

June 24, 1930.

E. H. CLARK ET AL

1,767,962

AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed Sept. 29, 1928

9 Sheets-Sheet 1

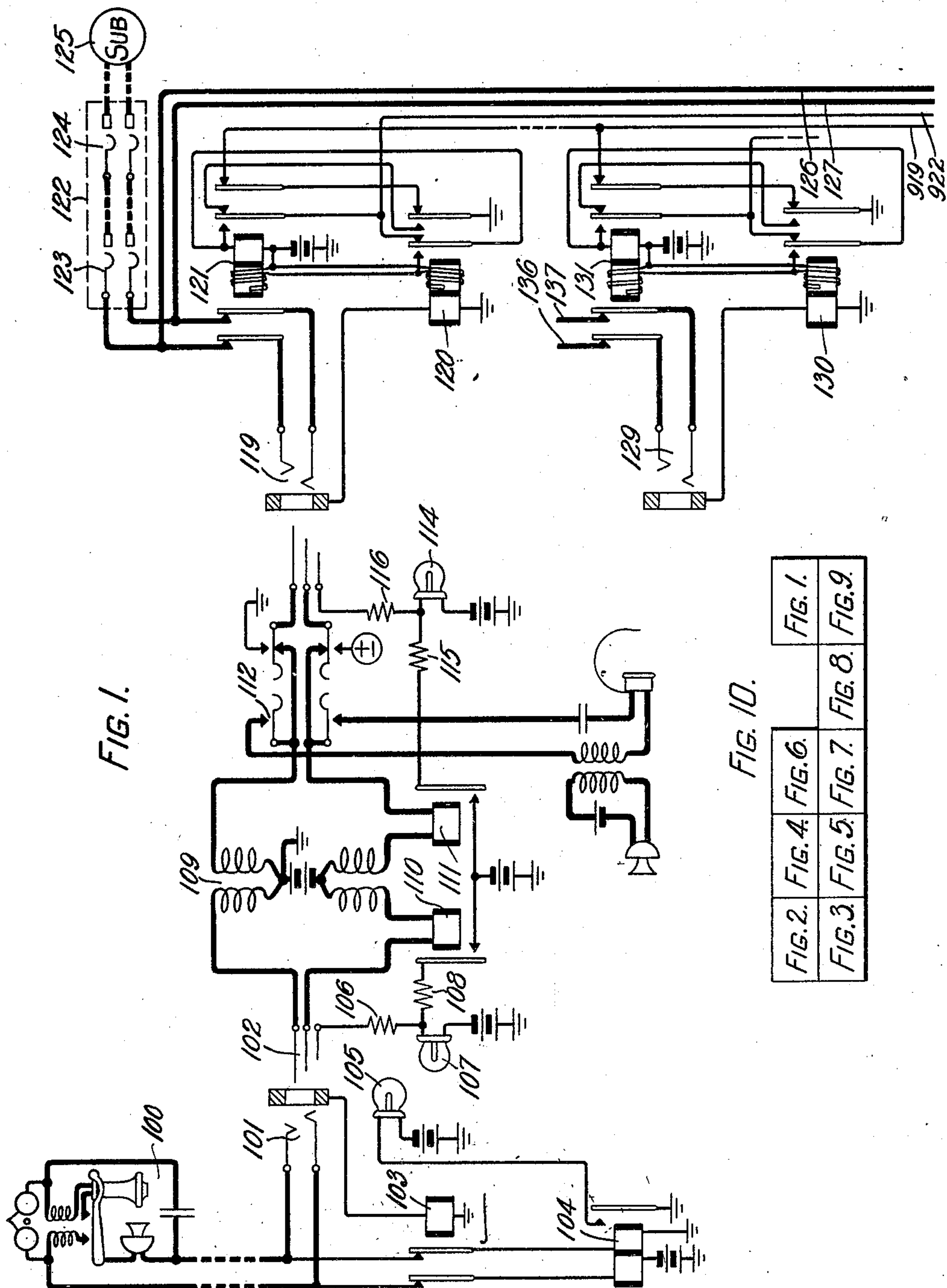


FIG. 1.

FIG. 10.

FIG. 1.	FIG. 2.	FIG. 3.	FIG. 4.	FIG. 5.	FIG. 6.	FIG. 7.	FIG. 8.	FIG. 9.
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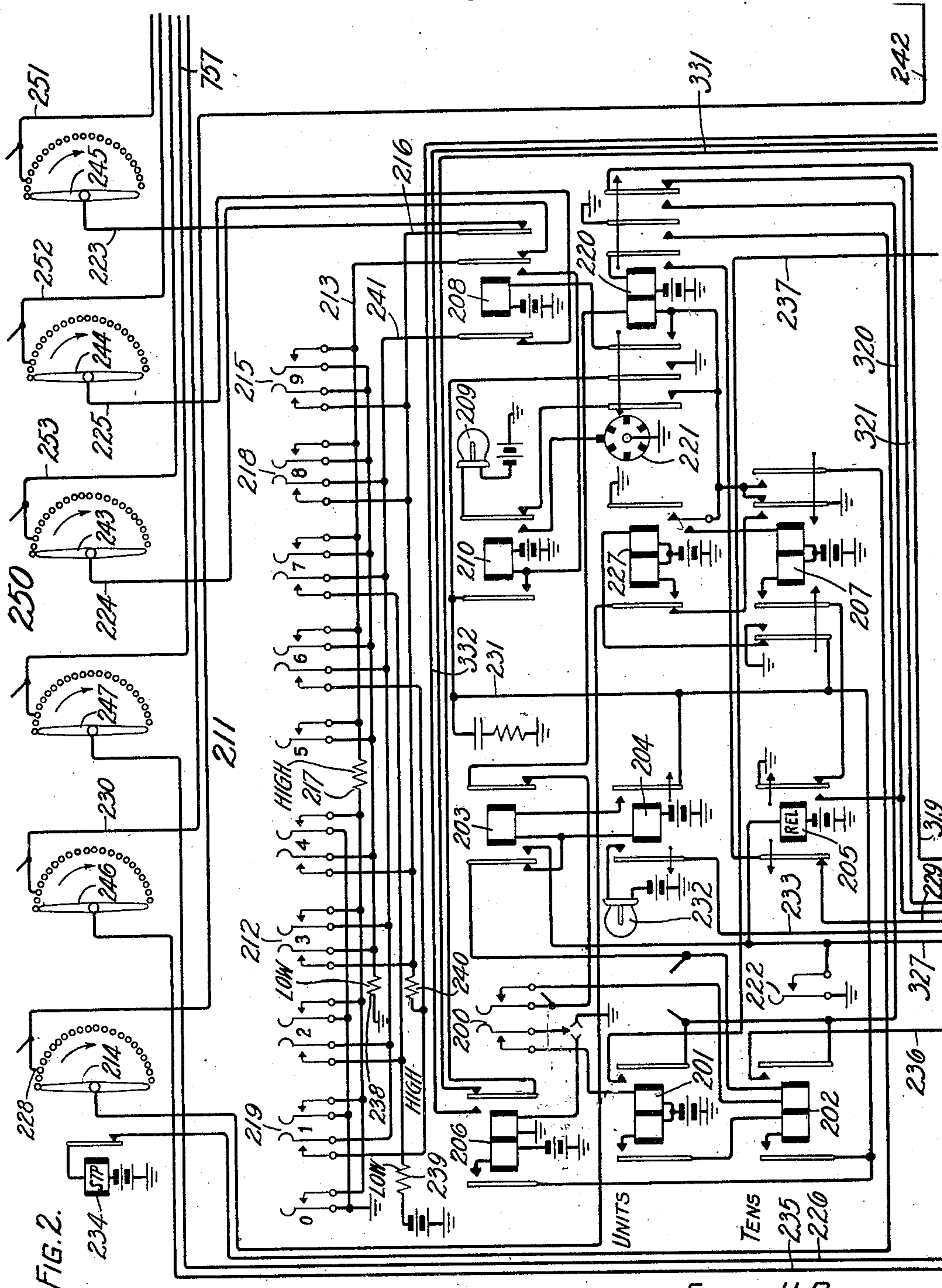
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9 Sheets-Sheet 3

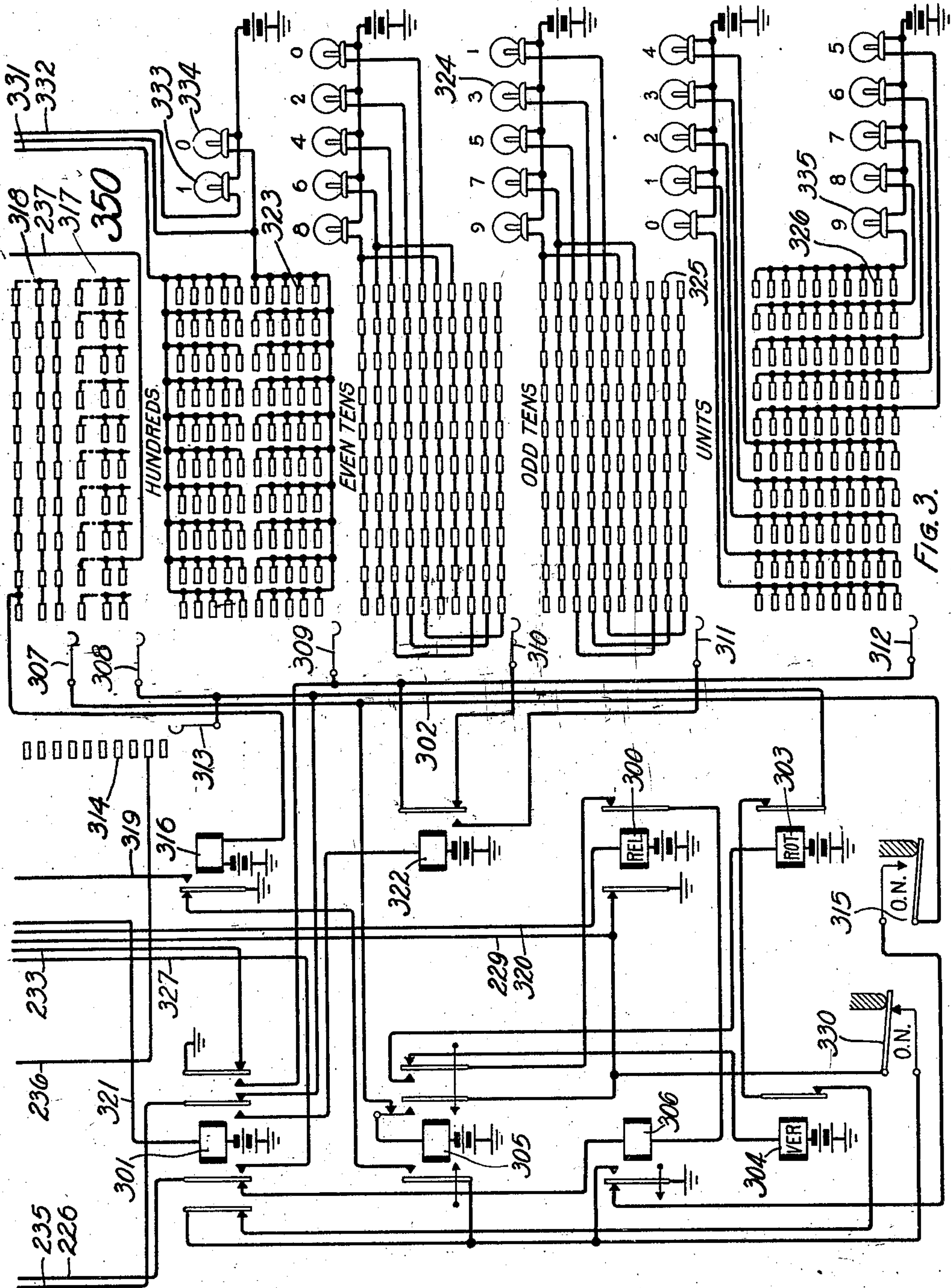


Fig. 3.

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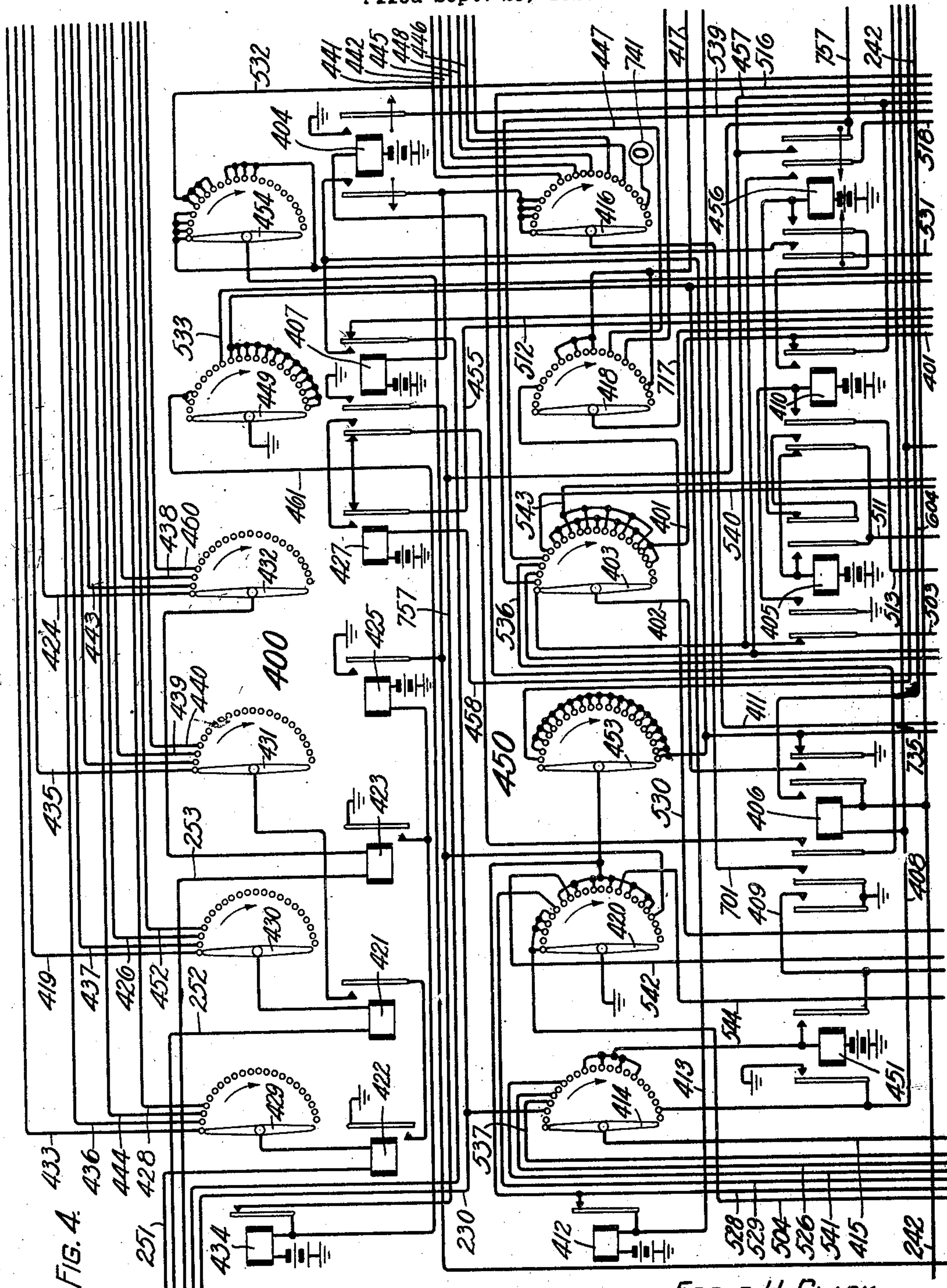
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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

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9 Sheets-Sheet 4



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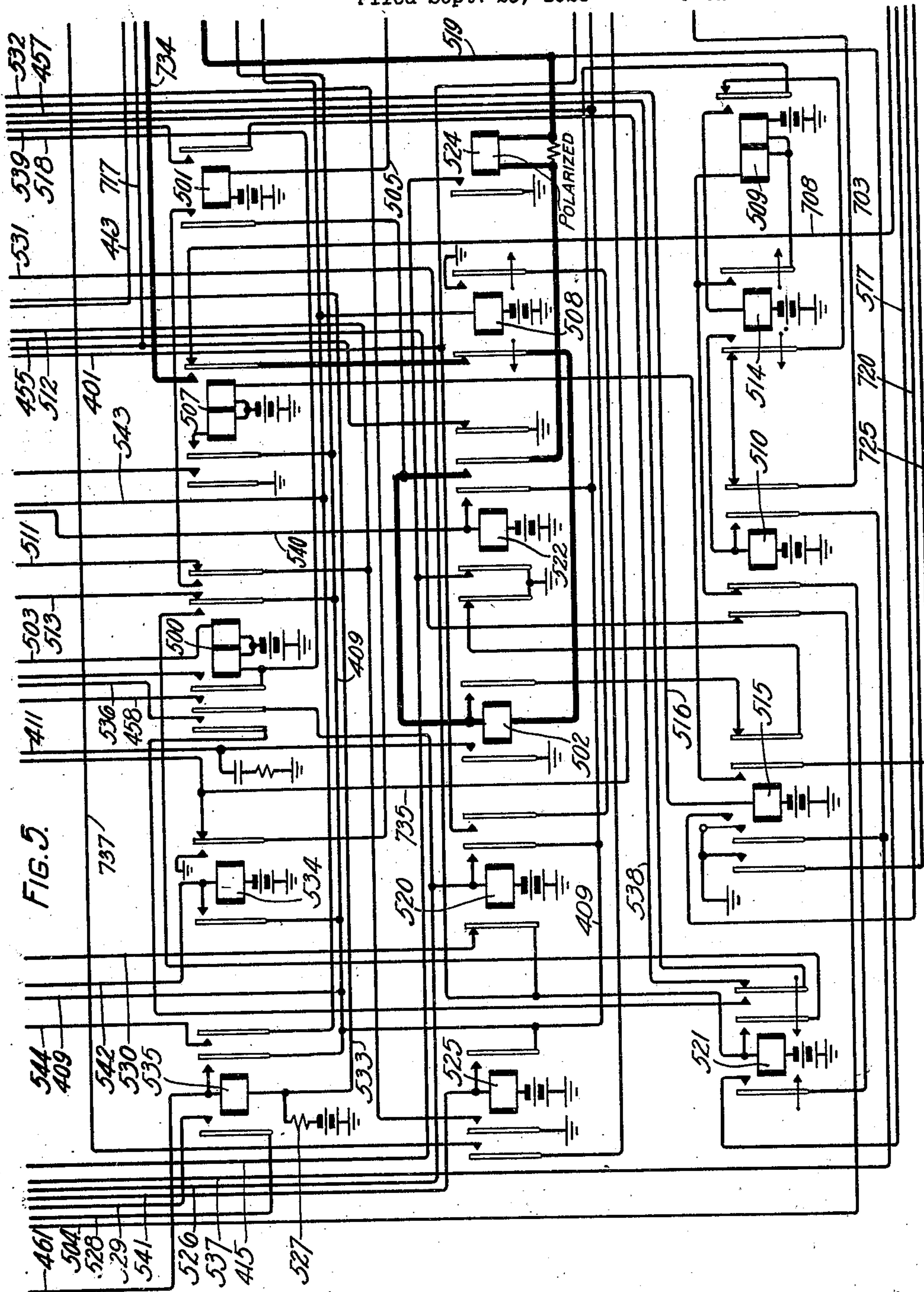
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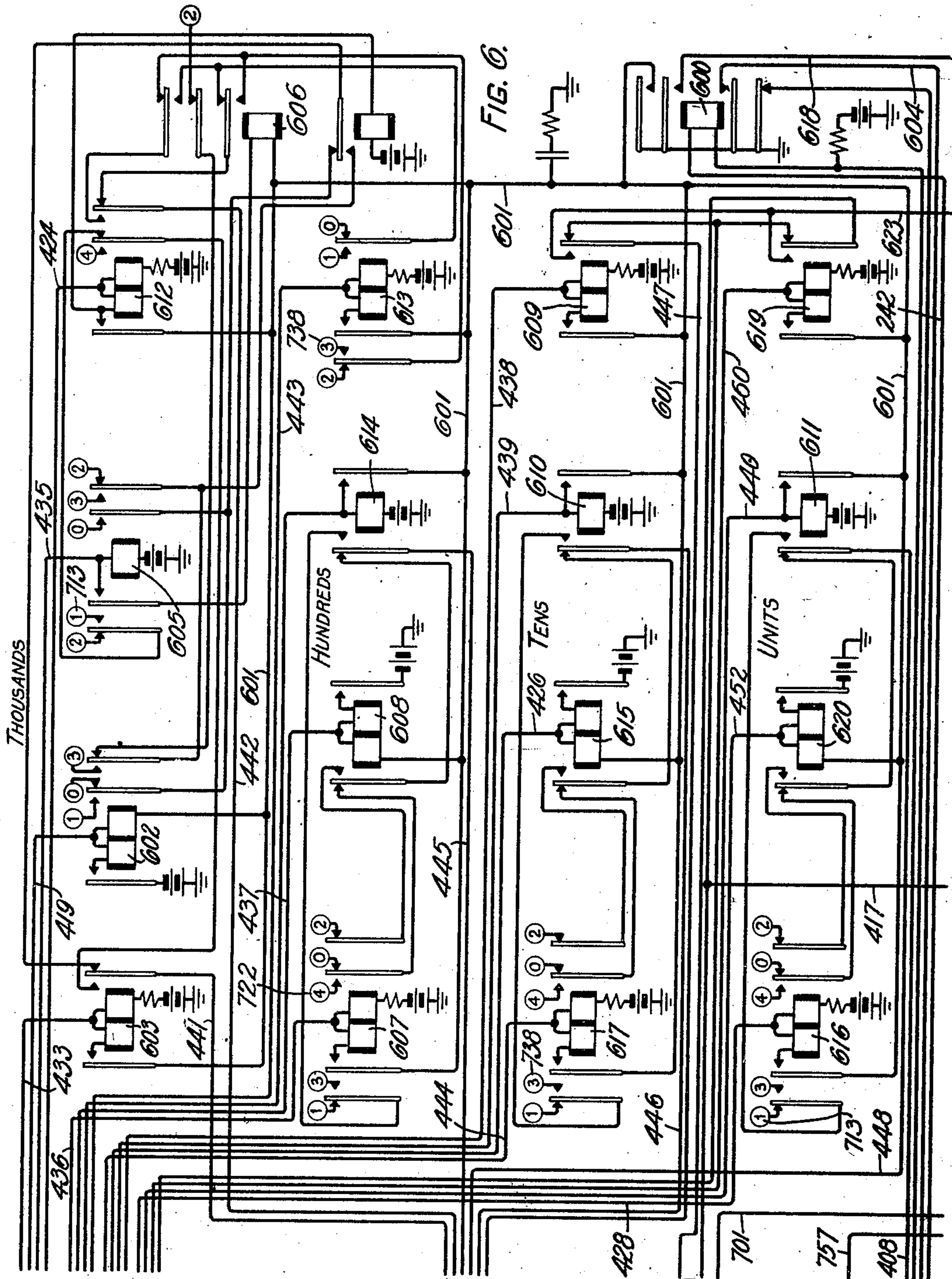
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9 Sheets-Sheet 6



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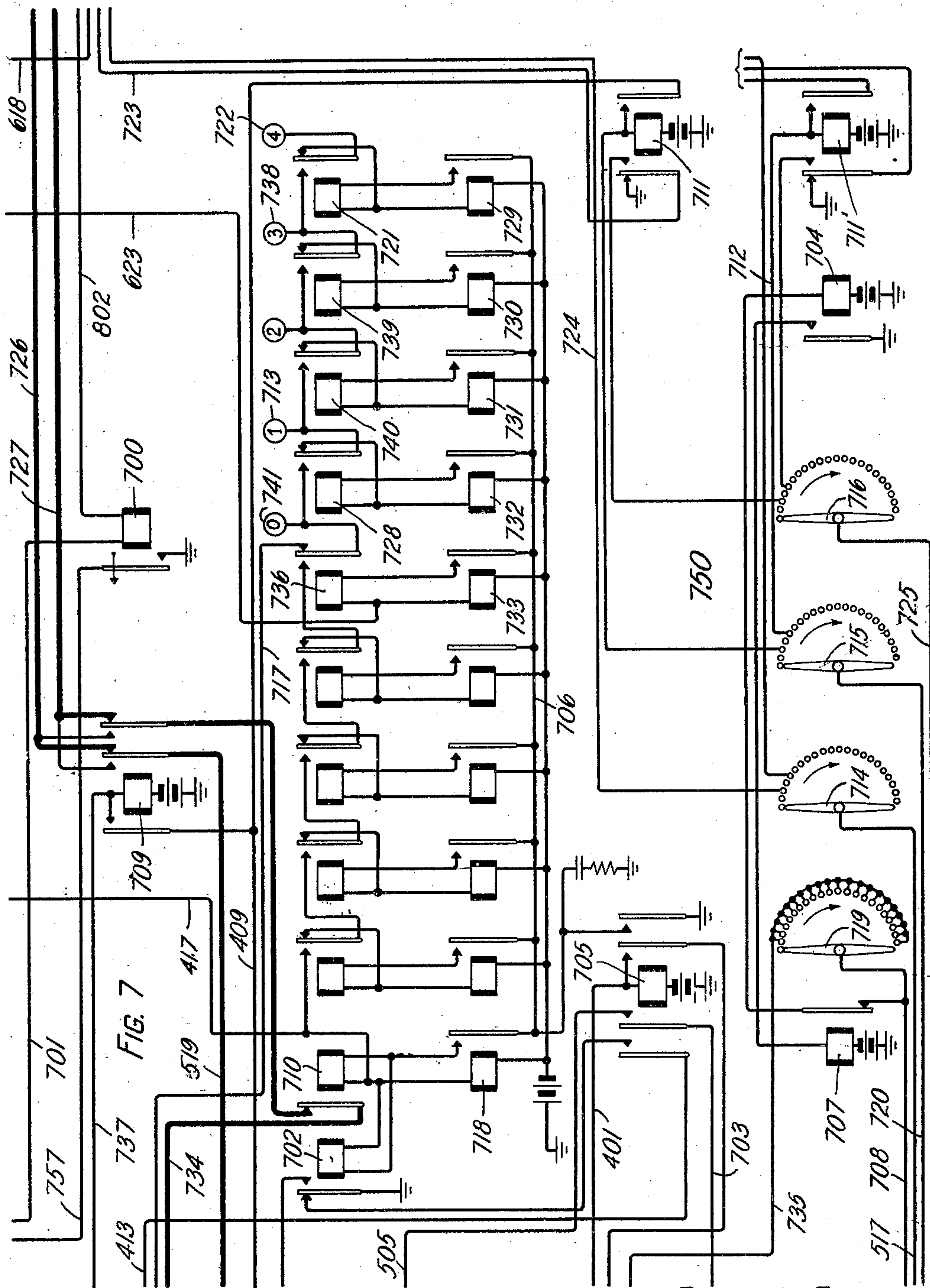
E. H. CLARK ET AL

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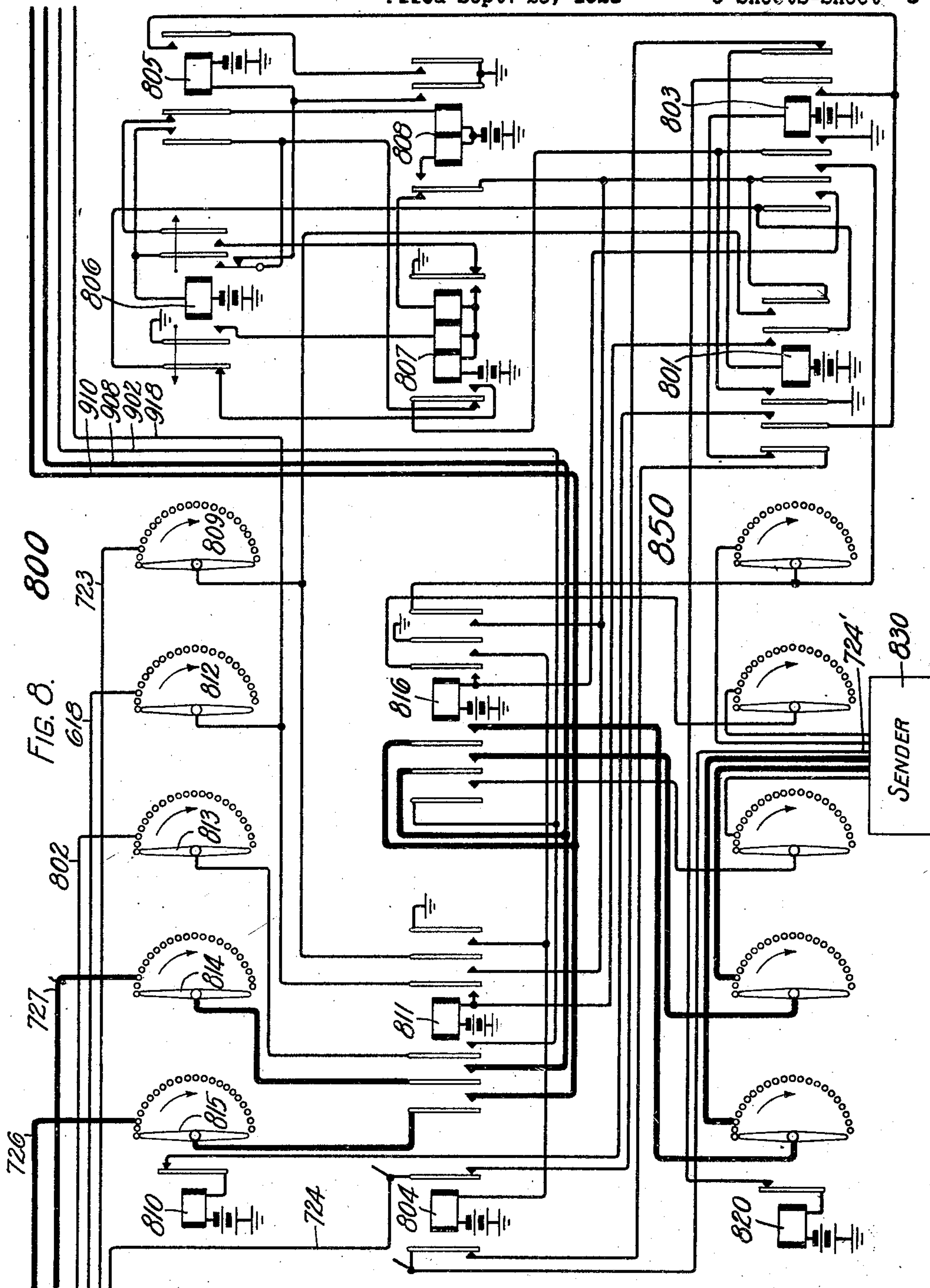
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9 Sheets-Sheet 8



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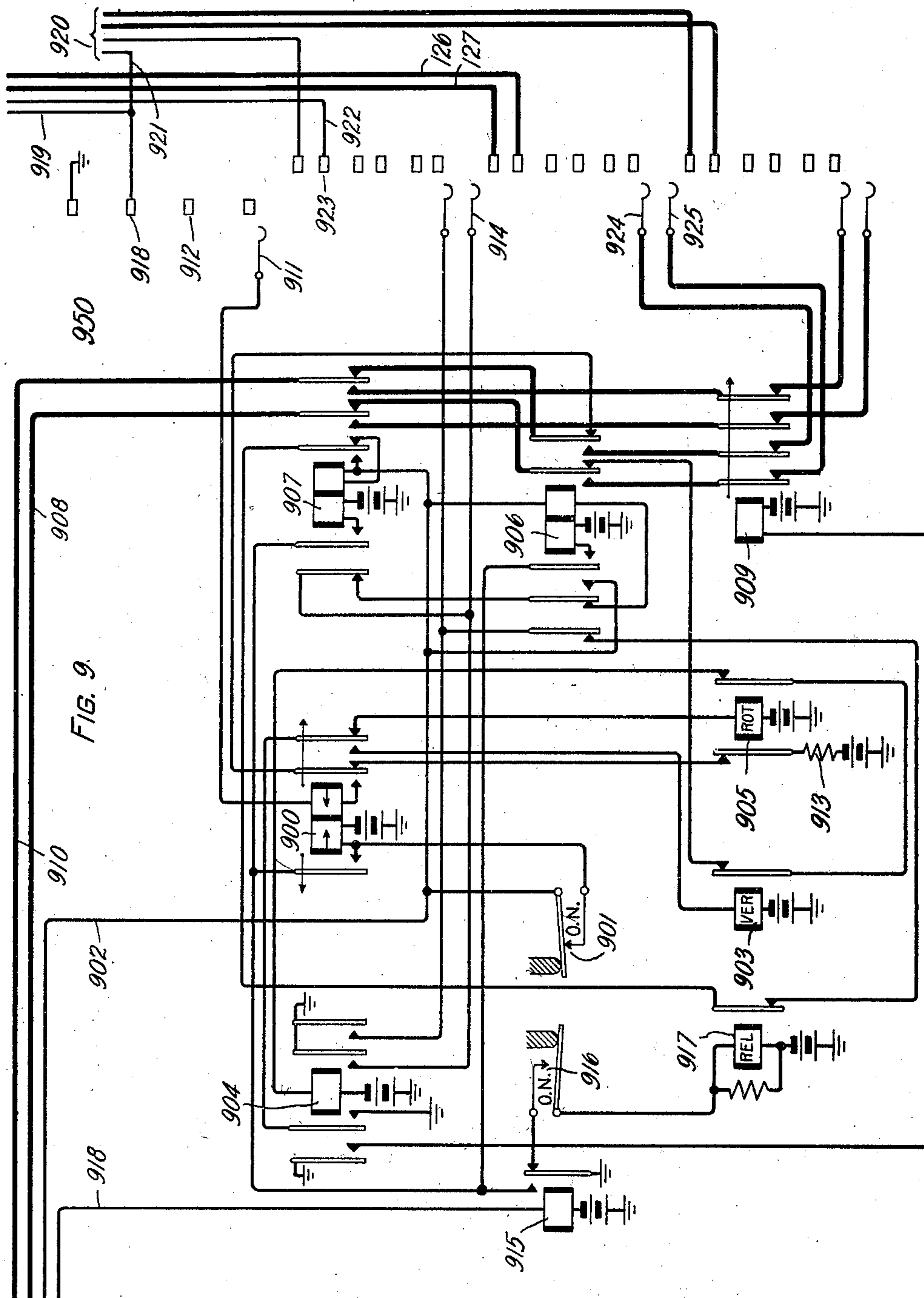
E. H. CLARK ET AL

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Filed Sept. 29, 1928

9 Sheets-Sheet 9



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UNITED STATES PATENT OFFICE

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AUTOMATIC TELEPHONE-EXCHANGE SYSTEM

Application filed September 29, 1928. Serial No. 309,177.

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' po-

sitions, divided into two main groups, all positions having 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.

The senders are divided into two groups, corresponding to the grouping of the operator's positions, and an idle sender in a group is taken for use by a position through a sender selecting switch individual to the position. In order that selected senders may become associated with idle trunks, outgoing to desired automatic offices, groups of link circuits are provided. Each of these links terminates at one end in a pair of sender hunting switches, each hunting switch having access to one of the groups of senders, and at the other end in a selector switch which has access to a group of trunks outgoing to particular automatic offices. Since links in each group of links are allotted for use in extending connections to particular automatic offices, the senders are provided with link selecting switches which may be directed to select a link which has access through its associated trunk selector to the office desired.

In the operation of the system the operator who answers an outgoing 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 sender-finder switch associated with her position to hunt for an idle sender in the group of senders serving the position, and causes the registration of the office code of the desired line on the office code registers 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. As soon as the sender becomes associated with the operator's position, a control circuit is established from the register switch of the position to the link selecting switch of the sender and these switches operate in unison until the position register assumes a position directed by the operated tens code register relay of the position.

The selected link then hunts for the trunk selector and a control circuit is established thereover from the trunk selector through the sender to the position register and the selector and register then operate in unison until the register assumes a position directed by the operated units code relay of the position. In this manner a group of trunks outgoing to the office in which the desired line terminates is selected. The position register is then restored and is reoperated in unison with further hunting movements of the selected selector until such selector has selected an idle trunk from a sub-group of trunks in the selected group to the desired office. In its reoperated position the 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 9 inclusive, arranged in accordance with the diagram of Fig. 10, 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 operator's 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, a sender-selecting switch, and control relays of the operator's position shown in Fig. 1.

Fig. 3 shows a trunk number indicating equipment individual to the operator's position 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. 4, 5, 6 and 7 taken together show one of a plurality of register senders available for the use of operator's positions of one

manual office. Fig. 4 shows two steering switches and certain control relays of the sender. Fig. 5 shows additional control relays. Fig. 6 shows relay registers for registering the numerical digits of wanted line numbers and Fig. 7 shows counting relays for setting the switches of the dial switching office under the control of the registers of Fig. 6 and a link selector switch for selecting a link of a group over which access to the desired dial switching office may be had.

Fig. 8 shows a link having sender finder switches for hunting for the sender in either of two groups of senders which an operator has taken for use for extending a connection from the sender toward the group of trunks extending to the desired dial switching office.

Fig. 9 shows a selector individual to the link of Fig. 8 for further extending a connection to a desired trunk group.

Fig. 10 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 type such as is shown in the patent to E. B. Craft and J. N. Reynolds, 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 1,395,977, granted November 1, 1921.

The steering switches 400 and 450 of Fig. 4, the sender selector 250 of Fig. 2, the link selector 750 of Fig. 7 and the sender finders 800 and 850 of Fig. 8 are of the rotary single motion step-by-step type driven by stepping magnets from terminal set to terminal set and are so arranged that the brushes move forward to the next set of terminals upon the deenergization of the corresponding stepping magnet. Of these switches the sender selector 250 and the sender finders 800 and 850 have no normal position, these switches remaining in the position to which they were last moved upon the release of their associated circuits.

The selector switch 950 of Fig. 9 and the position switch 350 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 particularly, these switches are of the type disclosed in the 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

keys, as shown at 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 position 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 registers the tens code letter of an office designation and the relays of the other group register the units code letter. By suitable interconnection 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.

The operators' positions of the manual office are divided into two groups and the senders are likewise divided into two groups. Any operator's position of one group may through the sender selectors individual to such positions, such as selector 250, have access to any sender of one group of senders and similarly the positions of the other group have access to the senders of the other group. For connecting a selected sender with groups of trunks outgoing to the offices to which the manual office has access, a plurality of groups of link circuits are provided, each group of link circuits having access to a certain plurality of such offices. Each sender is provided with a link selecting switch 750, which is set in accordance with the first code letter of the office designation which the operator registers at her position through the depression of an office key, to select idle links from the group over which access to the desired office may be had. The selection of such a group of links closes a start circuit for starting all idle links of such group to hunt for the calling sender, the first link to find such sender seizing it and the others being dismissed. Two sender finders are provided for each link to connect with the calling sender, regardless of which sender group such sender is located in. A selector such as 950 is permanently paired with each link and responds to the second code letter of the office designation which the operator registers at her position to complete the selection of the desired group of trunks and to then select an idle trunk from such group. The trunk hunting movements of such selector 950 are registered by the position switch 350 to cause the operation of indicating lamps to indicate to the operator the number of the trunk so selected.

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 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 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 headset 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 left contacts of key 200 to ground through the right winding of relay 206 and 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, the right contacts of key 200, the right back contact of relay 203, the left winding of relay 220 to ground at the inner right back contact of relay 207. Relays 201, 202, 204, 206 and 220 energize in these circuits, relay 220 locking over its right winding and inner right contact over the back contact of release relay 205,

conductor 229 to ground at the left back contact of release magnet 300 of position switch 350. 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 outer left contact of relay 220. Relay 206 also locks over its left winding and left contact to ground on conductor 231.

Relay 204 which is operated in the operating circuit of relay 202 locks through the winding of relay 203, 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 contact of relay 301. Relay 203, however, does not operate in the locking circuit of relay 204 until the key 200 is released, since both terminals of its winding are connected to ground. Lamp 232 which lights upon the energization of relay 204 remains lighted until the trunk number is completely registered on the position switch 350. Upon the release of key 200 relay 203 energizes, opening at its back contacts the initial energizing circuits of relays 201, 202, 204 and 220 and 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 201 and 202 also prepare circuits for controlling the positioning of switch 350 as will be hereinafter described.

Relay 220 upon energizing also establishes a circuit for relay 208, extending from battery through the winding of relay 208, the inner left contact of relay 220 to ground at the right back contact of relay 207 and a circuit for lamp 209 extending from battery through lamp 209, the right back contact of relay 210, outer left contact of relay 220 to ground at the inner right back contact of relay 207. Lamp 209 burns steadily at this time and relay 208 upon energizing connects the contacts of keyset 211 to battery through the winding of relay 210. Should the operator prematurely depress a key of the keyset, i. e. 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 contact to ground on conductor 231 and at its right contacts transfers the lamp 209 from steady ground to intermittent ground through the interrupter 221. The lamp will thereupon flicker as a signal that the operator should release her position and start to call again. She may do so by depressing the release key 222, thereby operating release relay 205, which in turn releases relay 220 and all other operated relays of her position. Relay 208 upon operating

also disconnects the key contacts of keyset 211 from conductors 223, 224 and 225, extending to brushes of the sender selector 250.

Association of an idle sender with the operator's position

Relay 220 upon operating also establishes a circuit for relay 227, extending from battery through the right winding thereof, the left back contact of relay 207 to ground on conductor 231. If the sender to which the switch 250 has access over the set of terminals upon which its brushes are at the time standing is busy, brush 214 will be connected to ground potential and relay 227 will thus lock over its left winding and left front contact and will establish a circuit for relay 207, extending from battery through the right winding of relay 207 to ground at the right contact of relay 227. Relay 207 upon energizing locks over its left winding and inner left contact to ground at the right back contact of release relay 205, connects ground to holding conductor 231 over its outer left front contact, at its inner right back contact disconnects ground from the operating circuit of relay 208 and lamp 209 and at its outer right front contact establishes a circuit extending from battery through the winding and contacts of magnet 234, the outer right contact of relay 207 to ground at the right front contact of relay 227 for advancing the brushes of switch 250 into engagement with the set of terminals connected to the next sender. The removal of ground from the circuits of relay 208 and lamp 209 does not release said relay or extinguish said lamp as they still receive operating ground from the right front contact of relay 227. At its outer left back contact relay 207 opens the initial energizing circuit of relay 227. The switch 250 will continue to step until its test brush 214 fails to find busy ground potential when relay 227 will release, no longer having a locking circuit over its left winding. Relay 227 upon releasing opens the circuit of magnet 234 to arrest the further advance of switch 250, releases relay 208 to connect the keyset 211 to the brushes 243, 244 and 245 of switch 250, preparatory to enabling the operator to set the numerical registers of the selected sender, and extinguishes lamp 209 as a signal that a sender has been found. It will be assumed that the switch 250 has advanced to position its brushes upon the third set of terminals of its arcs. A busy potential is now applied to the test terminal 228 from ground at the inner right front contact of relay 207 over the left back contact of relay 227 and brush 214 for marking the sender busy to sender selectors of other positions, this ground potential being extended over conductor 242 in parallel through the windings of relay 406 and 600 to battery on conductor 408.

Relay 406 upon energizing prepares several

circuits. At its outer left contact it places ground on conductor 409 for supplying locking ground to relays of the sender; at its outer right front contact it establishes a circuit extending from ground over conductor 402, brush 403 and the normal terminal of steering switch 450, the outer left back contact of relay 405, conductor 503 to battery through the right winding of relay 500 and at its inner left contact establishes a circuit for relay 404 extending from battery through the winding of relay 404, the inner left contact of relay 406, the outer left back contact of relay 407, the back contact of relay 427, conductor 455, the outer left back contact of relay 510, conductor 504 to ground over the normal terminal and brush 420 of steering switch 450. At its inner right contact relay 406 locks from battery on conductor 408 over its winding and inner right contact, conductor 604 to ground and the inner lower front contact of relay 600. Relay 600 upon energizing connects ground over its upper front contact to conductor 601 for furnishing locking ground for the register relays of Fig. 6 and connects ground to conductor 618 for a purpose to be later explained.

Relay 404 upon energizing establishes a circuit for relay 705, which may be traced from battery through the winding of relay 705, conductor 401, the right back contact of relay 410 to ground at the right contact of relay 404. Relay 705 upon energizing closes two circuits, one extending from battery to the winding of magnet 412 over conductor 413, the outer left contact of relay 705, to ground at the back contact of counting relay 702, preparing the magnet 412 for advancing steering switch 450 into position 2 and the other circuit extending from battery through the winding of relay 501, conductor 505, the inner left contact of relay 705, conductor 703, the right back contact of relay 510, the left back contact of relay 514, the right back contact of relay 509 to ground on conductor 409.

Operation of link finder 750 in accordance with first code letter of office designation

Relay 501 upon energizing establishes a circuit for relay 704, extending over the back contact of stepping magnet 707, conductor 708, the right back contact of relay 507, the left back contact of relay 508, the winding of stepping relay 502, the left contact of relay 501, the outer right front contact of relay 500, conductor 512, the right back contact of relay 407, conductor 230, brush 246, conductor 235, inner right back contact of relay 301, conductor 302, back contacts of rotary magnet 303 and vertical magnet 304, outer left back contact of relay 301, off-normal contacts 330 to ground at the left contact of release magnet 300. Relays 704 and 502 operate in this circuit, relay 704 establishing over its contact a circuit for stepping magnet 707 of

the switch 750, which latter magnet energizes, in turn opening the circuit of relays 704 and 502. Thus, as the switch 750 advances it causes the intermittent operation of pulsing relay 502. Upon the first energization of relay 502 a circuit is established for relay 407, extending from battery through the winding of relay 407, the first position terminal and brush 416 of steering switch 450, conductor 411 to ground at the front contact of relay 502. Relay 407 in turn opens at its outer left back contact the operating circuit of relay 404, but relay 404 being slow to release remains operated so long as relay 407 receives impulses from the stepping relay 502. At its inner left contact relay 407 establishes a circuit extending from ground over conductor 757, brush 247, conductor 226, the inner left back contact of relay 301, winding of slow-to-release relay 306, the right back contact of release magnet 300, the outer right back contact of relay 305 to battery through the winding of vertical magnet 304 of position switch 350. Magnet 304 energizes, advancing the position switch 350 one step vertically and relay 306 energizes, supplying operating ground to the pulsing circuit previously traced to the windings of relay 502 and relay 704 in place of ground over the off-normal contacts 330, which open upon the first vertical step of position switch 350.

Until magnet 304 fully energizes relay 407 is maintained energized to hold the circuit of magnet 304 closed in a circuit extending from battery through the winding of relay 407, the left contact of relay 404, the right front contact of relay 407, conductor 230, thence as traced to ground over the back contact of magnet 304 and the front contact of relay 306, even though the initial operating circuit of relay 407 is opened at the contact of relay 502. This is to insure that the magnet 304 will be energized until it has advanced the switch 350 a full step. As soon as magnet 304 completely energizes the pulsing circuit previously traced through windings of relays 502 and 704 is opened, and the holding circuit of relay 407 is opened. Relay 407 thereupon deenergizes, opening the circuit of magnet 304 and relay 306. Magnet 304 then deenergizes, again establishing the pulsing circuit for relays 502 and 704 and the above described operations are repeated for advancing the switch 750 and the position switch 350 another step. Relay 306 being slow to release, does not deenergize so long as impulses are transmitted through its winding to operate magnet 304.

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 350 has advanced two steps vertically and the commutator brush 313 has been raised to the second segment of commutator 314, a circuit

will be closed from ground at the intermediate right contact of relay 220, the right contact of register relay 202, conductor 236, brush 313, thence over the inner right back contact of relay 301, conductor 235, and as
 5 previously traced to battery through the winding of relay 407. Relay 407 is thus prevented from deenergizing when the vertical magnet 304 completes its second energization and therefore the circuit of relay 404 is held
 10 open at the right back contact of relay 407 for a sufficient period to permit slow-releasing relay 404 to release. Relay 404 upon releasing now opens the holding circuit of relay 407, which thereupon releases, in turn
 15 opening the circuit of vertical magnet 304 and slow-to-release relay 306. Relay 404 also opens at its right contact the previously traced circuit for relay 705, which in turn
 20 opens the circuits of relays 501 and magnet 412. Magnet 412 then advances the steering switch 450 into position 2. With relay 501 released, the pulsing circuit through relays 704 and 502 is opened at the left contact of
 25 relay 501.

As soon as the steering switch leaves normal the previously traced circuit of relay 500 is opened and since at this time slow releasing relay 306 has not had time to deenergize, a
 30 circuit is established for relay 405 extending from battery through the winding of relay 405, the left back contact of relay 410, conductor 511, outer right back contact of relay 500, conductor 512, right back contact of relay 407, conductor 230, brush 246, conductor
 35 235, inner right back contact of relay 301, conductor 302, back contacts of rotary magnet 303 and vertical magnet 304, outer left back contact of relay 301 to ground at the front contact of relay 306. Relay 405, upon
 40 energizing, locks over its inner right front contact to conductor 511 independently of the contacts of relay 410 and closes an obvious circuit for relay 410 which then operates and locks over its inner left contact, conductor 513, the inner right back contact of
 45 relay 500 to ground on conductor 409.

With steering switch 450 in position 2 a circuit is now established for relay 515 extending from battery, through its winding,
 50 over conductor 516, the second position terminal and brush 403 of steering switch 450, conductor 402 to ground at the outer right front contact of relay 406. Relay 515, upon
 55 energizing, establishes a circuit extending from battery through the winding of relay 711, the second position terminal and brush 715 of link selector 750, which it will be recalled was advanced into position 2 in response to the registering of the first code letter C of the office designation, conductor 720
 60 to ground at the outer left contact of relay 515. Relay 711, upon energizing, locks over its right front contact to ground on conductor 409 and at its left contacts establishes a test

condition on conductor 723 to mark the sender as calling to all sender finder switches of links having access thereto.

Association of sender with an idle link

Relay 515 also establishes a circuit for
 70 operating all start relays, such as 801 of idle links of the group of links selected by the link selector 750. This circuit may be traced from ground at the inner left front
 75 contact of relay 515, over conductor 517, brush 714, conductor 724, thence in parallel through the windings of start relays, such as 801. The circuit for relay 801 of the link
 80 shown in Fig. 8 is completed from conductor 724 over the right back contact of relay 804, the outer right back contact of relay 803 to battery, through the winding of relay 801. With relay 801 energized a circuit is established for relay 805 extending from battery
 85 through the winding of relay 805, the right normal contacts of relay 806, the left back contact of relay 807 to ground at the inner left contact of relay 801. Relay 805 energizes, connecting the winding of relay 806
 90 over the left front contact of relay 805 to ground over the left back contact of relay 807 and the inner left contact of relay 801, thereby causing the energization of relay 806. Relay 806, upon energizing, now locks over
 95 its inner right contacts to its operating circuit independent of the left contacts of relay 805, at its right normal contacts opens the circuit of relay 805 thereby releasing such relay and at its inner left contacts closes a
 100 circuit through the two left windings of relay 807. Relay 807, however, does not energize at this time since it energizes only when its three windings receive current in the same direction. With relay 805 released and relay
 105 806 energized, a circuit is now established from battery through the right winding of relay 808, the left back contact of relay 805, the outer right contact of relay 806 to ground at the right back contact of relay 807. Relay
 110 808 energizes in this circuit, at its inner right contact closing an obvious circuit for reenergizing relay 805 and at its outer right contact establishing a circuit for the stepping magnet 810 of sender finder switch 800
 115 extending from battery through the winding and contacts of magnet 810, the intermediate left front contact of relay 801, the right contact of relay 805, to ground at the outer right
 120 contact of relay 808.

If the set of terminals upon which the switch 800 is at the time standing is connected to a non-calling sender, ground potential will be connected over the back contact of relay
 125 711 of such sender, conductor 723, the terminal upon which brush 809 is resting, the outer right front contact of relay 801, the left front contact and left winding of relay 808 to battery and relay 808 will therefore remain energized after relay 805 energizes
 130

and opens its initial energizing circuit. If when the switch 800 is advanced to the next set of terminals through the energization and release of magnet 810, test brush 809 still encounters ground potential, relay 808 will remain locked and the operating circuit of magnet 810 will be maintained. When, however, switch 800 has advanced for example two steps and its brushes encounter the set of terminals connected to the calling sender of Figs. 4 to 7, inclusive, the brush 809 does not encounter ground potential as such potential has been removed through the energization of relay 711 and therefore relay 808 releases, opening the circuits of relay 805 and magnet 810. In a similar manner other idle sender finders of the same link group are simultaneously operated through the operation of their start relays, such as 801, to hunt for the calling sender.

Should two finders simultaneously find the calling sender a circuit will be established from battery through the right winding of relay 507, the inner right contact of relay 515, conductor 725, brush 716, the left front contact of relay 711, conductor 723, brush 809 of switch 800, the outer right contact of relay 801, the left back contact of relay 808, the two right windings of relay 807 to ground at the inner left front contact of relay 806. A similar circuit from brush 809 of the sender finder of the second link which has also found the same sender will also be closed to battery through the right windings of a relay similar to relay 807. In this case, relay 507 and the two relays 807 will not receive sufficient current to operate and therefore a circuit will be closed by each relay 807 for the corresponding relay 808 extending from ground at the right back contact of relay 807, the outer right front contact of relay 806, the inner left back contact of relay 805 to battery through the winding of relay 808. Relays 808 will again operate in turn operating relays 805 and closing the circuits of stepping magnets 810 of the two finders to further advance the finders. Relays 808 will again lock up so long as the finders test the terminals of non-calling senders. Since one finder will undoubtedly fall slightly behind the other in testing for the calling sender, therefore, when the brushes of one finder, such as 800, again reach the terminals of the calling sender, the other finder will not have reached them and therefore when relay 808 of the first finder, for example, the finder shown in Fig. 8 again deenergizes, relay 807 will operate and lock directly to ground over its left winding and right front contact. Relay 507 of the sender, however, does not operate in the energizing circuit of relay 807. Relay 807 at its right back contact opens the initial energizing circuit of relay 808 to prevent its reoperation and at its left back contact opens the locking circuit

of relay 806, whereupon relay 806 releases. As soon as relay 807 closes its right front contact relay 507 energizes and locks over its left winding and inner left contact to ground on conductor 409 and closes a circuit from ground at its outer left contact over the second position terminal and brush 453 of steering switch 450 to battery through the contacts and winding of magnet 412 for advancing steering switch 450 into position 3. With steering switch 450 in position 3 the circuit of relay 404 is again established extending from battery through the winding of relay 404, the inner left contact of relay 406, the outer left back contact of relay 407, the back contact of relay 427, conductor 455, the outer left back contact of relay 510, conductor 504 to ground at the third position terminal and brush 420 of steering switch 450. When steering switch 450 leaves position 2 relay 515 releases removing battery from the circuit previously traced through the right winding of relay 807. Relay 515 also at its left contacts opens the initial operating circuits of relays 711 and 801.

With relay 807 energized and relay 806 deenergized, a circuit is now closed for the relay 811 extending from battery through the winding of relay 811, the inner right contact of relay 801, the left back contact of relay 806, the left front contact of relay 807 to ground at the inner left contact of relay 801. Relay 811, upon energizing, locks over its inner right contact, brush 812 to ground on conductor 618, at its outer right contact closes an obvious circuit for relay 804 for opening the start circuits 724 and 724' extending from both groups of senders to the start relays 801 and 803, thereby releasing relay 801, and at its intermediate right contact extends conductor 723 over brush 809 to the right winding of relay 807 independent of the inner right contact of relay 801 which is now open. At its left contacts relay 811 also extends conductors 902, 908 and 910 from selector 950, over brushes 813, 814 and 815 of finder 800 to conductors 802, 727 and 726 extending to the sender.

At this point it may be explained that had a sender of the other group of senders been calling; a sender of such group being diagrammatically disclosed at 830, the start conductor 724' would have been grounded at such sender and a circuit closed for start relay 803 of the link extending from conductor 724' over the left back contact of relay 804, the outer left back contact of start relay 801, to battery through the winding of relay 803. Relay 803 functions in exactly the same manner as relay 801 except that it establishes a circuit for the stepping magnet 820 of the sender finder 850 upon the energization of relay 808, whereby the finder 850 hunts for a sender in the group in which sender 830 is located. Also relay 803 prepares a circuit for

relay 816 to establish connections from the sender 830 to the selector 950 individual to the link.

A circuit is now closed from battery through the winding of relay 915, over conductor 918, brush 812, conductor 618 to ground, whereupon relay 915 energizes, supplying at its right front contact locking ground for relays of the selector 950 and at its back contact opening at one point the operating circuit of release magnet 917. A circuit is also closed from battery through the left winding of relay 900 over off-normal contact 901, conductor 902, inner left contact of relay 811, brush 813, conductor 802, winding of relay 700, conductor 701 to ground at the intermediate left contact of relay 406. Relay 900 energizes in this circuit, but being low wound relay 700 does not operate. Relay 900, upon energizing, locks over its left front contact to ground at the front contact of relay 915 and at its outer right front contact prepares an operating circuit for the vertical magnet 903 of selector 950.

At the position switch 450 following the completion of the positioning of link selector 750 and the positioning of switch 350, relay 306 releases, opening the circuit of relay 405 and closing a circuit from ground at its back contact over the off-normal contacts 315, now closed, through the right normal contacts and winding of relay 305 to battery. Relay 305 operates, opening its own energizing circuit and locking over its inner right contacts to ground at the left back contact of release magnet 300. At its outer right contact relay 305 substitutes the rotary magnet 303 for the vertical magnet 304 in the circuit previously traced, extending to the sender.

At the sender upon the release of relay 405 a circuit is established for relay 456 extending from battery through the winding of relay 456, the right back contact of relay 405, the left front contact of relay 410, conductor 511, the right back contact of relay 500, conductor 512, the right back contact of relay 407, thence as traced over the back contacts of magnets 303 and 304, over the outer left back contact of relay 301, left front contact of relay 305 to ground at the left back contact of relay 316. Relay 456 energizes in this circuit and establishes a circuit for relay 500 extending from battery through the left winding of relay 500, over conductor 518, the inner right contact of relay 456, the third position terminal and brush 403 of steering switch 450 to ground on conductor 402. Relay 500 locks over its inner left contact and brush 403 to ground independent of the contacts of relay 456. Relay 500, upon energizing, now opens at its inner right back contact the locking circuit of relay 410, which relay now releases opening at its outer left front contact the circuit of relay 456 which also releases. Relay 410, upon releasing, also es-

tablishes a circuit for relay 705 extending from battery through the winding of relay 705, conductor 401, the right back contact of relay 410 to ground at the right contact of relay 404 and relay 705 in turn establishes the previously traced circuits for relay 501 and magnet 412. Relay 501 and magnet 412 now energize, magnet 412 preparing the steering switch 450 for advancing into position 4 and relay 501 establishing a pulsing circuit between the sender and the selector 950.

Setting the selector 950 in accordance with the second office code letter

A pulsing circuit between the selector 950 and the sender may now be traced from battery through the winding of relay 904, back contacts of rotary magnet 905 and vertical magnet 903, the inner right back contact of relay 906, the intermediate right back contact of relay 907, conductor 908, the intermediate left contact of relay 811, brush 814, conductor 727, the outer right back contact of relay 709, the back contact of counting relay 710, conductor 734, the right front contact of relay 507, the left back contact of relay 508, winding of relay 502, the left contact of relay 501, the outer right front contact of relay 500, conductor 512, the right back contact of relay 407, conductor 230, brush 246, conductor 235, the inner right back contact of relay 301, conductor 302, the back contacts of magnets 303 and 304, the outer left back contact of relay 301, the left contact of relay 305 to ground at the back contact of relay 316. Relays 904 and 502 energize in the circuit. Relay 502, upon energizing closes a circuit for itself over its right contact, the right back contact of relay 515 to ground at the outer left back contact of relay 522 independently of ground at the back contact of relay 316 and at its left contact establishes a circuit for relay 407 extending from battery through the winding of relay 407, the third position terminal and brush 416 of steering switch 450, conductor 411 to ground at the left contact of relay 502.

Relay 407 at its inner left contact establishes a circuit for rotary magnet 303 of the position switch 350 extending from battery through the winding of magnet 303, the outer right front contact of relay 305, the right back contact of release magnet 300, the winding of slow-to-release relay 306, the inner left back contact of relay 301, conductor 226, brush 247, conductor 757 to ground at the inner left front contact of relay 407. Magnet 303 and relay 306 energize in this circuit, magnet 303 stepping the brush shaft of switch 350 one step in a rotary direction. Relay 407 at its right back contact also opens the circuit previously traced for relay 404, but relay 404 being slow to release, does not do so as long as relay 502 continues to re-

ceive impulses due to the advance of selector 950 and to retransmit such impulses through the winding of relay 407. With relay 407 energized a holding circuit for relay 407 is closed from battery through its winding, the left contact of relay 404, the right front contact of the relay 407, conductor 230, brush 247, conductor 235, the inner right back contact of relay 301, the back contacts of magnets 303 and 304, the outer left back contact of relay 301, the left contact of relay 305 to ground at the left back contact of relay 316 and also to ground at the front contact of relay 306. Relay 407 therefore does not deenergize until the rotary magnet 303 has fully energized to advance the switch 350 one step.

At the selector 950, 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 502. The selector switch is thus stepped vertically one step, opening at the off-normal terminal 901 the initial energizing circuit of relay 900. Upon the opening of the pulsing circuit and the deenergization of relay 502, the initial energizing circuit of relay 407 is opened and upon the completion of the first step of magnet 303, the holding circuit of relay 407 is opened, whereupon it deenergizes opening the operating circuit of magnet 303 which also deenergizes. At the selector 950 upon the deenergization of vertical magnet 903 the pulsing circuit previously traced is again established and relays 502 and 904 again operate, both performing the same functions previously described to cause the further advance of the selector 950 and of the position switch 350 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 350 has advanced two steps in a rotary direction and the brush 308 is resting on the second terminal of the second level of bank 317, only the first two and tenth levels of such bank being disclosed, a circuit will be closed from ground at the intermediate right contact of relay 220 over the right contact of relay 201, conductor 237, brush 308, thence over the inner right back contact of relay 301, conductor 235 and as previously traced to battery through the right winding of relay 407. Relay 407 is thus prevented from deenergizing when rotary magnet 303 completes its second step for such a

period that the circuit for relay 404 is held open long enough to release relay 404. Relay 404 on releasing opens the circuit of relay 407 which thereupon releases and opens the circuit of rotary magnet 303 and slow-to-release relay 306 of the position switch 350. Relay 404 upon deenergizing also opens at its right contact the previously traced circuit for relay 705 which deenergizes in turn opening the circuits of relay 501 and magnet 412. Magnet 412 thereupon advances the steering switch 450 into position 4.

As soon as relay 407 deenergizes the circuit previously traced for relay 404 extending over the outer left back contact of relay 407 is closed and relay 404 energizes. When the steering switch 450 leaves position 3 the locking circuit for relay 500 is opened at brush 403 and relay 500 releases closing at its outer right back contact the circuit previously traced for relay 405 extending to ground at the front contact of slow-to-release relay 306 of the position switch 350. Relay 405 energizes, locks and establishes the circuit of relay 410 as previously described and relay 410 thereupon locks over its inner left front contact, conductor 513, the inner right back contact of relay 500 to ground on conductor 409. With steering switch 450 in position 4 a circuit is at this time prepared for relay 521 extending from battery, through the winding of this relay, the left back contact of relay 520, conductor 530, the fourth position terminal of brush 418 of steering switch 450, conductor 717 to ground at the right back contact of relay 522.

When relay 306 releases following the completion of the last rotary step of position switch 350, the locking circuit of relay 405 is opened at the front contact of relay 306 and a circuit is established from ground at the back contact of relay 306, over off-normal contacts 315, brush 307 and the terminal of bank 318 upon which it is resting, all terminals of such bank being strapped together but only the first two and tenth levels of such bank being shown, to battery through the winding of relay 316. Relay 316 upon energizing establishes at its left front contact a circuit for release magnet 300 of the position switch extending from ground at the front contact of relay 316, over conductor 319, the outer right front contact of relay 220, conductor 320 to battery through the winding of magnet 300. Magnet 300, upon energizing, releases the position switch 350 to normal, in which position the circuit of relay 316 is opened at brush 307, in turn opening the circuit of magnet 300. Magnet 300 at its left back contact also opens the locking circuit of relay 305 which releases, and disconnects ground from conductor 229, releasing relay 220. Relay 220, upon releasing, in turn removes ground from conductor 231 at

its outer 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.

5 With relay 405 released and relay 410 still energized a circuit is now established for relay 456 extending from battery through the winding of relay 456, the right back contact of relay 405, the left front contact of
10 relay 410, conductor 511, the outer right back contact of relay 500, conductor 512, thence as previously traced to the outer left back contact of relay 301, over off-normal contacts 330, now closed, since switch 350 has been
15 restored to normal, to ground at the left back contact of release magnet 300. Relay 456, upon energizing, now locks over its inner left contact, the right front contact of relay 410 to ground at the right contact of relay
20 404, and establishes a circuit for relay 407 extending from battery through the winding of relay 407, the left contact of relay 404, the outer left contact of relay 456, conductor 531, the left contact of relay 520, conductor 530, the fourth position terminal and
25 brush 418 of steering switch 450, conductor 717 to ground at the right back contact of relay 522.

Relay 407 upon energizing closes a circuit
30 for the vertical magnet 304 of the position switch 350 in series with relay 306 extending from battery through the winding of magnet 304, the outer right back contact of relay 305, the right back contact of release magnet
35 300, the winding of relay 306, the inner left back contact of relay 301, conductor 226, brush 247, conductor 757 to ground at the inner left front contact of relay 407. Until the magnet 304 fully energizes relay 407 is
40 locked through its winding, the left contact of relay 404, the right front contact of relay 407, conductor 230, brush 246, conductor 235, the inner right back contact of relay 301, conductor 302, the back contacts of magnets
45 303 and 304, the outer left back contact of relay 301 to ground over the off-normal contacts 330 and the left back contact of magnet 300, and after relay 306 energizes to ground at its front contact. The energization of re-
50 lay 407 also establishes a circuit for relay 500 extending from battery through the right winding of relay 500, conductor 503, the left back contact of relay 405, the outer right front contact of relay 456 to ground
55 at the inner left contact of relay 407. Relay 500 thereupon energizes opening at its inner right back contact the locking circuit of relay 410, thereby releasing relay 410 which in turn opens the holding circuit of
60 relay 456 which also releases. Relay 500 also closes a locking circuit at this time for relay 521 extending from battery through the winding and inner right front contact of relay 521, over the inner right front contact
65 of relay 500 to ground on conductor 409 and

establishes a locking circuit for itself extending from battery through its right winding over conductor 503, the left back contact of relay 405, conductor 457, the outer right
70 front contact of relay 521, the outer left contact of relay 500, conductor 536, brush 403 and its fourth position terminal to ground on conductor 402.

Relay 456 upon releasing opens the initial energizing circuit of relay 407. If at this
75 time the magnet 304 of the position switch has advanced such switch a full step, the holding circuit of relay 407 is opened at the back contact of magnet 304 and relay 407 deenergizes opening at its inner left contact
80 the operating circuit of magnet 304 and relay 306. Magnet 304 deenergizes but relay 306 being slow to release does not deenergize before its circuit is again closed as will be presently described. A circuit is now
85 closed for relay 705 extending from battery through the winding of relay 705, conductor 401, the right back contact of relay 410 to ground at the right contact of relay 404. Relay 705, upon energizing, closing the pre-
90 viously traced circuits for relay 501 and magnet 412. Magnet 412 upon energizing prepares to advance steering switch 450 into position 5.

Selection of idle trunk group by selector 950 and partial registration of tens digit of trunk number

Pulsing circuits are now established between selector 950 and the sender and between
100 the sender and the position switch 350 for setting the position switch in accordance with the vertical stepping of the selector to register the tens group of trunks which the selector now proceeds to hunt for. It will be as-
105 sumed that the group of trunks that is selected by the selector 950 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
110 code letter A, the switch shaft of selector 950 has positioned its brush sets opposite the second level of each bank, commutator brush 911, will now be standing on commutator segment 912. Should all of the trunks of the second
115 level of both banks be busy there will be no ground potential connected to the segment 912 and the circuit to be hereinafter traced from the brush 911 through the right winding of relay 900 will not be effective to dif-
120 ferentially release relay 900.

As a consequence, a circuit is completed from battery through the winding of relay 904, thence as previously traced to the wind-
125 ing of pulsing relay 502, the left contact of relay 501, the outer right front contact of relay 500, conductor 512, the right back contact of relay 407, conductor 230, brush 246, conductor 235, the inner right back contact of relay 301, conductor 302, the back contacts
130

of magnets 303 and 304, the outer left back contact of relay 301 to ground at the front contact of relay 306, relay 306 not yet having had time to release since the position switch 350 took its previous vertical step. Relays 502 and 904 are both energized, relay 502 locking to ground over its right front contact, the right back contact of relay 515 and the outer left back contact of relay 522, and closing at its left contact the previously traced circuit for relay 407. Relay 407 energizes and at its inner left contact closes the previously traced circuit for vertical magnet 304 and relay 306 of the position switch 350, and locks over the left contact of relay 404 and its own inner right front contact, thence to ground at the front contact of relay 306 over the circuit previously traced.

Magnet 304 upon energizing advances the position switch 350 another step to position its brushes opposite the second level of their respective banks. Relay 306 which was previously energized when the switch 350 took its first step and did not have time to release, is maintained energized at this time. Relay 904 of selector 950 energizes and again closes the previously traced circuit for the vertical magnet 903 which in turn opens the pulsing circuit through the windings of relays 502 and 904 just traced, relay 904 in turn opening the circuit of magnet 903. Thus, magnet 903 is operated and released to advance the switch shaft on step vertically to position the brushes opposite the third level of terminals in its banks. When relay 502 deenergizes upon the operation of vertical magnet 903 the initial energizing circuit of relay 407 is opened and when the vertical magnet 304 of the position switch completes its energization to advance the switch 350 a full step the locking circuit of relay 407 is opened and relay 407 releases, opening the operating circuit of magnet 304 and relay 306. Magnet 304 thereupon 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 911 encounters ground potential on the terminal 918 corresponding to the third 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, trunk 136, 137 being the first in the group of ten trunks appearing in the third level of the upper bank selector 950 and trunk 126, 127 being the tenth of such group. In a similar manner ten other trunks extending to the office 122 appear in the terminals of the third level of the lower bank of the selector 950, but with their tip and ring conductors reversed. It will be noted that so long as any trunk in the first group is idle ground will be connected to the commutator terminal 918 over the conductor 919, the outer back con-

tact of the cut-off relay of such trunk, for example, relay 121, and over the outer back contact of the sleeve relay of such trunk, for example, relay 120. Similarly so long as any trunk of the other group often, one trunk of which is indicated at 920 is idle, ground will be connected to the conductor 921, also connected to the commutator terminal 918. Thus brush 911 upon encountering ground potential establishes a circuit from such ground over brush 911, the right winding and inner right contact of relay 900, outer right back contact of relay 906, the outer right back contact of relay 907, conductor 910, outer left contact of relay 811, brush 815, conductor 726, inner right back contact of relay 709, conductor 519, the left front contact of relay 521, the inner left back contact of relay 510 to battery through both windings of relay 509. Relay 509 energizes and establishes a circuit for relay 514 from battery, winding of relay 514, front contact of relay 509 to ground at conductor 409. Relay 514 at its right contact shunts the left winding of relay 509, thereby reducing the resistance of the circuit previously traced through the right winding of relay 900 so that the right winding of this relay receives sufficient current to cause the differential release thereof. Relay 900 upon releasing opens the operating circuit of vertical magnet 903, to prevent the further vertical stepping of the selector. Relay 509 upon energizing also opens at its back contact the energizing circuit of relay 501, whereby relay 501 deenergizes.

When relay 900 deenergizes the previously traced circuit through relay 509 is opened at the inner right front contact of relay 900 and relay 509 deenergizes in turn opening the energizing circuit of relay 514. Relay 514 being slow to release momentarily closes a circuit for relay 510 before it releases, extending from battery through the winding of relay 510, the left front contact of relay 514, the right back contact of relay 509 to ground on conductor 409. Relay 510 upon energizing locks over its inner right contact, conductor 537, the fourth position terminal and brush 414 of steering switch 450, conductor 415 to ground at the inner left back contact of relay 522, at its inner left back contact opens the initial energizing circuit of relay 509 and at its outer left back contact opens the circuit of relay 404. Relay 404 thereupon releases opening the previously traced circuit for relay 705.

Relay 705 upon releasing now opens the circuit of magnet 412 advancing steering switch 450 into position 5. As soon as the steering switch leaves position 4 the locking circuit of relay 500 is opened at brush 403 whereupon relay 500 releases, in turn releasing relay 521. Also, the locking circuit of relay 510 is opened, releasing relay 510. With relay 500 deenergized the circuit pre-

viously traced through the winding of relay 405 to ground at the front contact of relay 306 is again closed before relay 306 has time to release, locking itself directly to its operating circuit independent of the outer left contact of relay 410 and establishing an obvious circuit for energizing relay 410. Relay 410 energizes and locks over conductor 513, the inner right back contact of relay 500 to ground on conductor 409. As soon as steering switch 450 reaches position 5 a circuit is established from battery through the winding of relay 520, conductor 526, brush 414, conductor 415 to ground at the inner left back contact of relay 522, relay 520 upon energizing locking directly to ground on conductor 409 over its inner right contact. With relay 510 deenergized a circuit is at this time completed for relay 404 extending from battery through its winding, the inner left contact of relay 406, the outer left back contact of relay 407, the back contact of relay 427, conductor 455, the outer left back contact of relay 510, conductor 504, the fifth position terminal and brush 420 of steering switch 450 to ground. Relay 404 now energizes and since relay 520 is at this time operated, a circuit is established for relay 705 extending from battery through the winding of relay 705, conductor 401, the outer right contact of relay 520 to ground at the front contact of relay 404. Relay 705 now energizes and closes the previously traced circuits for relay 501 and magnet 412, the magnet 412 preparing the steering switch for advancing into position 6.

When the slow releasing relay 306 at the position switch releases, the holding circuit of relay 405 is opened and relay 405 releases. Also relay 306 at its back contact establishes a circuit for relay 305 extending from ground at the back contact of relay 306 over off-normal contacts 315, the right normal contacts of relay 305 to the battery through the winding of relay 305. Relay 305 energizes, opening its own operating circuit and locking over its inner right contacts to ground at the left back contact of magnet 300, and at its outer right contacts substitutes the rotary magnet 303 for the vertical magnet 304 in the pulsing circuit extending as previously traced to the left front contact of relay 407 at the sender. As soon as relay 405 deenergizes, a circuit is established for relay 456 extending from battery through the winding of relay 456, the right back contact of relay 405, the outer left front contact of relay 410, conductor 511, the outer left back contact of relay 500, conductor 512, the right back contact of relay 407, thence as traced to the outer left back contact of relay 301, over the left contact of relay 305, to ground at the back contact of relay 316. Relay 456 energizes and locks over its inner left contact, the right front contact of relay 410, to ground at the right front contact of relay 404. The

release of relay 405 also closes a circuit for relay 500 extending from battery through the right winding of relay 500, conductor 503, the left back contact of relay 405, conductor 457, the right back contact of relay 521, conductor 538, the right front contact of relay 501, conductor 539, the fifth position terminal and brush 403 of steering switch 450 to ground on conductor 402. Relay 500 now energizes, unlocking and releasing relay 410 which in turn releases relay 456. With relay 500 energized a circuit is now established for relay 427 extending from battery through the winding of relay 427, conductor 458, the intermediate left contact of relay 500, conductor 526, the fifth position terminal and brush 414 of steering switch 450, conductor 415 to ground at the inner left contact of relay 522.

Selection of an idle trunk in the selected subgroup of trunks

A pulsing circuit is now established between the sender and the selector 950 for controlling the rotary hunting movement of such selector. This pulsing circuit extends from battery through the winding of relay 904, the back contacts of magnets 903 and 905, back contacts of relays 906 and 907, thence as previously traced through the winding of relay 502, the left contact of relay 501, the outer right front contact of relay 500, conductor 512, the right back contact of relay 407, thence as traced through the back contacts of magnets 303 and 304 at the position switch 350, the outer left back contact of relay 301, the left contact of relay 305 to ground at the back contact of relay 316. Relays 904 and 502 energize in this circuit.

At the selector upon the energization of relay 904 with relay 900 deenergized a circuit is established for the rotary magnet 905 extending 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. Relay 904 also establishes a circuit for relay 909 to disconnect the tip and ring brushes during the rotary hunting movement of the selector. Upon the closure of this pulsing circuit magnet 905 energizes opening the circuit previously traced through the windings of relays 904 and 502. Relay 904 upon deenergizing opens the circuit of magnet 905 which thereupon deenergizes, again closing the pulsing circuit. Thus relay 904 and magnet 905 reciprocally control each other, the magnet 905 advancing the switch shaft step-by-step in the search of an idle trunk.

At the sender upon the energization of relay 502 a circuit is established from ground at the left contact of relay 502 over conductor 411, brush 416 and the fifth position terminal of steering switch 450 to battery through the winding of relay 407. Relay 407 upon energizing closes a holding circuit for itself ex-

tending over the left contact of relay 404, its own right front contact, thence as traced over the back contacts of magnets 303 and 304 to ground at the left back contact of relay 316. at its outer left front contact closes a locking circuit for relay 404 extending from battery through the winding of relay 404, the inner left front contact of relay 406, the outer left front contact of relay 407, the front contact of relay 427, conductor 455, the outer left back contact of relay 510, conductor 504, the fifth position terminal and brush 420 to switch 450 to ground, and establishes a pulsing circuit for magnet 303 and relay 306 which extends as previously traced. Until relay 502 deenergizes upon the completion of the first rotary step of selector 950 and until the completion of the first rotary step of position switch 350 relay 407 remains energized. When these steps are completed relay 407 deenergizes, opening the circuit of magnet 303. In response to successive operations of relay 502 as the selector 950 advances in its rotary hunting movement relay 407 operates to retransmit impulses to the position switch 350.

In the present case it will be assumed that the trunks having an even tens number terminate in the lowermost banks of the selector 950 and that the trunks having an odd tens number terminate in the upper bank of the selector and that all trunks terminating in the upper bank have their tip and ring conductors reversed. For example, the trunks 0 to 9, 20 to 29, etc., terminate in the lower bank of the selector 950 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 914 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 922, test terminal 923, brush 914, the left back contact of relay 907, the intermediate left back contact and right winding of relay 906, conductor 902, the inner left contact of relay 811, brush 813, conductor 802, winding of relay 700, conductor 701 to ground at the intermediate left contact of relay 406. Relays 906 and 121 energize in this circuit, relay 121 locking over its inner right front contact to conductor 922 independent of relay 120 and relay 906 locking from battery through its left winding and inner left front contact to ground at the front contact of relay 915. At its outer left back contact, relay 906 opens the operating circuit of relay 907, at its intermediate left back contact opens its operating circuit, and at its intermediate left front con-

tact connects conductor 902 over the outer left back contact of relay 907 to test brush 914. At its right front contact relay 906 extends conductors 910 and 908 over the outer right and intermediate right back contacts of relay 907, right back contacts of relays 909 to the tip and ring brushes 924 and 925. Also at its inner right back contact, relay 906 opens the circuit previously traced through the windings of relays 904 and 502.

Relay 502 upon remaining deenergized holds open the initial energizing circuit of relay 407, and rotary magnet 303 upon completely energizing in response to the last impulse transmitted thereto by relay 407, opens the locking circuit of relay 407, whereupon relay 407 deenergizes, opening the pulsing circuit through magnet 303 and relay 306 and the holding circuit of relay 404. Relay 404 upon deenergizing opens the circuit of relay 705 which in turn deenergizes opening the circuits of relay 501 and magnet 412, thereby advancing the steering switch 450 into position 6. Relay 501 in turn opens the holding circuit of relay 500 which deenergizes, again establishing the previously traced circuits of relays 405 and 410. With the steering switch in position 6 a circuit is now closed for relay 522 extending from battery through the winding of relay 522, conductor 540, the sixth position terminal and brush 403 of the steering switch 450 to ground on conductor 402. Relay 522 energizes, locking to ground on conductor 409.

A fundamental circuit is now established from ground at the incoming selector 123 over trunk conductor 127, brush 924, thence as previously traced to conductor 726 over the inner back contact of relay 709, conductor 519, winding of polarized relay 524, the intermediate right front contact of relay 522, the winding of relay 502, back contact of relay 508, right front contact of relay 507, conductor 734, the back contact of counting relay 710, the outer back contact of relay 709, conductor 727, thence as traced to brush 925, 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 524 and relay 502 operate, the polarized relay 524 receiving current in the proper direction since the trunk conductors 126 and 127 have been assumed to be reversed. Relay 502 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 trans-
 piring the operator, noting that the lamp
 209 is extinguished, has proceeded to depress
 the digit keys to register the numerical desig-
 nation of the wanted line on the sender regis-
 ters shown in Fig. 7. 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 reg-
 ister 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 245, conductor 251,
 winding of relay 422, brush 429 and its first
 position terminal of the steering switch 400,
 conductor 433, right winding of thousands
 register 603 to battery. Relay 603 due to
 the low resistance of its operating circuit
 energizes and locks over both windings and
 its inner left contact to ground on conductor
 601 and relay 422 also operates. A second
 circuit is also established by the depression
 of key 212, extending from ground through
 the right winding of relay 602, conductor 419,
 the normal position terminal and brush 430
 of switch 400, winding of relay 421, conduc-
 tor 252, brush 244, conductor 225, the left
 back contact of relay 208, conductor 241 right
 contacts of key 212, high resistance 217, con-
 ductor 213, the inner right back contact of
 relay 208, conductor 224, brush 243, conduc-
 tor 253, winding of relay 423, brush 432 and
 the normal position terminal of steering
 switch 400, conductor 424, to battery through
 the right winding of relay 612. Due to the
 inclusion of high resistance 217, thousands
 register relays 612 and 602 do not operate
 but relays 421 and 423 both operate. With
 relays 422 and 421 operated, a circuit is es-
 tablished from ground through the contacts
 of these relays, brush 431 and its normal posi-
 tion terminal, conductor 435 to battery
 through the winding of thousands register
 relay 605. Relay 605 energizes and locks over
 its winding and inner left contacts through
 the winding of relay 606, to ground on con-
 ductor 601, operating relay 606. Thus relays
 603, 605 and 606 of the thousands register
 have been operated in response to the oper-
 ation of key 212 for the thousands digit 3.

Relay 423 upon operating closes a circuit
 from ground through the windings of relay
 425 and magnet 434 in parallel. Relay 425
 upon energizing closes a circuit from ground
 at its contact through the back contact of
 magnet 434, to battery through the winding
 of magnet 434. As soon as the operator re-
 leases the depressed key, relays 421, 422 and
 423 release, relay 423 in turn opening the
 circuits of relay 425 and magnet 434. Relay
 425 is, however, held energized over the back
 contact of magnet 434 until the magnet is
 fully energized when it releases opening at
 its front contact the circuit extending to bat-

tery through the contacts and winding of
 magnet 434. Relay 425 thus insures that the
 magnet 534 will energize fully to advance
 the steering switch 400 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 extend-
 ing from ground through low resistance 238,
 the left contacts of key 215, conductor 216,
 the right back contact of relay 208, conduc-
 tor 223, brush 245, conductor 251, winding
 of relay 422, brush 429 and the second posi-
 tion terminal of steering switch 400, conduc-
 tor 436 to battery through the right winding
 of hundreds register relay 607. Due to the
 low resistance of this operating circuit, relay
 607 operates and locks over its windings and
 inner left contact to ground on conductor
 601. Relay 422 also operates. At its right
 contacts key 215 closes a circuit from ground
 through the low resistance 238, the right con-
 tacts of key 215, conductor 213, the inner
 right back contact of relay 208, conductor
 224, brush 243, conductor 253, winding of
 relay 423, brush 432, and its second position
 terminal, conductor 443 to battery through
 the right winding of hundreds register relay
 613. Relays 423 and 613 operate in this cir-
 cuit, relay 613 locking to ground on conduc-
 tor 601 over its windings and inner left con-
 tacts. Hundreds register relays 607 and 613
 have thus been operated. Relay 422 performs
 no useful function at this time, but relay
 423 again causes the operation of relay 425
 and magnet 434 for advancing the brushes
 of steering switch 400 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 243,
 conductor 253, winding of relay 423, brush 432
 and its third position terminal, conductor 438
 to battery through the right winding of tens
 registered relay 609. Relays 423 and 609 en-
 ergize, relay 609 locking over its windings
 and left contact to ground at conductor 601.
 A second circuit is also established from bat-
 tery through the right winding of tens regis-
 ter relay 617 over conductor 444, the third po-
 sition terminal and brush 429 of steering
 switch 400, winding of relay 422, conductor
 251, brush 245, 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 244, conductor 252, winding of relay
 421, brush 430 and its third position terminal,
 conductor 426 to ground through the left
 winding of tens register relay 615. Due to
 the low resistance of this circuit, relays 421,
 615 and 617 operate, relay 615 locking over its

windings and right front contacts to ground on conductor 601, and relay 617 locking over its windings and inner left front contact to ground on conductor 601. Since relays 422 and 421 are both energized a circuit is established from ground over the contacts of these relays, brush 431 and its third position terminal, conductor 439, to battery through the winding of relay 610. Relay 610 energizes and locks over its winding and right front contact to ground on conductor 601. Tens register relays 609, 610, 615 and 617 are now operated. Relay 423 upon operating establishes the previously traced circuits for relay 425 and magnet 434 preparatory to advancing steering switch 400 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 243, conductor 253, winding of relay 423, brush 432 and its fourth position terminal, conductor 460, to battery through the right winding of units register relay 619. Due to the inclusion of high resistance 217, relay 619 does not operate, but relay 423 operates. A second circuit is also established from battery through the right winding of units register relay 616, conductor 428, brush 429 and its fourth position terminal, winding of relay 422, conductor 251, brush 245, 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 244, conductor 252, winding of relay 421, brush 430 and its fourth position terminal, conductor 452, to ground through the left winding of relay 620. Due to the inclusion of high resistance 240, register relays 616 and 620 do not operate, but relays 421 and 422 both operate and close a circuit from ground over their contacts, brush 431 and its fourth position terminal, conductor 440 to battery through the winding of units register relay 611. Relay 611 operates and locks over its winding and right contact to ground at conductor 601. Relay 611 is thus the only units register relay operated. Relay 423 upon operating again causes the operation of relay 425 and magnet 434 to advance steering switch 400 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 450 in position 6 and that the further advance of said steering switch awaited the registration of the hundreds digit to the wanted line number. Upon the registration of such digit a circuit is established for relay

535 extending from ground over brush 449 and the third position terminal of steering switch 400, conductor 461, winding of relay 535, resistance 527 to battery. Relay 535 energizes and locks over its inner right front contact to ground on conductor 409 and at its left contact establishes a circuit for advancing steering switch 450 into position 7, extending from battery through the winding and contacts of magnet 412, conductor 528, left contacts of relay 535, conductor 529, sixth position terminal and brush 420 of steering switch 450 to ground. With steering switch 450 in position 7 and polarized relay 524 operated over the fundamental circuit, a circuit is now established for relay 525 extending from battery through the winding of relay 525, conductor 541, the seventh position terminal and brush 414 of steering switch 450, conductor 415 to ground at the left front contact of relay 524. Relay 525 upon energizing locks over its right front contact to ground on conductor 409. The operation of relay 525 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 450 into position 8 which may be traced from battery through the winding and contacts of magnet 412, the seventh position terminal and brush 420, to ground.

With steering switch 450 in position 8, a circuit is established for relay 705 extending from battery through the winding of relay 705, conductor 401, the eighth position terminal and brush 403 of steering switch 450, a conductor 402 to ground at the outer right contact of relay 406, relay 705 upon energizing closing the previously traced circuit of magnet 412 preparatory to advancing steering switch 450 into position 9. In position 8, a circuit is established for relay 534 extending from battery through the winding of relay 534, over conductor 542, the eighth position terminal and brush 420 of steering switch 450 to ground. Relay 534 upon energizing locks over its left front contact to ground on conductor 409 and closes at its right front contact a circuit extending from ground over conductor 532, strapped terminals and brush 454 of steering switch 400 to battery through the contacts and winding of magnet 434, for advancing steering switch 400 out of position 5 if the numerical registration has been completed, into position 9. When the steering switch 400 reaches position 9 a shunt is established around the winding of relay 535 extending from resistance 527, over conductor 533, the ninth position terminal and brush 449 to ground thereby de-energizing relay 535 to prepare at its outer right contact a circuit for later enabling the fundamental circuit to be established when steering switch 450 reaches position 14.

Indication of trunk number

At the position switch upon the release of relay 306 the holding circuit previously traced for relay 405 is opened and a circuit is established for relay 316 extending from battery through the winding of relay 316, the bank terminal of bank 318 upon which brush 307 is now resting, assumed to be the tenth terminal of the second level, brush 307, off-normal contacts 315 to ground at the back contact of relay 306. Relay 316 upon energizing also establishes a circuit for relay 301 extending from battery through the winding of relay 301, conductor 321, the outer right back contact of relay 220, conductor 319 to ground at the front contact of relay 316. Relay 301 upon energizing opens at its outer right back contact the circuit of lamp 232 which becomes extinguished as a signal that the trunk number registration is completed, and closes a circuit for relay 322 extending from battery through the winding of relay 322, the inner right front contact of relay 301, conductor 235, brush 246, conductor 230, right back contact of relay 407, conductor 512 to ground at the inner left contact of relay 525. It is to be understood, however, that relay 322 energizes only if the second selector has selected a trunk in its upper bank and has caused the energization of relay 525 in the manner previously described. It will be noted that with relay 322 energized brush 311 of the position switch 350 having access over its corresponding bank terminals to lamps indicating an odd tens number is selected but that with relay 322 deenergized brush 310 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 350 positioned its brushes on the tenth set terminals of the second level of its banks. A circuit is therefore closed for the No. 0 hundreds lamp 334 extending from battery through said lamp, terminal 323, brush 309 to ground at the outer right front contact of relay 301. A circuit is also established for the No. 3 tens lamp 324 extending from battery, lamp 324, terminal 325, brush 311, front contact of relay 322 to ground at the outer left front contact of relay 301. A circuit is also established for the No. 9 units lamp extending from battery, lamp 335, terminal 326, brush 312 to ground at the outer right front contact of relay 301. 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 selector 950 and that had the selector stepped

vertically more than four steps the brush 309 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 over a circuit extending from the No. 1 lamp 333, conductor 332, the right front contact of relay 206, conductor 331 to the terminals in the upper half of the bank to which brush 307 has access. 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 502 has been energized thereover in series with the control relay of the incoming selector 123. With the steering switch 450 in position 8, relay 502 now closes a counting relay control circuit which may be traced from ground at the front contact of relay 502 over conductor 411, brush 416 and the eighth position terminal of steering switch 450, conductor 441, right front contact of thousands register relay 603, the inner right back contact of register relay 612, the outer left front contact of register relay 605, lead 713, the back contact of counting relay 728, to battery through the winding of counting relay 732. Relay 732 energizes and locks through the winding of relay 728 over its own front contact to ground on conductor 706, but relay 728 does not energize until the commutator of the incoming selector places a shunting ground around the winding of relay 502 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 502 deenergizes removing ground from lead 713, whereupon relay 728 energizes extending the lead 713 over its front contact, the back contact of counting relay 736, conductor 717, brush 418 and its eighth position terminal, conductor 417, to battery through the winding of counting relay 718. Upon the further advance of the incoming selector shaft and the removal of the shunt around the winding of relay 502 by the commutator of the selector, relay 502 again energizes completing the circuit of relay 718, which energizes and locks through the windings of relays 702 and 710 in parallel over the front contact of relay 718 to ground on conductor 706. Upon the next deenergization of relay 502, relays 702 and 710 operate in this locking circuit. Relay 710 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 702 upon energizing opens the

circuit of magnet 412 to advance steering switch 450 into position 9, thereby releasing relay 705. Relay 705 in turn removes ground from conductor 706 to thereby release all operated counting relays. A circuit is now closed for relay 508 extending from battery, winding of relay 508 to ground at the front contact of relay 702 which is effective to hold relay 508 energized to in turn hold the fundamental circuit open until relay 705 has released the counting relays. As soon as the steering switch advances into the position 9, relay 508 is maintained energized from battery through its winding, conductor 543, the ninth position terminal and brush 403 of steering switch 450, to ground on conductor 402.

Relay 508 upon energizing now closes a circuit for reversing relay 709 over conductor 737, outer left contact of relay 525 to ground at the front contact of relay 508. Relay 709 upon energizing locks over its right contact directly to ground on conductor 409, and at its right contacts reverses the conductors of the fundamental circuit with respect to the winding of polarized relay 524. In position 9 a circuit is established for advancing the steering switch 450 into position 10 extending from battery through the winding and contacts of magnet 412, the ninth position terminal and brush 420 of the switch 550, to ground. The circuit of relay 508 is now opened and this relay deenergizes again establishing the fundamental circuit extending to the incoming selector 123, whereupon relay 502 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 502 establishes a circuit for controlling the counting relays of the sender. The polarized relay 524 is at this time not energized since relay 709 has now reversed the connection of trunk conductors 908 and 910 with respect to the winding of relay 524. With the steering switch 450 in position 10 a circuit as previously traced is established for relay 705 for supplying locking ground to the counting relays and the previously traced circuit is closed for magnet 412 preparatory to advancing steering switch 450 into position 11.

Incoming group selection

With relay 502 energized a circuit is now closed from ground at the front contact of relay 502 over conductor 411, brush 416 and its tenth position terminal, conductor 442, the outer right back contact of the thousands register relay 612, the lower front contact of relay 606, the outer left front contact of hundreds register relay 613, lead 738, the back contact of counting relay 739 to battery through the winding of counting relay 730. Relay 730 energizes and locks through the winding of relay 739 and over its own front

contact to ground on conductor 706, but relay 739 being shunted over the contact of relay 502 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 502 as the tripped set of brushes approaches each group selection position. Upon the first shunting of relay 502, it deenergizes permitting the operation of relay 739 which thereupon extends the lead 738 over its front contact and the back contact of counting relay 740 to battery through the winding of counting relay 731 upon the next energization of relay 502. In the manner previously described the pairs of counting relays are successfully operated until relays 718, 710 and 702 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 710 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 702 upon energizing opens the circuit of magnet 412 which deenergizes advancing steering switch 450 into position 11. Upon leaving position 10 relay 705 releases in turn unlocking all operated counting relays. In the manner previously described relay 508 is operated over the front contact of relay 702 until relay 702 releases following the release of relay 705 and is held operated over the eleventh position terminal and brush 403 of steering switch 450 until it leaves position 11. In position 11 the previously traced circuit over brush 420 is closed to advance steering switch 450 into position 12, thereupon reoperating relay 705, releasing relay 508 and reestablishing the fundamental circuit.

Final brush selection

With the fundamental circuit again established pulsing relay 502 and the control relay (not shown) of the final selector are operated, the control relay of the final selector preparing the circuits thereof for brush selection and the pulsing relay 502 closing a counting relay control circuit extending from ground at the front contact of relay 502 thence as traced to brush 416 and its twelfth position terminal, conductor 445, the back contact of hundreds register relay 614, the back contact of hundreds register relay 608, the inner right front contact of hundreds register relay 607, lead 722, the back contact of counting relay 721, to battery through

the winding of counting relay 729. Relay 729 energizes the locks through the winding of relay 721 and its own front contact to ground on conductor 706, but relay 721 being shunted at the front contact of relay 502 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 502. Upon the first shunting of relay 502 such relay deenergizes permitting counting relay 721 to operate to extend the pulsing lead 722 over its front contact and back contact of counting relay 739, to battery through the winding of relay 730. In the well known manner in response to the advance of the final selector shaft pairs of counting relays are successfully operated until relays 718, 710 and 702 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 710 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 702 upon energizing opens the circuit of magnet 412, which thereupon advances the steering switch 450 into position 13.

Upon leaving position 12, relay 705 releases in turn unlocking all operated counting relays. In the manner previously described relay 508 is operated over the front contact of relay 702 until relay 702 releases following the release of relay 705, and is held operated over the thirteenth position terminal and brush 403 of steering switch 450 until it leaves position 13. In position 13 the previously traced circuit over brush 420 is closed to advance the steering switch 450 into position 14, thereupon reoperating relay 705, releasing relay 508 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 400 will not have advanced beyond position 4 and relay 535 will still be locked-up and therefore when the steering switch 450 advances into position 14 the fundamental will not be closed since relay 508 will be held energized over a circuit extending from battery through the winding of relay 508, the outer right front contact of relay 535, conductor 544, the fourteenth position terminal and brush 420 of steering switch 450, to ground. As soon as the numerical registration is completed and relay 535 is shunted down as previously described, relay 508 deenergizes reestablishing the fundamental circuit.

Final tens selection

With the fundamental circuit again established pulsing relay 502 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 502 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 502 thence as traced to brush 416 and its fourteenth position terminal, conductor 446, the front contact of the tens register relay 610, the outer left front contact of tens register relay 617, counting relay lead 738, the back contact of counting relay 739 to battery through the winding of relay 730. Relay 730 energizes and locks through the winding of relay 739 and its own front contact to ground on conductor 706, but relay 739 does not energize since it is at the time shunted over the front contact of pulsing relay 502. As the ten shaft of the final selector advances in its brush selection movement the commutator thereof intermittently shunts the sender pulsing relay 502. At the first shunting, relay 502 deenergizes permitting counting relay 739 to operate to extend the operating lead 738 over the front contact of relay 739, the back contact of relay 740, to the counting relay 731. In the well known manner in response to the advance of the final selector shaft, pairs of counting relays are successively operated until relays 728 and 732 operate, when the lead 738 becomes extended over the front contact of relay 728, the back contact of relay 736, conductor 717, brush 418 and the fourteenth position terminal of steering switch 450, conductor 447, the right front contact of tens register relay 609, which always operates when the tens digit registered is greater than four, conductor 623 to battery through the winding of counting relay 733. The remaining relays are then successively operated as the final selector advances in its tens selection movement, until relays 718, 710 and 702 operate, at which time the tripped brush set of the final selector will be positioned beneath the first terminal of the eighth tens group, in which lines 3980 to 3989 terminate.

Relay 710 upon operating opens the fundamental circuit thereby arresting the advance of the final selector. Relay 702 upon energizing opens the circuit of magnet 412, which deenergizes and advances the steering switch 450 into position 15. Upon leaving position 14, relay 705 releases in turn unlocking all operated counting relays. In the manner previously described, relay 508 is operated following the energization of relay 702 and is held operated over the fifteenth position terminal and brush 403 of steering switch 450 until it leaves position 15. In position 15 the previously traced circuit over brush 420 is closed to advance the steering switch 450 into position 16, thereby reoperat-

ing relay 705, releasing relay 508 and re-establishing the fundamental circuit.

Final units selection

5 With the fundamental circuit again established pulsing relay 502 and the control relay of the final selector are operated, the control relay of the final selector starting the final selector in its units selection movement.

10 Pulsing relay 502 closes a counting relay control circuit for controlling the units selection movement of the final selector, extending from ground at the front contact of relay 502, thence as traced to brush 416 and its

15 sixteenth position terminal, conductor 448, the left front contact of units register relay 611, the left back contact of the units register relay 616, the counting relay lead 713, the back contact of counting relay 728 to battery

20 through the winding of relay 732. Relay 732 energizes and locks through the winding of relay 728 and its own front contact to ground on conductor 706, but relay 728 does not operate as its winding is shunted over the front

25 contact of pulsing relay 502. As the brush shaft of the final selector advances, the commutator thereof intermittently shunts the stepping relay 502, thereby causing the operation of successive counting relays until relays 718, 710 and 702 energize at which time

30 the tripped set of brushes will have been positioned upon the terminal of the wanted line 125. Relay 702 upon energizing opens the circuit of magnet 412 which thereupon advances steering switch 450 into position 17.

35 Relay 710 opens the fundamental circuit thereby arresting the further advance of the final selector. Upon leaving the position 16, steering switch 450 opens the circuit of relay 705 which deenergizes in turn releasing

40 all operated counting relays. In the manner previously described relay 508 is operated over the front contact of relay 702 until relay 705 releases, following the release of relay 705

45 and is held operated over the seventeenth position terminal and brush 403 of the steering switch until it leaves position 17. In position 17 a circuit is closed from battery through the winding and contacts of magnet

50 412 the seventeenth and eighteenth position terminals and brush 420 of steering switch 450, to ground for advancing the steering switch into position 19.

55 In position 19 a circuit is established for advancing steering switch 400 out of position 9 into normal position extending from battery through the winding and contacts of magnet 434, the nineteenth position terminal and brush 420 of steering switch 450, to

60 ground. Upon reaching position 10 steering switch 400 establishes a circuit for magnet 412 extending from battery through the winding of magnet 412, conductor 413, the tenth position terminal and brush 449 of steering

65 switch 400 to ground, preparatory to advancing

ing steering switch 450 into position 20. This circuit is maintained until the steering switch 400 reaches normal position when it is opened and steering switch 450 is permitted to advance into position 20, opening the driving circuit of magnet 434.

Incoming selector advances for ringing called line

75 With steering switch 450 in position 20 the previously traced circuit of relay 705 is established and relay 705 energizes establishing the previously traced circuit for magnet 412 preparatory to advance steering switch 450 into position 21. Upon leaving the position 17, steering switch 450 opens the circuit

80 of relay 508 which thereupon releases again closing the fundamental circuit.

At the final selector following the completion of units selection, the circuits of the final 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 502 and the control relay of the incoming selector, relay 502 at this time establishing a circuit

85 for counting relay 718, extending from ground at the front contact of relay 502, thence as traced to brush 416, counting relay operating lead 741, the back contact of counting relay 736, conductor 717, brush 418, the

90 twentieth position terminal of steering switch 450, conductor 417, to battery through the winding of relay 718. Relay 718 operates and locks through the windings of relays 702 and

95 710 in parallel, but the latter relays being shunted over the contact of relay 502 do not operate until the sequence switch of the incoming selector advances under the control of the relay thereof to open the fundamental

100 circuit and release relay 502. When the sequence switch of the incoming selector advances and relay 502 deenergizes relays 702 and 710 operate.

110 Relay 710 upon operating opens the fundamental circuit and relay 702 upon operating opens the circuit of magnet 412 to advance the steering switch 450 into position 21. The circuit of relay 705 is now opened to release relays 718, 710 and 702. Upon the operation

115 of relay 702, relay 508 again operates, but releases as soon as relay 702 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 502 and 524 of

120 the sender operate. Relay 524 operates at this time because the fundamental circuit has been reversed at the incoming selector in the well known manner. The testing of the

125 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

130

from the wanted line to the trunk conductors 126 and 127 is established.

Upon the energization of the polarized relay 524, a circuit is established from ground at its contact over conductor 415, the twenty-first position terminal and brush 414 of steering switch 450, to conductor 408 thereby shunting relays 406 and 600 for initiating the release of the sender.

Operator completes connection by plugging into indicated trunk jack

When the operator plugs into the trunk jack 119, in accordance with the trunk number 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 700. Relay 700 now receives sufficient current to energize and at its right contact connects ground over conductor 757, brush 247, conductor 226, the inner left front contact of relay 301, conductor 327 to battery through the winding of release relay 205 at the operator's position equipment.

Release of operator's equipment

Relay 205 upon operating closes a circuit for release magnet 300 of the opposition switch 350 which energizes, releasing such switch to normal. Magnet 300 upon energizing also opens the locking circuit of relay 305 whereupon relay 305 releases. As soon as switch 350 reaches normal, the circuit of relay 316 is opened at brush 307 and the circuits of the lighted lamps are opened at brushes 309 to 312 inclusive. The release of relay 316 also opens the circuit of relay 301 and such relay releases. Relay 301 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 300 energized over its left contact and at its outer right contact maintains the previously traced holding circuit for relay 207 open. Relay 207 thereupon releases at its outer left front contact removing ground from conductor 231, thereby releasing relays 201 to 204 inclusive. All apparatus of the operator's position equipment has now been restored to normal.

At the sender upon the shunting of the windings of relays 600 and 406 these relays release. The release of relay 406 removes ground from conductor 409 whereupon all operated relays of Figs. 4, 5, 6 and 7 release. A circuit is now closed for advancing steering switch 450 out of position 21 into normal

position. This circuit extends from battery through the winding and contacts of magnet 412, brush 453, and the strapped terminals of its bank to ground at the outer right back contact of relay 406. At its outer right back contact relay 406 also closes a circuit for relay 704 extending from battery through the winding of relay 704, back contact of magnet 707, brush 719 and the strapped terminals of its bank, conductor 735 to ground at the back contact of relay 406. Relay 704 energizes and closes an obvious circuit for magnet 707. Magnet 707 upon energizing opens the circuit of relay 704. Thus, relay 704 and magnet 707 reciprocally control each other to advance the switch 750 into normal position when the circuit of relay 704 is opened at the brush 719. Relay 600 upon deenergizing opens at its uppermost contact the circuits of the numerical register relays of the sender and at its intermediate lower contact opens the circuit of relay 915 of selector 950.

Relay 915 upon deenergizing now closes the circuit of release magnet 917 which energizes and restores the selector 950 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 selector.

Upon the release of relay 406 ground is removed from conductor 701, releasing relays 700 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 selectors such as the one shown in Fig. 9. With relay 121 released and relay 120 energized ground potential is maintained on test conductor 922 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 selectors, and ground is removed at the outer right back contact of relay 120 from conductor 919 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 450 in positions 10, 12, 14 or 16, polarized relay 524 operates closing a circuit for overflow relay 451 extending from ground at the contact of relay 524, conductor 415, brush 414, to battery through the winding of relay 451. Relay 451 upon energizing locks to ground on conductor 409 and at its right contact connects ground to conductor 408 thereby shunting relays 406 and 600 and causing the release of the sender. 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.

What is claimed is:

1. In an automatic telephone exchange system a plurality of operators' positions, a plurality of offices, a group of trunks outgoing to each of said offices and terminating therein in switching mechanism, office keys at each position corresponding to said plurality of offices, a plurality of senders common to said positions for operating said switching mechanism, means for associating any position with an idle sender, a plurality of link circuits each comprising a trunk selector and sender finder for connecting said sender with outgoing trunks, a link selector in each sender, and means under the control of said office keys for directing the link selector of a sender and the trunk selector of a selected link to select a group of trunks outgoing to a desired office.

2. In an automatic telephone exchange system a plurality of operators' positions, a plurality of offices, a group of trunks outgoing to each of said offices and terminating therein in switching mechanism, office keys at each position corresponding to said plurality of offices, a plurality of senders common to said positions for operating said switching mechanism, means for associating any position with an idle sender, a plurality of groups of link circuits each group common to a plurality of said groups of trunks, said link circuits each comprising a trunk selector and a sender finder for connecting said sender with outgoing trunks, a link selector in each sender, and means under the control of said office keys for directing the link selector of a sender to select a particular group of link circuits and for directing the trunk selector of an idle link circuit of a selected link group to select a group of trunks outgoing to a desired office.

3. In an automatic telephone exchange system a plurality of operators' positions, a plurality of offices, a group of trunks outgoing to each of said offices, office keys at each position corresponding to said plurality of offices, a plurality of groups of link circuits each group common to a plurality of said

groups of trunks, said link circuits each comprising a finder switch and a trunk selector for connecting a calling position with outgoing trunks, a link selector, and means under the control of said office keys for directing the link selector to select a particular group of link circuits and for directing the trunk selector of an idle link circuit of a selected link group to select a group of trunks outgoing to a desired office.

4. In an automatic telephone exchange system, a plurality of operators' positions, a plurality of offices, groups of trunks outgoing to each of said offices, office keys at each position corresponding to said plurality of offices, a plurality of groups of link circuits each group common to a plurality of said groups of trunks, said link circuits each comprising a finder switch and a trunk selector for connecting a calling position with outgoing trunks, a link selector, and means under the control of said office keys for directing the link selector to select and start all idle link circuits of a particular group of link circuits to search for the calling position and for directing the trunk selector of the first link circuit of the selected group which finds the position to select a group of trunks outgoing to a desired office.

5. In an automatic telephone exchange system, a plurality of operators' positions divided into a plurality of groups, a plurality of offices, a group of trunks outgoing to each of said offices, office keys at each position corresponding to said plurality of offices, a plurality of groups of link circuits, each group common to a plurality of groups of trunks, said link circuits each comprising as many finder switches as there are groups of positions and a trunk selector for connecting a calling position with outgoing trunks, a link selector, and means under the control of said office keys for directing the link selector to select and start all idle link circuits of a particular group of links to search for the calling position and for directing the trunk selector of the first link circuit of the selected group which finds the position to select a group of trunks outgoing to a desired office.

6. In an automatic telephone exchange system, a plurality of operators' positions divided into a plurality of groups, a plurality of offices, a group of trunks outgoing to each of said offices, office keys at each position corresponding to said plurality of offices, a plurality of groups of link circuits, each group common to a plurality of groups of trunks, said link circuits each comprising as many finder switches as there are groups of positions and a trunk selector for connecting the calling position with outgoing trunks, a link selector common to the positions of each group, means under the control of said office keys for directing the link selector to select and start all idle link circuits of a particular

group of link circuits to search for the calling position and for directing the trunk selector of the first link circuit of the selected group which finds the position to select a group of trunks outgoing to a desired office, and means controlled by the link selector associated with the calling group of positions to cause only the position finders of the selected group of link circuits which have access to the group of positions in which the calling position is located to hunt for said position.

7. In an automatic telephone exchange system, a plurality of operators' positions, a plurality of offices, a group of trunks outgoing to each of said offices and terminating therein in switching mechanism, office keys at each position corresponding to said plurality of offices, a plurality of senders common to said positions for operating said switching mechanism, means for associating any position with an idle sender, a plurality of groups of link circuits each comprising finder switches and a trunk selector for connecting a calling sender with outgoing trunks, a link selector in each sender, and means under the control of said office keys for directing the link selector to select and start all idle link circuits of a particular group of link circuits to search for the calling sender and for directing the trunk selector of the first link circuit of the selected group which finds the sender to select a group of trunks outgoing to a desired office.

8. In an automatic telephone exchange system, a plurality of operators' positions divided into a plurality of groups, a plurality of offices, a group of trunks outgoing to each of said offices and terminating therein in a switching mechanism, office keys at each position corresponding to said plurality of offices, a plurality of groups of senders for operating said switching mechanism, each group of senders being common to a group of operators' positions, means for associating any position of a group with an idle sender of the corresponding group, a plurality of groups of link circuits, each group common to a plurality of groups of trunks, each link circuit comprising as many finder switches as there are groups of senders and a trunk selector for connecting a calling sender with outgoing trunks, a link selector for each sender, and means under the control of said office keys for directing the link selector to select and start all idle link circuits of a particular group of links to search for the calling sender and for directing the trunk selector of the first link circuit of the selected group which finds the sender to select a group of trunks outgoing to a desired office.

9. In an automatic telephone exchange system, a plurality of operators' positions divided into a plurality of groups, a plurality of offices, a group of trunks outgoing to each of said offices and terminating therein

in switching mechanism, office keys at each position corresponding to said plurality of offices, a plurality of groups of senders for operating said switching mechanism, each group of senders being common to a group of operators' positions, means for associating any position of a group with an idle sender of the corresponding group, a plurality of groups of link circuits, each group common to a plurality of groups of trunks and each link circuit comprising as many finder switches as there are groups of senders and a trunk selector for connecting a calling position with outgoing trunks, a link selector for each sender means under the control of said office keys for directing the link selector to select and start all idle link circuits of a particular group of link circuits to search for the calling sender and for directing the trunk selector of the first link circuit of the selected group which finds the sender to select a group of trunks outgoing to a desired office, and means controlled by the link selector associated with the calling sender to cause only the sender finders of the selected group of link circuits which have access to the group of senders in which the calling sender is located to hunt for said sender.

10. In an automatic telephone exchange system, a plurality of operators' positions, a plurality of offices, a group of trunks outgoing to each of said offices, office keys at each position corresponding to said plurality of offices, a register switch at each position, a plurality of groups of link circuits, each group common to a plurality of groups of trunks, said link circuits each comprising a finder switch and a trunk selector for connecting a calling position with outgoing trunks, a link selector, means for first operating said register switch and said link selector in unison to select a particular group of link circuits and for then operating said register switch and the trunk selector of an idle link circuit of a selected group of link circuits in unison to select a group of trunks outgoing to a desired office, and means under control of an operated office key for determining the extent of movement of said register switch.

11. In an automatic telephone exchange system, a plurality of offices, a group of trunks outgoing to each of said offices, office keys at each position corresponding to said plurality of offices, a register switch at each position having two selective movements, a plurality of groups of link circuits, each group common to a plurality of groups of trunks, said link circuits each comprising a finder switch and a trunk selector for connecting a calling position with outgoing trunks, a link selector, means for operating said register switch in one selective movement and said link selector in unison there-

with to select a particular group of link circuits and for then operating said register switch in its other selective movement and the trunk selector of an idle link circuit of a selected group of link circuits in unison therewith to select a group of trunks outgoing to a desired office, and means under the control of an operated office key for determining the extent of the movements of said register switch.

12. In an automatic telephone exchange system, a plurality of operators' positions, a plurality of offices, a group of trunks outgoing to each of said offices, office keys at each position corresponding to said plurality of offices, a tens and a units office code register at each position under the control of said keys for registering the office codes of desired offices, a register at each position having two selective movements, a plurality of groups of link circuits, each group common to a plurality of groups of trunks, said link circuits each comprising a finder switch and a trunk selector for connecting a calling position with outgoing trunks, a link selector, means for operating said register switch in one selective movement and said link selector in unison therewith to select a particular group of link circuits and for then operating said register switch in its other selective movement and the trunk selector of an idle link circuit of a selected group of link circuits in unison therewith to select a group of trunks outgoing to a desired office, and means under the control of said office code registers for determining the extent of the movements of said register switch.

13. In an automatic telephone exchange system a plurality of operators' positions, a plurality of offices, a group of trunks outgoing to each of said offices, office keys at each position corresponding to said plurality of offices, a register switch and indicating lamps at each position, a plurality of groups of link circuits each common to a plurality of groups of trunks, said link circuits each comprising a finder switch and a trunk selector for connecting a calling position with outgoing trunks, a link selector, means under the control of said office keys for directing the link selector to select a particular group of link circuits and for directing the trunk selector of an idle link circuit of the selected link group to select a group of trunks outgoing to a desired office, means for thereafter operating said register switch and said trunk selector in unison 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.

14. In an automatic telephone exchange system, a plurality of operators' positions, a plurality of offices, a group of trunks outgoing to each of said offices, office keys at each

position corresponding to said plurality of offices, a register switch and indicating lamps at each position, a plurality of groups of link circuits, each group common to a plurality of groups of trunks, said link circuits each comprising a finder switch and a trunk selector for connecting a calling position with outgoing trunks, a link selector, means for operating said register switch and said link selector in unison to select a particular group of link circuits and for then further operating said register switch and the trunk selector of an idle link circuit of a selected group of link circuits in unison to select a group of trunks outgoing to a desired office, means under the control of an operated office key for determining the extent of the movements of said register switch, means for thereafter releasing said register switch, means for then operating said register switch and for further operating said trunk selector in unison therewith to select an idle trunk in the selected group of trunks, 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, 1928.

EDGAR H. CLARK.

WARREN W. CARPENTER.

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