

June 24, 1930.

E. H. CLARK ET AL

1,767,961

AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed Sept. 29, 1928

11 Sheets-Sheet 1

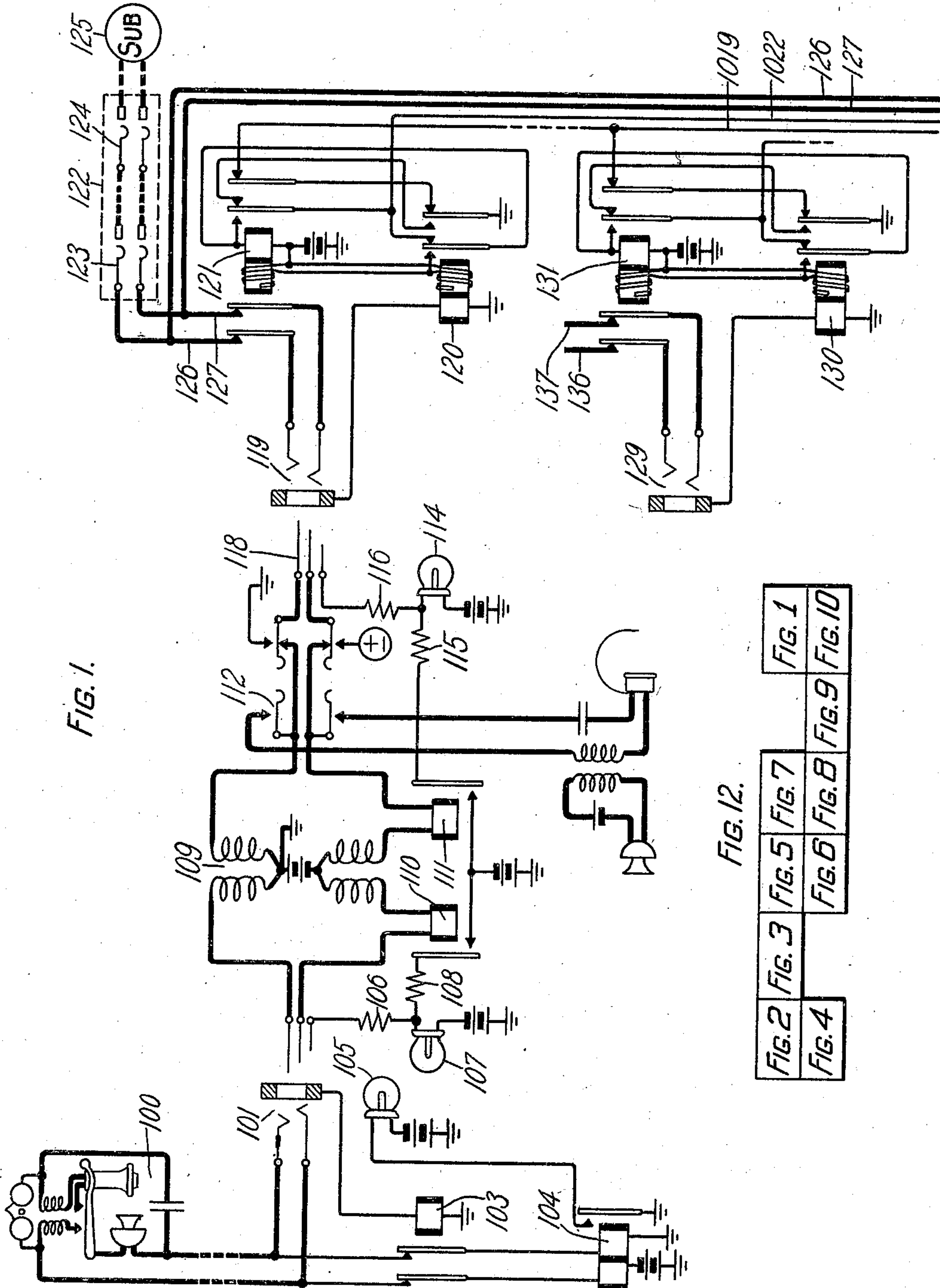


FIG. 1.

FIG. 12.

FIG. 1	FIG. 2	FIG. 3	FIG. 4	FIG. 5	FIG. 6	FIG. 7	FIG. 8	FIG. 9	FIG. 10

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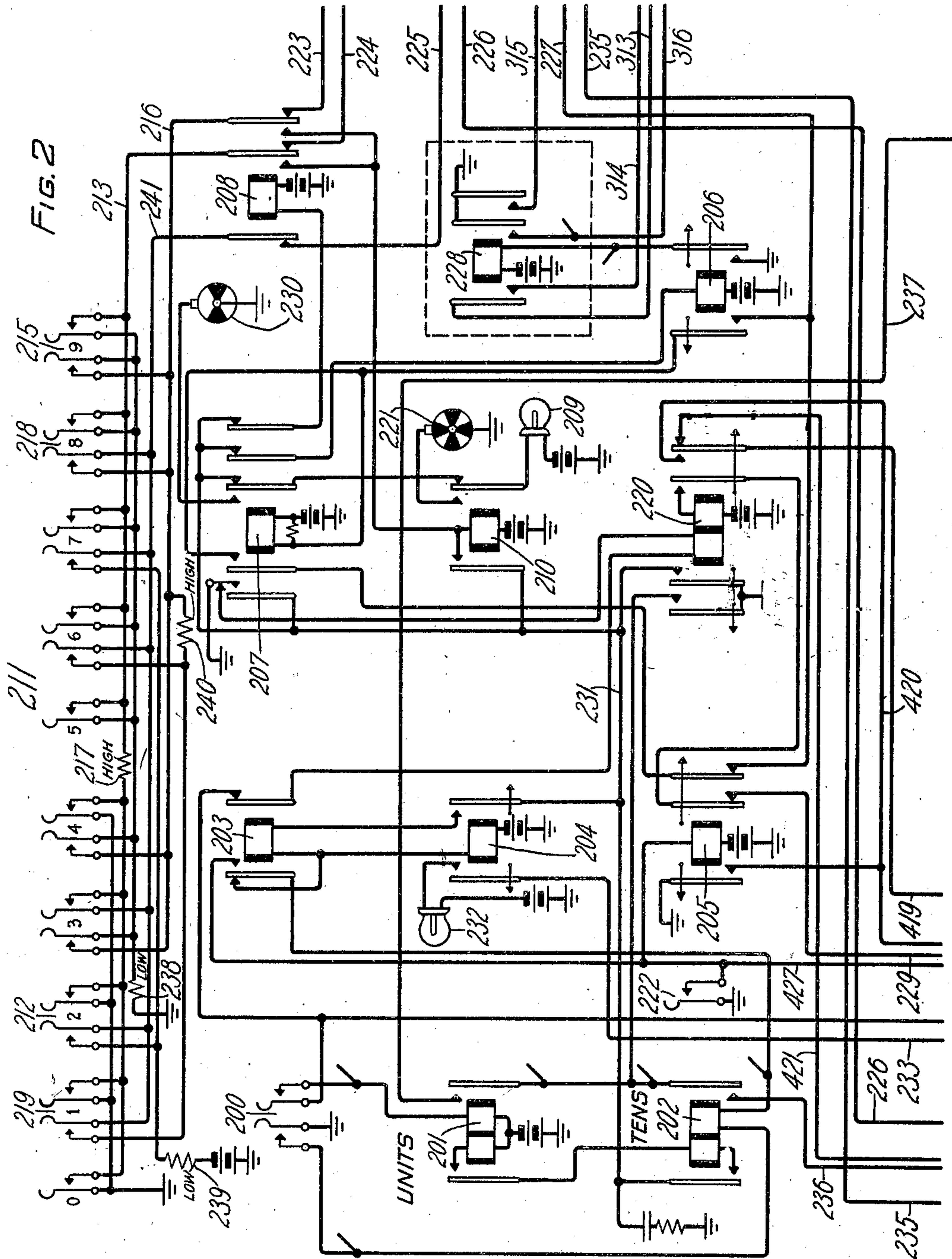
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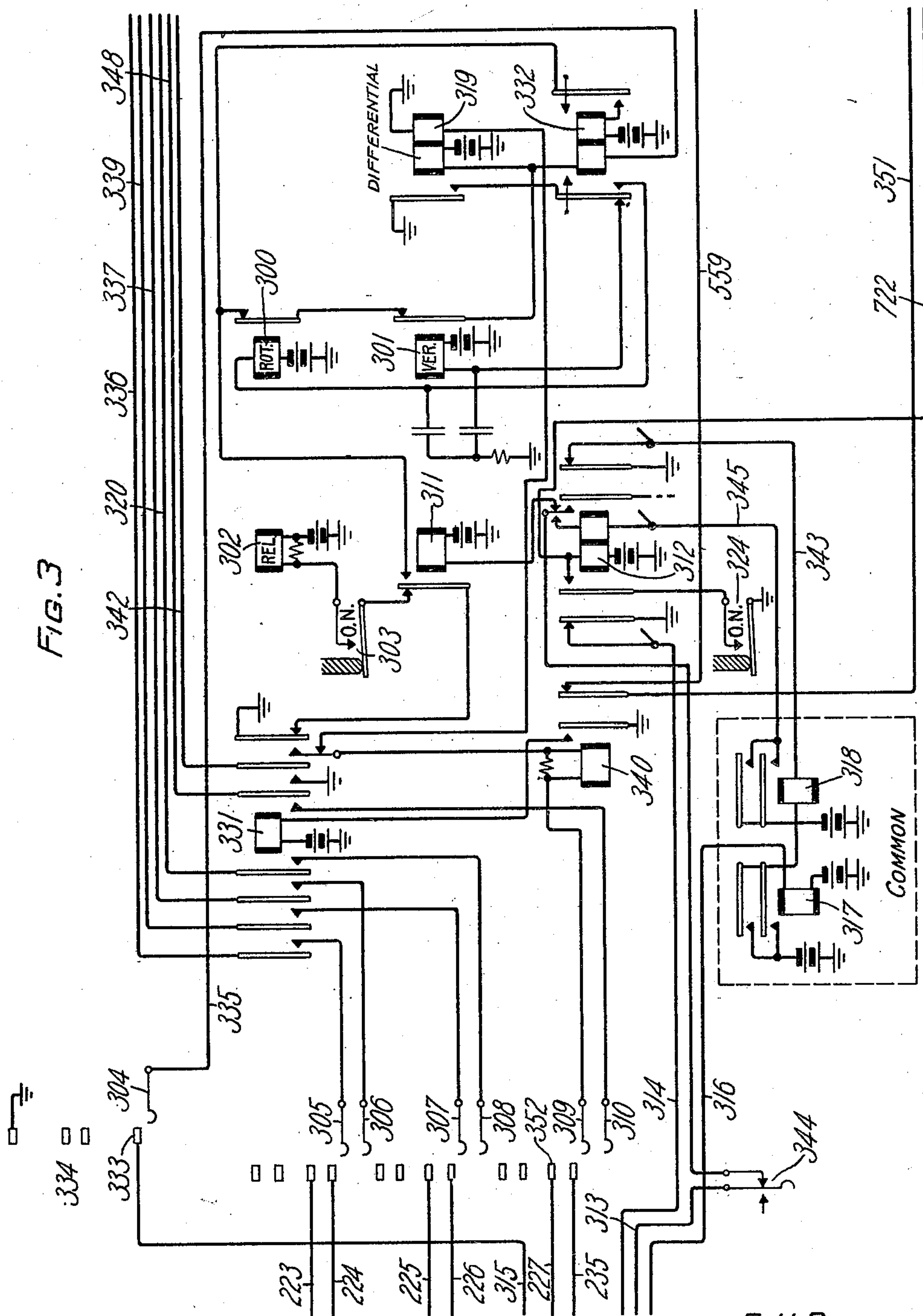
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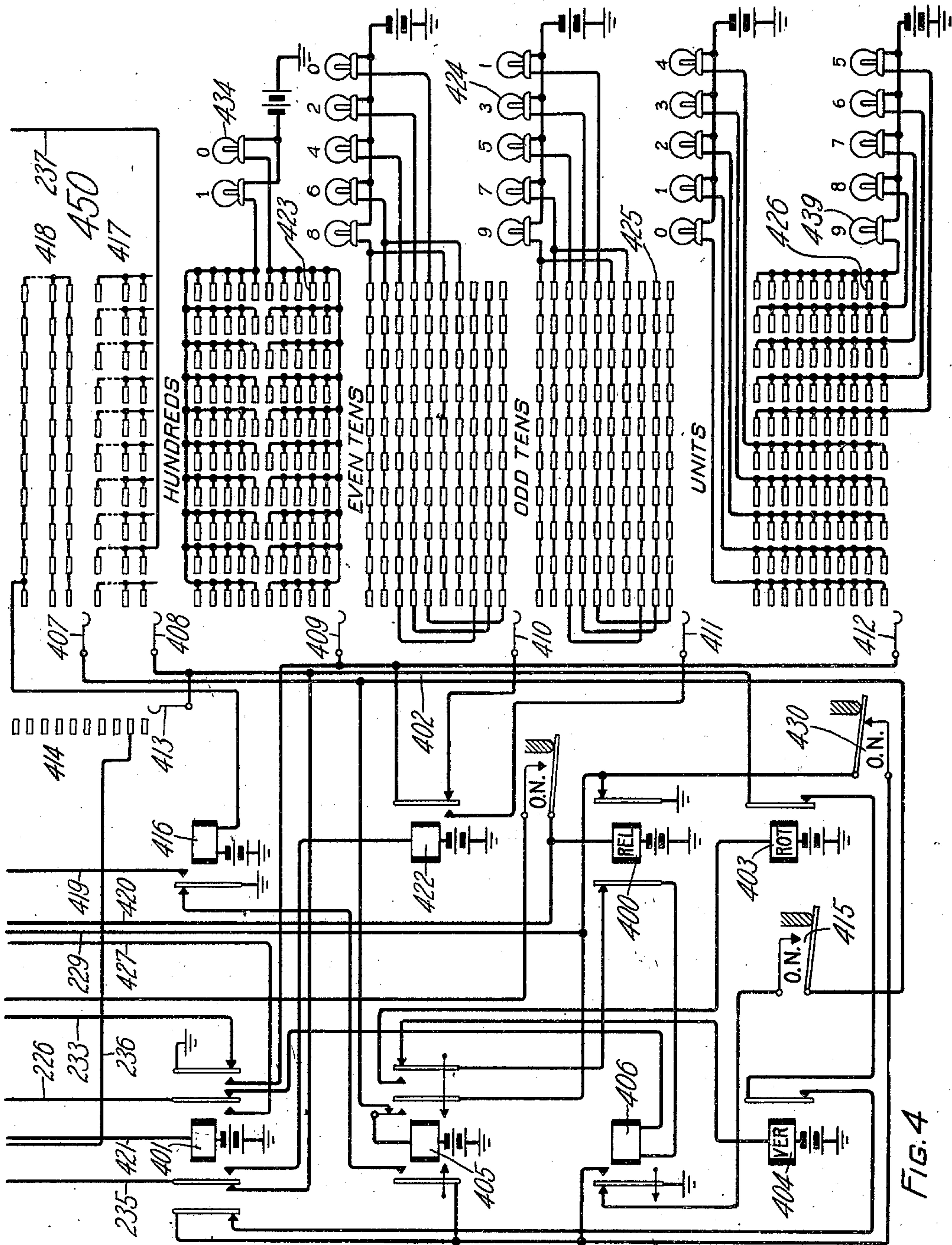


FIG. 4

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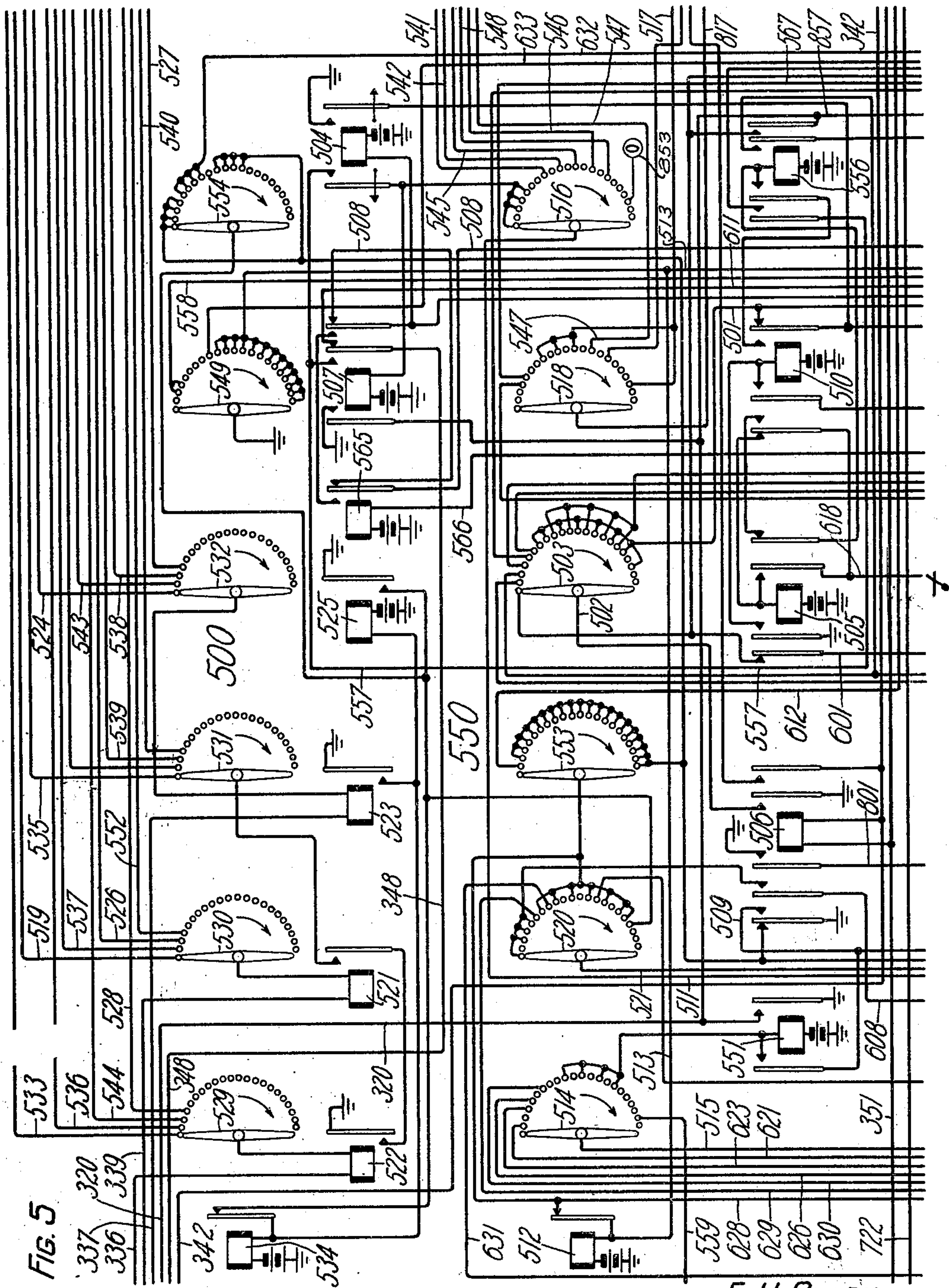


FIG. 5

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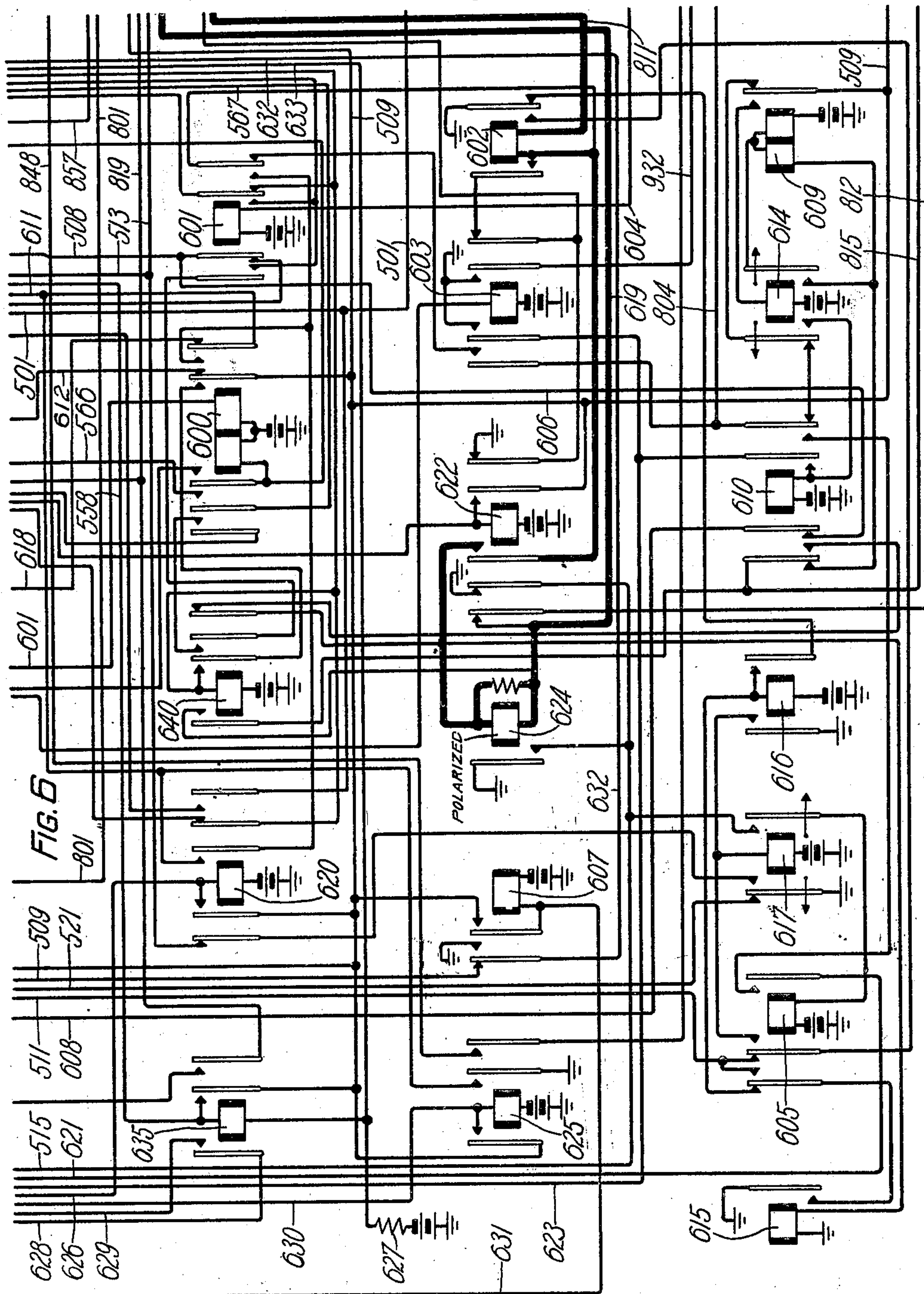
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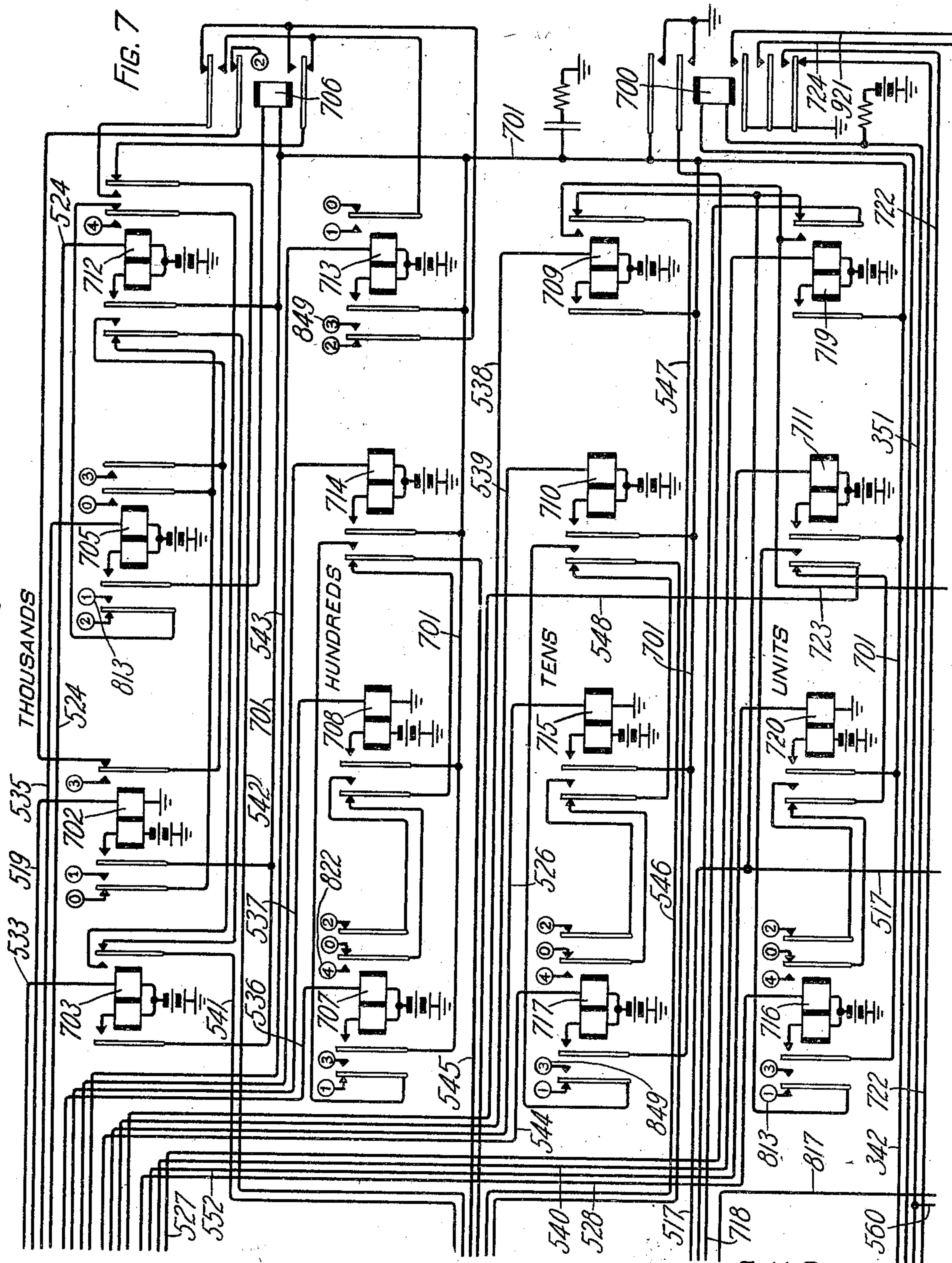
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11 Sheets-Sheet 7



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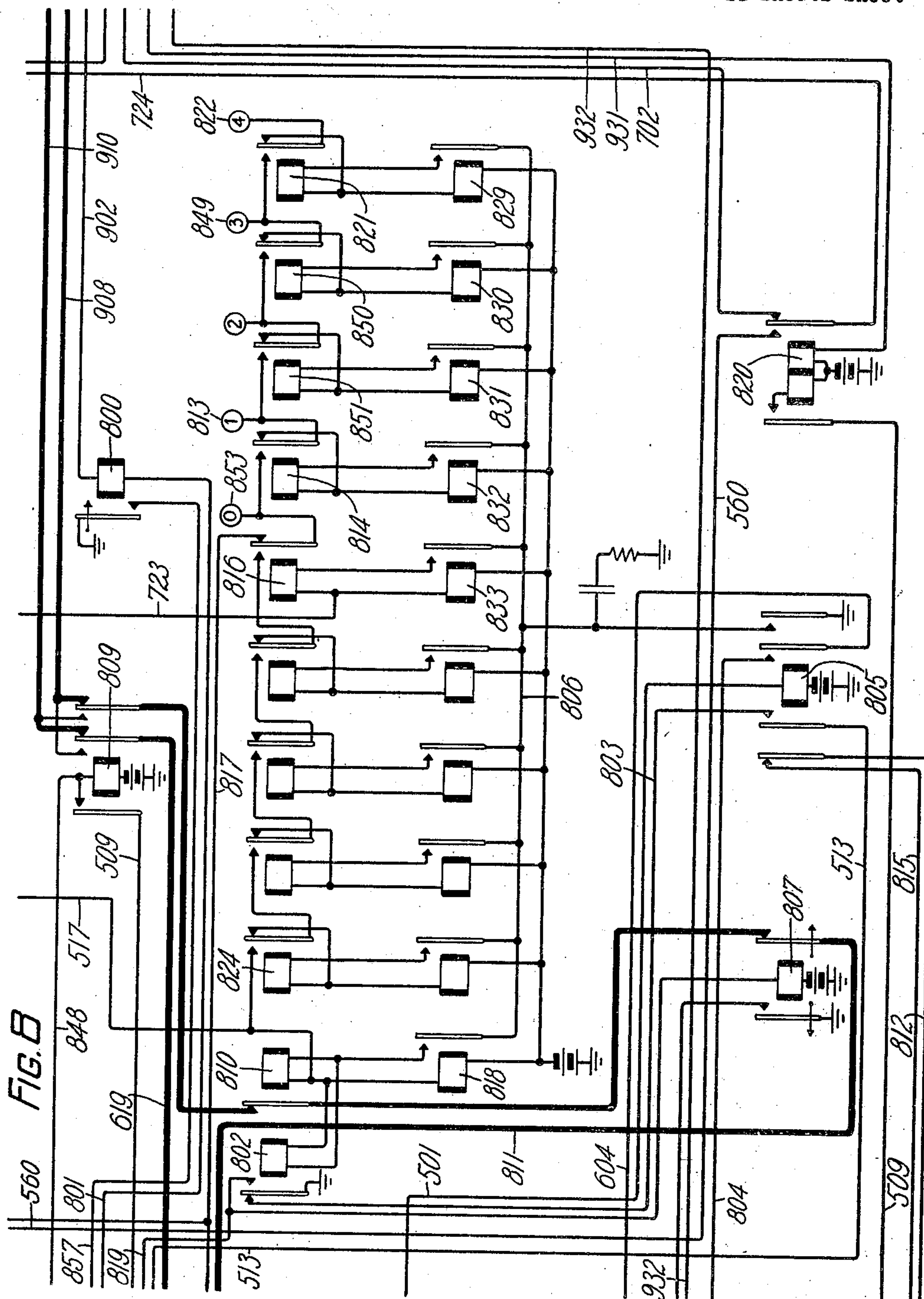
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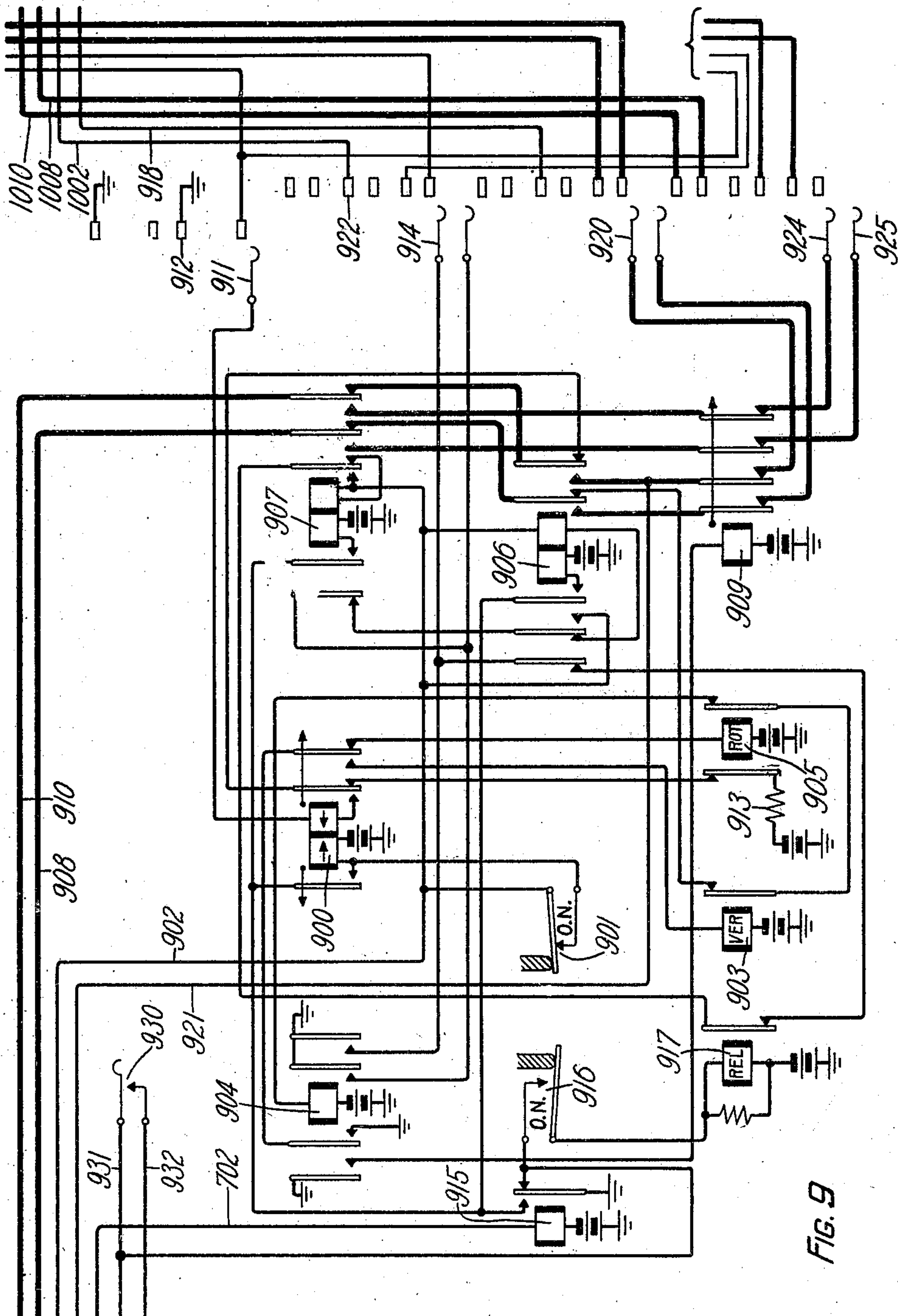
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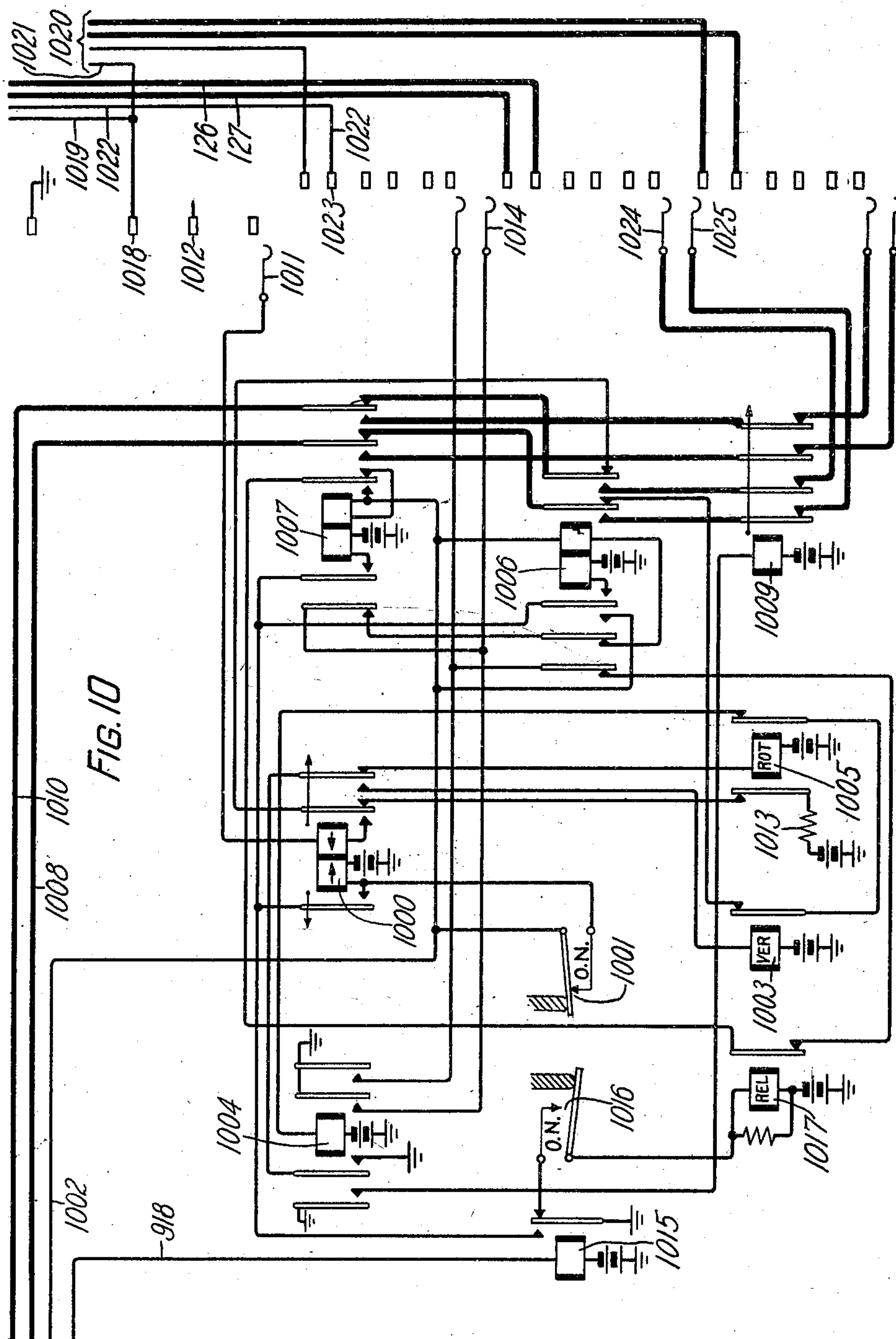
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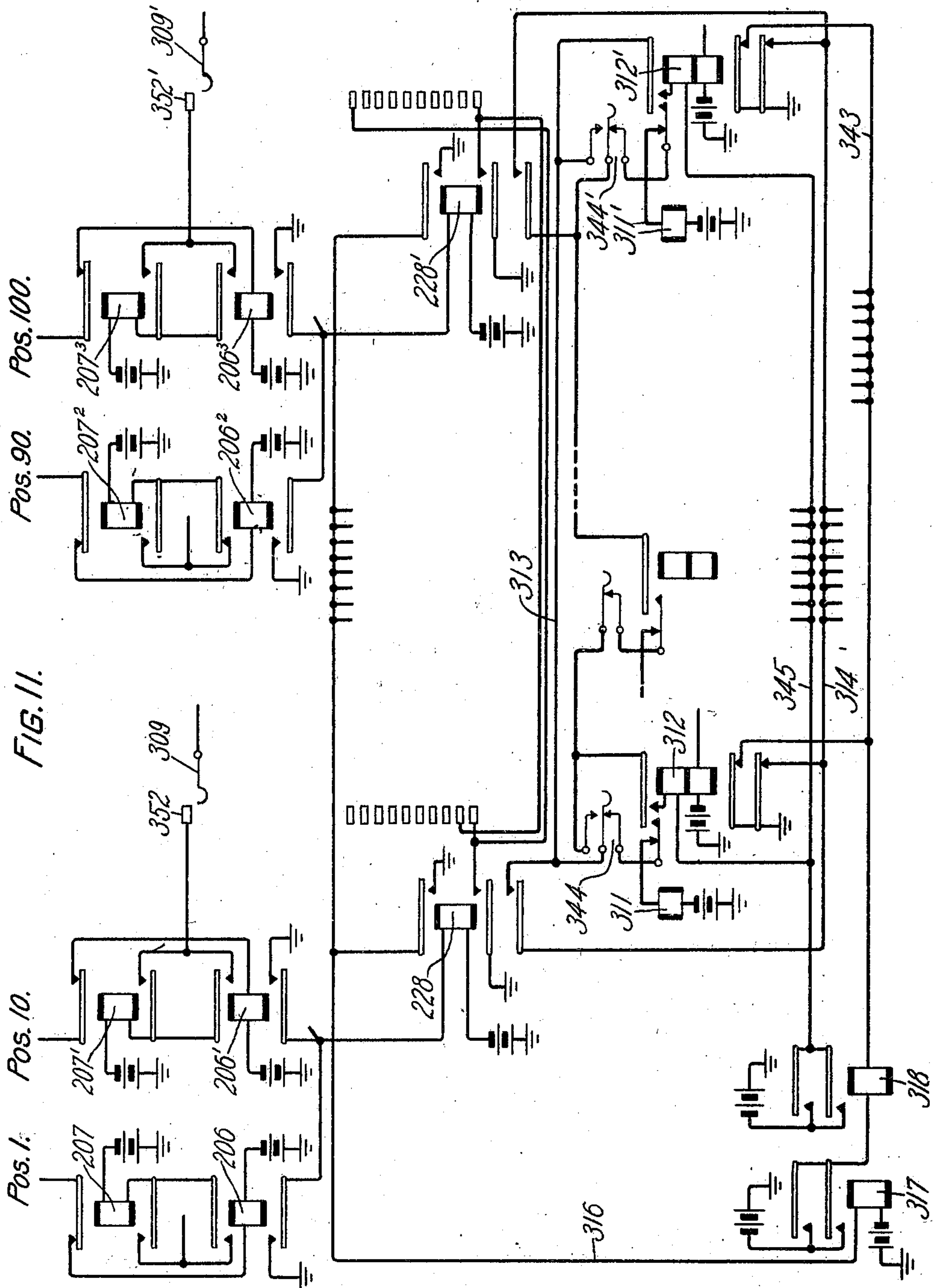
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UNITED STATES PATENT OFFICE

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AUTOMATIC TELEPHONE-EXCHANGE SYSTEM

Application filed September 29, 1928. Serial No. 309,176.

This invention relates to telephone exchange systems and particularly to those systems wherein mechanical switching apparatus is employed in the establishment of connections between subscribers' lines terminating in manual offices of the exchange area and subscribers' lines terminating in machine switching offices of the same area.

The invention has for its object the simplification of apparatus necessary for the establishment of such connections and the increased economy in the first cost and maintenance thereof.

In exchange areas which are being changed through the installation of machine switching apparatus to operate on a full mechanical basis rather than on a strictly manual basis, it is desirable that provision be made for the extension of calls originating in a manual office of the exchange to any of the outlying automatic offices through the control of the selector switches in the called automatic office by mechanism located at the calling manual office. As the exchange area becomes more nearly full mechanical through the changing of a greater number of the manual offices to automatic offices, the need for such control equipment for the remaining manual offices becomes more essential. By this plan the operator who has answered the call is enabled to establish the interoffice connection which leads to a distant automatic office without assistance, the entire operation of the switches at the distant automatic office being governed by mechanism at the originating office controlled by the answering operator therein.

This has been accomplished satisfactorily in the past by circuits of the type shown, for example, in Patent 1,513,362, issued October 28, 1924, to L. M. Allen. The present invention was developed to attain the same results as have been heretofore attained in the employment of circuits of the type disclosed in

this patent with simpler apparatus and with greater economy.

In accordance with the present invention one embodiment of which has been disclosed herein, by way of example, each manual office is provided with a plurality of operators' positions, each of which has access to a plurality of groups of outgoing trunks, one group leading to each of the automatic offices of the exchange area. Each position is further equipped with a sender controlling key board, a set of office keys and office code register relays, and a register switch of the step-by-step type which has two functions, first, to control the setting of trunk selecting switches to select a group of trunks to a desired office, corresponding to the office code registered at the position; and second, to register the number of an idle trunk in the desired office group selected by the trunk selecting switches for the purpose of operating indicating lamps at the position to indicate the number of the particular selected trunk.

In order that an idle sender common to all operators' positions may be taken for use to extend a call and associated with the operator's position concerned, each sender is provided with a step-by-step position finder individual thereto which hunts for a calling operator's position. To enable the selected sender to become associated with an idle trunk outgoing to the desired automatic office, each sender is associated with a first selector switch individual thereto, which in turn has access either directly or through second selector switches to all of the trunks in the different groups extending to the desired automatic offices.

In the operation of the system the operator who answers an incoming call at the originating manual office first depresses an office key at her position corresponding to the office in which the desired line terminates and thereby causes the position finder switch associated with an idle sender to hunt for her position

and to associate it with such sender, and causes the registration of the office code designation of the desired line on the office code register relays of her position. She may then depress keys in her key board to register on the numerical registers of the sender the numerical designation of the desired line. When the sender becomes associated with the operator's position, a control circuit is established from the register switch of the position through the sender to the first selector, and assuming that both first and second selectors are to be used, the first selector is operated in unison with the position register until the register assumes a position directed by the operated tens code register relay of the position. The first selector then hunts for an idle second selector and the selected second selector and register switch thereafter operate in unison until the register assumes a position directed by the operated units code register relay. In this manner a group of trunks outgoing to the office in which the desired line terminals is selected. The position register is then restored and is re-operated in unison with further hunting movements of the second selector until such second selector has selected an idle trunk from a sub-group of trunks in the selected office group. In its reoperated position, the position register causes trunk number indicating lamps at the position to be lighted to indicate to the operator the number of the selected outgoing trunk. The operator then plugs into the jack of the indicated trunk and her position apparatus is freed for another call. The sender then proceeds to operate the selector switches in the selected automatic office in accordance with the numerical designation registered on the registers thereof in the well known manner.

Referring to the drawings Figs. 1 to 10, inclusive, arranged in accordance with the diagram of Fig. 12 disclose so much of a telephone system embodying the principles of this invention as is necessary to a comprehensive understanding thereof.

Fig. 1 shows one of a plurality of answering operators' positions of a manual office provided with cord circuits for extending subscribers' lines over interoffice trunks outgoing to distant dial switching offices. One of these outgoing trunks terminating in a dial switching office is illustrated in this figure.

Fig. 2 shows a set of numerical keys, one office key, a portion of the office code registers and control relays of the operator's position shown in Fig. 1.

Fig. 3 shows a position finder switch individual to the sender of Figs. 5, 6, 7 and 8 for associating the operator's position equipment of Figs. 2 and 4 with such sender.

Fig. 4 shows a trunk number indicating equipment individual to the operator's posi-

tion of Fig. 1 for indicating to the operator the number of the interoffice trunk over which a connection to the desired dial switching office is to be extended.

Figs. 5, 6, 7 and 8 taken together show one of a plurality of register senders available for the use of all operators' positions of one manual office. Fig. 5 shows two steering switches of the sender. Fig. 6 shows control relays. Fig. 7 shows relay registers for registering the numerical digits of wanted line numbers and Fig. 8 shows counting relays for setting the switches of the dial switching office under the control of the registers of Fig. 7.

Fig. 9 shows a first selector individual to the sender and Fig. 10 shows one of a plurality of second selectors for connecting a selected sender with an idle trunk extending to a desired dial switching office.

Fig. 11 shows diagrammatically the arrangement of start circuits for a plurality of position finders, such as the one shown in Fig. 3.

Fig. 12 is a diagram showing how the various figures should be arranged with relation to each other.

General description of apparatus

The selector switches 123 and 124 diagrammatically illustrated in Fig. 1 and located in the distant dial switching office 122 are of the well known power driven types, such as are shown in the patent to E. B. Craft and J. N. Reynolds, No. 1,223,396, granted January 5, 1915. More particularly, they are of the specific type fully disclosed and described in the patent to F. A. Stearn and F. J. Scudder, No. 1,395,977, granted November 1, 1921.

The steering switches 500 and 550 of Fig. 5 are of the rotary single motion step-by-step type driven by stepping magnets from terminal set to terminal set and so arranged that the brushes are moved forward to the next set of terminals upon the deenergization of the corresponding stepping magnet.

The selector switches of Figs. 9 and 10, the position switch 450 of Fig. 4 and the position finder switch of Fig. 3 are of the step-by-step type having both a vertical and a rotary motion. Each switch is provided with a pair of brush sets and corresponding banks of terminals. More specifically, these switches are of the type disclosed in Patent No. 1,700,466, granted to W. W. Carpenter Jan. 29, 1929.

The operator's position equipment shown in Fig. 2 comprises a set of ten non-locking digit keys 211 upon which the operator may write up the numerical digits of wanted line numbers, a plurality of office keys only one of which 200 has been illustrated and two groups of office code relays, only one relay of each group having been disclosed. As many office keys are provided at each po-

sition as there are dial switching offices in the exchange area to which the manual office has access. Each such group of code register relays comprises eight relays, only the first of each group having been disclosed. The register relays of one group register the tens code letter of an office designation and the relays of the other group register the units code letter. By suitable interconnections with the office keys it is possible by the depression of a single key to register the first two letters of an office designation. For example, as will be hereinafter more fully described, the depression of key 200 registers the office code CA for the office CANal on the tens register relay 202 and on the units register relay 201.

Detailed description

It is believed that the invention will be best understood from a detailed explanation of the manner in which a connection may be established. To this end it will be assumed that the subscriber of line 100 in the manual office wishes to converse with the subscriber of the line 125 in a distant dial switching office 122. Upon removing his receiver from the switchhook, the calling subscriber completes a circuit for the energization of line relay 104, which in turn, causes the illumination of lamp 105. The operator upon observing the illumination of lamp 105 answers by inserting the plug 102 of one of her cord circuits into the jack 101. The insertion of the plug in the jack completes a circuit from battery through the lamp 107, resistance 106, sleeves of plug 102 and jack 101, winding of relay 103 to ground. Relay 103 operates and severs the circuit of relay 104 which causes the line lamp 105 to become extinguished. The receiver being off the switchhook, the insertion of the plug in the jack also completes a circuit from battery through the lower left winding of repeating coil 109, the winding of relay 110, rings of plug 102 and jack 101, over the loop of the line, returning over the tips of jack 101 and plug 102, upper left winding of repeating coil 109 to ground. Relay 110 operates in this circuit and closes a circuit from battery through its contact, resistances 108 and 106, thence over the path previously traced through the winding of relay 103 to ground. This latter circuit shunts the lamp 107 causing the same to remain extinguished. The operator next depresses the listening key 112 connecting her head set into conversational relation with the calling line and ascertains the wishes of the calling subscriber.

Upon learning that he wishes to talk with a subscriber at a distant office 122, the operator depresses the office key 200 of Fig. 2 which key corresponds to such distant office. For the purposes of this description,

it will be assumed that the wanted line number is CANal 3981 and that, therefore, upon the depression of key 200, the No. 2 units code register relay 201 is operated over a circuit extending from battery through the right winding of relay 201, the right contacts of key 200, right contact of relay 203, the left winding of relay 220 to ground at the left normal contacts of relay 207, and that the tens code register relay 202 is operated over a circuit from battery through the winding of relay 204, the left back contact of relay 203, the right winding of relay 202 to ground at the left contacts of key 200. Relays 201, 202, 204 and 220 energize in these circuits, relay 220 locking over its right winding and inner right contact, the inner right back contact of release relay 205, conductor 229 to ground at the back contact of release magnet 400 of the position switch 450. Relays 201 and 202 close a mutual locking circuit for each other extending from battery, through the left winding and left contact of relay 201, the left winding and left contact of relay 202, conductor 231 to ground at the inner let contact of relay 220. Relay 204 operates in the operating circuit of relay 202 and locks through the winding of relay 203 the right front contact of relay 204 to ground on conductor 231 and closes a circuit for lamp 232 extending from battery through said lamp, the left contact of relay 204, conductor 233 to ground at the outer right back contact of relay 401, but relay 203 does not operate in this locking circuit until the key 200 is released. Lamp 232 lights and remains lighted until the trunk number is completely registered on the position switch 450. Upon the release of key 200, relay 203 energizes opening at its back contacts the initial energizing circuits of relays 201 and 202 and of all other register relays of the position to prevent interference with the call should the operator depress another office key before the call has been completed and her position equipment released. The code register relays prepare circuits for controlling the positioning of the position switch 450 as will be hereinafter described.

Association of an idle sender with the operator's position

Relay 220, upon energizing, established a circuit for relay 206 extending from battery through the winding of such relay, the intermediate right back contact of relay 207 to ground on conductor 231, a circuit for relay 208 extending from battery, through the winding thereof, over the outer right back contact of relay 207 to ground on conductor 231 and a circuit for lamp 209 extending from battery through such lamp, the back contact of relay 210, the inner right back contact of relay 207 to ground on conductor

231. Lamp 209 burns steadily at this time and relay 208, upon energizing, connects the contacts of the keys of keyset 211 to battery through the winding of relay 210. Should the operator prematurely depress a key of the keyset, that is, while the lamp 209 is burning steadily denoting that a sender has not yet been associated with her position equipment, relay 210 will operate locking over its left front contact to ground on conductor 231 and at its right contacts transfers the lamp 209 from steady ground to intermittent ground through the fast interrupter 221. The lamp will thereupon flicker as a signal that the operator should release her position and start the call again. She may do so by depressing the release key 222 thereby operating release relay 205, which in turn releases all operated relays of the position. Relay 208, upon operating, also disassociates the key contacts of keyset 211 from conductors 223 to 225, inclusive, extending to the brushes of the position finder of Fig. 3.

Relay 206, upon operating, at its left contact prepares an operating circuit for the cut-off relay 207, extending to conductor 227 and at its right contact establishes an obvious circuit for the group relay 228. By referring to Fig. 11, it will be noted that provision is made for 100 operators' positions, said positions being sub-divided into ten groups of ten positions each. Each subgroup of ten positions has common thereto a group start relay 228. In Fig. 11 the individual start relays 206 and 206' and cut-off relays 207 and 207' of the first and tenth positions of the first subgroup and the individual start relays 206² and 206³ and cut-off relays 207² and 207³ of the 91st and 100th positions of the tenth subgroup of positions together with corresponding group relays 228 and 228' have been illustrated. A position finder individual to a sender such as is shown in Figs. 5 to 8, inclusive, is provided for normally serving each group of ten positions, but the start circuits are so arranged as shown in Fig. 11 that a finder individual to any idle sender may be made available to serve any one of the 100 positions.

Referring to Fig. 3 in which the position finder individual to the sender of Figs. 5 to 8 is disclosed for serving the group of positions in which the position of Fig. 2 is located, such finder is illustrated as having a rotary magnet 300, a vertical magnet 301, release magnet 302, off-normal contacts 303 and 324, vertical commutator 334 and brush 304 and six shaft brushes 305 to 310, inclusive. Relays 317 and 318 shown in the dotted rectangle are common to all position finders. When therefore the group relay 228 of the subgroup in which the position equipment of Fig. 2 is located operates, assuming that the finder normally allotted for serving such subgroup is idle, a circuit is extended from bat-

tery, through the winding of relay 311, the make-before-break contacts of relay 312, transfer key 344, conductor 313, the left contacts of relay 228, conductor 314 to ground at the left back contact of relay 312. Relay 228 at its outer right contact also connects ground over a conductor, such as 315, to place a calling potential on the commutator of the position finder corresponding to the bank level thereof in which the subgroup of positions appear, and at its inner front contact connects ground to conductor 316 for operating the common relay 317. Relay 317 energizes in turn operating the common relay 318 in a circuit extending to ground at the back contacts of all relays similar to relay 312 of line finders that are at the time idle. Relay 318, upon operating, furnishes locking battery for the relay of each position finder corresponding to relay 312 for a purpose to be later explained. Relay 311, upon operating, establishes a circuit for relay 319 extending from battery through the left winding thereof, the back contacts of magnets 300 and 301, the front contact of relay 311 to ground at the outer right back contact of relay 331. Relay 319 operates in this circuit and at its left contact establishes a circuit for vertical magnet 301 extending from battery through the winding of magnet 301, the back contact of relay 332 to ground at the left contact of relay 319. Magnet 301 energizes, opening the energizing circuit of relay 319. When, therefore, vertical magnet 301 is completely energized and the finder shaft has been advanced vertically one step, relay 319 releases, in turn, opening the operating circuit of magnet 301.

It will be assumed that the calling operator's position terminates in the first bank level of this finder and that therefore when the finder has been stepped to this level, ground potential placed upon commutator terminal 333 by the group relay 228 will be encountered by the commutator brush 304 and a circuit completed therefrom over conductor 335, through the left winding of relay 332 to battery through the left winding of relay 319 before the vertical magnet 301 releases. Relays 319 and 332 thereupon energize, relay 319 locking itself energized over its left winding and the back contacts of magnets 300 and 301 upon the release thereof and relay 332 locking itself from battery over its right winding and right contact to ground at the outer right back contact of relay 331. With relays 319 and 332 both energized a circuit is now established for the rotary magnet 300 extending from battery through the winding of magnet 300, the left front contact of relay 332 to ground at the left contact of relay 319. Magnet 300 energizes, advancing the brushes of the finder one step in a rotary direction. The energization of magnet 300 now opens the holding circuit of relay 319 and since its

initial energizing circuit was opened at the commutator brush 304 as soon as the finder rotated one step, relay 319 deenergizes, opening the operating circuit of magnet 300. This magnet, in turn, deenergizes again closing an operating circuit for relay 319 extending from battery, through its left winding, back contacts of magnets 300 and 301, the front contact of relay 311 to ground at the outer right back contact of relay 331. Relay 319 again energizes and establishes the operating circuit of magnet 300. In this manner magnet 300 and relay 319 reciprocally operate to advance the brushes of the position finder in a rotary hunting movement.

When the brushes have been so advanced to the terminals associated with the calling operator's equipment, a circuit becomes established from battery, winding of cut-off relay 207, the left contact of relay 206, conductor 227, test terminal 352, test brush 309, winding of relay 340, right normal contacts of relay 331 to ground through the right winding of relay 319, thereby energizing relays 207 and 340 and differentially releasing relay 319. Relay 207, upon energizing, locks over its winding and inner left front contact, the outer right back contact of relay 205, directly to conductor 227 independently of relay 206, opens at its right contacts the circuits of relays 206 and 208, thereby releasing said relays and at its inner right front contact establishes a circuit from ground through the slow interrupter 230, over the right back contact of relay 210 to battery through the lamp 209. Lamp 209 now flashes to indicate that the operator's position has been attached to an idle sender and that she may proceed to operate the keys of keyboard 211 to set the numerical registers of such sender to record the numerical designation of the desired line. The release of relay 206 opens the circuit of group relay 228 which, in turn, releases releasing relays 311, 317 and 318, the two latter relays releasing only in case there is no other call initiated at the time.

Relay 340 upon operating closes an obvious circuit over its front contacts for relay 331 which, upon operating, extends control circuits from the operator's position equipment over brushes 305 to 308 and 310, inclusive. At its right back contact relay 331 opens the holding circuit of relay 332, the circuit previously traced through the left winding of relay 319 and at its right make-before-break contacts substitutes direct ground in the circuit of relays 207 and 340 in place of ground through the right winding of relay 319. Relay 332 thereupon, releases. At its intermediate right contact relay 331 also closes a circuit extending from ground over such contact, conductor 342, winding of relay 506, conductor 351 to battery. A circuit is also closed in parallel with relay 506 from ground on

conductor 342, through the winding of relay 700 to battery on conductor 351.

Relay 506, upon energizing, prepares several circuits. At its inner left contact it establishes a circuit for relay 900 of the first selector, extending from ground over conductor 801, winding of relay 800, conductor 902, off-normal contact 901 to battery through the left winding of relay 900. At its inner right contact it establishes a circuit for relay 600 extending from battery through the right winding of relay 600, conductor 601, the left back contact of relay 505, normal position terminal and brush 503 of steering switch 550, conductor 502 to ground at the inner left contact of relay 506, at its outer right contact it connects holding ground to conductor 509 for locking relays of Figs. 5, 6 and 8 and at its intermediate left contacts establishes a circuit for relay 504 extending from battery through the winding of relay 504, the outer right back contact of relay 507, the back contact of relay 565, conductor 508, conductor 606, the inner left back contact of relay 610, conductor 608, the intermediate left front contact of relay 506, the normal position terminal and brush 520 of steering switch 550, conductor 521 to ground at the left back contact of relay 617.

Relay 700, upon energizing at its uppermost front contact, connects ground to conductor 701 for locking the register relays of Fig. 7, at its inner upper front contact connects ground over conductor 718, the outer right contact of relay 506 through the winding of relay 506 to battery on conductor 351 for holding itself and relay 506 operated, and at its intermediate lower contact connects ground over conductor 724, the back contact of relay 820, conductor 702, through the winding of release relay 915 of the first selector to battery. Relay 915 energizes in this circuit, at its front contact furnishing locking ground for relay 900 and for other relays of the first selector and at its back contact opening at one point the circuit of release magnet 917. At its inner lower front contact relay 700 connects ground to conductor 921 for a purpose to be later explained and at its lowermost front contact connects ground over conductor 722 to battery through the left winding of relay 312.

Relay 312 thereupon energizes locking over its left winding and inner left front contact and off-normal contact 324 to ground, removes ground at its left back contact from the start conductor 314, removes ground at its right back contact from the common conductor 343 and at its inner right make-before-break contacts extends the starting conductor 313 to the start relay corresponding to relay 311 of the next position finder associated with an idle sender.

It will be explained at this point how another call initiated at a position of the

same subgroup is able to associate another idle sender with such position. For this purpose it will be assumed that upon the depression of an office key at such other position, for example, the tenth position of such subgroup, relay 206' disclosed in Fig. 11 becomes energized, in turn, operating the common group relay 228. It will further be assumed that the next idle sender is the sender normally assigned for serving positions 91 to 100, inclusive. Referring to Fig. 11, with relay 312 energized as just described, a circuit is now established from ground at the lower back contact of relay 312' associated with the position finder individual to such sender, over the common conductor 314, the lower front contact of group relay 228, conductor 313, transfer key 344, the front contact of relay 312, thence in a chain circuit through the front contacts of other relays similar to relay 312 associated with position finders of other busy senders, thence to transfer key 344', the normal contact of relay 312' to battery through the winding of start relay 311'. Start relay 311', upon operating, starts the position finder associated with the idle sender in the manner previously described. So long as there is an initiated call at any position and any group relay, such as 228, is energized, relay 317 remains energized, in turn, maintaining relay 318 operated until all senders have been taken for use, since relay 318 receives operating ground from common conductor 343, and a back contact of the relay 312 of the position finder associated with each idle sender. With relay 318 energized battery is connected to common conductor 345. Thus, upon the energization of relay 312 an auxiliary locking circuit is established for relay 312 extending from battery on conductor 345, through a winding and inner front contact of relay 312, key 344, the front contact of group relay 228 to ground on common conductor 314. This insures that relay 312 will be maintained operated if a second call has been initiated in the first subgroup even though the sender which was taken for use by a previously initiated call in that subgroup should become idle. Since relay 312 cannot therefore release to open the chain starting circuit, the second call is not therefore mutilated.

Relay 504, upon energizing, establishes a circuit for relay 805 extending from battery through the winding of relay 805, conductor 501, the right back contact of relay 510 to ground at the right contact of relay 504. At its outer right contact relay 805 connects ground to conductor 806 for furnishing holding ground for the counting relays, at its inner left contact establishes a circuit for magnet 512 of steering switch 550 preparatory to advancing such switch into position 2, and at its inner right contact establishes a circuit for relay 601. The circuit of magnet

512 may be traced from battery through the winding of such magnet, conductor 513, the inner left contact of relay 805, conductor 803, to ground at the back contact of counting relay 802. The circuit of relay 601 may be traced from battery through the winding of relay 601, conductor 604, the inner right contact of relay 805, conductor 804, the outer right back contact of relay 610, the left back contact of relay 614, the back contact of relay 609 to ground on conductor 509.

Operation of first selector in accordance with first code letter of office designation

It will first be assumed that in order to reach a trunk to the desired office 122 both the first and the second selectors must be used. With relay 601 energized a pulsing circuit for operating the first selector vertically in accordance with the first or tens code letter registered by relay 202 of the operator's position is established, extending from battery through the winding of relay 904, back contacts of rotary magnet 905 and vertical magnet 903, inner right back contact of relay 906, intermediate right back contact of relay 907, conductor 908, outer right back contact of relay 809, back contact of counting relay 810, back contact of relay 807, conductor 811, winding of pulsing relay 602, outer right front contact of relay 601, outer right front contact of relay 600, conductor 611, inner right back contact of relay 507, conductor 348, inner right contact of relay 331, brush 310, conductor 235, inner left contact of relay 401, conductor 402, back contact of rotary magnet 403, back contact of vertical magnet 404, outer left back contact of relay 401, off-normal contacts 430 to ground at the right back contact of release magnet 400. Relays 602 and 904 energize in this circuit, relay 602 upon energizing closing a circuit for itself over its left contact, right back contact of relay 603 to ground at the right back contact of relay 622 independently of ground at the position switch 450 and at its right front contact establishing a circuit for relay 507, extending from battery, winding of relay 507, normal position terminal and brush 516 of steering switch 550, conductor 511, the inner left back contact of relay 605 to ground at the right front contact of relay 602.

Relay 507 at its outer left front contact establishes a circuit for the vertical magnet 404 of the position switch 450, extending from battery through the winding of magnet 404, the outer right back contact of relay 405, the left back contact of release magnet 400, winding of relay 406, the inner right back contact of relay 401, conductor 226, brush 308, inner left contact of relay 331, conductor 320 to ground at the left contact of relay 507. Magnet 404 and slow releasing relay 406 energize in this circuit, magnet 404 stepping the brush shaft of the switch 450 one step

vertically to position the brushes 407 to 412 inclusive, opposite the first level of terminals in their respective banks and to position the commutator brush 413 opposite the first segment of the vertical commutator 414. Relay 406 being slow to release remains energized so long as the stepping magnet 404 receives impulses. Relay 507 at its outer right back contact also opens the circuit previously traced for relay 504, and since relay 601 is at the time energized no circuit exists for relay 504 over the inner left contacts of relay 601. The relay 504 being slow to release does not do so, so long as relay 602 continues to transmit impulses to the winding of relay 507. With relay 507 energized, it is held energized in a circuit from battery through its winding, left front contact of relay 504, the inner right front contact of relay 507, conductor 348, thence as traced through the left back contact of relay 401 to ground through the back contact of vertical magnet 404 and the left front contact of relay 406. Relay 507 thus does not deenergize until the vertical magnet 404 has fully completed its energization to advance the switch 450 a full step.

At the selector of Fig. 9 upon the energization of relay 904 a circuit is closed for the vertical magnet 903 from battery through the winding of magnet 903, the outer right front contact of relay 900 to ground at the inner left front contact of relay 904. Relay 904 also closes an obvious circuit for relay 909, which disconnects the tip and ring brushes of the selector during its vertical selection movement. Magnet 903 energizes and at its contacts, opens the previously traced pulsing circuit through the winding of relay 904, and the winding of relay 602. The selector switch is thus stepped vertically one step, opening at the off-normal contacts 901 the initial energizing circuit of relay 900.

Upon the opening of the pulsing circuit and the deenergization of relay 602 the initial energizing circuit of relay 507 is opened and upon the completion of the first step of position switch 450 the holding circuit of relay 507 is opened, whereupon it deenergizes, opening the operating circuit of magnet 404. At the selector upon the deenergization of the vertical magnet 903 following the deenergization of relay 904, the pulsing circuit previously traced is again established, to ground at the front contact of relay 406 and relays 602 and 704 again operate both performing the same functions previously described to cause the advance of the first selector and of the position switch 450 another step.

It has been assumed that the first code letter registered upon the tens code register relay 202 was C, having a numerical equivalent of 2. Therefore, when the position switch 450 has advanced two steps vertically and the commutator brush 413 is raised to the second

segment of commutator 414, a circuit will be closed from ground at the outer left contact of relay 220, over the right contact of register relay 202, conductor 236, brush 413, thence over the inner left back contact of relay 401, conductor 235 and as previously traced to battery through the winding of relay 507. Relay 507 is thus prevented from deenergizing when vertical magnet 404 completes its second energization and therefore the circuit of relay 504 is held open at the outer right contact of relay 507 for a sufficient period to permit relay 504 to release. Relay 504 upon releasing now opens the circuit of relay 507, which thereupon releases, in turn opening the circuit of vertical magnet 404 and the circuit of slow-to-release relay 406. Relay 504 upon deenergizing opens at its right contact the previously traced circuit for relay 805, which in turn opens the previously traced circuits for relay 601 and magnet 512. Magnet 512 upon deenergizing advances the steering switch 550 into position 2.

As soon as the steering switch leaves normal the previously traced circuit of relay 600 is opened, whereupon a circuit is established for relay 505, extending from battery through the winding of relay 505, left back contact of relay 510, conductor 618, outer right back contact of relay 600, conductor 611, inner right back contact of relay 507, conductor 348, inner right contact of relay 331, brush 310, conductor 235, inner left back contact of relay 401, conductor 402, back contacts of magnets 403 and 404, outer left back contact of relay 401 to ground at the front contact of relay 406, relay 406 being slow to release and having not yet released. Relay 505 upon energizing locks over its inner right contact directly to conductor 618 independently of the contacts of relay 510 and closes an obvious circuit for relay 510, which then locks over its inner left contact, conductor 612, the inner right back contact of relay 600 to ground on conductor 509. With the steering switch in position 2 a circuit is established from battery through the winding of relay 603, the second position terminal and brush 503 of steering switch 550, conductor 502 to ground at the inner right contact of relay 506.

As soon as relay 406 releases following the opening of its circuit by the deenergization of relay 507, a circuit is established for relay 405, extending from battery through the winding and right normal contacts thereof, vertical off-normal contacts 415 to ground at the back contact of relay 406. Relay 405 upon energizing locks over its inner right front contact to ground at the right back contact of release magnet 400 and at its outer right contacts substitutes the winding of the rotary magnet 403 for the winding of the vertical magnet 404 in the previously traced pulsing circuit extending to the left front contact of relay 507. Relay 406 upon releasing

also opens the locking circuit of relay 505 which then releases. A circuit is now closed for relay 556 extending from battery winding of relay 556, right back contact of relay 505, left front
5 contact of relay 510, outer right back contact of relay 600, conductor 611 thence as traced over the outer left back contact of relay 401, the left contact of relay 405 to ground at the back contact of relay 416.

10 *First selector hunts for idle second selector*

When relay 805 deenergizes, a circuit is established for relay 609, extending from battery through both windings thereof, the outer
15 left back contact of relay 610, conductor 815, the outer left back contact of relay 805, conductor 812, the outer left back contact of relay 622, conductor 619, the inner right back contact of relay 809, conductor 910, the outer
20 right back contact of relay 907, the outer right back contact of relay 906, the inner right front contact and right winding of relay 900, which is wound differentially to the left winding thereof, commutator brush 911 to
25 ground on terminal 912 of the commutator corresponding to the second level of the banks of the first selector, which level of terminals has been assumed to be connected to terminals of trunks extending to second selectors such
30 as the one shown in Fig. 10. Relay 609 operates in this circuit and closes a circuit for relay 614, extending from battery, winding of relay 614, front contact of relay 609 to ground, on conductor 509. Relay 614 upon
35 energizing shunts at its right contact the left winding of relay 609, thereby increasing the current flowing through the right winding of relay 900, whereupon relay 900 differentially releases, removing the vertical magnet
40 903 from the control of the pulsing relay 904. Relay 900 also connects the right winding of relay 609 over the circuit previously traced to the inner right back contact of relay 900, thence to battery through resistance
45 913, over the back contact of rotary magnet 905. Relay 609 thereupon releases and at its front contact opens the previously traced circuit of relay 614. Since relay 614 is slow to release, a circuit is momentarily closed upon
50 the release of relay 609, from ground on conductor 509, over the back contact of relay 609, the left front contact of relay 614 to battery through the winding of relay 610, which thereupon energizes and locks to ground at
55 the inner left contact of relay 603.

Relay 610 upon energizing opens the initial circuit of relay 609 at its left back contact and at its outer right front contact closes a circuit for relay 615, extending from
60 ground therethrough over right back contact of relay 640, the outer left front contact of relay 610, conductor 815, the back contact of relay 805, conductor 812, thence as traced to battery through resistance 913 at the first
65 selector. Relay 615 operates, in turn operat-

ing relay 616 over a circuit extending from battery through the winding of relay 616, outer left back contact of relay 605 to ground at the contact of relay 615. Relay 616 upon
70 operating locks over its right contact to ground at the back contact of pulsing relay 602 and at its left contact establishes an obvious circuit for relay 617, which relay in turn establishes a circuit for magnet 512 of
75 the steering switch 550, extending from battery through the magnet 512 over conductor 513, the outer left back contact of relay 620 to ground at the left front contact of relay 617. Relay 617 also at its front contact closes
80 a circuit for relay 605, extending from battery through the winding of relay 605, the right front contact of relay 617 to ground at the intermediate left back contact of relay 622.

A circuit is now established for the step-
85 ping relay 904 of the first selector extending from battery through the winding of relay 904, back contacts of rotary magnet 905 and vertical magnet 903, back contacts of relays
90 906 and 907, conductor 908, outer right back contact of relay 809, back contact of counting relay 810, right back contact of relay 807, conductor 811, winding of pulsing relay 602, outer right back contact of relay
95 601, outer left front contact of relay 603, outer right front contact of relay 610, right contact of relay 605, conductor 621, second position terminal and brush 514 of steering switch 550, conductor 515 to ground at the in-
100 termediate left back contact of relay 622. Relay 904 upon energizing closes the circuit of relay 909 to disconnect the tip and ring brushes of the selector during its rotary hunting movement and closes the circuit of rotary
105 magnet 905, which may be traced from battery through the winding of magnet 905, the outer right back contact of relay 900 to ground at the inner left contact of relay 904. Magnet 905 upon energizing in turn
110 opens the previously traced circuit for relays 904 and 602, relay 904 in turn opening the circuit of magnet 905. Thus, relay 904 and magnet 905 cooperate with each other to cause the step-by-step rotation of the first se-
115 lector brushes over the selected second level of their banks in search of an idle second selector.

At the sender upon the energization of pulsing relay 602 the holding circuit of re-
120 lay 616 is opened at the back contact of relay 602 and relay 616 deenergizes, in turn opening the initial energizing circuit of relay 617. Relay 617 being slow to release, however, does not release before a holding
125 circuit is established therefor from battery through its winding, the inner left front contact of relay 605 to ground at the front contact of relay 602. Therefore, as long as relay 602 continues to receive impulses of current
130 due to the hunting movement of the first se-

lector, relay 617 is held energized and in turn maintains relay 605 operated. Relay 615, at this time deenergizes since its operating circuit was opened at the back contact of rotary magnet 905 upon the first energization of magnet 905 and the initial operating circuit of relay 616 is therefore opened at the contact of relay 615.

When an idle second selector is found, a circuit is established for relay 1015, extending from battery, winding of relay 1015, conductor 918, terminal 919, brush 920, next to inner back contact of relay 909, conductor 921 to ground at the inner lower contact of relay 700. Relay 1015 energizes, connecting locking ground for the relays of the second selector and opening at one point the circuit of release magnet 1017. Another circuit is also established from battery through the left winding of relay 1000, off-normal contacts 1001, conductor 1002, terminal 922, brush 914, the outer left back contact of relay 906, the back contact of release magnet 917, inner right back contact and right winding of relay 907, conductor 902, winding of relay 800, conductor 801 to ground at the inner left contact of relay 506. Relays 1000 and 907 operate in this circuit, but due to its small number of turns relay 800 does not operate. Relay 1000 upon operating locks over its left contact to ground at the front contact of relay 1015 and at its outer right front contact prepares the operating circuit of the vertical magnet 1003. Relay 907 upon operating locks over its left front contact to ground at the front contact of relay 915, at its left back contact opens the energizing circuit for relay 906 and at its inner right back contact opens its own initial energizing circuit, and connects the trunk conductors 908 and 910 over its outer and intermediate right front contacts, right back contacts of relay 909, ring and tip brushes 925 and 924 to the selected trunk conductors 1008 and 1010. At its inner right front contact relay 907 connects ground on conductor 902 over the back contact of release magnet 917, the outer left back contact of relay 906, brush 914, terminal 922 to conductor 1002. At its intermediate right back contact relay 907 also opens the circuit previously traced through the windings of relays 904 and 602, whereupon these relays are released.

Pulsing relay 602 upon releasing opens the holding circuit of slow-to-release relay 617, which in turn releases relay 605. Relay 617 upon releasing also opens the circuit of magnet 512 which advances the brushes of steering switch 550 into contact with their third position terminals. As soon as the steering switch leaves position 2, the circuit of relay 603 is opened and that relay releases, opening the holding circuit of relay 610, which also releases in turn releasing relay 615. With the steering switch 550 in position 3,

the previously traced circuit for relay 504 is again established. With relay 556 energized a circuit is closed for relay 600 extending from battery through the left winding of relay 600, the inner right front contact of relay 556, the third position terminal and brush 503 of steering switch 550 to ground on conductor 502. Relay 600 upon energizing at its inner left contact locks directly over the third position terminal and brush 503 of switch 550 and at its inner right back contact opens the holding circuit of relay 510 which thereupon releases, in turn releasing relay 556. Relay 510 upon releasing again closes the previously traced circuit for relay 805 which in turn closes the previously traced circuits for relay 601 and stepping magnet 512.

Setting the second selector in accordance with second office code letter

It has been assumed that the second code letter registered on the units code register relay of the operator's position was A, having a numerical equivalent of 2, and that the units relay 201 has established a connection to the terminal of bank 417 of the position switch 450 in such a manner as to stop the position switch after it has rotated in synchronism with the vertical stepping of the second selector to measure two vertical steps of such selector. With the steering switch 550 in position 3 a pulsing circuit may now be traced from battery, winding of relay 1004, back contacts of rotary magnet 1005 and vertical magnet 1003, inner right back contact of relay 1006, intermediate right back contact of relay 1007, conductor 1008, brush 925, next to outer right back contact of relay 909, intermediate right front contact of relay 907, conductor 908, outer right back contact of relay 809, back contact of relay 810, back contact of relay 807, conductor 811, winding of pulsing relay 602, outer right front contact of relay 601, outer right front contact of relay 600, conductor 611, inner right back contact of relay 507, conductor 348, inner right contact of relay 331, brush 310, conductor 235, inner left back contact of relay 401, conductor 402, back contact of rotary magnet 403, back contact of vertical magnet 404, outer left back contact of relay 401, left contact of relay 405 to ground at the back contact of relay 416. Relays 602 and 904 energize in this circuit. Relay 602 upon energizing closes a circuit for itself over its left contact, the right back contact of relay 603 to ground at the right back contact of relay 622, independently of ground at the back contact of relay 416 and at its right front contact, establishes a circuit for relay 507, extending from battery, winding of relay 507, third position terminal and brush 516 to steering switch 550, conductor 511, the

inner left back contact of relay 605 to ground at the right front contact of relay 602.

Relay 507 at its outer left front contact establishes a circuit for rotary magnet 403 of the position switch 450, extending from battery through the winding of magnet 403, the outer right front contact of relay 405, the left back contact of release magnet 400, the winding of relay 406, the inner right back contact of relay 401, conductor 226, brush 308, the inner left contact of relay 311, conductor 320 to ground at the left contact of relay 507. Magnet 403 and slow-to-release relay 406 energize in this circuit, magnet 403 stepping the brush shaft of switch 450 one step in a rotary direction. Relay 507 at its outer right back contact also opens the circuit previously traced for relay 504, but relay 504 being slow to release does not do so as long as relay 602 continues to receive pulses due to the advance of the second selector and retransmits pulses through the winding of relay 507. With relay 507 energized a holding circuit for relay 507 is closed from battery through its winding, the left front contact of relay 504, the inner right front contact of relay 507, conductor 348, thence as traced through the left back contact of relay 401 to ground over the back contact of the rotary magnet 403 and the front contact of relay 406. Relay 507 therefore does not deenergize until the rotary magnet 404 has fully completed its energization to advance the switch 450 one step.

At the selector of Fig. 10 upon the energization of relay 1004 a circuit is closed for the vertical magnet 1003 through the winding of magnet 1003, the right front contact of relay 1000 to ground at the inner left front contact of relay 1004. Relay 1004 also closes an obvious circuit for relay 1009 which disconnects the tip and ring brushes of the selector during its vertical selection movement. Magnet 1003 energizes and at its contacts opens the previously traced pulsing circuit through the winding of relay 1004 and the winding of relay 602. The selector switch is thus stepped vertically one step opening at the off-normal terminal 1001 the initial energizing circuit of relay 1000. Upon the opening of the pulsing circuit and the deenergization of relay 602 the initial energizing circuit of relay 507 is opened and upon the completion of the first step of magnet 403 the holding circuit of relay 507 is opened, whereupon it deenergizes, opening the operating circuit of magnet 403, which thereupon deenergizes. At the selector, upon the deenergization of the vertical magnet 1003 the pulsing circuit previously traced is again established and relays 602 and 1004 again operate both performing the same functions previously described to cause the advance of the second selector and of the position switch 450 another step.

It has been assumed that the second code letter registered upon the units code register relay 201 was A, having a numerical equivalent of 2. Therefore, when the position switch 450 has advanced two steps in a rotary direction and the brush 408 is resting on the second terminal of the second level of bank 417, only the first two and tenth levels of such bank being disclosed, as circuit will be closed from ground at the outer left contact of relay 220, the right contact of relay 201, conductor 237, brush 408, thence over the inner left back contact of relay 401, conductor 235 and as previously traced to battery through the winding of relay 507. Relay 507 is thus prevented from deenergizing when rotary magnet 403 completes its second step for such a period that the circuit of relay 504 is held open long enough to release relay 504. Relay 504 on releasing opens the circuit of relay 507 which thereupon releases and opens the circuit of rotary magnet 403 and slow-to-release relay 406 of the position switch. Relay 504 upon deenergizing also opens at its right contact the previously traced circuit for relay 805 which deenergizes, in turn opening the circuits of relay 601 and magnet 512. Magnet 512, thereupon advances the steering switch 550 into position 4.

As soon as the steering switch leaves position 3 the previously traced locking circuit of relay 600 is opened, whereupon a circuit is established for relay 505, extending from battery through the winding of relay 505, left back contact of relay 510, conductor 618, outer right back contact of relay 600, conductor 611, inner right back contact of relay 507, conductor 348, inner right contact of relay 331, brush 310, conductor 235, inner left back contact of relay 401, conductor 402, back contacts of magnets 403 and 404, outer left back contact of relay 401, left contacts of relay 405 to ground at the back contact of relay 416. Relay 505 on energizing locks over its inner right contact directly to conductor 618 and closes an obvious circuit for relay 510, which then locks over its inner left contact, conductor 612, the inner right back contact of relay 600 to ground on conductor 509. With the steering switch in position 4 a circuit is established from battery through the winding of relay 504, outer right back contact of relay 507, back contact of relay 565, conductors 508 and 606, the inner left back contact of relay 610, conductor 608, the intermediate left contact of relay 406, the fourth position terminal and brush 520 of steering switch 550, conductor 521 to ground at the left back contact of relay 617. A circuit is also established from battery through the winding of relay 640, the right back contact of relay 620, brush 518, and its fourth position terminal conductor 817 to ground at the right back contact of relay 622.

As soon as relay 406 releases a circuit is established for relay 416, extending from battery, winding of relay 416, strapped terminals of the second level of bank 418, only the first two and tenth levels of such bank being shown, brush 407, off-normal contacts 415 to ground at the back contact of slow releasing relay 406. Relay 416 upon energizing at its front contact establishes a circuit for the release magnet 400 of the position switch extending from ground at the front contact of relay 416 over conductor 419, the outer right front contact of relay 220, conductor 420 to battery through the winding of magnet 400. Magnet 400 upon energizing releases the position switch 450 to normal, in which position the circuit of relay 416 is opened at brush 407, in turn opening the circuit of magnet 400. Magnet 400 at its right back contact also opens the locking circuit of relay 405, which thereupon releases, and disconnects ground from conductor 229, releasing relay 220. Relay 220 upon releasing in turn removes ground from conductor 231 at its inner left contact, but holding ground is still maintained on conductor 231 for holding operated relays of Fig. 2 energized, over the outer left contacts of relay 207. As soon as relay 416 energizes the circuit of relay 505 is opened and it deenergizes.

A circuit is now established for relay 556, extending from battery through the winding of relay 556, the outer right back contact of relay 505, the outer left front contact of relay 510, conductor 618, the left back contact of relay 600, conductor 611, thence as traced over the back contacts of magnets 403 and 404, the outer left back contact of relay 401, off-normal contacts 430 now closed since switch 450 is in normal position to ground at the right back contact of release 400. Relay 556 now locks over its inner left front contact, the right front contact of relay 510 to ground at the right contact of relay 504. With relays 504 and 556 both energized a circuit is now established for relay 507, extending from battery through the winding of relay 507, the left front contact of relay 504, conductor 557, the outer left contact of relay 556, the right back contact of relay 620, the fourth position terminal and brush 518 of steering switch 550, conductor 817 to ground at the right back contact of relay 622. Relay 507 upon energizing closes a circuit for the vertical magnet 404 of the position switch 450 in series with relay 406, extending from battery through the winding of magnet 404, the right back contact of relay 405, the left back contact of release magnet 400, winding of relay 406, inner right back contact of relay 401, conductor 226, brush 308, inner left contact of relay 331, conductor 320 to ground at the outer left contact of relay 507. Until the magnet 404 fully energizes, relay 507 is locked through its winding, the

front contact of relay 504, the inner right front contact of relay 507, conductor 348, the inner right front contact of relay 331, brush 310, conductor 235, the inner left back contact of relay 401, the back contacts of magnets 403 and 404, the outer left contact of relay 401 to ground at the front contact of relay 406. A circuit is also established upon the energization of relay 507 from ground at its left contact through the outer right contact of relay 556, the left back contact of relay 505, conductor 601 to battery through the right winding of relay 600. The energization of relay 600 now opens the locking circuit of relay 510, which deenergizes, in turn opening the circuit of relay 556 and closing a circuit for relay 805 extending from battery through the winding of relay 805, conductor 501, the right back contact of relay 510 to ground at the front contact of relay 504. Relay 805 upon energizing closes the previously traced circuits of relays 601 and magnet 512. Relay 600 also closes a locking circuit for relay 640 extending from battery through the winding and inner right contact of relay 640, inner right front contact of relay 600 to ground on conductor 509 and establishes a locking circuit for itself from battery through the right winding of relay 600, the left back contact of relay 505, the outer right front contact of relay 640, the outer left front contact of relay 600, the fourth position terminal and brush 503 to ground on conductor 502. Relay 556 upon deenergizing opens the initial energizing circuit of relay 507 and as soon as the vertical magnet 404 of the position switch completes its stroke to advance the position switch vertically a full step the holding circuit of relay 507 is opened at the back contact of magnet 404 and relay 507 releases, in turn opening the circuit previously traced through the windings of magnet 404 and relay 406. Although relay 507 upon energizing opens the circuit of relay 504 at its outer right back contact, it remained energized too short a time to permit the slow releasing relay 504 to be energized. The position switch 450 has now been advanced to position its brushes opposite the first level of terminals in the several banks. Relay 406 being slow to release does not deenergize to close the circuit of relay 405 before its circuit is again closed in a manner to be later described.

Selection of idle trunk group at second selector and partial registration of tens digit of trunk number

When the steering switch 550 in position 4 pulsing circuits are now established between the second selector and the sender and between the sender and the position switch 450 for setting the position switch in accordance with the vertical stepping of the second selector to register the tens group of trunks which the second selector now proceeds to

hunt for. It will be assumed that the group of trunks that is selected by the second selector of Fig. 10 extending to the distant office 122 comprises 40 trunks appearing in the second and third levels of the banks of such selector and as in response to the second code letter A, the switch shaft of the second selector has positioned its brush sets opposite the second level of each bank, commutator brush 1011 will now be standing on commutator segment 1012. Should all of the trunks in the second level of both banks be busy, there will be no ground potential connected to the segment 1012 and the circuit to be herein-
 10 after traced from the brush 1011 through the right winding of relay 1000 will not be effective to differentially release relay 1000. As a consequence a circuit is completed from battery through the winding of relay 1004
 20 thence as previously traced to the winding of pulsing relay 602, the outer right front contact of relay 601, the inner right front contact of relay 600, conductor 611, the inner right back contact of relay 507, conductor
 25 348, the inner right contact of relay 331, brush 310, conductor 235, the inner left back contact of relay 401, the back contacts of magnets 403 and 404, the outer left back contact of relay 401, the left front contact of relay 406 to ground, relay 406 not yet having
 30 had time to release since the position switch 450 took its previous vertical step. Relays 602 and 1004 are both energized, relay 602 locking to ground over its left contact, right back contact of relay 603, and the right back
 35 contact of relay 622, and closing at its right front contact the previously traced circuit for relay 507. Relay 507 energizes and at its left contact closes the previously traced
 40 circuit for the vertical magnet 404 and relay 406 of the position switch 450, and locks over the left contact of relay 504, its own inner right front contact, thence to ground at the front contact of relay 406 over the circuit
 45 previously traced.

Magnet 404 upon energizing advances the position switch 450 another step to position its brushes opposite the second level of their respective banks. Relay 406 which was previously energized when the switch 450 took its first step, and did not have time to release, is maintained energized at this time. Relay 1004 energizes and again closes the previously traced circuit for the vertical magnet 1003
 55 which in turn opens the pulsing circuit through the windings of relay 602 and 1004 just traced, relay 1004 in turn opening the circuit of magnet 1003. Thus magnet 1003 is operated and released to advance the switch shaft one step vertically to position the
 60 brushes opposite the third level of terminals in its banks. When relay 602 deenergizes upon the operation of vertical magnet 1003, the initial energizing circuit of relay 507 is
 65 opened and when the vertical magnet 404 of

the position switch completes its stroke to advance the switch 450 a full step, the locking circuit of relay 507 is opened and relay 507 releases, opening the operating circuit of magnet 404 and relay 406. Magnet 404 there-
 70 upon releases.

It will be assumed that when the second selector has stepped to position its brush sets opposite the third level of its banks, the brush 1011 encounters ground potential on the terminal 1018 corresponding to the third
 75 bank levels of the selector. In Fig. 1 the terminal equipment of two trunks extending to the office 122 both appearing in jacks before the operator has been illustrated, trunks
 80 136, 137 being the first in the group of ten trunks appearing in the third level of the upper bank of the second selector and trunk 126, 127 being the tenth in such group. In a
 85 similar manner ten other trunks extending to the office 122 appear in the terminals of the third level of the lower bank of the second selector, but with their tip and ring
 90 conductors reversed. It will be noted that so long as any trunk in this group is idle, ground will be connected to the commutator terminal 1018, over conductor 1019, the outer
 95 back contact of cut-off relay of such trunk, for example, relay 131, and over the outer back contact of the sleeve relay of such trunk, for example, relay 130. Similarly
 100 so long as any trunk in the other group of ten, one trunk of which is indicated at 1020, is idle, ground will be connected to the conductor 1021, also connected to the commuta-
 105 tor terminal 1018. Thus brush 1011 upon encountering ground potential establishes a circuit from such ground over brush 1011, right winding and inner right contact of relay 1000, the outer right back contact of relay
 110 1006, the outer right back contact of relay 1007, conductor 1010, brush 924, outer back contact of relay 909, outer right front contact of relay 907, conductor 910, inner right
 115 back contact of relay 809, conductor 619, the left front contact of relay 640, the outer left back contact of relay 610, to battery through both windings of relay 609. Relay 609
 120 energizes and establishes a circuit for relay 614 from battery, winding of relay 614, front contact of relay 609, to ground on conductor 509. Relay 614 at its right contact shunts the left winding of relay 609 thereby reducing the resistance of the circuit previously
 125 traced through the right winding of relay 1000 so that the right winding of this relay receives sufficient current to cause the differential release thereof. Relay 1000 upon releasing opens the operating circuit of the vertical magnet 1003 to prevent further
 130 vertical stepping of the selector. Relay 609 upon energizing also opens at its back contact the energizing circuit of relay 601 where-
 135 upon relay 601 deenergizes.

When relay 1000 deenergizes the previ- 130

ously traced circuit through relay 609 is opened at the inner right front contact of relay 1000 and relay 609 deenergizes in turn opening the energizing circuit of relay 614. Relay 614 being slow to release momentarily closes a circuit for relay 610 before it releases, extending from battery through the winding of relay 610, the left front contact of relay 614, right back contact of relay 609 to ground on conductor 509. Relay 610 upon energizing locks over its inner right contact, conductor 623, the fourth position terminal and brush 514 of steering switch 550, conductor 515, to ground at the intermediate left back contact of relay 622, at its outer left back contact, opens the initial energizing circuit of relay 609 and at its inner left back contact opens the circuit of relay 504. Relay 504 thereupon releases opening the previously traced circuit for relay 805.

Relay 805 upon deenergizing opens the circuit of magnet 512 thus advancing steering switch 550 into position 5. With the steering switch in position 5 a circuit is now closed for relay 620 extending from battery through the winding of relay 620, conductor 626, the fifth position terminal and brush 514 of the steering switch, conductor 515, to ground at the intermediate left back contact of relay 622. Relay 620 energizes and locks to ground on conductor 509. Upon leaving position 4 the locking circuits of relays 610, 600 and 640 are opened and with relay 507 released, a circuit is established from battery through the winding of relay 504, the outer right back contact of relay 507, the back contact of relay 565, conductor 508, conductor 606, the inner left back contact of relay 610, conductor 608, the intermediate left front contact of relay 506, the fifth position terminal and brush 520 of steering switch 550, conductor 521 to ground at the left back contact of relay 617. With relays 504 and 620 energized, a circuit is established for relay 805 extending from battery through the winding of relay 805, conductor 501, outer right front contact of relay 620, to ground at the right contact of relay 504. Relay 805 upon energizing in turn establishes the previously traced circuits of relay 601 and magnet 512.

With relay 600 deenergized a circuit is now established for relay 505 extending from battery through the winding of relay 505, the outer left back contact of relay 510, conductor 618, the outer right back contact of relay 600, contact 611, the inner right back contact of relay 507, conductor 348, thence as traced over conductor 235, the inner left back contact of relay 401, conductor 402, the back contacts of magnets 403 and 404, the outer left back contact of relay 401, the front contact of relay 406 to ground. Relay 505 upon energizing locks directly to conductor 618 and thence over the circuit just traced

and closes an obvious circuit for relay 510, which locks over conductor 612 and the inner right back contact of relay 600 to ground on conductor 509.

At the position switch 450 after an interval following the opening of the circuit of vertical magnet 404 and relay 406, by the deenergization of relay 507, measured by the releasing time of relay 406, the previously traced circuit of relay 405 is established from ground at the back contact of relay 406, and relay 405 energizes locking directly over its inner right front contact to ground at the right back contact of release magnet 400 and substituting the rotary magnet 403 for the vertical magnet 404 in the pulsing circuit extending to the left contact of relay 507. The deenergization of relay 406 also removes holding ground from the previously traced circuit of relay 505, and relay 505 deenergizes.

Selection of idle trunk in selected trunk group

With relay 601 energized and relay 505 deenergized a circuit is established from battery through the right winding of relay 600, conductor 601, outer left back contact of relay 505, the inner right front contact of relay 601, the fifth position terminal and brush 503 of steering switch 550 to ground on conductor 502. Relay 600 upon energizing opens the holding circuit of relay 510 thereby releasing relay 510 and establishes a pulsing circuit between the sender and the second selector for controlling the rotary hunting movement of the second selector. With relay 600 energized a circuit is now established for relay 565 extending from battery through the winding of relay 565, conductor 566, the intermediate left contact of relay 600, conductor 567, brush 518 and its fifth position terminal, conductor 817 to ground at the right back contact of relay 622. The pulsing circuit extends from battery through the winding of relay 1004, the back contacts of magnets 1003 and 1005, back contacts of relays 1006 and 1007 thence as previously traced through the winding of relay 602, the outer right front contact of relay 601, the next to the inner right front contact of relay 620, conductor 611, the inner right back contact of relay 507, thence as previously traced through the back contacts of magnets 403 and 404 at the position switch 450, the outer left back contact of relay 401, the left front contacts of relay 405 to ground at the back contact of relay 416. Relays 1004 and 602 energize in this circuit.

At the selector upon the energization of relay 1004 with relay 1000 deenergized, a circuit is established for the rotary magnet 1005 extending from battery, winding of magnet 1005, the outer right back contact of relay 1000, to ground at the inner left contact of relay 1004. Relay 1004 also es-

establishes a circuit for relay 1009 to disconnect the tip and ring brushes during the rotary hunting movement of the selector. Upon the closure of this pulsing circuit, magnet 1005 energizes opening the circuit previously traced, through the windings of relays 1004 and 602. Relay 1004 upon deenergizing opens the circuit of magnet 1005, which thereupon deenergizes again closing the pulsing circuit. Thus relay 1004 and magnet 1005 reciprocally control each other, the magnet 1005 advancing the switch shaft step by step in search of an idle trunk.

At the sender upon the energization of relay 602, a circuit is established from ground at the right front contact of relay 602, over the inner left back contact of relay 605, conductor 511, the fifth position terminal and brush 516 of steering switch 550, to battery through the winding of relay 507. Relay 507 upon energizing opens the energizing circuit of slow releasing relay 504, closes a holding circuit for itself extending through its winding, the right front contact of relay 504, the inner right front contact of relay 507, to ground over conductor 348 as previously traced, at its outer right front contact establishes a holding circuit for relay 504 extending over the front contact of relay 565, conductor 508, conductor 606, the inner left back contact of relay 610, conductor 608, the intermediate left front contact of relay 506, the fifth position terminal and brush 520, conductor 521, to ground at the left back contact of relay 617, and at its left contact establishes a pulsing circuit extending from battery through the winding of magnet 403 and winding of relay 406, thence as traced over conductor 320, to ground at the left contact of relay 507. Until relay 602 deenergizes upon the completion of the first rotary step of the second selector and the completion of the first rotary step of the position switch 450, relay 507 remains energized. When these steps are completed it deenergizes opening the circuit of magnet 403. In response to the successive operations of relay 602, as the second selector advances in its rotary hunting movement, relay 507 operates to retransmit impulses to the position switch 450.

In the present case it will be assumed that the trunks having an even tens number terminate in the lowermost banks of the second selector and that the trunks having an odd tens number terminate in the upper bank of the second selector and that all trunks terminating in the upper banks have their tip and ring conductors reversed. For example, trunks 0 to 9, 20 to 29 etc. terminate in the lower bank of the second selector of Fig. 10 and trunks 10 to 19, 30 to 39, etc., terminate in the upper bank. It will further be assumed that the selector hunts to its tenth rotary step position and finds the last trunk

126, 127 numbered 39, appearing in the last terminal set of the third level of the upper bank thereof, in an idle condition.

At the selector upon the test brush 1014 encountering the test terminal of the idle trunk 126, 127 a circuit is established from battery through the right winding of cut-off relay 121, the inner right back contact of sleeve relay 120, conductor 1022, test terminal 1023, brush 1014, the left back contact of relay 1007, the intermediate left back contact and right winding of relay 1006, the conductor 1002, terminal 922, brush 914, the outer left back contact of relay 906, the back contact of release magnet 917, the inner right front contact of relay 907, conductor 902, winding of relay 800, conductor 801 to ground at the inner left contact of relay 506. Relays 1006 and 121 energize in this circuit, relay 121 locking over its inner right front contact to conductor 1022 independent of relay 120 and relay 1006 locking from battery through its left winding and inner left front contact to ground at the front contact of relay 1015. At its outer left back contact, relay 1006 opens the operating circuit of relay 1007, at its intermediate left back contact opens its operating circuit, and at its intermediate left front contact connects conductor 1002 over the outer left back contact of relay 1007 to test brush 1014. At its right front contacts relay 1006 extends conductors 1010 and 1008 over the outer right and intermediate right back contacts of relay 1007, right back contacts of relays 1009 to the tip and ring brushes 1024 and 1025. Also at its inner right back contact, relay 1006 opens the circuit previously traced through the windings of relays 1004 and 602.

Relay 602 upon remaining deenergized holds open the initial energizing circuit of relay 507, and rotary magnet 403 upon completely energizing in response to the last impulse transmitted thereto by relay 507, opens the locking circuit of relay 507, whereupon relay 507 deenergizes, opening the pulsing circuit through magnet 403 and relay 406 and the holding circuit of relay 504. Relay 504 upon deenergizing opens the circuit of relay 805 which in turn deenergizes opening the circuits of relay 601 and magnet 512, thereby advancing the steering switch 550 into position 6. Relay 601 in turn opens the holding circuit of relay 600 which deenergizes, again establishing the previously traced circuits of relays 505 and 510. With the steering switch in position 6 a circuit is now closed for relay 622 extending from battery through the winding of relay 622, the sixth position terminal and brush 503 of the steering switch to ground on conductor 502. Relay 622 energizes locking to ground on conductor 509. Upon leaving position 5 relay 565 releases.

A fundamental circuit is now established from ground at the incoming selector 123

over trunk conductor 127, brush 1024, thence as previously traced to conductor 910 over the inner back contact of relay 809, conductor 619, winding of polarized relay 624, the inner left front contact of relay 622, the winding of relay 602, back contact of relay 807, the back contact of counting relay 810, the outer back contact of relay 809, conductor 908, thence as traced to brush 1025, over trunk conductor 126 to battery through the control relay (not shown) at the incoming selector 123. If the incoming selector is in a condition to be operated at this time, relay 624 and relay 602 operate, the polarized relay 624 receiving current in the proper direction since the trunk conductors 126 and 127 have been assumed to be reversed. Relay 602 is without function, however, at this time. The circuits now remain in this condition until after the operator has caused the registration of the thousands and hundreds digit of the wanted line number on the registers of the sender.

Registration of numerical digits of wanted line number

All of the foregoing circuit operations have resulted from the depression of an office key by an operator. While this has been transpiring the operator has proceeded to depress the digit keys to register the numeral designation of the wanted line on the sender registers shown in Fig. 7, as soon as the lamp 302 flashes indicating that an idle sender has been attached to her position equipment. It has been assumed that the number of the desired line in the office 122 is 3981. The operator therefore first depresses the No. 3 digit key 212 to register the thousands digit 3. At its left contact key 212 establishes a circuit from ground through low resistance 238 over conductor 216, the outer right back contact of relay 208, conductor 223, brush 305, the outer left contact of relay 331, conductor 336, winding of relay 522, brush 529 and its first position terminal of the steering switch 500, conductor 533, right winding of thousands register 703 to battery. Relay 703 due to the low resistance of its operating circuit energizes and locks over its left winding and left contact to ground on conductor 701 and relay 522 also operates. A second circuit is also established by the depression of key 212, extending from ground through the right winding of relay 702, conductor 519, the normal position terminal and brush 530 of switch 500, winding of relay 521, conductor 339, the next to outer left contact of relay 331, brush 307, conductor 225, the left back contact of relay 208, conductor 241, right contacts of key 212, high resistance 217, conductor 213, the inner right back contact of relay 208, conductor 224, brush 306, the next to inner left contact of relay 331, conductor 337, winding of relay 523, brush 532 and the normal position terminal of steering switch

500, conductor 524, to battery through the right winding of relay 712. Due to the inclusion of high resistance 217, thousands register relays 712 and 702 do not operate but relays 521 and 523 both operate. With relays 522 and 521 operated, a circuit is established from ground through the contacts of these relays, brush 531 and its normal position terminal, conductor 535 to battery through the right winding of thousands register relay 705. Relay 705 energizes and locks over its left winding through the winding of relay 706, to ground on conductor 701, operating relay 706. Thus relays 703, 705 and 706 of the thousands register have been operated in response to the operation of key 212 for the thousands digit 3. Relay 523 upon operating closes a circuit from ground through the windings of relay 525 and magnet 534 in parallel. Relay 525 upon energizing closing a circuit from ground at its contact through the back contact of magnet 534, to battery through the winding of magnet 534. As soon as the operator releases the depressed key, relays 521, 522 and 523 release, relay 523 in turn opening circuits of relay 525 and magnet 534. Relay 525 is, however, held energized over the back contact of magnet 534, until the magnet is fully energized when it releases opening at its front contact the circuit extending to battery through the contacts and winding of magnet 534. Relay 525 thus insures that the magnet 534 will energize fully to advance the steering switch 500 one step as soon as the operator releases the depressed key.

The operator next depresses the No. 9 key 215 to register the hundreds digit 9. At its left contact key 215 closes a circuit extending from ground through low resistance 238, the left contacts of key 215, conductor 216, the right back contact of relay 208, conductor 223, brush 305, the outer left contact of relay 331, conductor 336, winding of relay 522, brush 529 and the second position terminal of steering switch 500, conductor 536 to battery through the right winding of hundreds register relay 707. Due to the low resistance of this operating circuit, relay 707 operates and locks over its left winding and inner left contact to ground on conductor 701. Relay 522 also operates. At its right contacts key 215 closes a circuit from ground through the low resistance 238, the right contacts of key 215, conductor 213, the inner right back contact of relay 208, conductor 224, brush 306, the next to the inner left contact of relay 331, conductor 337, winding of relay 523, brush 532, and its second position terminal, conductor 543 to battery through the right winding of hundreds register relay 713. Relays 523 and 713 operate in this circuit, relay 713 locking to ground on conductor 701 over its left winding and inner left contacts. Hundreds register relays 707 and

713 have thus been operated. Relay 522 performs no useful functions at this time, but relay 523 again causes the operation of relay 525 and magnet 534 for advancing the brushes of steering switch 500 to position 3 upon the release of the operated key 215.

In response to the depression of the No. 8 digit key 218 for registering the tens digit 8, a circuit is established from ground through the low resistance 238, the right contacts of key 218, conductor 213, the inner right back contact of relay 208, conductor 224, brush 306, the next to the inner left contact of relay 331, conductor 337, winding of relay 523, brush 532 and its third position terminal, conductor 538 to battery through the right winding of tens register relay 709. Relays 523 and 709 energize, relay 709 locking over its left winding and left contact to ground at conductor 701. A second circuit is also established from battery through the right winding of tens register relay 717 over conductor 544, the third position terminal and brush 529 of steering switch 500, winding of relay 522, conductor 336, the outer left contact of relay 331, brush 305, conductor 223, the outer right back contact of relay 208, conductor 216, the left contacts of key 218, conductor 241, the left back contact of relay 208, conductor 225, brush 307, the next to the outer left contact of relay 331, conductor 339, winding of relay 521, brush 530 and its third position terminal, conductor 526 to ground through the right winding of tens register relay 715. Due to the low resistance of this circuit, relays 521, 715 and 717 operate, relays 715 and 717 locking over their left windings and inner left front contacts to ground on conductor 701. Since relays 522 and 521 are both energized a circuit is established from ground over the contacts of these relays, brush 531 and its third position terminal, conductor 539, to battery through the right winding of relay 710. Relay 710 energizes and locks over its left winding and inner left front contact to ground on conductor 701. Tens register relays 709, 710, 715 and 717 are now operated. Relay 523 upon operating establishes the previously traced circuits for relay 525 and magnet 534 preparatory to advancing steering switch 500 into position 4 upon the release of the depressed key 218.

In response to the depression of the No. 1 key 219 for registering the units digit 1, a circuit is established from ground over the right contacts of key 219, through high resistance 217, conductor 213, the inner right back contact of relay 208, conductor 224, brush 306, the next to the inner left contact of relay 331, conductor 337, winding of relay 523, brush 532 and its fourth position terminal, conductor 527, to battery through the right winding of units register relay 719. Due to the inclusion of high resistance 217, relay 719 does not operate, but relay 523 op-

erates. A second circuit is also established from battery through the right winding of units register relay 716, conductor 528, brush 529 and its fourth position terminal, winding of relay 522, conductor 336, the outer left contact of relay 331, brush 305, conductor 223, the outer right back contact of relay 208, conductor 216, high resistance 240, the left contacts of key 219, conductor 241, the left back contact of relay 208, conductor 225, brush 307, the next to the outer left contact of relay 331, conductor 339, winding of relay 521, brush 530 and its fourth position terminal, conductor 552, to ground through the right winding of relay 720. Due to the inclusion of high resistance 240, register relays 716 and 720 do not operate, but relays 521 and 522 both operate and close a circuit from ground over their contacts, brush 531 and its fourth position terminal, conductor 540 to battery through the right winding of units register relay 711. Relay 711 operates and locks over its left winding and inner left front contact to ground at conductor 701. Relay 711 is thus the only units register relay operated. Relay 523 upon operating again causes the operation of relay 525 and magnet 534 to advance steering switch 500 into position 5 upon the release of the depressed key 219. The numerical registers of the sender have now been set.

It will be recalled that the fundamental circuit between the sender and the incoming selector 123, was established with the steering switch 550 in position 6 and that the further advance of said steering switch awaited the registration of the hundreds digit of the wanted line number. Upon the registration of such digit a circuit is established for relay 635 extending from ground over brush 549 and the third position terminal of steering switch 500, conductor 558, winding of relay 635, resistance 627 to battery. Relay 635 energizes and locks over its inner right front contact to ground on conductor 509 and at its left contact establishes a circuit for advancing steering switch 550 into position 7, extending from battery through the winding and contacts of magnet 512, conductor 628, left contacts of relay 635, conductor 629, sixth position terminal and brush 520 of steering switch 550, conductor 521, to ground at the left back contact of relay 617. With steering switch 550 in position 7 and polarized relay 624 operated over the fundamental circuit, a circuit is now established for relay 625 extending from battery through the winding of relay 625, conductor 630, the seventh position terminal and brush 514 of steering switch 550, conductor 515 to ground at the left front contact of relay 624. Relay 625 upon energizing locks over its left front contact to ground on conductor 509. The operation of relay 625 at this time indicates

to the sender that a trunk terminating in the upper bank of the second selector has been seized. A circuit is also established at this time for advancing steering switch 550 into position 8 which may be traced from battery through the winding and contacts of magnet 512, the seventh position terminal and brush 520, conductor 521 to ground at the left back contact of relay 617.

10 With steering switch 550 in position 8, a circuit is established for relay 805 extending from battery through the winding of relay 805, conductor 501, the eighth position terminal and brush 503 of steering switch 550, conductor 502 to ground at the inner right contact of relay 506, relay 805 upon energizing closing the previously traced circuit of magnet 512 preparatory to advancing steering switch 550 into position 9. In position 20 8, a circuit is established for relay 607 extending from battery through the winding of relay 607, over conductor 631, the eighth position terminal and brush 520 of steering switch 550, conductor 521 to ground at the 25 left back contact of relay 617. Relay 607 upon energizing locks over its inner left front contact to ground on conductor 509 and closes at its outer left front contact a circuit extending from ground over conductor 30 632, strapped terminals and brush 554 of steering switch 500 to battery through the contacts and winding of magnet 534, for advancing steering switch 500 out of position 5 if the numerical registration has been completed, into position 9. When the steering 35 switch 500 reaches position 9 a shunt is established around the winding of relay 635 extending from resistance 627, over conductor 633, the ninth position terminal and brush 549 to ground thereby deenergizing relay 635 to prepare at its outer right back contact a circuit for later enabling the fundamental circuit to be established when steering switch 550 reaches position 14.

45 At the position switch upon the release of relay 406 the holding circuit previously traced for relay 505 is opened and a circuit is established for relay 416 extending from battery through the winding of relay 416, the bank terminal of bank 418 upon which brush 407 is now resting assumed to be the tenth terminal of the second level, brush 407, off-normal contacts 415 to ground at the back contact of relay 406. The relay 416 upon 55 energizing also establishes a circuit for relay 401 extending from battery through the winding of relay 401, conductor 421, the right back contact of relay 220, conductor 419 to ground at the front contact of relay 416. Relay 401 upon energizing now closes a circuit for relay 422 extending from battery through the winding of relay 422, inner left front contact of relay 401, conductor 235, brush 310, inner right front contact of relay 60 331 conductor 348, the inner right back con-

tact of relay 507, conductor 611, to ground at the inner right front contact of relay 625. It is to be understood, however, that relay 422 energizes only if the second selector has selected a trunk in its upper bank and has caused the energization of relay 625 in the manner previously described. It will be noted that with relay 422 energized brush 411 of the position switch 450 having access over its corresponding bank terminals to lamps indicating an odd tens number is selected, but that with relay 422 deenergized brush 410 having access over its corresponding bank terminals to lamps indicating an even tens number is selected.

It has been assumed that in selecting an idle trunk, the second selector stepped one step vertically and ten steps in a rotary direction and that selection was made over the upper bank thereof. Correspondingly the position switch 450 positioned its brushes on the tenths set of terminals of the second level of its banks. A circuit is therefore closed for the No. 0 hundreds lamp 434 extending from battery through such lamp, terminal 423, brush 409 to ground at the outer right front contact of relay 401. A circuit is also established for the No. 3 tens lamp 424 extending from battery, lamp 424, terminal 425, brush 411, front contact of relay 422 to ground at the outer right front contact of relay 401. A circuit is also established for the No. 9 units lamp extending from battery, lamp 439, terminal 426, brush 412 to ground at the outer right front contact of relay 401. These lighted lamps now indicate to the operator that trunk No. 039 has been selected. It is to be noted in this connection that trunks numbered above 99 appear in the upper halves of the banks of the second selector and that had the second selector stepped vertically more than four steps, the brush 409 of the position switch would have correspondingly advanced above the center of its bank, and the No. 1 hundreds lamp would have been lighted instead of the No. 0 lamp. The operator noting the illumination of the trunk number indicating lamps may now plug into the indicated trunk at her leisure.

Incoming brush selection

It will be recalled that a fundamental circuit has been established and that relay 602 has been energized thereover in series with the control relay of the incoming selector 123. With the steering switch 550 in position 8, relay 602 now closes a counting relay control circuit which may be traced from ground at the front contact of relay 602 over the inner left back contact of relay 605, conductor 511, brush 516, and the eighth position terminal of steering switch 550, conductor 541, right front contact of thousands register relay 703, the inner right back contact of register relay 712, the outer left front contact of register

relay 705, lead 813, the back contact of counting relay 814, to battery through the winding of counting relay 832. Relay 832 energizes and locks through the winding of relay 814 over its own front contact to ground on conductor 806, but relay 814 does not energize until the commutator of the incoming selector places a shunting ground around the winding of relay 602 as soon as the incoming selector reaches its first brush selection position. This selector switch action is well known in the art and it is thought need not be fully described herein. When such shunting ground is applied, relay 602 deenergizes removing ground from lead 813, whereupon relay 814 energizes extending the lead 813 over its front contact, the back contact of counting relay 816, conductor 817, brush 518 and its eighth position terminal, conductor 517, to battery through the winding of counting relay 818. Upon the further advance of the incoming selector shaft and the removal of the shunt around the winding of relay 602 by the commutator of the selector, relay 602 again energizes completing the circuit of relay 818, which energizes and locks through the windings of relays 802 and 810 in parallel over the front contact of relay 818 to ground on conductor 806. Upon the next deenergization of relay 602, relays 802 and 810 operate in this locking circuit. Relay 810 upon energizing opens the fundamental circuit arresting the further movement of the incoming selector and advancing the sequence switch thereof into position for operating the brush tripping magnet. Relay 802 upon energizing opens the circuit of magnet 512 to advance steering switch 550 into position 9, thereby relay 805. Relay 805 in turn removes ground from conductor 806 to thereby release all operated counting relays. A circuit is now closed for relay 807 extending from battery, winding of relay 807 to ground at the front contact of relay 802 which is effective to hold relay 807 energized to in turn hold the fundamental circuit open until relay 805 has released the counting relays. As soon as the steering switch advances into the position 9, relay 807 is maintained energized from battery through its winding, conductor 819, the ninth position terminal and brush 503 of steering switch 550, to ground at the inner right contact of relay 506.

Relay 807 upon energizing now closes a circuit for reversing relay 809, over conductor 848, outer right contact of relay 625 to ground at the front contact of relay 807. Relay 809 upon energizing locks over its left contact directly to ground on conductor 509, and at its right contacts reverses the conductors of the fundamental circuit with respect to the winding of polarized relay 624. In position 9 a circuit is established for advancing the steering switch 550 into position 10 extending from battery through the winding and con-

tacts of magnet 512, the ninth position terminal and brush 520 of the switch 550, conductor 521 to ground at the left back contact of relay 617. The circuit of relay 807 is now opened and this relay deenergizes again establishing the fundamental circuit extending to the incoming selector 123, whereupon relay 602 and the control relay of the selector energize. The control relay of the selector circuit prepares the selector for brush tripping and incoming group selection and relay 602 establishes a circuit for controlling the counting relays of the sender. The polarized relay 624 is at this time not energized since relay 809 has now reversed the connection of trunk conductors 908 and 910 with respect to the winding of relay 624. With the steering switch 550 in position 10 a circuit as previously traced is established for relay 805 for supplying locking ground to the counting relays and the previously traced circuit is closed for magnet 512 preparatory to advancing steering switch 550 into position 11.

Incoming group selection

With relay 602 energized a circuit is now closed from ground at the front contact of relay 602 over the inner left back contact of relay 605, conductor 511, brush 516 and its tenth position terminal, conductor 542, the outer right back contact of the thousands register relay 712, the lower front contact of relay 706, the outer left front contact of hundreds register relay 713, lead 849, the back contact of counting relay 850 to battery through the winding of counting relay 830. Relay 830 energizes and locks through the winding of relay 850 and over its own front contact to ground on conductor 806, but relay 850 does not operate. At the incoming selector the brush shaft is started upon the closure of the fundamental circuit to trip the selected set of brushes and to make group selection, the selector commutator intermittently shunting the sender pulsing relay 602 as the tripped set of brushes approaches each group selection position. Upon the first shunting of relay 602, it deenergizes permitting the operation of relay 850 which thereupon extends the lead 849 over its front contact and the back contact of counting relay 851 to battery through the winding of counting relay 831 upon the next energization of relay 602. In the manner previously described the pairs of counting relays are successfully operated until relays 818, 810 and 802 operate at which time the incoming selector shaft will have advanced in such a manner as to position the second set of brushes thereof upon the lowermost set of terminals in the fourth group to which said brush set has access. Relay 810 upon operating opens the fundamental circuit thereby arresting the advance of the incoming selector and causing circuit

changes thereat to start the incoming selector hunting for an idle final selector trunk. The incoming selector has now selected an idle final selector having access to the 500 lines, 3500 to 3999 inclusive. Relay 802 upon energizing opens the circuit of magnet 512 which deenergizes advancing steering switch 550 into position 11. Upon leaving position 10 relay 805 releases in turn unlocking all operated counting relays. In the manner previously described relay 807 is operated over the front contact of relay 802 until relay 802 releases following the release of relay 805 and is held operated over the eleventh position terminal and brush 503 of steering switch 550 until it leaves position 11. In position 11 the previously traced circuit over brush 520 is closed to advance steering switch 550 into position 12, thereupon reoperating relay 805, releasing relay 807 and reestablishing the fundamental circuit.

Final brush selection

With the fundamental circuit again established pulsing relay 602 and the control relay of the final selector are operated. The control relay of the final selector preparing the circuits thereof for brush selection and the pulsing relay 602 closing a counting relay control circuit extending from ground at the front contact of relay 602 thence as traced to brush 516 and its twelfth position terminal, conductor 545, the back contact of hundreds register relay 714, the back contact of hundreds register relay 708, the inner right front contact of hundreds register relay 707, lead 822, the back contact of counting relay 821, to battery through the winding of counting relay 829. Relay 829 energizes and locks through the winding of relay 821 and its own front contact to ground on conductor 806, but relay 821 being shunted at the front contact of relay 602 does not energize. As the brush shaft of the final selector advances in its brush selection movement, the commutator thereof intermittently shunts the sender pulsing relay 602. Upon the first shunting of relay 602 such relay deenergizes permitting counting relay 821 to operate to extend the pulsing lead 822 over its front contact and back contact of counting relay 850, to battery through the winding of relay 830. In the well known manner in response to the advance of the final selector shaft pairs of counting relays are successfully operated until relays 818, 810 and 802 operate at which time the selector switch shaft will have advanced to a position to trip the fifth set of brushes having access to lines 3900 to 3999 inclusive. Relay 810 upon operating opens the fundamental circuit thereby arresting the advance of the final selector and causing circuit changes thereat to prepare for tripping the selected set of brushes. Relay 802 upon energizing opens the circuit of magnet 512,

which thereupon advances the steering switch 550 into position 13.

Upon leaving position 12, relay 805 releases in turn unlocking all operated counting relays. In the manner previously described relay 807 is operated over the front contact of relay 802 until relay 802 releases following the release of relay 805, and is held operated over the thirteenth position terminal and brush 503 of steering switch 550 until it leaves position 13. In position 13 the previously traced circuit over brush 520 is closed to advance the steering switch 550 into position 14, thereupon reoperating relay 805, releasing relay 807 and reestablishing the fundamental circuit, providing that the tens digit has been registered.

If the tens digit has not yet been registered, the steering switch 500 will not have advanced beyond position 4 and relay 635 will still be locked-up and therefore when the steering switch 550 advances into position 14 the fundamental will not be closed since relay 807 will be held energized over a circuit extending from battery through the winding of relay 807, conductor 819, the outer right front contact of relay 635, the fourteenth position terminal and brush 520 of steering switch 550, conductor 521, to ground at the left back contact of relay 617. As soon as the numerical registration is completed and relay 635 is shunted down as previously described, relay 807 deenergizes reestablishing the fundamental circuit.

Final tens selection

With the fundamental circuit again established pulsing relay 602 and the control relay of the final selector are operated. The control relay of the final selector starting the final selector in its tens selection movement, tripping the selected set of brushes. The pulsing relay 602 now closes a counting relay control circuit for controlling the tens selection movement of the final selector extending from ground at the front contact of relay 602 thence as traced to brush 516 and its fourteenth position terminal, conductor 546, the outer front contact of the tens register relay 710, the outer left front contact of tens register relay 717, counting relay lead 849, the back contact of counting relay 850 to battery through the winding of relay 830. Relay 830 energizes and locks through the winding of relay 850 and its own front contact to ground on conductor 806, but relay 850 does not energize since it is at the time shunted over the front contact of pulsing relay 602. As the brush shaft of the final selector advances in its brush selection movement the commutator thereof intermittently shunts the sender pulsing relay 602. At the first shunting, relay 602 deenergizes permitting counting relay 850 to operate to extend the operating lead 849 over the front contact of relay 850, the

back contact of relay 851, to the counting relay 831. In the well known manner in response to the advance of the final selector shaft, pairs of counting relays are success-
 5 fully operated until relays 814 and 832 operate, when the lead 849 becomes extended over the front contact of relay 814, the back contact of relay 816, conductor 817, brush 518 and the fourteenth position terminal of steering switch 550, conductor 547, the right front
 10 contact of tens register relay 709, which always operates when the tens digit registered is greater than four, conductor 723 to battery through the winding of counting relay 833.
 15 The remaining relays are then successfully operated as the final selector advances in its tens selection movement, until relays 818, 810 and 802 operate, at which time the tripped brush set of the final selector will be positioned beneath the first terminal of the
 20 eighth tens group, in which lines 3980 to 3989 terminate.

Relay 810 upon operating opens the fundamental circuit thereby arresting the advance
 25 of the final selector. Relay 802 upon energizing opens the circuit of magnet 512, which deenergizes and advances the steering switch 550 into position 15. Upon leaving position 14, relay 805 releases in turn unlocking all
 30 operated counting relays. In the manner previously described, relay 807 is operated following the energization of relay 802 and is held operated over the fifteenth position terminal and brush 503 of steering switch
 35 550 until it leaves position 15. In position 15 the previously traced circuit over brush 520 is closed to advance the steering switch 550 into position 16, thereby reoperating relay 805 releasing relay 807 and reestablish-
 40 ing the fundamental circuit.

Final units selection

With the fundamental circuit again established pulsing relay 602 and the control re-
 45 lay of the final selector are operated, the control relay of the final selector starting the final selector in its units selection movement. Pulsing relay 602 closes a counting relay control circuit for controlling the units selec-
 50 tion movement of the final selector, extending from ground at the front contact of relay 602, thence as traced to brush 516 and its sixteenth position terminal, conductor 548, the outer front contact of units register relay 711,
 55 the left back contact of the units register relay 716, the counting relay lead 813, the back contact of counting relay 814 to battery through the winding of relay 832. Relay 832 energizes and locks through the winding of
 60 relay 814 and its own front contact to ground on conductor 806, but relay 814 does not operate as its winding is shunted over the front contact of pulsing relay 602. As the brush shaft on the final selector advances, the com-
 65 mutator thereof intermittently shunts the

stepping relay 602, thereby causing the operation of successive counting relays until relays 818, 810 and 802 energize at which time the tripped set of brushes will have been positioned upon the terminal of the wanted line
 70 125. Relay 802 upon energizing opens the circuit of magnet 512 which thereupon advances steering switch 550 into position 17. Relay 810 opens the fundamental circuit thereby arresting the further advance of the
 75 final selector. Upon leaving the position 16, steering switch 550 opens the circuit of relay 805 which deenergizes in turn releasing all operated counting relays. In the manner previously described relay 807 is operated
 80 over the front contact of relay 802 until relay 802 releases, following the release of relay 805 and is held operated over the seventeenth position terminal and brush 503 of the steering switch until it leaves position
 85 17. In position 17 a circuit is closed from battery through the winding and contacts of magnet 512 the seventeenth and eighteenth position terminals and brush 520 of steering switch 550, conductor 521 to ground at the
 90 left back contact of relay 617, for advancing the steering switch into position 19.

In position 19 a circuit is established for advancing steering switch 500 out of position
 95 9 into normal position extending from battery through the winding and contacts of magnet 534, the nineteenth position terminal and brush 520 of steering switch 550, conductor 521 to ground at the left back contact
 100 of relay 617. Upon reaching position 10 steering switch 500 establishes a circuit for magnet 512 extending from battery through the winding of magnet 512 conductor 513, the tenth position terminal and brush 549 of steering
 105 switch 500 to ground, preparatory to advancing steering switch 550 into position 20. This circuit is maintained until the steering switch 500 reaches normal position when it is opened and steering switch 550 is permitted to advance into position 20, opening the
 110 driving circuit of magnet 534.

Incoming selector advances for ringing called line

With steering switch 550 in position 20 the
 115 previously traced circuit of relay 805 is established and relay 805 energizes establishing the previously traced circuit for magnet 512 preparatory to advancing steering switch 550 into position 21. Upon leaving
 120 the position 17, steering switch 550 opens the circuit of relay 807 which thereupon releases again closing the fundamental circuit.

At the final selector following the completion of units selection, the circuits of the final
 125 selector are cut through for talking and the incoming selector sequence switch is advanced in the well known manner to again complete the fundamental circuit through relay 602 and the control relay of the incoming selector, 130

relay 602 at this time establishing a circuit for counting relay 818, extending from ground at the front contact of relay 602, thence as traced to brush 516, counting relay operating lead 853, the back contact of counting relay 816, conductor 817, brush 518 the twentieth position terminal of steering switch 550, conductor 517, to battery through the winding of relay 818. Relay 818 operates and locks through the windings of relays 802 and 810 in parallel, but the latter relays being shunted over the contact of relay 602 do not operate until the sequence switch of the incoming selector advances under the control of the relay thereof to open the fundamental circuit and release relay 602. When the sequence switch of the incoming selector advances and relay 602 deenergizes relays 802 and 810 operate.

Relay 810 upon operating opens the fundamental circuit and relay 802 upon operating opens the circuit of magnet 512 to advance the steering switch 550 into position 21. The circuit of relay 805 is now opened to release relays 818, 810 and 802. Upon the operation of relay 802, relay 807 again operates, but releases as soon as relay 802 releases, to reestablish the fundamental circuit. Upon the reestablishment of the fundamental circuit at the incoming selector the control relay of the incoming selector and relays 602 and 624 of the sender operate. Relay 624 operates at this time because the fundamental circuit has been reversed at the incoming selector in the well known manner. The testing of the wanted line 125 by the final selector and the application of ringing current thereto, if such line is found to be idle, proceeds in the well known manner after which the talking circuit from the wanted line to the trunk conductors 126 and 127 is established.

Upon the energization of the polarized relay 624, a circuit is established from ground at its contact over conductor 515, the twenty-first position terminal and brush 514 of steering switch 550, to conductor 559 preparatory to releasing the sender. The release, however, does not proceed until after the operator has plugged into the jack 119.

Operator completes connection by plugging into indicated trunk jack

When the operator plugs into the trunk jack 119, in accordance with the trunk member 039 indicated to her on her trunk number indicating lamps, a circuit is closed from battery through lamp 114, resistance 116, sleeves of plug 118 and jack 119 to ground through the left winding of sleeve relay 120. Relay 120 energizes and at its inner right front contact connects the right non-inductive winding of relay 120 and the left non-inductive winding of relay 121 in parallel with the right winding of relay 121 over the circuit previously traced to ground through the

winding of relay 800. Relay 800 now receives sufficient current to energize and at its right contact connects ground over conductors 857 and 320, over the inner left contact of relay 331, brush 308, conductor 226, the inner right front contact of relay 401, conductor 427 to battery through the winding of release relay 205 at the operator's position equipment.

Release of operator's equipment and sender

Relay 205 upon operating closes a circuit for release magnet 400 of the position switch 450 which energizes releasing such switch to normal. Magnet 400 upon energizing also opens the locking circuit of relay 405 whereupon relay 405 releases. As soon as switch 450 reaches normal, the circuit of relay 416 is opened at brush 407 and the circuits of the lighted lamps are opened at brushes 409 to 412 inclusive. The release of relay 416 also opens the circuit of relay 401 and such relay releases. Relay 401 in turn opens the circuit of release relay 205, but relay 205 being slow to release does not deenergize immediately. Until it does release it maintains release magnet 400 energized over its left contact and at its outer right contact maintains the previously traced holding circuit for relays 207 and 340 open. These latter relays thereupon release, relay 207 at its outer left front contact removing ground from conductor 231 thereby releasing relays 201 to 204 inclusive. Relay 340 upon deenergizing at its inner left contact opens the circuit of relay 331 which thereupon releases. Relay 331 upon deenergizing now closes a circuit extending from ground at its outer right back contact, over the back contact of relay 311, off-normal contacts 303, through the winding of release magnet 302 to battery. This magnet upon energizing now releases the position finder switch of Fig. 3 to normal. As soon as the finder reaches normal, the off-normal contacts 303 and 324 open, the contacts 324 opening the locking circuit of relay 312 which thereupon releases, and contacts 303 opening the circuit of release magnet 302.

Upon its release relay 340 completes at its right back contact the circuit previously traced to conductor 559 over conductor 351 to battery on conductor 626. This circuit is in shunt of the windings of relays 700 and 506 which thereupon deenergize. The release of relay 506 removes ground from conductor 509 whereupon all operated relays of Figs. 5, 6 and 8 release. A circuit is now closed for advancing steering switch 550 out of position 21 into normal position extending from battery through the winding and contacts of magnet 512, brush 553 and the strapped terminals of its arc to ground at the outer left back contact of relay 506. Relay 700 upon deenergizing opens at its upper-

most contact the holding circuits of the numerical register relays of the sender and at its intermediate lower contact opens the circuit of relay 915 of the first selector.

Relay 915 upon deenergizing now closes the circuit of release magnet 917 which energizes and restores the first selector of Fig. 9 to normal. As soon as this selector reaches normal, the circuit of magnet 917 is opened at off-normal contacts 916. At its front contact relay 915 also unlocks all operated relays of the first selector. At its intermediate lower contact relay 700 also removes ground from conductor 921 thereby releasing relay 1015 of the second selector which thereupon releases, unlocking all operated relays of such selector and closing at its back contact the circuit of release magnet 1017. Magnet 1017 energizes and releases the second selector, its own circuit being opened at off-normal contacts 1016 as soon as the selector is completely restored.

Upon the release of relay 506 ground is removed from conductor 801, releasing relays 800 and 121. Relay 121 upon releasing now connects the trunk conductors 126 and 127 to the tip and ring contacts of jack 119, and disconnects such conductors from the terminal banks of second selectors such as the one shown in Fig. 10. With relay 121 released and relay 120 energized ground potential is maintained on test conductor 1022 over the outer right front contact of relay 120 and the inner right back contact of relay 121 to mark the trunk as busy to second selectors, and ground is removed at the outer right back contact of relay 120 from conductor 1019 to mark the trunk as busy in the group of twenty trunks to which it belongs. The lamp 114 which lighted when the operator plugged into jack 119 becomes extinguished in the well known manner when the called subscriber answers and relay 111 operates. All of the equipment which the operator has employed to select the trunk 126, 127 and to set the switches of the distant office has now been restored. The talking connection between the calling subscriber on line 100 and the called subscriber on line 125 is restored upon the termination of the conversation in the well known manner and need not be described in detail herein.

Incoming or final selector trunk to overflow position

If the incoming selector during group selection or the final selector during any of its selection movements advances to an overflow position thereby reversing the fundamental circuit, with the steering switch 550 in positions 10, 12, 14 or 16, polarized relay 624 operates closing a circuit for overflow relay 551 extending from ground at the contact of relay 624, conductor 515, brush 514, to battery through the winding of relay 551.

Relay 551 upon energizing locks to ground on conductor 509 and at its right contact connects ground to conductor 320 thence as previously traced to battery through the winding of release relay 205 at the operator's position equipment. In the manner previously described all apparatus which the operator has employed to reach the trunk 126, 127 is restored. The operator may then proceed to reestablish the connection.

Outgoing trunk reached directly through reversed selection

In the foregoing description it has been assumed that both first and second selectors were necessary to reach an idle trunk extending to the desired office 122. It will now be assumed that the trunks of Fig. 1 terminate directly in the banks of the first selector of Fig. 9 and that in response to the registration of the first code letter on the office code relays of the operator's position, the first selector has positioned its brush sets opposite the first level of its banks in which trunks extending to the office 122 terminate. By this time the steering switch 550 will have advanced to position 2. On all levels in which access to outgoing trunks may be directly made from the first selector, shaft springs 930 are closed. Therefore, when the first selector has been advanced to such a level, for example to the first level, a circuit is closed from battery through the right winding of relay 820, conductor 931, shaft springs 930, conductor 932, the outer right contact of relay 603 to ground. Relay 820 upon energizing locks over its left winding to ground on conductor 509 and closes a circuit for advancing steering switch 550 out of position 2, into position 3. This circuit extends from battery through the winding and contacts of magnet 512, brush 553, and the second position terminal of the steering switch, conductor 560, the right front contact of relay 820, conductor 724 to ground at the intermediate lower front contact of relay 700. The shaft contacts 930 also close a circuit for the release magnet 917 of the first selector extending from battery through the winding of magnet 917, off-normal contacts 916, shaft contacts 930, conductor 932 to ground at the inner right contact of relay 603. Magnet 917 energizes, releasing the selector to normal, its own circuit being opened at the off-normal contacts 916 when the selector is completely restored.

With the selector in normal position and the steering switch 550 of the sender in position 3, the first selector is controlled again in a vertical movement in accordance with the second code letter of the office code, in the same manner as previously described in connection with the operation of the second selector. From this point the call progresses in exactly the same manner as previously

described except that the operations which the second selector previously performed are now performed by the first selector, the first selector stepping vertically and then in a rotary direction to select an idle trunk and in such movement controlling the trunk number indicator of Fig. 4 to indicate to the operator the number of the trunk which has been so selected.

10 What is claimed is:

1. In an automatic telephone exchange system a plurality of offices, a group of trunks outgoing to each of said offices, a plurality of operators' positions, office keys at each of said positions corresponding to said plurality of offices, a register switch at each of said positions, selector switches, and means for operating said selector switches and said register switch in unison under the control of said office keys for connecting a calling one of said positions with a desired one of said trunk groups.

2. In an automatic telephone exchange system a plurality of offices, a group of trunks outgoing to each of said offices, a plurality of operators' positions, office keys at each of said positions corresponding to said plurality of offices, a two motion step-by-step register switch at each of said positions, step-by-step selector switches, and means for operating said selector switches and said register switch in unison under the control of said office keys for connecting a calling one of said positions with a desired one of said trunk groups.

3. In an automatic telephone exchange system a plurality of offices, a group of trunks outgoing to each of said offices, a plurality of operators' positions, office keys at each of said positions corresponding to said plurality of offices, a two motion step-by-step register switch at each of said positions, two motion step-by-step selector switches, and means for operating said register switch successively in its two motions in unison with the vertical motions of successive ones of said selector switches under control of said office keys for connecting a calling one of said positions with a desired one of said trunk groups.

4. In an automatic telephone exchange system a plurality of offices, a group of trunks outgoing to each of said offices, a plurality of operators' positions, office keys at each of said positions corresponding to said plurality of offices, a register switch and indicating lamps at each position, a train of selector switches, means under the control of said office keys for controlling said switches to select a group of trunks to a desired office, means for thereafter operating said register switch and the last of said train of selector switches in unison to select an idle trunk in the selected group of trunks, and means for lighting said lamps in accordance with the position as-

sumed by said register switch to indicate the number of the idle trunk selected.

5. In an automatic telephone exchange system a plurality of offices, a group of trunks outgoing to each of said offices, a plurality of operators' positions, office keys at each of said positions corresponding to said plurality of offices, a two motion step-by-step register switch and indicating lamps at each of said positions, a train of two motion step-by-step selector switches, means under the control of said office keys for controlling said switches to select a group of trunks to a desired office, means for thereafter operating said register switch and the last of said train of switches successively and in unison in their two motions to select an idle trunk in the selected group of trunks, and means for lighting said lamps in accordance with the position assumed by said register switch to indicate the number of the idle trunk selected.

6. In an automatic telephone exchange system a plurality of offices, a group of trunks outgoing to each of said offices, a plurality of operators' positions, office keys at each of said positions corresponding to said plurality of offices, a register switch and indicating lamps at each of said positions, a train of selector switches, means for operating said selector switches and said register switch in unison under the control of said office keys for connecting a calling one of said positions with a desired one of said trunk groups, means for thereafter restoring said register switch, means for then reoperating said register switch and for further operating the last of said train of selector switches in unison to select an idle trunk in the selected trunk group, and means for lighting said lamps in accordance with the position last assumed by said register switch to indicate the number of the idle trunk selected.

7. In an automatic telephone exchange system a plurality of offices, a group of trunks outgoing to each of said offices and terminating therein in switching mechanism, a plurality of operators' positions, office keys at each of said positions corresponding to said plurality of offices, a register switch at each of said positions, a plurality of senders common to said positions for controlling said switching mechanism, means for associating a position with an idle one of said senders, selector switches for associating any sender with an idle trunk in any desired ones of said trunk groups, and means for operating said selector switches and said register switch in unison under the control of said office keys.

8. In an automatic telephone exchange system, an operator's position, a register at said position having vertical and rotary movements, indicating lamps, a plurality of offices, a group of trunks outgoing to each of said offices, a selector switch having rotary and vertical selective movements for connecting

said operator's position with a desired trunk group, said switch having two sets of brushes and corresponding banks of terminals and having access to the trunks of the same trunk group over a plurality of levels of both its banks, means controlled from said position to direct the brushes of said switch to the first level in which trunks of a desired trunk group terminate, means for thereafter causing said switch to hunt for a level in which an idle trunk of the selected group terminates and for an idle trunk terminating in such level in either of its banks, means operative through the hunting movements of said switch to correspondingly operate said register in its vertical and rotary movements, means for establishing at said register a record of the bank of said selector switch in which the selected trunk terminates, and means for lighting said lamps in accordance with the record established at said register to indicate the number of the trunk selected.

9. In an automatic telephone exchange system, an operator's position, a plurality of offices, a group of trunks outgoing to each of said offices, a selector switch operable in vertical and rotary movements for connecting said operator's position with a desired trunk group, means controlled from said position for causing said switch to select a desired trunk group and to then hunt by vertical and rotary movements for an idle trunk in such group, a register at said position operable in vertical and rotary movements having a plurality of banks of terminals and corresponding brushes, hundreds, tens and units trunk number indicating lamps terminating in separate banks of said register, and means for operating said register in its vertical and rotary movements in accordance with the corresponding vertical and rotary hunting movements of said selector switch to indicate on said lamps the number of the trunk selected.

10. In an automatic telephone exchange system, an operator's position, a plurality of offices, a group of trunks outgoing to each of said offices, a selector switch operable in vertical and rotary movements for connecting said operator's position with a desired trunk group, said switch having two sets of brushes and corresponding banks of terminals and having access to even numbered trunks of a group over a plurality of levels of one of its banks and to odd numbered trunks of the same group over corresponding levels of its other bank, means controlled from said position to direct the brushes of said switch to the first level in which trunks of a desired group terminate, means for thereafter causing said switch to hunt for a level in which an idle trunk terminates and for an idle trunk in such level in either of its banks, a register at said position operable in vertical and rotary movements having a plurality of banks of terminals and corresponding brushes, hundreds and units trunk number indicating lamps terminating in separate banks of said register, and odd and even numbered tens trunk number indicating lamps terminating in two other banks of said register, means for operating said register in its vertical and rotary movements in accordance with the corresponding vertical and rotary hunting movements of said selector switch, means for selecting a bank of said register having access to an even or odd numbered tens lamp in accordance with the bank of said selector switch in which the idle trunk is selected, and means for thereupon operating the lamps selected by said register to indicate the number of the trunk selected.

11. In an automatic telephone exchange system, an operator's position, a plurality of offices, a group of trunks outgoing to each of said offices, a selector switch operable in rotary and vertical movements for connecting said operator's position with a desired trunk group, said switch having two sets of brushes and corresponding banks of terminals and having access over the lower halves of each bank to trunks of a group numbered below one hundred and over the upper halves of each bank to trunks of the same group numbered above one hundred, means controlled from said position to direct the brushes of said switch to the first level in which trunks of a desired group terminate, means for thereupon causing said switch to hunt for a level in which an idle trunk terminates and for an idle trunk in such level of either bank, a register at said position having a plurality of banks and corresponding brushes, naught and one hundreds trunk number indicating lamps terminating in the terminals of the lower and upper halves of one bank of said register respectively, and tens and units lamps terminating in other banks of said register, and means for operating said register in its vertical and rotary movements in accordance with the corresponding movements of said selector switch to indicate on said lamps the number of the trunk selected.

12. In an automatic telephone exchange system, a plurality of offices, a group of trunks outgoing to each of said offices, an operator's position, office keys at said position corresponding to said plurality of offices, a two-motion step-by-step register switch and indicating lamps at said position, a train of two-motion step-by-step selector switches, means for operating said selector switches and said register switch in unison under the control of said office keys to select a group of trunks to a desired office, means for thereafter restoring said register switch and re-operating it arbitrarily to a definite position, means for thereafter further operating said register switch and the last of said train of

selector switches in unison to select an idle trunk in the selected trunk group, and means for lighting said lamps in accordance with the position last assumed by said register switch to indicate the number of the idle trunk selected.

13. In an automatic telephone exchange system, a plurality of offices, a group of trunks outgoing to each of said offices, an operator's position, office keys at said position corresponding to said plurality offices, a register switch having vertical and rotary movements and indicating lamps also at said position, a train of two-motion step-by-step selector switches, means for operating said selector switches and said register switch in unison to select a group of trunks to a desired office, means for thereafter restoring said register switch and for reoperating it arbitrarily one step vertically, means for thereafter further operating said register switch and the last of said train of selector switches in unison to select an idle trunk in the selected trunk group, and means for lighting said lamps in accordance with the position last assumed by said register switch to indicate the number of the idle trunk selected.

In witness whereof, we hereunto subscribe our names this 28th day of September, 1828.

EDGAR H. CLARK.

WARREN W. CARPENTER.