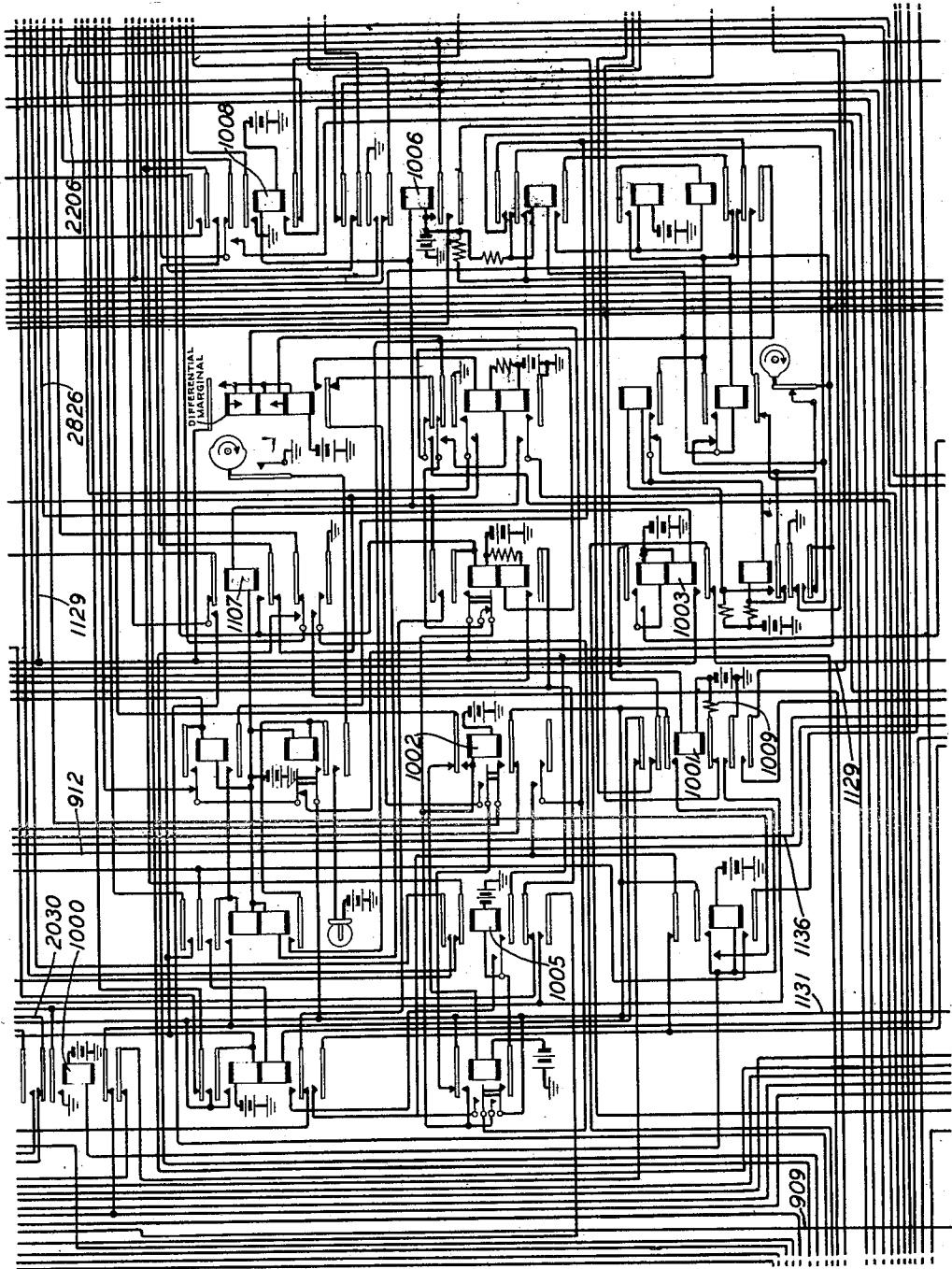


FIG. 10

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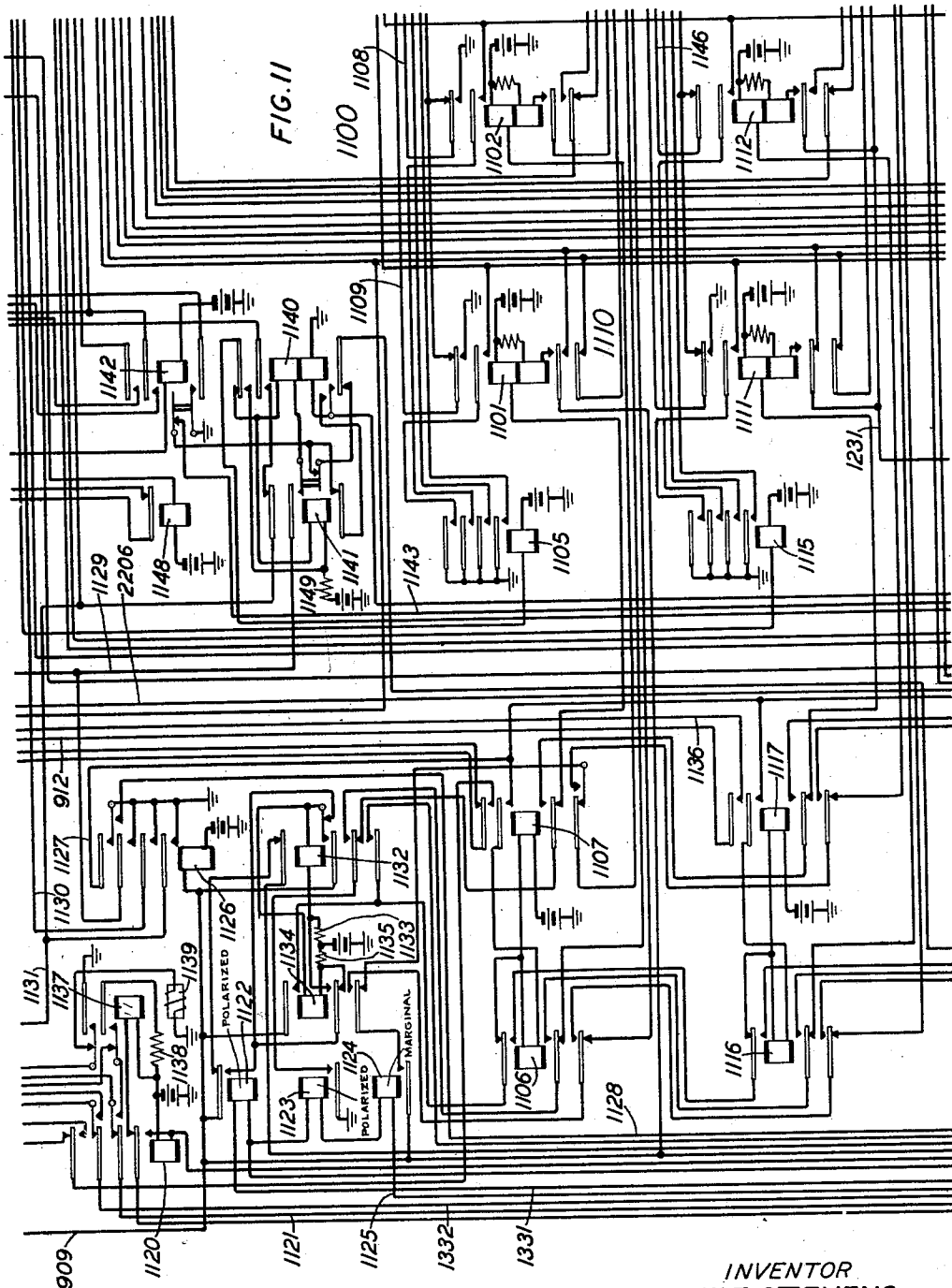
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18 Sheets-Sheet 11



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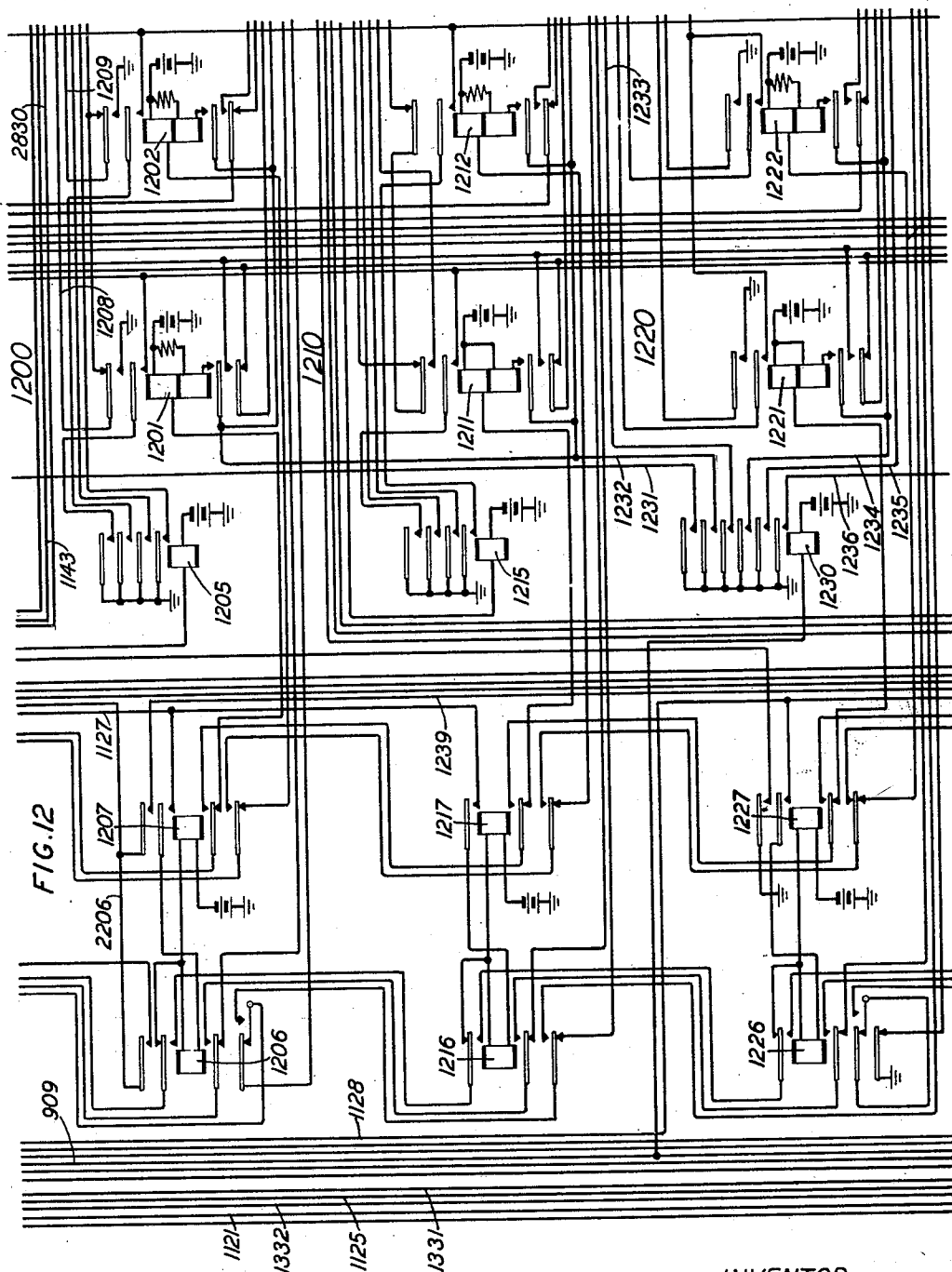
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18 Sheets-Sheet 12



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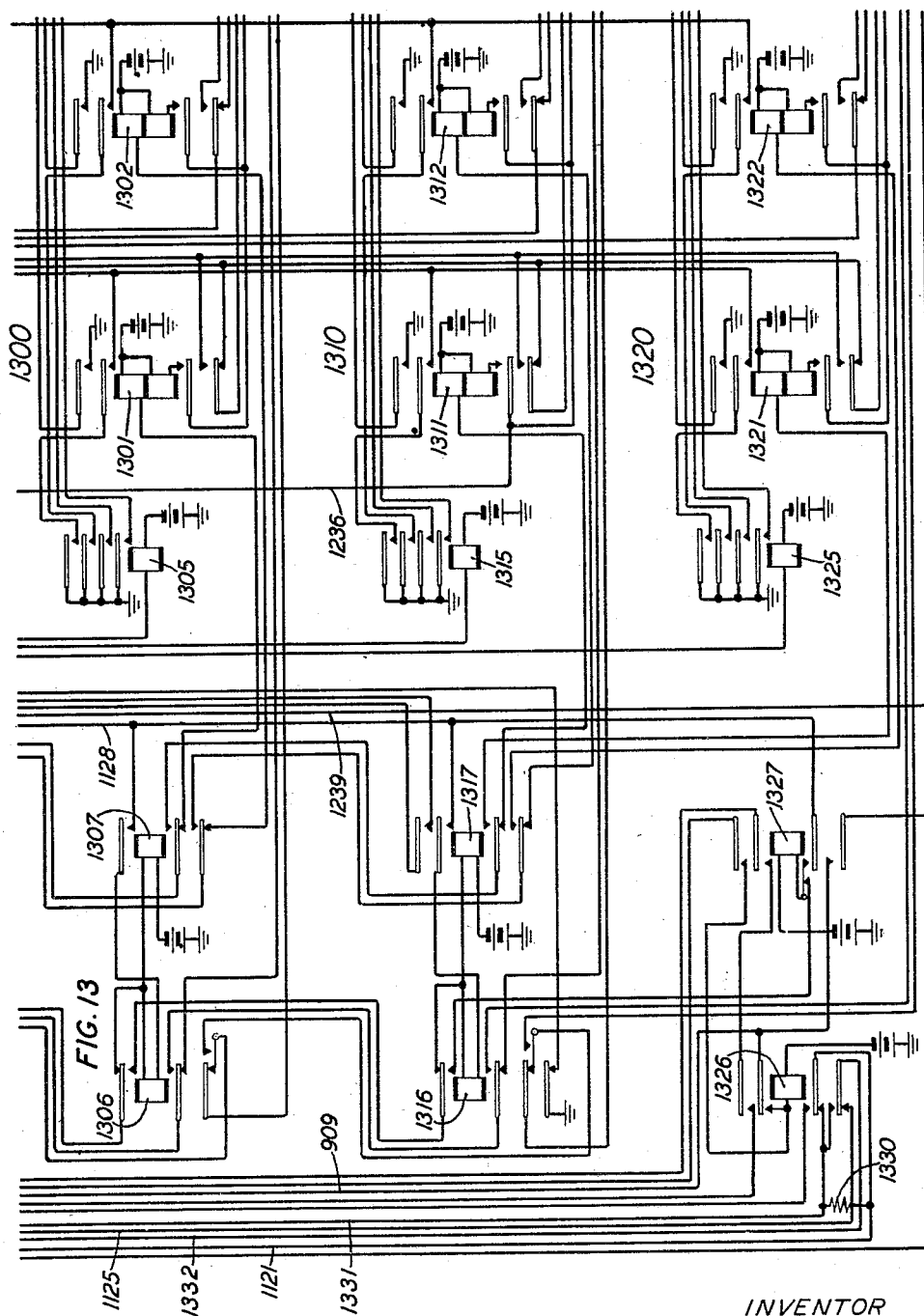
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18 Sheets-Sheet 13



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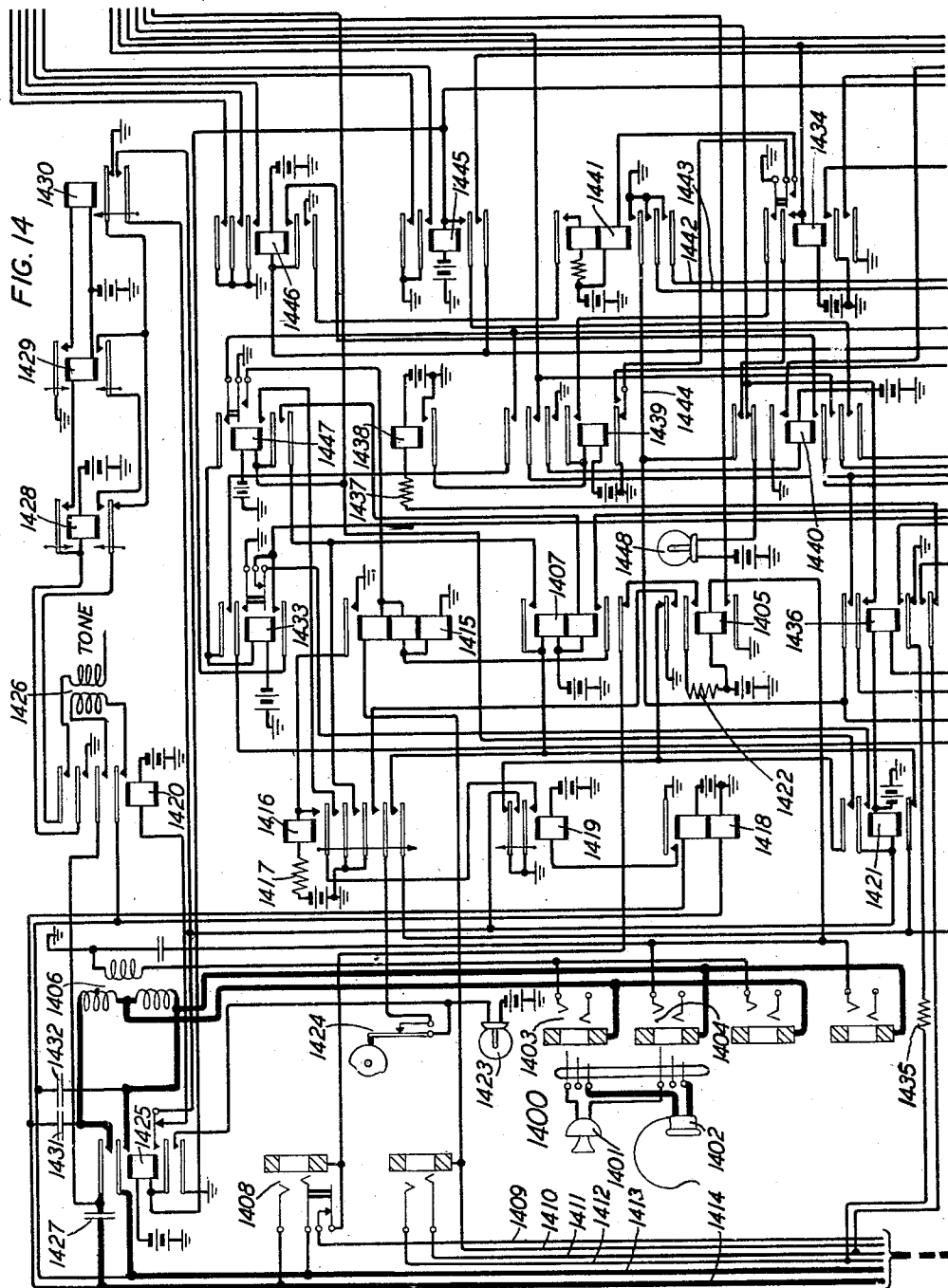
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TELEPHONE SYSTEM

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18 Sheets-Sheet 14



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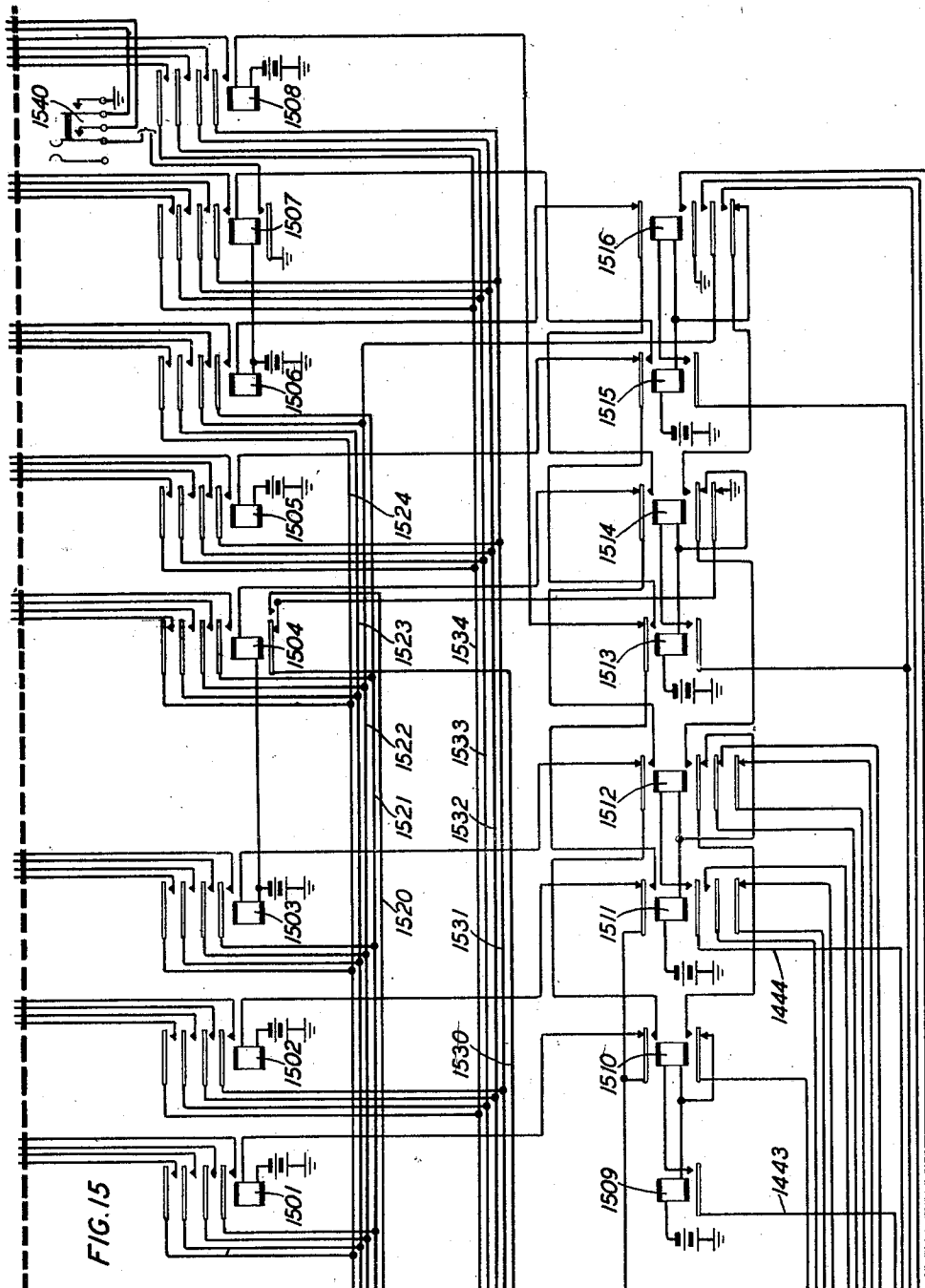
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TELEPHONE SYSTEM

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18 Sheets-Sheet 15



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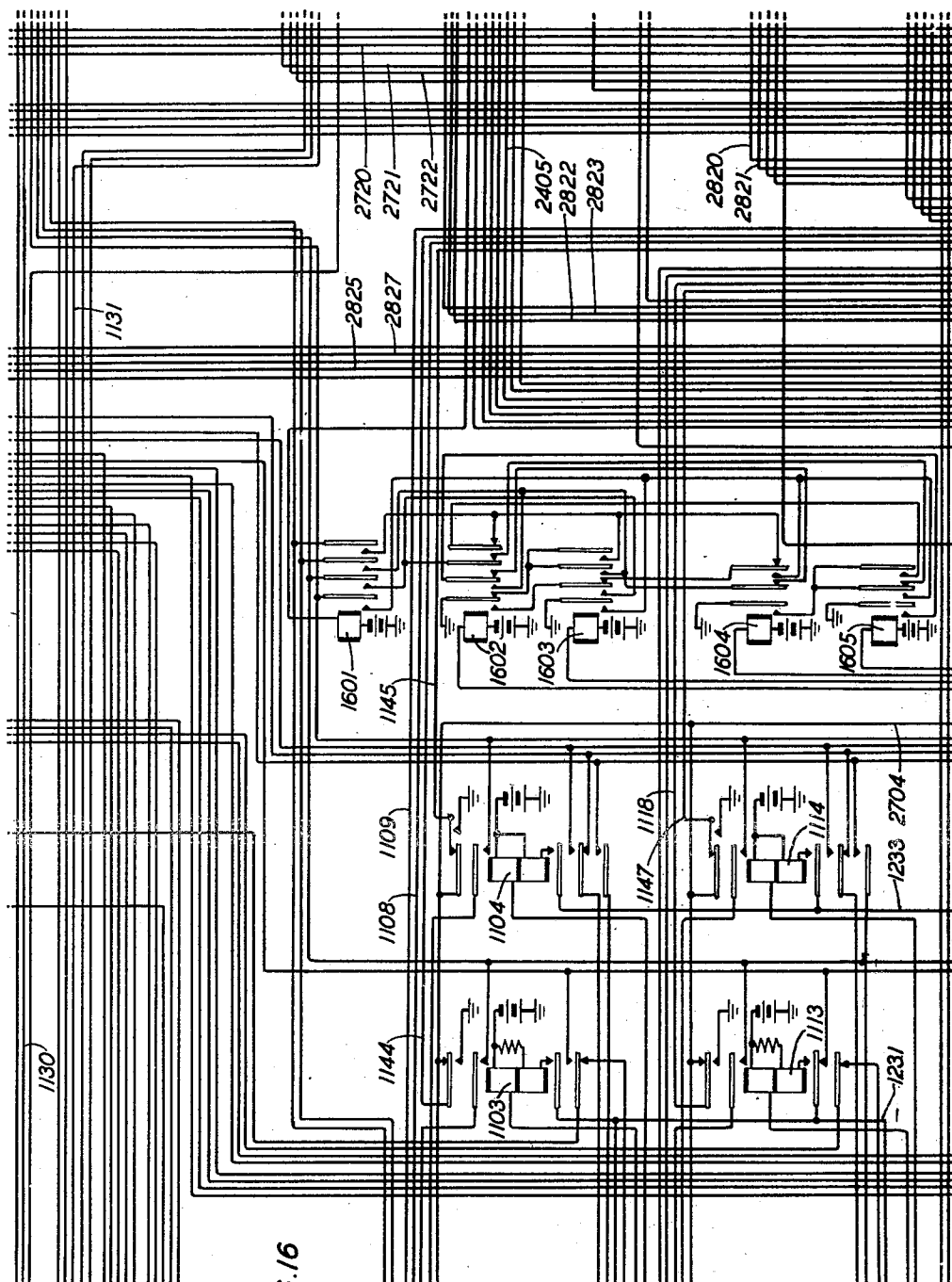


FIG. 16

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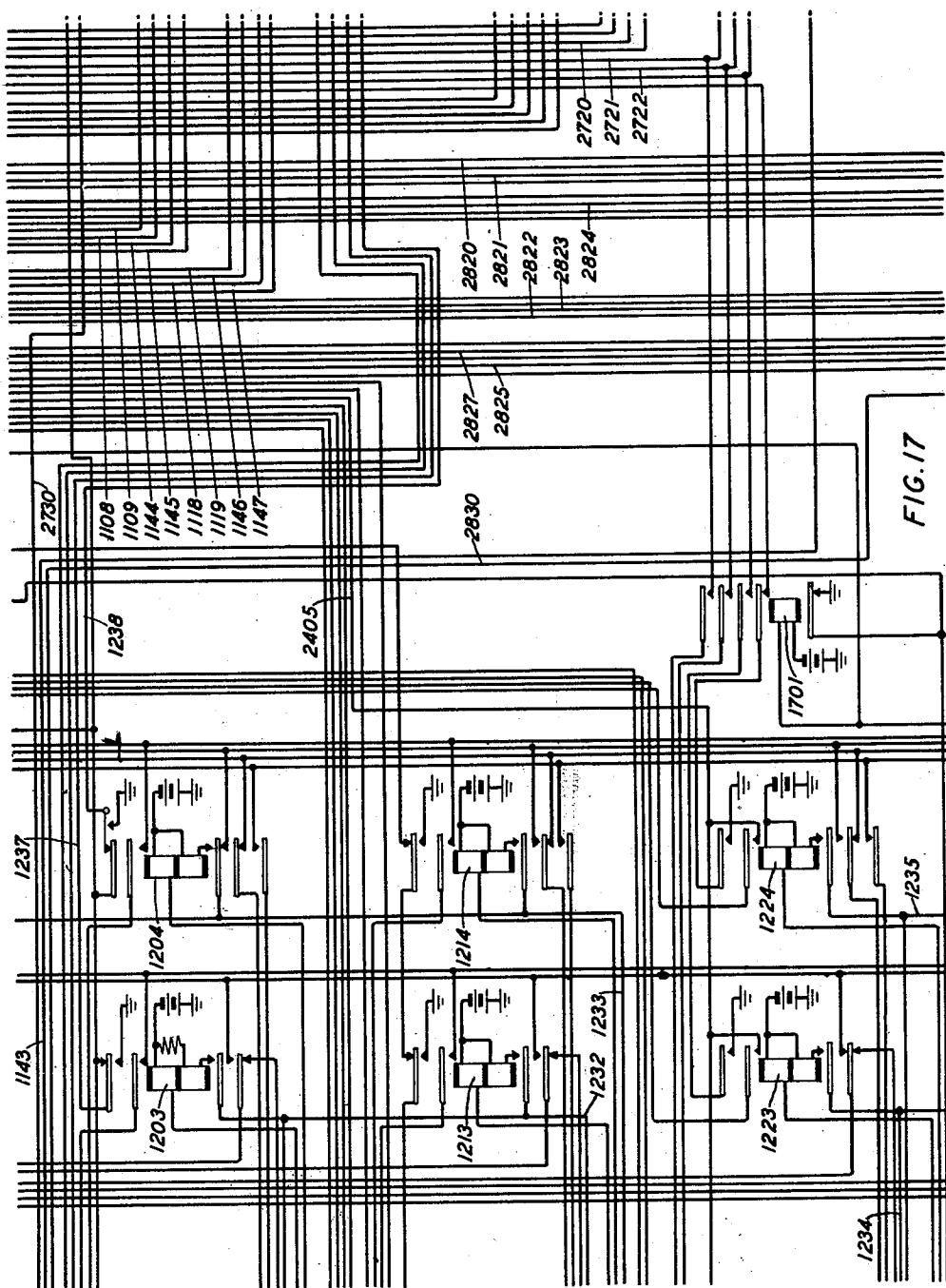


FIG. 17

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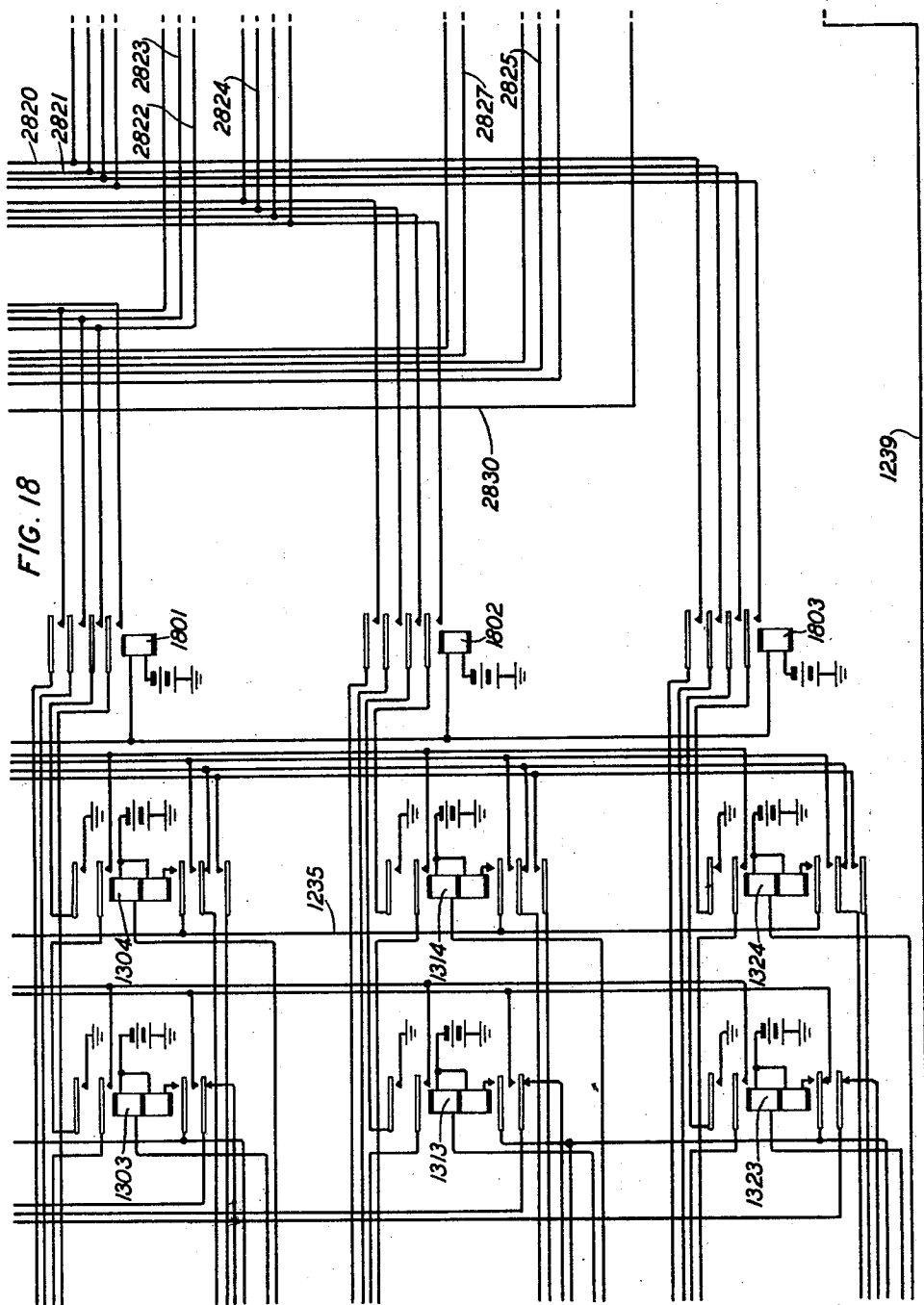
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18 Sheets-Sheet 18



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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Application filed December 31, 1930. Serial No. 505,835.

This invention relates to telephone systems in which calls are established by means of automatically operated apparatus and has for its object to increase the speed and efficiency with which operators may control automatic switching equipment.

In large telephone areas, although a majority of the calls may be completed by means of switching equipment under the control of the subscriber's dial, there are numerous calls in which the assistance of an operator is necessary.

The present invention contemplates the provision of operator controlled equipment in connection with a tandem office whereby the sender registers may be positioned by means of code pulses transmitted directly from the operator's position.

In the particular embodiment chosen for the disclosure of the present invention the operator is provided with a key set comprising a plurality of rows of keys, each row corresponding to a digit of the called subscriber's number including both the office code and the numerical designation. When the first key is operated the position is associated with an idle sender and as soon as the sender is found and the office keys operated the transmission of the office code is started. The depression of the last key together with the complete transmission of the office code releases the office keys. It also renders the position selectable in connection with a second call, permitting the operator to receive instructions regarding the second call during the time that the sender is being positioned for the first call. When transmission of the numerical digits has started, the office keys are released and the office code may be recorded, but the operation of the key set is ineffective to cause the association of the position with a second sender until the first sender has been disconnected. The operator is provided with a reorder key to permit erasing an erroneously recorded designation and signaling the originating operator.

The invention has been embodied in an operator's position suitable for use at a tandem office in connection with a sender of the type disclosed and claimed in Patent 1,840,132,

granted to T. H. Roberts, Jan. 5, 1932, to which reference is made for the complete showing of the sender and for the details of the operation of various parts of the present disclosure.

The operator's position is provided with a key set comprising a row of keys for each digit of telephonic designation, that is, three rows of keys corresponding to three office code digits, a single key on which to record the digit 1 which may be used as a 10,000 digit, four rows of keys corresponding to the four numerical digits and a row of keys for the stations digit. The keys of this row also act as start keys and an additional key is provided for use where the designation does not include a station's digits or is otherwise abbreviated. The position equipment also includes a relay arrangement for generating cord pulses according to the call indicator code under the control of the key set and for transmitting them in the proper order to an associated sender.

The operation of the system is briefly as follows: This position is used to receive calls from manual offices which are to be completed through a tandem office to some other office. When the operator at the originating office plugs into a jack leading to an outgoing trunk to the tandem office, a bridge is connected across the trunk which causes a relay in the tandem district selector to mark the district to the district finders of the link circuits having access thereto and to ground the start conductor. A start circuit is provided which responds to such ground to initiate the operation of link circuits in a predetermined order. The link circuits hunt for the marked district and an idle operator's position at the same time. When both have been found, the link sequence switch advances and the link waits for the operator. When the position is found the talking conductors are closed between the position and the district selector and therefore to the originating operator over the trunk, and, after the transmission of the two order tones, to the tandem operator's headset. The originating operator then informs the tandem operator of the wanted number and the tandem operator records the

number on her key set. As soon as the first key has been operated, the link is given a signal to which it responds by hunting for and seizing an idle sender. When the sender has been found the incoming pulsing conductors of the sender are connected through to the outgoing pulsing conductors of the position. When the last office code key has been depressed and the sender found, the transmission of the office code digits starts. If a start key has not been depressed by the time the office code has been completely transmitted, pulsing ceases and the circuit waits.

When a start key has been operated the remainder of the number is sent out. After the office code pulses have been transmitted and the start key operated, the keys on which the office code was recorded are released and a signal is transmitted to the link, which opens the incoming talking conductors between the district selector and the position and restores the selectable condition to the operator's position. A second link circuit may thereupon select the position, order tones may be given to the second originating operator, the second wanted number passed, and the office code of the second number recorded on the key set, during the time that the numerical digits of the first wanted number are being transmitted to the first sender. However, no signal is given to the second link circuit to hunt for an idle sender until after the transmission of the first number has been completed and the first link has been disconnected.

If the operator makes a mistake in setting up the wanted number she operates a reorder key which brings about the release of that part of the connection which has been established up to that time and transmits a signal to the originating operator that the call must be extended again.

The invention will be more clearly understood from a detailed consideration of the operation of the system as a whole. The drawings which set forth the invention include the following figures:

Figs. 3, 4, 14, and 15 show the operator's headset, key set and other equipment located at her position;

Fig. 2 shows a district selector;

Figs. 5, 6, 7 and 8 show a link circuit for associating the district selector of Fig. 2 with the sender and with the operator's position;

Figs. 9 and 10 show certain control relays of the sender;

Figs. 11, 12, 13, 16, 17 and 18 show the incoming registers, the transfer relays and certain relays controlled thereby.

Fig. 1 shows the manner in which Figs. 2 to 18 are to be arranged.

The somewhat irregular numbering arrangement of the figures of the drawings results from the fact that the same designations have been employed as in the Roberts'

patent above referred to. Figs. 2, 6 to 13, and 16 to 18 are copies of the similarly numbered figures, of that patent. This has been done to facilitate reference to the Roberts' patent.

When the manual operator at the originating office inserts the plug of her cord in the jack of the trunk leading to the district selector of Fig. 2, a relay is connected across the tip and ring conductors at the outgoing end of the trunk, completing a circuit from battery through the right winding of relay 201, lower right and upper left contacts of cam 202, over the tip conductor, through the relay of the trunk circuit and back over the ring conductor to the lower left and upper right contacts of cam 203, left winding of relay 201 and ground. Relay 201 operates, closing a circuit from battery through the winding of relay 204, contact of relay 201, right contacts of cam 205 to ground. Relay 204, in operating, disconnects ground from conductor 209 to mark the district selector in the banks of district finders such as finder 600 of the link circuits. It also closes an obvious circuit for relay 207. Relay 207 connects ground from the left back contact of relay 212, right front contact of relay 207, lower contacts of cam 211, to start conductor 210 and thence to the start circuit of Fig. 8. The start circuit serves to connect the district selectors one at a time with link circuits as they become available. The selectors and link circuits are normally divided into two groups and the start circuit controls transfer between the two groups when necessary because of trouble or busy conditions. A similar start circuit is disclosed in U. S. Patent 1,567,072, granted December 29, 1925 to W. H. Matthies.

The link circuit sequence switches stand, when out of use, in positions 9 or 18 and are advanced one at a time into positions 1 or 10 to allot the links for use. Assuming that the link shown in Figs. 5 and 7 is ready for use, the connection of ground to conductor 210 completes a circuit extending through jack 801, upper back contact of relay 802, outer upper back contact of relay 803, right contacts of cam 701, to the winding of relay 601 and battery. Relay 601 closes a locking circuit for itself over commutator strip 603, brush 605, upper right contact of cam 704 to ground. Relay 601 also closes a circuit from ground at its inner lower contact over the upper back contact of relay 510 to the upper winding of relay 602 and battery. Relay 602 locks through its lower winding and inner lower contact, lower left contact of cam 702 to ground. A branch of this locking circuit extends to the upper winding of relay 511 and battery. Relay 511 operates, closing a circuit from battery through the winding of relay 512, inner upper front contact of relay 511 to ground over the upper right con-

tact of cam 703. Relay 512 closes a circuit from battery through the updrive magnet 604 of the district finder 600, upper front contact of relay 512, middle upper front contact of relay 601 to ground over the lower left contact of cam 702. District finder 600 is moved upward under the control of this circuit in search of the district selector marked by the absence of ground on the terminal served by brush 607.

When relays 601 and 602 operated, a circuit was closed from battery over the middle lower contact of relay 804, lower winding of relay 803, lowermost front contact of relay 601, outer lower contact of relay 602, lower right contact of cam 704 to ground. Relay 803 locks through its upper winding and inner upper contact, back contact of relay 805, to ground at key 806. It also closes a circuit from ground at its inner lower contact through the winding of relay 807. In addition it opens the energizing circuit of relay 601. As the district finder moves upward, relay 601 is held operated between segments of commutator 603 over the inner upper back contact of relay 606 and brush 607 of the district finder to ground at the district selector circuits other than that of Fig. 2. When selector 200 has been found, relay 601 releases as soon as the district finder moves off the conducting segment of commutator 603, the release of relay 601 opening the circuit of updrive magnet 604, and bringing the district finder to rest. It also closes a circuit from battery through the winding of sequence switch magnet 700 of the link circuit, lower back contact of relay 601, outer lower front contact of relay 602, lower right contact of cam 704 to ground. Sequence switch 700 is advanced to position 2 in this circuit. As soon as relay 601 releases, ground is connected to brush 607 over the inner upper back contact of relay 606, upper back contact of relay 601 and the upper right contact of cam 704 to prevent another district finder from selecting this set of terminals.

A circuit is closed in position 2 of sequence switch 700 from ground over the upper left and lower right contacts of cam 705, contact of jack 708, lower left and upper right contacts of cam 709, to the winding of the relay corresponding to relay 602 in the next link to allot that link provided its sequence switch is standing in position 9 or 18. If not, the circuit extends over the lower right contact of cam 709 to the next link which will be allotted if ready.

With sequence switch 700 in position 2 a circuit is closed from ground at the right contact of relay 807 through resistance 808, winding of relay 805, back contact of relay 513, left contacts of cam 712, brush 608 of the district finder, conductor 214, left contacts of cam 215 to the right winding of relay 212 and battery. Relay 212 locks over its inner right

front contact to ground over the left contacts of cam 213 and extends its locking ground back to the winding of relay 805 which now operates in series with battery and resistance 809. Relay 212 disconnects ground from the start conductor 210 and closes a circuit from ground at its left front contact over the lower left contact of cam 216 to the winding of sequence switch magnet 206 and battery, advancing the sequence switch to position 3. As soon as sequence switch 206 leaves position 1, ground is connected over the left contacts of cam 217 to conductor 209 to prevent the selection of this district selector by any other district finder. The advance of sequence switch 206 from position 2 opens the locking circuit of relay 212 and that relay releases in turn releasing relay 805.

The operation of relay 805 as above described closes a circuit from ground over key 806, front contact of relay 805, left contacts of cam 713, upper winding of relay 513 and battery. Relay 513 locks in a circuit from battery through its lower winding and inner lower contact to ground over the lower right contact of cam 703, so that it remains operated after relay 805 is released to restore the start circuit to use with other calls.

When relay 602 operated it also closed a circuit to battery through the lower winding of relay 612, upper left and lower right contacts of cam 716, upper back contact of relay 611, to ground at the inner upper contact of relay 602. At its outer upper contact relay 602 connects the lower winding of relay 611 to its middle and upper windings. Relay 612 connects ground over its upper contact to the upper winding of relay 611 preparing that relay to operate quickly when the test circuit through its middle winding is completed.

Relay 612 closes a circuit from battery through the winding of relay 508, outer lower contact of relay 510, back contact of the operating magnet 507 of the position finder 500, inner upper contact of relay 514, right contacts of cam 718, lower front contact of relay 612, lower back contact of relays 611 and 609, inner upper contact of relay 602 to ground. Relay 508 in operating completes a circuit from battery through magnet 507 over the outer contact of relay 508, upper left and lower right contacts of cam 718, to ground over the circuit of relay 508. Relay 508 therefore prepares the position finder to hunt for an idle operator's position. With sequence switch 700 in positions 1 to 3 the middle winding of relay 611 is connected over the lower left and upper right contacts of cam 719 and the back contact of relay 515 to test brush 506 of the position finder.

When an operator occupies her position at the switchboard she inserts the plug of her headset in the jack at the position. A circuit is thereby closed from battery through the winding of relay 1405, tip of jack 1404

through the transmitter 1401 of head set 1400, tip of jack 1403, right winding of repeating coil 1406 to ground. At the same time receiver 1402 is connected across the lower left winding of repeating coil 1406. Relay 1405 connects battery through resistance 1422, inner upper front contact of relay 1405, back contact of relay 1407, contact of jack 1408 to conductor 1409, and thence to the terminal corresponding to this position in the bank of brush 506.

When magnet 507 operates under the control of relay 508, it opens the circuit of that relay and both release to reoperate in turn and thus cause switch 500 to move its brushes in search of a position at which an idle operator is located as indicated by battery through a resistance such as resistance 1422 connected to conductor 1409. When such a battery is found the circuit through the upper and middle windings of relay 611 is completed and that relay operates, opening the circuits of relay 508 and magnet 507. Relay 611 locks from battery at the operator's position through its middle winding over its upper front contact to ground over the inner upper contact of relay 602 or, when sequence switch 700 reaches position 2, over the upper right contact of cam 703. The operation of relay 611 opens the circuit of relay 612 which now slowly releases and closes a circuit from battery through the lower winding of relay 510, back contact of relay 612, lower front contact of relay 611, lower back contact of relay 609 to ground over the upper right contact of cam 703. Relay 510 locks through its upper winding and inner upper contact, inner lower contact of relay 602, to ground over the lower left contact of cam 702. With relay 510 operated as an indication that an idle operator's position had been found, and relay 513 operated as an indication that the district selector had been found and advanced, a circuit is closed from battery through the winding of sequence switch magnet 700, lower right contact of cam 717, middle upper front contact of relay 510, outer lower contact of relay 513, to ground over the lower left contact of cam 702 advancing the link sequence switch to position 3.

In position 3 the locking circuits of relays 513 and 602 open and these relays release in turn releasing relays 511 and 512. Relay 611 remains operated in the locking circuit above traced. In this position also, ground is connected through resistance 729, left contacts of cam 721, brush 622, conductor 221, contacts of cam 220 to the windings of relays 208 and 229 and battery. Relay 229 being marginal does not operate, but relay 208 operates, closing a circuit from ground over its right front contact, lower contacts of cam 222, left winding of relay 212 and battery, and over the left contacts of cam 222 to the winding of relay 223 and battery. Relay 212

operates, advances sequence switch 206 to position 4 and releases. Relay 223 disconnects the tip and ring conductors from the windings of relay 201 and extends them towards the link circuit where the release of relay 512 further extends them towards the operator's position. Relay 223 in operating provides a local holding circuit for relay 201 which may be traced from battery through the right winding of relay 201, left front contact of relay 207, inner lower front contact of relay 223, upper left contact of cam 250, lower left contact of cam 222 to ground at the right front contact of relay 208. When sequence switch 206 reaches position 4 the local circuit of relay 201 extends over the left front contact of relay 207, inner lower back contact of relay 226, inner left back contact of relay 229 to ground over the upper left and lower right contacts of cam 218 and the left contacts of cam 217. Relays 201 and 207 are therefore held operated under the control of relays 226 and 229 until the sequence switch 206 reaches position 12.

A circuit between the two operators' positions may now be traced from battery through the upper winding of relay 1418, conductor 1414, brush 501, inner upper back contacts of relays 516 and 512, uppermost back contact of relay 606, brush 620, conductor 228, upper back contact of relay 226, left contacts of cam 225 to the tip conductor through the relay in the outgoing end of the trunk to the ring conductor, left contacts of cam 224, outer lower back contact of relay 226, outer left back contact of relay 229, conductor 227, brush 621, right contacts of cam 713, lowermost contact of relay 606, outer upper back contacts of relays 512 and 516, brush 502, conductor 1413, lower winding of relay 1418 to ground. The originating operator's telephone is connected in bridge of the relay at the outgoing end of the trunk, while the tandem operator's headset has not as yet been connected with the talking circuit. A low efficiency connection exists over condensers 1431 and 1432 to permit her to hear the order tones.

With sequence switch 700 in position 3 a circuit is also closed from battery through the lower winding of relay 517, lower winding of relay 518, upper winding of relay 515, lower right and upper left contacts of cam 730, inner lower back contact of relay 516, brush 505, conductor 1410, windings of relay 1415 to ground. Relay 1415 operates in this circuit but the link relays do not, due to the high resistance of the lower winding of relay 1415. Relay 1415 in turn operates relay 1416. Relay 1416 closes a circuit from battery through lamp 1423, interrupter 1424, fourth contact of relay 1416 to ground at the outer upper front contact of relay 1405. Lamp 1423 flashes under the control of inter-

rupter 1424 to inform the operator that her position has been selected.

The operation of relay 1418 in the talking circuit above traced in turn causes the operation of relay 1419. Relay 1419 furnishes locking ground for relay 1416 and closes a circuit from ground over its outer front contact to the winding of relay 1421 and over the normal contact of relay 1425, to the winding of relay 1420 and battery. Relay 1421 locks over its inner upper contact, normal contact of relay 1433 to ground at the uppermost back contact of relay 410. Relay 1420 connects the secondary winding of tone coil 1426 to the talking circuit through condenser 1427. It also closes a circuit from the tone source through the primary winding of tone coil 1426, uppermost contact of relay 1420, back contact of relay 1428, back contact of relay 1430 to ground. In addition relay 1420 closes an obvious circuit for relay 1428. Relay 1428 being slow to operate, after an interval opens the primary circuit of the tone coil and extends its operating circuit to relay 1429. Relay 1429 recloses the tone circuit and operates relay 1430. Relay 1430 reopens the tone circuit and closes an operating circuit for relay 1425. Since relays 1429 and 1430 are also slow to operate two measured impulses of tone are transmitted over the talking circuit to the originating operator. The tones are also made audible to the tandem operator through condensers 1431 and 1432 and repeating coil 1406.

Relay 1425 in operating extends the talking circuit to the repeating coil 1406, opens the circuit of relay 1420, locks under the control of relay 1419, and closes direct ground to lamp 1423 to cause that lamp to light steadily. The originating operator may now pass the wanted number to the tandem operator. Relays 1428, 1429 and 1430 release following the release of relay 1420.

When the tandem operator has received the wanted number she starts to write the number on her key set by depressing one key in each row required by the nature of the called number. Assuming that the number is Chelsea 6789M she will depress keys 302, 314, 323, 346, 357, 368, 379 and 384. These keys are self-locking and are electrically released by the magnets 310, 320 etc. shown at the top of each strip of keys. The contacts 391, 392, 393, and 394 are closed whenever a key in the corresponding strip is operated and remain closed until the key is released. Therefore when the tandem operator depresses key 302 a circuit is closed from battery through the upper winding of relay 1407, lowermost contact of relay 1416, inner upper back contact of relay 410, contact 391, middle lower back contact of relay 1512 to ground at the lower back contact of relay 411. A circuit is also closed from battery through the winding of relay 1434 over con-

tact 391 to ground as just traced. Relay 1434 starts the operation of the pulsing relays preparatory to transmitting the designation to the sender as will be described hereinafter.

Relay 1407 locks through its upper winding and contact to ground at the middle contact of relay 1416. It also disconnects battery through resistance 1422 from conductor 1409 and the winding of relay 611 as a signal to the link circuit to start hunting for an idle sender. Relay 611 therefore releases in turn releasing relay 510. With relay 611 released a circuit is closed from battery through the winding of sequence switch magnet 700, upper right contact of cam 717, upper back contact of relay 611, to ground at the upper right contact of cam 703 advancing sequence switch 700 to position 4. In position 4 a circuit is closed from battery through the upper winding of relay 602, upper back contact of relay 510, to ground over the lower left contact of cam 704, and a second circuit from battery through the lower winding of relay 612, upper left and lower right contacts of cam 716, upper back contact of relay 611 to ground at the upper right contact of cam 703. As before relay 602 connects the lower winding of relay 611 with the middle and upper windings of the same relay and relay 612 connects ground to the upper winding of that relay. In position 4, however, the middle winding is connected over the left contacts of cam 719, outer upper back contact of relay 609, middle upper back contact of relay 514 to brush 613 of the sender selector 615. Relay 612 also closes a circuit from battery through the lower winding of relay 610, lower contacts of cam 718, outer lower front contact of relay 612, lower back contact of relay 611, lower back contact of relay 609, to ground over the upper right contact of cam 703. When relay 610 operates it closes a circuit from battery through the winding of updrive magnet 614 of the sender selector, inner lower back contact of relay 606, inner upper back contact of relay 609, outer upper front contact of relay 610, lower left contact of cam 704, to ground. The sender selector 615 is advanced in search of an idle sender under the control of magnet 614.

An idle sender is characterized by battery through a resistance such as resistance 902, connected to the terminal to which link brush 613 has access. Assuming that the sender shown is the first idle sender, when brush 613 engages the terminal leading to this sender, a circuit is closed from battery through resistance 902, upper back contact of relay 901, contact of relay 900, brush 613, and thence to the middle winding of relay 611 as above traced. Relay 611 now operates and closes a locking circuit for itself from battery through its middle winding as above traced and thence over its upper front contact

to ground over the upper right contact of cam 703. It also opens the circuit of relay 610 but relay 610 remains operated over the lower contacts of cam 720 until brush 617 moves off the conducting segment of commutator strip 616, thus insuring that the brush set is properly centered. When relay 610 releases it opens the circuit of the updrive magnet 614 and brings the sender finder 615 to rest. It also releases relay 612 which is made slow to release to provide ample time for relay 611 to operate and lock. Relay 611 also closes a circuit from battery through the lower winding of relay 510, lower back contact of relay 612, assuming that relay has released, lower front contact of relay 611, lower back contact of relay 609, to ground over cam 703. Relay 510 in turn closes a circuit from battery through the winding of magnet 700, lower right contact of cam 717, middle upper front contact of relay 510 to ground over the lower left contact of cam 704, advancing sequence switch 700 to position 5. Relay 510 also releases relay 602.

With sequence switch 700 in position 5 a circuit is closed from battery through the winding of relay 519, outer lower back contact of relay 512 to ground over the lower right contact of cam 703. The function of relay 519 will be described later. Relay 522 is also operated over the outer lower back contact of relay 516 to ground at the upper left contact of cam 702 for a purpose to be disclosed hereinafter.

If no idle sender had been found before the sender selector 615 reaches the top of its bank, when brush 617 reaches commutator segment 636, a circuit is closed from ground over the lower right and upper left contacts of cam 727 through the winding of relay 609 and resistance 632 to battery. Relay 609 locks over its middle lower front contact to ground over the upper left contact of cam 704. It opens the circuit of the updrive magnet 614 and also the test circuit through relay 611 and closes a circuit from battery through the winding of the downdrive magnet 630, lower contacts of cam 722, lowermost front contact of relay 609, to ground at the upper right contact of cam 703. When the sender selector reaches normal under the control of the downdrive magnet, ground over brush 627 is connected over commutator segment 631, lower contacts of cam 723, to resistance 632 in shunt of the winding of relay 609 which thereupon releases opening the circuit of the downdrive magnet and restoring the circuit of the updrive magnet and the test circuit, so that the hunt for an idle sender is continued.

With sequence switch 700 in position 5 a circuit is closed from ground through the lower and middle windings of relay 905, inner upper contact of relay 904, lower back

contact of relay 903, conductor 919, brush 619 of the sender selector, outer upper contact of relay 514, lower back contact of relay 518, upper winding of relay 612, lower right and upper left contacts of cam 721, brush 622, conductor 221, lower left and upper right contacts of cam 220 to the winding of relay 208 and battery. Relay 208 is held operated in this circuit.

Relay 905 operates in the circuit with relay 208, and in turn operates relays 906 and 907. Relay 907 operates relay 908 which locks over its inner lower front contact and closes a circuit for operating relay 901. The operation of relays 906, 907 and 901 connects ground to conductor 909 operating relays 1126 and 1230 to supply off-normal ground to the various parts of the sender. With relay 1126 operated ground is connected to conductor 1131 and over the lower back contact of relay 1002 to the winding of relay 920 and battery. Relay 920 prepares circuits which become effective later.

Relay 901 in operating disconnects battery from brush 613 and releases relay 611, in turn releasing relay 510. The release of relay 611 closes a circuit from battery through the winding of sequence switch magnet 700, upper right contact of cam 717, upper back contact of relay 611 to ground at the upper right contact of cam 703, advancing sequence switch 700 to position 6.

With sequence switch 700 in positions 5 and 6, brush 623 is connected over cam 722, upper back contact of relay 511 to brush 503, and brush 624 is connected over cam 723, lower back contact of relay 511 and the winding of relay 520 to brush 504. In the sender, brush 623 is connected over the outer lower back contact of relay 1000, second back contact of relay 1120, conductor 1121, inner lower back contact of relay 1326, in parallel with resistance 1330, conductor 1331, windings of relays 1122, 1123 and 1124 in series, conductor 1125, outer lower back contact of relay 1326, conductor 1332, third back contact of relay 1120, inner lower back contact of relay 1000, outer upper back contact or relay 1001 to brush 624. At the position, brush 503 is connected over conductor 1412, resistance 1435 to ground at the inner lower back contact of relay 1436 while brush 504 is connected over conductor 1411, outer lower back contact of relay 1436, resistance 1437 to the winding of relay 1438 and battery. Therefore relays 1122, 1123, 1124, 520 and 1438 are connected in series. Relay 1438 operates in this circuit but the remaining relays do not, due to the high resistance included in the circuit. Relay 1438 closes an obvious circuit for relay 1439 which in turn closes an obvious circuit for relay 1440.

At the time relay 1434 operated in response to the recording of the first digit of the wanted number, it closed a circuit from bat-

tery through the lower winding of relay 1441, middle upper contact of relay 1434 to ground at the lower back contact of relay 1439. When relay 1439 operates as above described in response to the connection of the sender with the position, it closes a substitute circuit for relay 1441, over its lower alternate contact, to ground at the inner upper back contact of relay 412. Relay 1440 in operating closes a locking circuit for relay 1434 over the outer upper front contact of relay 1440 to ground at the inner lower contact of relay 1441. Relay 1441 supplies off-normal ground to conductors 1442, 1443 and 1444 for operations to be described hereinafter. Relay 1434 also provides a locking circuit for relay 1439 and operates relays 1501 and 1502 over the back contacts of relays 1510 and 1511 respectively. The connection of ground to conductor 1442 closes a circuit over the back contact of relay 413, resistance 414, contact of jack 419, lower winding of relay 401, contact of jack 419, resistance 418 to battery. Relay 401 operates extending ground from conductor 1442 to the windings of relays 402 and 403 in parallel and battery. This prepares a circuit for generating call indicator pulses by means of which the registers of the sender are to be positioned.

After one key in each of the first three rows, that is keys 302, 314, and 323 which correspond to the office code of the wanted number, have been operated, contacts 391, 392 and 393 will have been closed. If at this time the sender has been found, as indicated by the operation of relays 1438, 1439 and 1440, a circuit is closed from ground over the lower back contact of relay 411, middle lower back contact of relay 1512, contacts 391, 392 and 393 and thence over the third upper contact of relay 1439, outer upper contact of relay 412 to the winding of relay 1436 and battery and over the middle lower contact of relay 1440 to the winding of relay 413 and battery. The operation of these relays initiates the transmission of the code pulses as will be described. Relay 1436 in operating closes a holding circuit for itself which extends over the outer upper contact of relay 412, outer upper contact of relay 1436, to grounded conductor 1444, and relay 413 locks over its inner upper contact to conductor 1444.

The code pulses to be transmitted to the sender are arranged according to the code employed in the setting of relay call indicators at operators' positions. In the Roberts' patent above referred to, the pulses are transmitted by means of a sequence switch type impulser. In the present arrangement the pulses are generated by the action of relays. The operation of relay 136, following the depression of the key corresponding to the third digit of the office code, transfers the circuit of relays 1122, 1123 and 1124 from the wind-

ing of relay 1438 and ground to the upper and lower armatures of relay 402. From the armatures of relay 402 the pulsing circuit is extended to ground and battery in accordance with the operation of the keys of key set 300 and of the transfer relays. Relay 402 is alternately operated and released by relay 401 which operates intermittently with a period determined by the constants of condenser 422 and resistances 414 to 418.

It will be remembered that a circuit was closed by the operation of relay 1441 from grounded conductor 1442 over the upper back contact of relay 413, through resistance 414 and the contact of jack 419 to the lower winding of relay 401 and through resistances 416 and 415, condenser 422 and the contact of jack 419 to the upper winding of relay 401. Battery is connected through resistance 418 to point 423 where the two windings of relay 401 join. Therefore relay 401 is operated and condenser 422 charged by battery connected to its upper terminal. These circuits are maintained until relay 413 is operated. With relay 401 operated, relay 403 is also operated. When relay 413 is operated, as above described, it removes the steady ground from the winding of relay 401 and relay 401 starts to release. Since relay 403 is operated, as soon as relay 413 operates, a circuit is closed from grounded conductor 1442, upper front contact of relay 403, lower back contact of relay 1511, lower front contact of relay 413, to the point 423 in shunt of resistance 418 and battery. The operation of relay 413 has removed ground from the lower winding of relay 401 and therefore the circuit extending from battery through resistances 417 and 414 to the lower winding of relay 401 is effective to complete a circuit through that winding to ground on point 423 as above traced. Battery is also connected through resistances 417, 416 and 415 to condenser 422, which is connected in turn to the upper winding of relay 401 and thence to ground. Condenser 422 which was charged as above described by the connection of battery to its upper terminal and ground to its lower terminal during the time that relay 401 was operated under the control of relay 413, now discharges and is charged in the opposite direction. The discharge current opposes the current flowing through the lower winding and delays the release of relay 401. When the discharge is complete and the charging current starts to flow, the currents in the two windings assist each other and relay 401, which is polarized, is operated in a direction to close its back contact. The closure of the back contact of relay 401 opens the circuit of relay 403 and that relay releases as does relay 402 which is in parallel therewith. When relay 403 releases, it opens the connection of ground to point 423, and connects ground through resistances 416 and 415 to the lower terminal of

condenser 422 and thence to the upper winding of relay 401. The removal of ground from point 423 permits battery through resistance 418 to again become effective. Ground is also connected from conductor 1442 over the back contact of relay 403 and resistance 414 to the lower winding of relay 401. The circuits through the two windings of relay 401 have therefore been reversed. Once more condenser 422 is discharged and recharged in the opposite direction. As before, the discharge current opposes the current in the lower winding and the charging current assists it so that after an interval, relay 401 operates to close its front contact, reclosing the circuits of relays 402 and 403. This intermittent action continues until halted by the action of the control relays. Resistance 416, which is short-circuited when relays 401 and 403 release, alters the discharge and charge times of the condenser 422 to equalize the operated and released periods of relay 402.

Each time that relay 403 operates it closes a circuit for controlling the transfer relays. Ground is connected over conductor 1444, inner upper contact of relay 413 to the lower armature of relay 403. When relay 403 first operates this circuit extends over the upper normal contact and winding of relay 405, through resistance 424 to battery. Relay 405 operates and locks through its upper front contact to grounded conductor 1443. It also prepares a circuit for relay 404 through resistance 425 over the same contact, but relay 404 cannot operate being shunted by ground over the front contact of relay 403, connected over the lower back contact of relay 404 to resistance 425 in shunt of the winding of relay 404. When relay 403 releases the first time, relay 404 operates, in turn closing an obvious circuit for relay 406. Relay 406 closes a circuit from ground over its outer lower contact, normal contact and winding of relay 408, resistance 426 to battery. Relay 408 locks over its outer lower contact to conductor 1443 and closes a circuit from battery through resistance 427, winding of relay 407, outer lower front contact of relay 408 to conductor 1443, but relay 407 is prevented from operating by a branch of the operating circuit of relay 408, connected to resistance 427 in shunt of the winding of relay 407.

The second operation of relay 403 closes a circuit from ground as above traced over its lower front contact, lower front contact of relay 404 to resistance 424 in shunt of the winding of relay 405 which releases. Relay 404 is held operated over the normal contact of relay 405 to the front contact of relay 403. The second release of relay 403 permits relay 404 to also release in turn releasing relay 406. With relay 406 released, the shunt is removed from the winding of relay 407 and that relay

operates, in turn operating relay 409 in an obvious circuit.

The third operation of relay 403 again operates relay 405 and shunts relay 404, while the third release of relay 403 permits the operation of relay 404 which reoperates relay 406. Relay 406 connects ground over its lower front contact, inner lower front contact of relay 407 to resistance 426 in shunt of the winding of relay 408 which releases. Relay 407 is held operated over the normal contact of relay 408 to ground at the outer lower contact of relay 406.

The fourth operation of relay 403 again shunts and releases relay 405 holding relay 404, while the fourth release of relay 403 permits relay 404 to release in turn releasing relay 406. The release of relay 406 opens the holding circuit for relay 407 which also releases. All of these transfer relays have now been released and the cycle is repeated each four times that relay 403 is operated and released. Since a pulse is transmitted to the sender each time that relay 403 operates and each time that it releases the cycle is repeated each eight pulses.

Relay 408 controls the operation of the relays 1501 to 1516 which prepare the code pulsing circuits through the key set at the proper times. When relay 408 operates during the second pulse period a circuit is closed from ground over its inner lower front contact, lower back contact of relay 1510 to the winding of relay 1509 and battery. Relay 1509 operates and locks through the winding of relay 1510 to grounded conductor 1443 but relay 1510 cannot operate, being shunted by the operating circuit of relay 1509. When relay 408 releases during the sixth pulse, the shunt is removed from the winding of relay 1510 and that relay operates. When relay 408 reoperates during the tenth pulse the ground closed at its contact is extended over the lower front contact of relay 1510, inner lower back contact of relay 1512 to the winding of relay 1511 and battery. Relay 1511 operates and locks through the winding of relay 1512 to grounded conductor 1444, but relay 1512 is shunted and cannot operate. When relay 408 releases during the fourteenth pulse, relay 1512 operates. In a similar manner relay 1513 is operated during the eighteenth pulse and relay 1514 during the twenty-second pulse, relay 1515 during the twenty-sixth pulse, and relay 1516 during the thirtieth pulse. At the thirty-fourth pulse the circuit controlled by relay 408, extends over the front contacts of relays 1510, 1512, 1514 and 1516 to the normal contact and winding of relay 412.

When relay 1510 operates during the sixth pulse, relay 1501 is released and relay 1503 operated over the back contact of relay 1512. Relay 1511 during the tenth pulse releases relay 1502 and operates relay 1508. Relay

1512 during the fourteenth pulse releases relay 1503 and operates relay 1504. Relay 1513 during the eighteenth pulse releases relay 1508 and operates relay 1505. Relay 1514 during the twenty-second pulse releases relay 1504 and operates relay 1506. Relay 1515 during the twenty-sixth pulse releases relay 1505 and operates relay 1507 and relay 1516 during the thirtieth pulse releases relay 1506. It will be apparent that two of the cut-through relays 1501 to 1508 are operated at all times during pulsing so that the pulsing circuits are always prepared well in advance.

In accordance with the call indicator code, the pulses to be sent out are as follows:

C	2	Heavy Negative	Light Negative
H	4	Light Negative	Positive
E	3	Positive	Heavy Negative
	5	Light Negative	Heavy Negative
	6	Positive	Light Negative
	7	Heavy Negative	Heavy Negative
	8	Positive	Heavy Negative
	9	Light Negative	Positive

In the generation of the positive pulses ground is always connected to the ring conductor and battery is either connected to the tip conductor or is not according to the setting of the key set.

In the generation of negative pulses ground is connected to the tip conductor and battery through a high resistance to the ring conductor, while this resistance is or is not shunted by a low resistance according to the setting of the key set. Positive pulses are always transmitted with relay 402 operated and negative pulses with relay 402 released. The ground for the positive pulses is supplied over the inner lower contact of relay 1434, upper back contacts of relay 411, to the lower front contact of relay 402, while ground is supplied for the negative pulses over the inner lower front contact of relay 1434, outer upper back contact of relay 411 to the upper back contact of relay 402. The battery supply circuit for the first positive pulse extends over the upper front contact of relay 402, uppermost front contact of relay 413, inner upper back contacts of relays 404 and 408, conductor 1521, and the innermost armature of relay 1501 whence it extends to the contacts of keys corresponding to the first digit of the office code. The circuit for the second pulse which is the first negative pulse extends over the lower back contact of relay 402 and the middle upper front contact of relay 413 to battery through high resistance 428, and in parallel therewith over the outer lower front contact of relay 405, which was operated while relay 402 was operated during the first pulse, inner upper

back contact of relay 407, conductor 1522, to next to the inner armature of relay 1501. The circuit for the third pulse, which is the second positive pulse extends over the upper front contact of relay 402, outer upper front contact of relay 413, inner upper front contact of relay 404, which was operated during the second pulse, outer upper back contact of relay 407, to conductor 1523 and the next to the outer armature of relay 1501. The circuit for the fourth pulse which is the second negative pulse extends to battery through resistance 428, and over the lower back contact of relay 402, lower back contact of relay 405, which has now been released, outer upper front contact of relay 408 to conductor 1524 and the uppermost armature of relay 1501.

The contact of the innermost armature of relay 1501 may be extended over the contacts of keys 301, 303, 306 or 308 to battery through high resistance 396; the next to the innermost contact may be extended over contacts of keys 302, 303, 307 and 308 to battery through low resistance 397. Similarly the next to the upper contact of relay 1501 may be extended over the contacts of keys 304 and 309 to battery through resistance 396 and the upper contact of relay 1501 may be extended over the contacts of keys 305 to 309 inclusive to battery through resistance 397. Since we have assumed that key 302 was operated the only circuit completed over the contacts of relay 1501 is that over the next to the inner contact and the right contact of key 302. Consequently, during the four pulse period corresponding to the first digit the only pulses to be transmitted are a heavy negative pulse during the second period and a light negative pulse during the four period.

During the next four pulse period the front contact of relay 402 is extended in the first period over the upper contact of relay 413, back contact of relay 404, inner upper front contact of relay 408, to conductor 1531 and the innermost armature of relay 1502 and in the third period over the inner front contact of relay 404, upper front contact of relay 407, to conductor 1533 and the next to the upper armature of relay 1502. The back contact of relay 402 is extended in the second period over the lower front contact of relay 405, inner upper front contact of relay 407 to conductor 1532 and the next to the inner armature of relay 1502 and in the fourth period over the lower back contact of relay 405 and the outer upper back contact of relay 408 to conductor 1534 and the uppermost armature of relay 1502. As before the tip conductor may be extended to battery through high resistance 396 and the ring conductor to battery through low resistance 397 according to the setting of the keys in the row corresponding to the second office code digit. Since key 314 was operated, the

only circuit closed is that over the tip conductor to the next to the upper contact of relay 1502 so that the pulses transmitted corresponding to the second code digit will be a light negative, a positive and a second light negative. At the end of the eight pulses making up the first two digits, the transfer relays have been restored to normal and are ready to reoperate.

The next four pulses to be sent are therefore determined over conductors 1521 to 1524. It will be remembered however, that at the sixth pulse relay 1510 was operated releasing relay 1501 and operating relay 1503. Therefore the next four pulses are controlled over the contacts of relay 1503 and the strip of keys corresponding to the third code digit. At the tenth pulse relay 1511 is operated opening the connection between the front contact of relay 403 and point 423. During the eleventh pulse, however, relay 406 is operated and a substitute circuit is closed over the front contact of relay 403, over the inner lower contact of relay 406, lower contact of relay 413 to point 423. The twelfth pulse does not employ this circuit and at the thirteenth pulse, relay 406 is released so that if the key set has not been completely operated or the start key 385 operated, the pulses will cease and wait for the operation of a key in the last row.

A circuit is also closed at this time from grounded conductor 1442 over the lower back contact of relay 410, outer lower front contact of relay 1511, upper back contact of relay 406 to resistance 414 and the lower winding of relay 401 in parallel with the circuit normally closed over the back contact of relay 403 to hold relays 401, 402, and 403 operated. When the key in the last row has been operated, contact 394 is closed and a circuit is completed from battery through the winding of relay 410, inner upper front contact of relay 1436, contact 394, middle lower back contact of relay 1512 to ground at the lower back contact of relay 411. Relay 410 locks over its inner upper front contact to grounded conductor 1444. It also closes at its lowermost front contact a substitute path for that over the lower back contact of relay 1511 so that the upper front contact of relay 403 again becomes effective. If, as is usually the case, the key in the last row is operated before the first three digits have been transmitted there will be no interruption of the transmission at this point. If the key in the last row is operated before the sender has been found, a circuit is closed from battery through lamp 1448, over the upper back contact of relay 1440 to the contact 394 and thence to ground as above traced to inform the operator that a sender has not as yet been connected with her position.

When the thirtieth pulse is reached, relay 1516 is operated in turn operating relay 411.

With relay 411 operated the ground for the first negative pulse of the last digit is supplied over the inner lower front contact of relay 1434, middle upper front contact of relay 404, upper front contact of relay 409 to the upper back contact of relay 402. For the last positive pulse ground is supplied over the inner lower front contact of relay 1434, upper front contact of relay 406, lower front contact of relay 402. For the last negative pulse ground is supplied to the upper back contact of relay 402, over the inner upper back contact of relay 405 and the inner lower front contact of relay 1434.

The thirty-third pulse period is blank to allow time for the sender to prepare to receive the heavy positive pulse. At the thirty-fourth pulse period a negative pulse would normally be transmitted. However, the tip conductor is extended over the upper back contact of relay 402, upper front contact of relay 411, upper back contact of relay 409, low resistance 429 to battery, and the ring conductor extends over the lower back contact of relay 402, outer lower front contact of relay 405, inner upper back contact of relay 407, middle lower front contact of relay 1516 to ground at the lower front contact of relay 411. This heavy positive pulse is a signal to both the link and the sender that pulsing has been completed.

When relay 1504 operates for the transmission of the first numerical digit a circuit is closed from ground at the outer lower back contact of relay 1514, lower front contact of relay 1504, conductor 1520, winding of relay 1445 to battery. Relay 1445 closes circuits for release magnets 310, 320, and 330 which release the office code keys. When relay 1514 operates, the circuit of relay 1445 is opened and the magnets deenergize, ample time having been allowed to unlock and release the keys. During the blank interval prior to the transmission of the heavy positive pulse, a circuit is closed from battery through the winding of relay 1446, inner upper front contact of relay 411, inner lower front contact of relay 405, lower back contact of relay 409 to grounded conductor 1443. Relay 1446 locks over its inner lower contact, inner lower contact of relay 1440, lower back contact of relay 409 to grounded conductor 1443. Relay 1446 also closes a locking circuit for off-normal relay 1441. Relay 1446 in addition closes circuits for operating release magnets 340 to 390, thus completing the release of the key set.

It will be remembered that relay 412 operates when relay 408 operates following the operation of relay 1516. Relay 412 locks to ground at the lower front contact of relay 411 and removes the operating ground from relay 1441. Relays 408 and 412 also close a holding circuit for relay 1446 over the inner lower front contact of relay 408, outer lower

front contact of relay 412, inner lower front contact of relay 1440, inner lower front contact of relay 1446, in substitute for the locking circuit over the lower back contact of relay 409 which is operated when relay 407 operates. When relay 408 releases the locking circuit of relay 1446 is opened and that relay releases, in turn releasing relay 1441 which removes ground from conductors 1442, 1443 and 1444 thus releasing all of the pulsing, transfer and chain relays which were controlled from off-normal ground.

The operation of relay 410 in response to the depression of a start key following the recording of the wanted number on the key set is effective, provided the sender has been found as indicated by the operation of relay 1407 to shunt the high resistance lower winding of relay 1415, thus connecting a medium resistance ground to conductor 1410 and therefore to the windings of relays 515, 518 and 517. The winding of relay 515 was short-circuited over the lower left contact of cam 730 when sequence switch 700 reached position 4¾. Therefore, relay 517 is now able to operate and lock over its inner upper front contact to ground at the upper right contact of cam 703. It also connects this same ground over its outer upper front contact to the winding of relay 516 and battery. Relay 516 disconnects conductor 1410 from the windings of relays 517 and 518. It also disconnects the tip and ring talking conductors from the operator's position and connects them through the two windings of relay 521 to ground and battery respectively, holding the connection. The connection over conductor 1409 was severed in the link circuit as soon as sequence switch 700 reached position 4. Therefore all of the conductors connecting the operator's position with the link circuit are opened except those actually employed in transmitting pulses to the sender. The disconnection of the talking tip and ring conductors opens the circuit of relay 1418 which in turn releases relay 1419. Relay 1419 opens the holding circuit of relay 1416 and the opening of the circuit of relay 1415 opens the operating circuit of relay 1416 so that relay 1416 also releases. Relay 1416 also opens the locking circuit of relay 1407 which now releases since its operating circuit was opened when relay 410 operated. The release of relay 1407 restores the connection of battery through resistance 1422 to conductor 1409, marking the position selectable to other link circuits. Relay 516 in operating opens the circuit of relay 522 but relay 521, operating over the calling end of the connection, provides a substitute circuit for relay 522 preventing release at this time.

Returning to the sender, relay 1122 is polarized to respond to negative impulses. Relay 1123 is polarized to respond to positive impulses and relay 1124 is marginal so

that it responds to heavy impulses of either sort received over the impulsing circuit above traced.

The first code impulse, which, as shown above, is a heavy negative impulse, causes the operation of relays 1122 and 1124. Relay 1122 in operating connects ground from conductor 909 over its front contact, normal contact and winding of relay 1132, resistance 1133 to battery. Relay 1132 operates and locks to conductor 909 over its lower alternate contact. It also closes a circuit from battery through resistance 1135, winding of relay 1134, alternate contact of relay 1132 to conductor 909 to prepare the operation of relay 1134. Relay 1134 is prevented from operating at this time since ground is connected over the contact of relay 1122 and the back contact of relay 1134 to resistance 1135 in shunt of the winding of relay 1134. Relay 1124, in operating, connects ground from conductor 909 over its front contact, outer lower back contact of relay 1134, outer lower back contact of relay 1107, to the upper winding of relay 1102 of the tandem hundreds register 1100 and battery. Relay 1102 locks through its lower winding to grounded conductor 1231. When the pulse terminates relays 1122 and 1124 release. Relay 1122 removes the shunt from around the winding of relay 1134 which now operates. With relay 1134 operated a circuit is closed from battery through the winding of relay 1107, upper back contact of relay 1106, upper front contact of relay 1134 to grounded conductor 909. Relay 1107 locks through the winding of relay 1106, inner upper front contact of relay 1107 to grounded conductor 1127. Relay 1106 is shunted by the operating ground of relay 1107 until relay 1134 releases. The next pulse received is a light negative pulse and therefore relay 1122 operates alone. It closes a circuit from ground over conductor 909, front contact of relay 1122, lower front contact of relay 1134 to resistance 1133 in shunt of the winding of relay 1132 which now releases. The first lower contact of relay 1132 is a make before break contact so that relay 1134 is held operated over the normal contact of relay 1132 and the front contact of relay 1122 to conductor 909 until the pulse terminates, at which time relay 1134 also releases. When relay 1134 releases, relay 1106 operates in the locking circuit of relay 1107. Relays 1107 and 1106 transfer the circuits controlled by relays 1122, 1123, 1124 to the tandem tens register 1110. It will be apparent that only relay 1102 is operated in the tandem hundreds register 1100.

During the reception of the first pulse of the next digit relay 1122 is operated alone as described and in turn operates relay 1132. At the end of the pulse, relay 1134 is also operated closing a circuit from battery through the winding of relay 1117, upper

back contact of relay 1116, upper front contact of relay 1106 to grounded conductor 909 over the front contact of relay 1134. The second pulse of this digit is a positive pulse causing the operation of relay 1123. Relay 1123 closes a circuit from ground over its front contact, middle lower front contact of relay 1132, inner lower front contact of relay 1106, inner lower back contact of relay 1116 to the upper winding of relay 1113 and battery. Relay 1113 locks through its lower winding to grounded conductor 1231. The third pulse of the digit causes the operation of relay 1122 which releases relays 1132 and 1134 as previously described, and permits the operation of relay 1116 in the locking circuit of relay 1117. Relay 1113 alone of the tandem tens register 1110 is operated.

In a similar manner relays 1122, 1123 and 1124 are operated in response to the pulses transmitted over the pulsing circuit from the operator's position, operating the transfer relays 1206, 1207, 1216, 1217 etc. in turn and operating register relays 1201 and 1202 of the tandem units register, relay 1214 of the stations register, relays 1221 and 1222 of the thousands register, relays 1302 and 1304 of the hundreds register, relays 1311, 1312 and 1314 of the tens register and relays 1323 and 1324 of the units register.

Relays 1326 and 1327 operate in a slightly different manner from the other transfer relays. The operation of relay 1134 during the transmission of the units digit closes a circuit from battery through the winding of relay 1327 and its normal contact, upper front contacts of relays 1316, 1306, 1226, 1216, 1206, 1116 and 1106, upper contact of relay 1134 to grounded conductor 909. Relay 1327 locks over its lower alternate contact to grounded conductor 1128. It also prepares a circuit from battery through the winding of relay 1326, outer upper contact of relay 1327, to the upper back contact of relay 1132, back contact of relay 1122, and grounded conductor 909. This circuit is not completed until relay 1122 releases the second time at the completion of the digit. Relay 1326 now operating locks to grounded conductor 909. With relays 1326 and 1327 operated, the connection of the tip and ring conductors to relay 1122 is altered to render that relay responsive to the final heavy positive pulse. This altered circuit may be traced from brush 623 to conductor 1121 as before and thence over the inner lower front contact of relay 1326 and the winding of relay 1122 in parallel with resistance 1330, over the outer lower front contact of relay 1326 to conductor 1332 and back to brush 624 as previously traced. The resistance of the pulsing circuit is thus materially decreased while the connection of relay 1122 therein is reversed. Relay 1122 now operates in response to the final positive pulse causing the

operation of relay 1132 which prepares a circuit for relay 1134 as before. When relay 1122 releases, relay 1134 operates. At this time the operation of relay 1134 closes a circuit from grounded conductor 909, upper front contact of relay 1134, outer lower front contact of relay 1132, inner upper front contact of relay 1327, outer upper front contact of relay 1326 to the winding of relay 1120 and battery.

When relay 1327 operated a circuit was closed from battery through the winding of relay 1137, inner back contact of relay 1120, outer lower front contact of relay 1327, to grounded conductor 909. Relay 1137 is released when relay 1120 operates and two circuits are momentarily closed due to the contact arrangement of relays 1137 and 1120, one from battery through resistance 1138, inner upper front contact of relay 1137, next to the inner upper front contact of relay 1120 to the tip conductor and from ground over the upper front contact of relay 1137, outer lower contact of relay 920, next to the outer upper front contact of relay 1120 to the ring conductor charging the interoffice trunk to prevent the false operation of relay 914 due to the capacity of the trunk if the trunk is opened at this time. When relay 1137 completely releases the ring conductor is extended over its upper back contact to resistance 1139 and ground. The tip conductor is extended over next to the inner upper front contact of relay 1120, inner upper back contact of relay 1137 to the winding of relay 914 and battery. Relay 914 is employed to hold the connection between the sender and the district selector and also to prepare circuits for releasing the sender if the call is abandoned.

When relay 1207 operates it connects battery over conductor 2206, which received it from a source, not shown, to conductor 1239 to provide battery for the operation of a decoder relay. When relay 1206 operates indicating that the office code has been completely registered, battery is connected from conductor 2206, over the outer upper front contact of relay 1206, lower back contact of relay 1140, inner upper back contact of relay 1141, lower back contact of relay 1142 to conductor 1143 which is the start conductor for the decoder connector. These relays therefore initiate the operation of the decoder and the function of the sender in controlling the establishment of a connection.

The final positive pulse which indirectly causes the operation of relay 1120 is of sufficient strength and in the proper direction to operate relay 520 of the link circuit. Relay 520 closes a circuit from battery through the lower winding of relay 513, front contact of relay 520, lower right contact of cam 702 to ground. Relay 513 locks over its inner lower contact to ground at the lower right contact of cam 703. At the end of the pulse,

relay 520 releases and closes a circuit from battery through the winding of relay 508, outer lower contact of relay 510, back contact of magnet 507, upper front contact of relay 513, back contact of relay 520 to ground at the lower right contact of cam 702. Relay 508 closes a link in the circuit of magnet 507 but this circuit is opened at the contact of cam 718 so that the magnet is not operated. However, relay 508 does close a circuit from battery through the lower winding of relay 511, inner lower contact of relay 508 to ground at the lower right contact of cam 702. Relay 511 connects the incoming tip conductor 228 over brush 620, outer upper back contact of relay 606, outer upper front contact of relay 511, upper contacts of cam 722 to brush 623 whence it extends as previously traced to the winding of relay 914, and connects the incoming ring conductor 227 over brush 621, right contacts of cam 713, outer lower back contact of relay 606, lower front contact of relay 511, upper contacts of cam 723 to brush 624, whence it extends to ground through retardation coil 1139. The operation of relay 511 at the same time disconnects the pulsing conductors 1412 and 1411 from the sender and renders the position free to complete other calls.

Relay 511 also closes a circuit from battery through the winding of relay 512, inner upper front contact of relay 511, upper right contact of cam 703 to ground. The operation of relay 512 disconnects relay 521 from the district tip and ring conductors and opens the circuit of relay 519 which was operated over cam 703, when sequence switch 700 reached position 5. During the interval between the operation of relay 511 and the release of relay 519, the tip and ring conductors leading to the sender are connected together over the middle upper front contact of relay 511 and the front contact of relay 519 to insure the operation of relays 914 and 910 and prepare the sender to respond to a disconnect or reorder condition.

For a complete description of the operation and release of the sender in establishing connections to different offices, for the setting and release of the district selector and the release of the link circuit, reference may be had to the above-identified Roberts patent.

If the wanted number is one which does not include a party letter, key 385 is operated in the last row to close contact 394 and initiate the transmission of the numerical designation. Since key 385 closes no circuit over the contacts of relay 1508, two light negative pulses corresponding to the digit zero will be transmitted in place of the stations digit which is normally the fourth digit to be transmitted. If an operator's code of three digits such as used for the long distance operator, etc., is to be transmitted, the three code digit keys are depressed and then

key 385. In this case all the numerical digits will be zeros since none of the numerical keys were operated. However, it is necessary to transmit the full number of digits so that the sender may properly handle the heavy positive pulse which is necessary for the release of the link circuit.

When relay 412 operates, it releases relay 1436 which disconnects conductors 1412 and 1411 from the pulsing circuit and reconnects them to ground and the winding of relay 1438. If the relay 511 does not operate, disconnecting these conductors from the sender, relay 1438 will reoperate either over the loop at the sender or from ground through retardation coil 1139. Relay 1438 will hold relay 1439 operated after relay 1434 releases, following the release of relay 1441. The continued operation of relay 1439 holds relay 1440 operated and relays 1513 to 1516 remain locked to ground at the inner upper contact of relay 1440. With relay 1516 operated, relay 411 is also held operated.

It will be remembered that the circuits over conductors 1414, 1413 and 1410 were opened in the link circuit as soon as a key in the last row was operated, while the circuit over conductor 1409 was opened in the link circuit as soon as the sequence switch left position 3. The incoming part of the operator's circuit is therefore freed from the link circuit over which the sender is receiving pulses. As soon as the conductors 1413 and 1414 are opened, relays 1418, 1419 and 1416 release and the indication that the position is idle and occupied is given to the link circuits, by the reconnection of battery through resistance 1422 to conductor 1409 and thence in multiple to the corresponding terminals of brushes like brush 506 of other link circuits. If any of these other link circuits is now hunting for an operator's position, it may seize this operator's position and extend the incoming talking conductors to the operator's head set in the manner above described. Since the keys do not unlock until after the digits corresponding thereto have been transmitted, she may write the wanted number up on her key set as soon as the keys are ready to receive it. As described above, to prevent interference between the two link circuits which are thus connected to the same operator's position, relay 411 is held operated so that the second link can not receive the signal from the operator to hunt for a sender until after the pulsing conductors 1412 and 1411 have been disconnected from the position by the first link.

When for any reason the operator can not complete a call after it has been extended to her position, she can transmit a reorder signal to the originating operator by operating the reorder key 1540. This key, in addition to operating a message register over its inner contact, connects ground over its outer con-

tact to the winding of relay 1447. If no key has been depressed, relay 1447 operates locking over its inner lower contact to ground at the front contact of relay 1416. Relay 1447 closes a holding circuit for relay 1407, to prevent the position from becoming reselectable prematurely. It also connects ground to the upper winding of relay 1415 and thence to the windings of relays 515, 518 and 517. These relays operate and lock, relays 515 and 517 directly to ground at the upper right contact of cam 703 and relay 518 over the back contact of relay 512 to ground at the upper left contact of cam 702. The operation of relay 515 opens the circuit of relay 611 which releases and advances sequence switch 700 to position 4.

In position 4, with relay 515 operated, ground is connected over the upper right contact of cam 702, contact of relay 515, resistance 731 to the upper right contact of cam 721, in parallel with ground through resistance 729 which is connected over the lower left contact of cam 721 and thence as previously described to conductor 221 and the windings of relays 208 and 229. Relay 208 is held operated, while the decrease in resistance permits relay 229 to operate. Ground is also connected over the upper left contact of cam 702, winding of relay 521, upper front contact of relay 515, right contacts of cam 713 to brush 621, conductor 227, and the outer left armature of relay 229. Relay 229 in operating, locks over its outer right contact to ground at the lower contacts of cam 205 and extends conductor 227 over its outer left front contact to the upper winding of relay 226, which operates and locks under the control of relay 204. The operation of relay 229 opens one holding circuit for relay 201. It also extends its locking ground over its two right contacts, lower right contact of cam 216 to the winding of sequence switch magnet 206 and battery, advancing the district selector sequence switch to position 5. Since relay 212 is not operated at this time sequence switch 206 is immediately advanced to position 6 over the back contact of relay 212. The district selector 200 is still in its normal position, therefore a circuit is closed for sequence switch magnet 206 over the upper right contact of cam 216, normal commutator segment 248, brush 239, upper contacts of cam 217 to ground, advancing the sequence switch to position 9. Relay 212 is still unoperated and advances the sequence switch to position 10, from which position the normal commutator segment advances it to position 14.

If the connection is still maintained by the originating operator, as would probably be the case where the reorder key is used, the operation of relay 226 provides a circuit for relay 201 over the front contact of relay 207, inner upper back contact of relay 244, through the upper left winding of repeating coil 242, upper front contact of relay 226, left contacts of cam 225 to the tip conductor, and from ground through the left winding of relay 201, over the lower back contact of relay 244, lower left winding of repeating coil 242, outer lower front contact of relay 226, left contacts of cam 224 to the ring conductor, holding relay 201 operated and thus maintaining the circuits of relays 204 and 207. In position 16 therefore, ground is connected over the right contacts of cam 205, left front contact of relay 201, normal contact of relay 244, interrupter 253, lower left contact of cam 250, upper right contact of cam 222 to the winding of relay 244 and over the upper left contact of cam 222 to the winding of relay 223. These relays operate and release following the interrupter. Thereby relay 244 causes reversals of the connection of battery to the incoming trunk which are translated into the proper signals to give a reorder signal to the originating operator. Relay 223 connects battery over the upper left and lower right contacts of cam 245 to the right winding of relay 201, holding that relay operated during the time that relay 244 is changing its contacts. The originating operator in response to this signal will remove the plug from the outgoing end of this trunk and proceed to set up the call over another trunk. The release of relay 201 in turn releases relays 204, 207 and 226. When relay 207 releases an interrupted disconnect tone is connected over interrupter 255, the back contacts of relay 207 and cams 224 and 225 to the trunk to warn any other operator that the district selector is not ready for use. A circuit is also closed through the winding of sequence switch magnet 206, lower left and upper right contacts of cam 254, right back contact of relay 207, left back contact of relay 212 to ground, advancing the sequence switch to position 18 in which position the disconnect tone is removed and the normal commutator segment 248 is again effective to advance the sequence switch to its normal position which is position 1.

In the link, the operation of relay 515 also closes a circuit from battery through the winding of relay 606, two inner lower contacts of relay 515 to ground over the upper right contact of cam 702. It also closes a circuit through the lower winding of relay 511 and through the winding of relay 514 over the two outer lower contacts of relay 515 to ground over the upper right contact of cam 703. Relay 517 connects ground from the upper right contact of cam 703 over its outer upper front contact to the winding of relay 516. Relay 516 opens the tip and ring talking conductors and the circuit of conductor 1410. Relay 606 locks over its outer lower front contact to ground over the upper right contact of cam 704. The operation of

relay 606 opens the circuit of the sender selector updrive magnet 614. It also closes a circuit over its lower front contacts, and the lower left contact of cam 717 to the winding of sequence switch magnet 700, advancing the sequence switch to position 8. In position 8 it closes a circuit from battery through the winding of downdrive magnet 633 of the district finder, lower right and upper left contacts of cam 725, to ground over its lower contacts. Relay 511 in operating opens the pulsing conductors between the position and the sender and operates relay 512. The opening of the talking conductors and conductor 1410 releases relays 1418 and 1415 in the position circuit permitting the restoration of the position to normal.

Relay 514 opens the test and control leads and the fundamental circuit for controlling selection. When the district finder reaches normal, ground is connected over the upper right contact of cam 704, brush 634, normal commutator segment 635, upper contacts of cam 728, winding of magnet 700 to battery, advancing the link sequence switch to position 9 which is its normal idle position until such time as it is allotted for use.

If the reorder key is depressed after the link circuit has been advanced to position 4 to hunt for a sender but before the sender has been found, relay 1447 will be operated and locked as above described. Relay 1433 is also operated over the upper front contact of relay 1447 to ground at the middle upper back contact of relay 410. Relay 1433 closes a circuit from battery through the winding of relay 1445, lower front contact of relay 1433, to ground at the outer upper back contact of relay 410. Relay 1445 operates the release magnets 310, 320 and 330 restoring the office code keys. It also closes a circuit from battery through the winding of relay 1446, outer lower front contact of relay 1445, lower back contact of relay 1512, inner upper contact of relay 1433 to ground. Relay 1446 operates magnets 340, 350, 360, 370, 380 and 390 restoring the remainder of the key set to normal. Relay 1433 was also operated in the previously described case but, since no keys had been operated, was ineffective and the operation was not described. Relay 1447 connects ground to the upper winding of relay 1415 as previously described. The link and district selectors function in the same way as above described except that the operation of relay 606 opens the circuit of updrive magnet 614 and brings the sender selector to rest. This selector remains in the position last used until driven from that position in response to the next call.

If the reorder key is depressed after the sender is found and before the start key has been operated, the release magnets are so arranged that the common contacts 391 to

394 momentarily close before they are opened by the release of the key so that pulsing is begun in the manner described in the completion of a regular call. This is necessary to advance the link since it depends on the operation of relay 520 in response to the heavy positive pulse. Any digits which have not been transmitted at the time the reorder becomes effective will be transmitted as zeros since when the keys release no paths are closed for positive pulses or for heavy negative pulses. The light negative pulses through resistance 428 continue to go out until relay 412 operates for the final positive pulse. In positions 5 and 6 of the link circuit, into which positions the link moves after the sender has been found, the connection of ground to the upper winding of relay 1415 in response to the operation of the reorder key, causes the operation of relays 517, and 518 only, since the winding of relay 515 is shunted over the lower contacts of cam 730. Relay 517 operates, locks and operates relay 516 which functions as above described to open the talking and control conductors toward the position and connects ground through the winding of relay 521 to conductor 207. Relay 518 locks under the control of relay 512 and connects ground to conductor 221. It also disconnects conductor 919 from conductor 221 and connects battery through resistance 523 to conductor 919 to prevent the release of the sender. Relay 521 operates and connects ground over the upper left contact of cam 702, over its outer lower contact, to resistance 524 in shunt of the locking winding of relay 518 which now releases restoring the connection between conductors 919 and 221. When the heavy positive pulse is received, relay 520 operates and functions as described in the course of a normal call. If the district selections have not started, the district selector functions as though the sender had not been found. If selections have started the momentary connection of the tip and ring conductors together under the control of relays 511 and 519 signals the sender, which then functions to send either the district selector or some subsequent selector to the top of its bank, or tell-tale, in which position reverse battery is transmitted to the sender, and the sender responds to this reversed battery in the same way that it responds to reversed battery from the incoming selector, causing the release of the sender and link in the usual manner and the advance of the district selector to position 13. Since relay 229 is operated, sequence switch 206 is advanced out of position 13 through the lower right contact of cam 216 and advances to position 16 in which the reorder signal is transmitted to the originating operator in the manner previously described.

If the originating operator abandons the

call while connected with the tandem operator's position, the talking circuit is opened and relay 1418 releases, in turn releasing relay 1419. With relay 1419 released a circuit is closed from ground over the back contact of relay 1419, outer upper front contact of relay 1421, which is locked to the back contact of relay 410 until a key in the last row has been operated, winding of relay 1447 to battery. The operation of relay 1447 transmits the reorder signal and releases the connection in the same manner as though it were operated by the reorder key.

Similarly a reorder signal is automatically given when the tandem operator vacates her position, while a call is connected thereto since the release of relay 1405 provides a ground for the above traced circuit of relay 1447 in place of that at the back contact of relay 1419 or the reorder key.

What is claimed is:

1. In a telephone exchange system, an operator's position, a register sender, means to associate said sender with said position, a key set at said position comprising a row of keys for each digit of an office designation and a row of keys for each digit of a numerical designation, means for generating impulses differing in strength and polarity, means for transmitting said impulses to said sender and means effective following the operation of a key in each row of said office keys to start the transmission of said office digits prior to the registration of said numerical designation.

2. In a telephone exchange system, an operator's position, a register sender, means to associate said sender with said position, a key set at said position comprising a row of keys for each digit of an office designation and a row of keys for each digit of a numerical designation, means for generating impulses differing in strength and polarity, means for transmitting said impulses to said sender, means effective following the operation of a key in each row of said office keys to start the transmission of said office digits, and means for arresting the transmission of impulses following the transmission of the office digits provided a key in the last row of said numerical keys has not been operated.

3. In a telephone exchange system, an operator's position, a register sender, means to associate said sender with said position, a key set at said position comprising a row of keys for each digit of an office designation and a row of keys for each digit of a numerical designation, means for generating impulses differing in strength and polarity, means for transmitting said impulses to said sender, means effective following the operation of a key in each row of said office keys to start the transmission of said office digits, and means for arresting the transmission of

impulses following the transmission of the office digits provided the keys corresponding to all of the numerical digits have not been operated.

4. In a telephone exchange system, an operator's position, a register sender, means to associate said sender with said position, a key set at said position comprising a row of keys for each digit of an office designation and a row of keys for each digit of a numerical designation, the keys in one row of said key set acting as start keys, means for generating impulses differing in strength and polarity, means for transmitting said impulses to said sender, means effective following the operation of a key in each row of said office keys to start the transmission of said office digits and means for arresting the transmission of impulses following the transmission of the office digits providing a start key has not been operated.

5. In a telephone exchange system, an operator's position, a register sender, means to associate said sender with said position, a key set at said position comprising a row of keys for each digit of an office designation and a row of keys for each digit of a numerical designation, means for generating impulses differing in strength and polarity, means for transmitting said impulses to said sender, means effective following the operation of a key in each row of said office keys to start the transmission of said office digits, means for arresting the transmission of impulses following the transmission of the office digits providing the keys corresponding to all of the numerical digits have not been operated and means for restarting the transmission responsive to the operation of a key in the last row of said numerical keys.

6. In a telephone exchange system, an operator's position, a register sender, means to associate said sender with said position, a key set at said position comprising a row of keys for each digit of an office designation and a row of keys for each digit of a numerical designation, the keys of one row of said key set acting as start keys, means for generating impulses differing in strength and polarity, means for transmitting said impulses to said sender, means effective following the operation of a key in each row of said office keys to start the transmission of said office digits, means for arresting the transmission of impulses following the transmission of the office digits provided a start key has not been operated, and means for restarting the transmission responsive to the operation of one of said start keys.

7. In a telephone exchange system, an operator's position, a plurality of register senders, a link circuit for associating said position with an idle one of said senders, a key set at said position comprising a row of keys for each digit of a telephone designa-

tion and means to start said link circuit hunting for an idle sender responsive to the depression of a key in the first row of said key set.

8. In a telephone exchange system, an operator's position, a plurality of register senders, a link circuit for associating said position with an idle one of said senders, a key set at said position for recording wanted line numbers, and means to start said link circuit hunting for an idle sender responsive to recording the first digit of a wanted number.

9. In a telephone system, a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch, position and sender, a key set at said position comprising a row of keys for each digit of telephonic designations and means in said link circuit responsive to the complete setting of said key set to disconnect said position from said selector switch while maintaining the connection between said position and said sender.

10. In a telephone system, a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch, position and sender, a key set at said position comprising a row of keys for each digit of telephonic designations, means responsive to recording the first digit of a wanted number to cause said link circuits to start hunting for an idle sender, and means responsive to the operation of a key in the last row of said key set to disconnect said position from said selector switch without disconnecting said position from said sender.

11. In a telephone system, a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch, position and sender, a key set at said position comprising a row of keys for each digit of telephonic designations, means in said link circuit responsive to the complete setting of said key set to disconnect said position from said selector switch, and means to then render said position selectable by another link circuit prior to the disconnection of said position from said first link circuit.

12. In a telephone system, a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch, position and sender, a key set at said position comprising a row of keys for each digit of telephonic designations, means in said link circuit responsive to the complete setting of said key set to disconnect said position from said selector switch, and means to render the position selectable by another link circuit while maintaining the connection between the said position and said sender.

13. In a telephone exchange system, an operator's position, a register sender, means for associating said sender with said position, a key set at said position comprising a

row of self-locking keys for each digit of an office designation and a row of self-locking keys for each digit of a numerical designation, means for generating impulses differing in strength and polarity, means for transmitting said impulses to said sender, means effective following the operation of a key in each row of said office keys for starting the transmission of said office digits, and means to unlock said office keys following the transmission of the office digits and the operation of a key in the last row of said numerical keys.

14. In a telephone exchange system, an operator's position, a register sender, means for associating said sender with said position, a key set at said position comprising a row of self-locking keys for each digit of an office designation and a row of self-locking keys for each digit of a numerical designation, means for generating impulses differing in strength and polarity, means for transmitting said impulses to said sender, means effective following the operation of a key in each row of said office keys for starting the transmission of said office digits, other means effective following the operation of a key in each row of said numerical keys to start the transmission of said numerical digits, and means to automatically unlock said office keys during the transmission of the first numerical digit.

15. In a telephone system, a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch, position and sender, a key set at said position comprising a row of keys for each digit of telephonic designations, impulsing means under the control of said key set for transmitting telephonic designations to said sender, means in said link circuit responsive to the complete setting of said key set to render said position selectable by another link circuit, means to associate a second link circuit with said position, and means to transmit a tone over said second link circuit at the same time that impulses are being transmitted over said second link circuit.

16. In a telephone system, a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch, position and sender, a key set at said position comprising a row of keys for each digit of telephonic designations, means in said link circuit responsive to the complete setting of said key set to disconnect said position from said selector switch, means to associate a second link circuit with said position, and means to delay the association of a sender with said second link circuit until said first link circuit has been disconnected from said position.

17. In a telephone system, a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch and said position, a key set at said

position comprising a row of keys for each digit of telephonic designations, the keys of one row of said key set acting as start keys, means responsive to the operation of a key in the first row of said key set to cause the link circuit to associate a sender with said position, means to render said position selectable by another link circuit as soon as a start key has been operated, means to associate a second link circuit with said position and means to render the operation of a key in the first row of said key set ineffective to cause the second link circuit to hunt for a sender.

18. In a telephone system, a selector switch, a plurality of operators' positions, a plurality of register senders, a link circuit, means responsive to the seizure of said selector switch to cause said link circuit to find said selector switch and an idle one of said positions, a key set at said position comprising a row of keys for each digit of telephonic designations, means responsive to the depression of a key in the first row of said key set to cause said link circuit to find an idle sender, means responsive to the depression of a key in the last row of said key set to render said position selectable by another link circuit, means to associate a second link circuit with said position, and means to render the depression of a key in the first row of said key set ineffective to cause the second link circuit to hunt for a sender.

19. In a telephone system, a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch and said position, a key set at said position comprising a row of self-locking keys for each digit of the office code and a row of self-locking keys for each digit of the numerical designation of telephonic designations, means responsive to the depression of a key in the first row of said key set to cause the link circuit to hunt for an idle sender, means responsive to the finding of a sender and the depression of a key in each row of said office designation keys to initiate the transmission of said office code digits to said sender, means responsive to the depression of a key in the last row of said numerical keys to start the transmission of said numerical digits and to render said position selectable to another link circuit, means to associate a second link circuit with said position, means effective during the transmission of the first numerical digit to unlock said office digit keys whereby the operator can record the office code digits of a second number, and means effective as long as said first link is associated with said position to render the depression of a key in said first row ineffective to cause the second link circuit to hunt for a sender.

20. In a telephone system a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch, position and sender, a key set at said

position comprising a row of keys for each digit of telephonic designations, means for generating impulses differing in strength and polarity, means for establishing a pulsing circuit between said position and said sender for transmitting said impulses to said sender, means to render said position selectable by another link circuit as soon as the numerical keys have been completely operated, means effective following the complete transmission of a designation for opening said pulsing circuit, means to associate a second link circuit with said position, and means to prevent hunting for a sender by said second link circuit if said first link circuit fails to open said pulsing circuit.

21. In a telephone system, a trunk circuit terminating in a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch, position and sender, a key set at said position comprising a row of self-locking keys for each digit of telephonic designations, means to transmit said designations to said sender, means responsive to the complete transmission of said designations to disconnect said position from said link circuit, releasing means effective prior to the complete transmission of said designation to unlock said key set and to break down the connection between said link, selector switch, position and sender, and operator controlled means for operating said releasing means.

22. In a telephone system, a trunk circuit terminating in a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch, position and sender, a key set at said position comprising a row of self-locking keys for each digit of telephonic designations, means to transmit said designations to said sender, means responsive to the complete transmission of said designations to disconnect said position from said link circuit, releasing means effective prior to the complete transmission of said designation to unlock said key set and to break down the connection between said link, selector switch, position and sender, operator controlled means for operating said releasing means, and means in said selector switch under the control of said releasing means for transmitting a signal over said trunk circuit.

23. In a telephone system, a trunk circuit terminating in a selector switch, an operator's position, a register sender, a link circuit for interconnecting said selector switch, position and sender, a key set at said position comprising a row of self-locking keys for each digit of telephonic designations, means to transmit said designations to said sender, means responsive to the complete transmission of said designations to disconnect said position from said link circuit, releasing means effective prior to the complete transmis-

sion of said designation to unlock said key set and to break down the connection between said link, selector switch, position and sender, operator controlled means for operating said releasing means, and means to automatically operate said releasing means responsive to the opening of said trunk circuit at the outgoing end.

24. In a telephone system, a trunk circuit terminating in a selector switch, an operator's position, an operator's telephone, means responsive to the connection of said operator's telephone with said operator's position to render said position selectable, a register sender, a link circuit, means responsive to the extension of a call to said selector switch to cause said link circuit to select said selector switch and said position, operator controlled means to cause said link circuit to associate said sender with said position, a key set at said position comprising a row of self-locking keys for each digit of telephonic designations, means to transmit said designations to said sender, means responsive to the complete transmission of said designation to disconnect said position from said link circuit, releasing means effective prior to the complete transmission of said designation to unlock said key set and to break down the connection between said link circuit, selector switch, position and sender, operator controlled means for operating said releasing means, and means for automatically operating said releasing means if said operator's headset is disconnected from said position.

25. In a telephone exchange system, an operator's position, a register sender, means to associate said sender with said position, a key set comprising a plurality of rows of keys, each row corresponding to a digit of telephonic designations, means for generating current impulses differing in strength and polarity, means for transmitting said impulses to said sender under the control of said key set, and means to start the transmission of said impulses prior to the complete operation of said key set.

In witness whereof, I hereunto subscribe my name this 29th day of December, 1930.

WILLIAM E. STEVENS.