

June 24, 1930.

E. H. CLARK ET AL

1,767,959

AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed Sept. 29, 1928

10 Sheets-Sheet 1

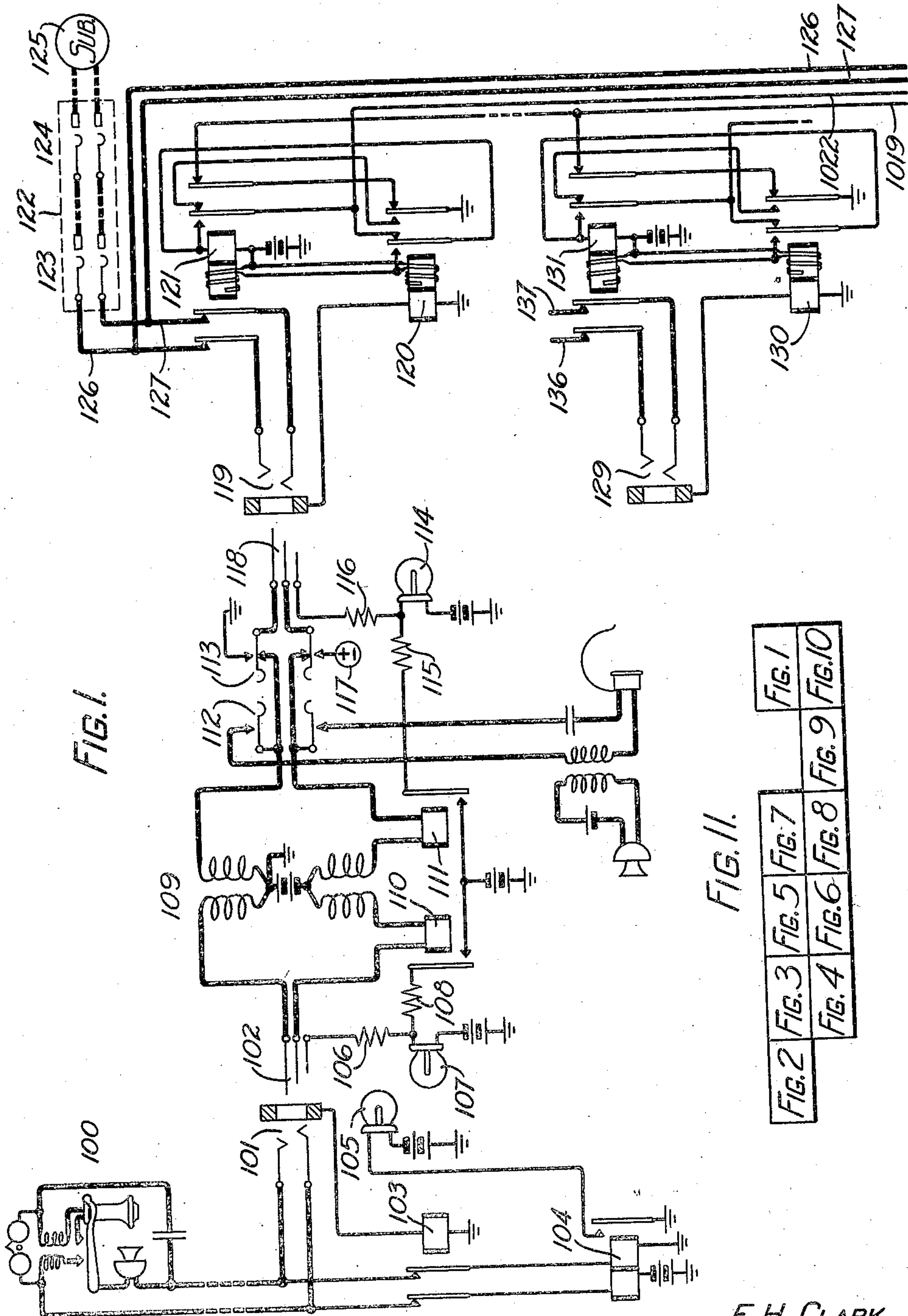


FIG. I.

FIG. II.

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

INVENTORS: E. H. CLARK
W. W. CARPENTER
BY P. C. Smith

ATTORNEY

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E. H. CLARK ET AL

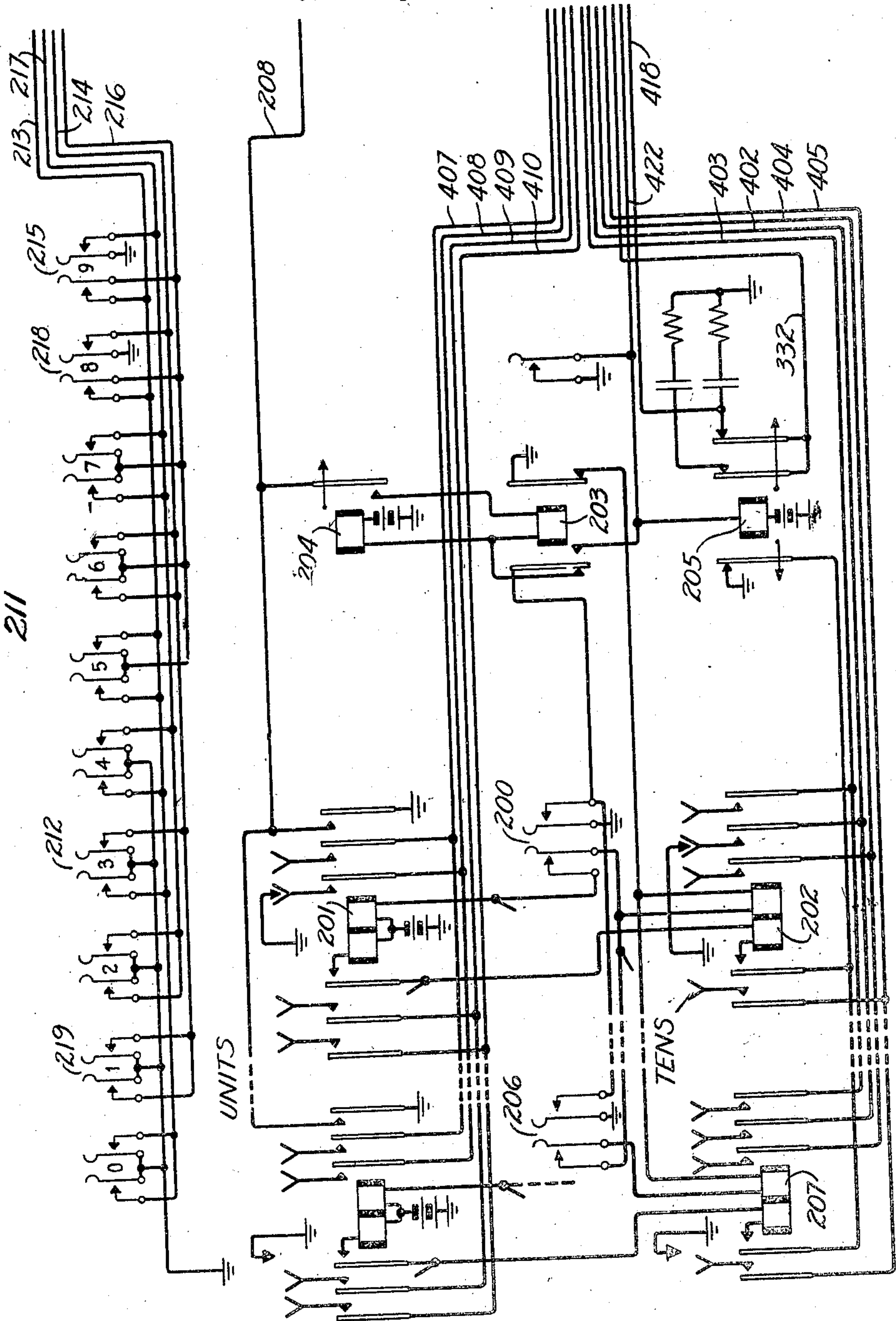
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FIG. 2
211



INVENTORS: E. H. CLARK
W. W. CARPENTER

BY *P. C. Smith*

ATTORNEY

June 24, 1930.

E. H. CLARK ET AL

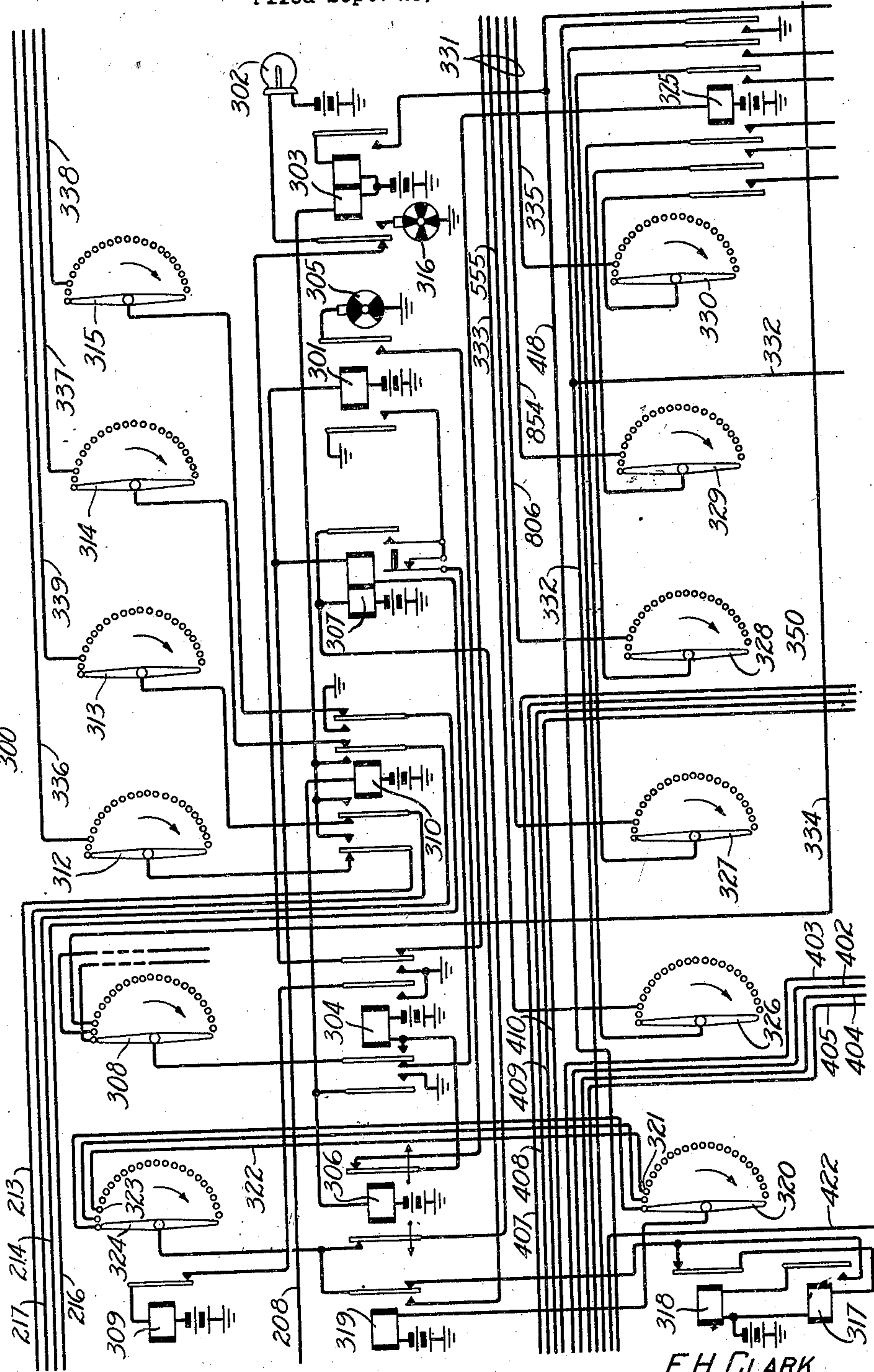
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FIG. 3
300



INVENTORS: E. H. CLARK
W. W. CARPENTER

BY P. C. Smith
ATTORNEY

June 24, 1930.

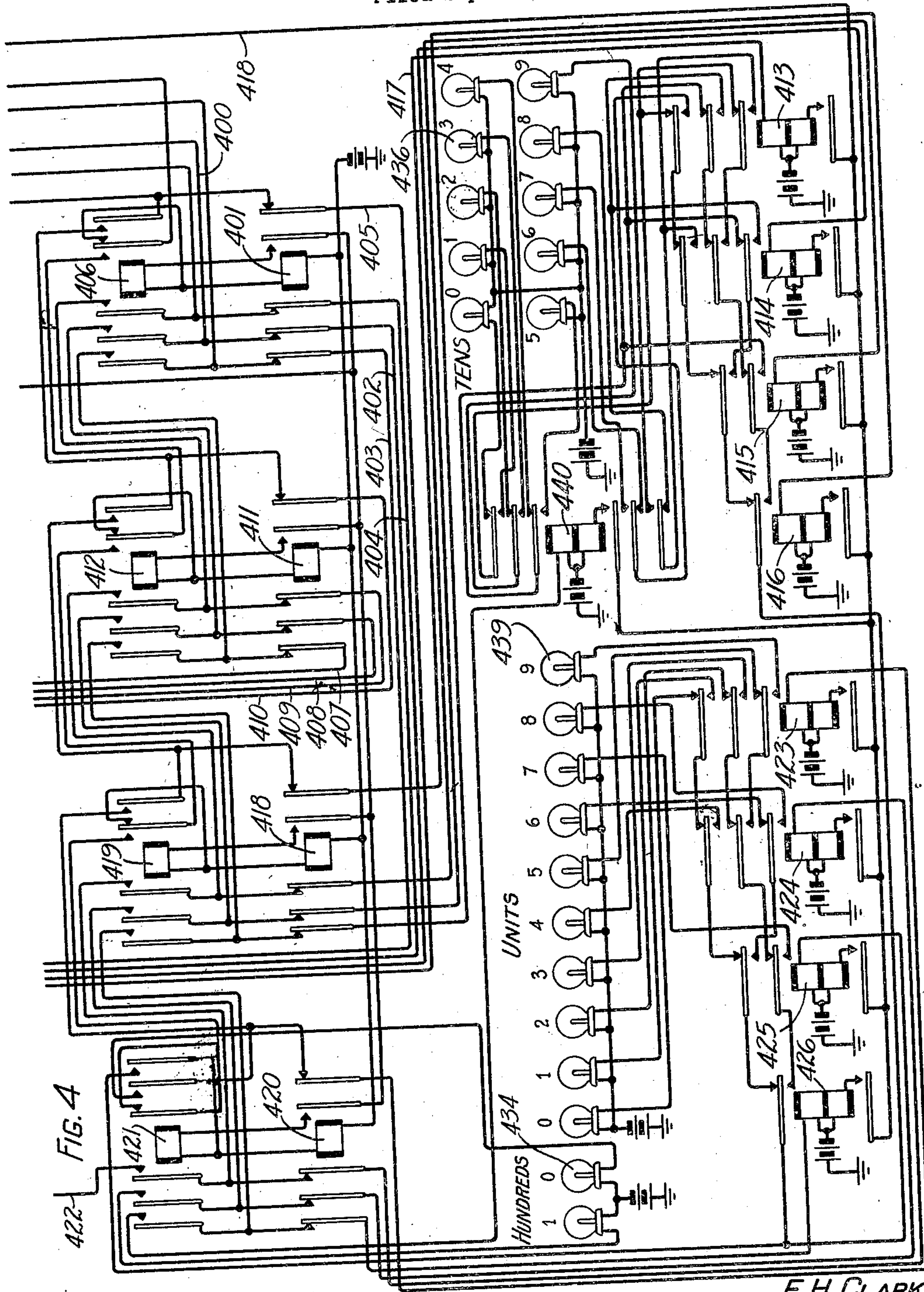
E. H. CLARK ET AL

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INVENTORS: E. H. CLARK
W. W. CARPENTER

BY

P. C. Smith

ATTORNEY

June 24, 1930.

E. H. CLARK ET AL

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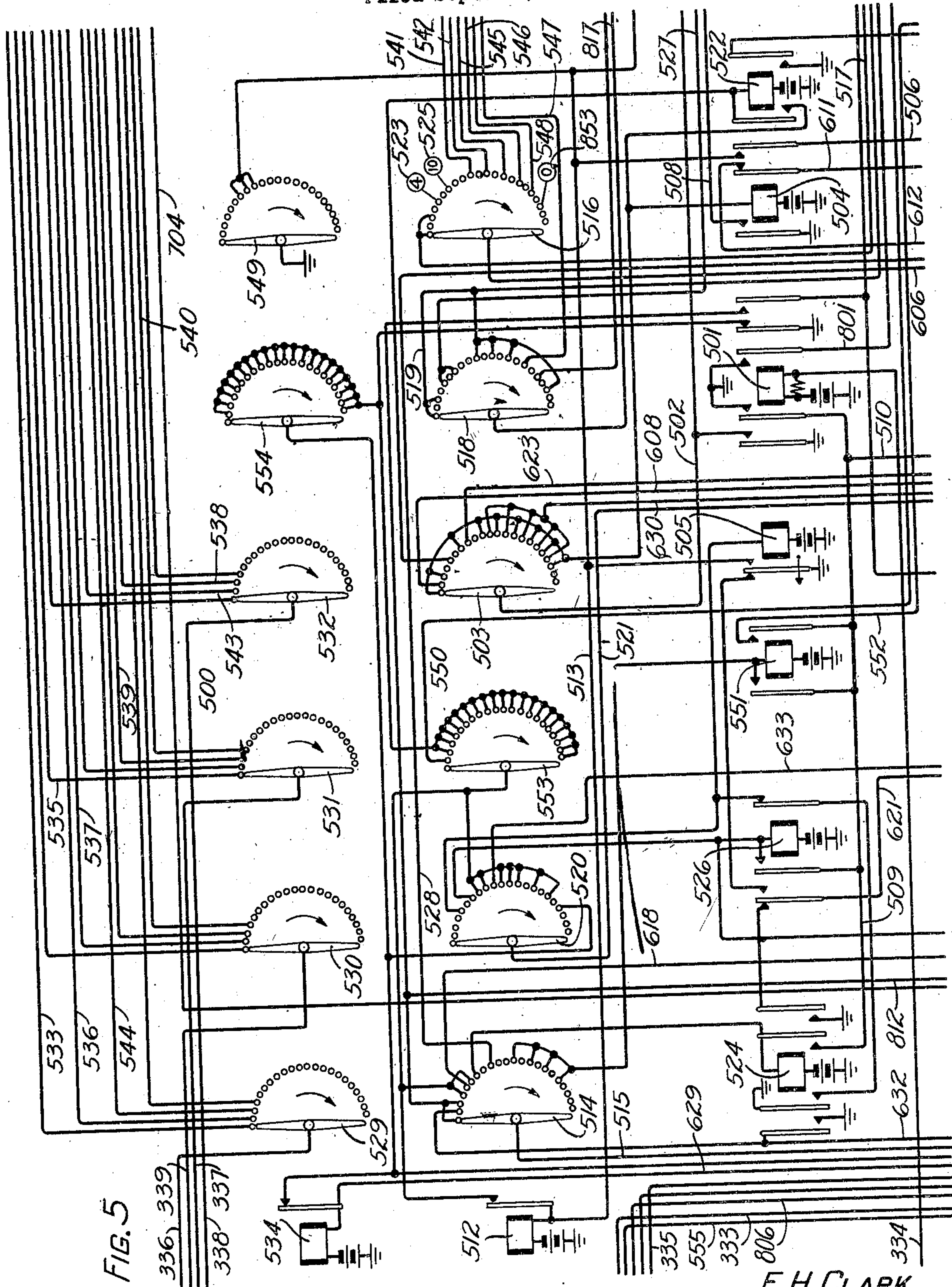


FIG. 5

INVENTORS: E. H. CLARK
W. W. CARPENTER

BY P. C. Smith

ATTORNEY

June 24, 1930.

E. H. CLARK ET AL

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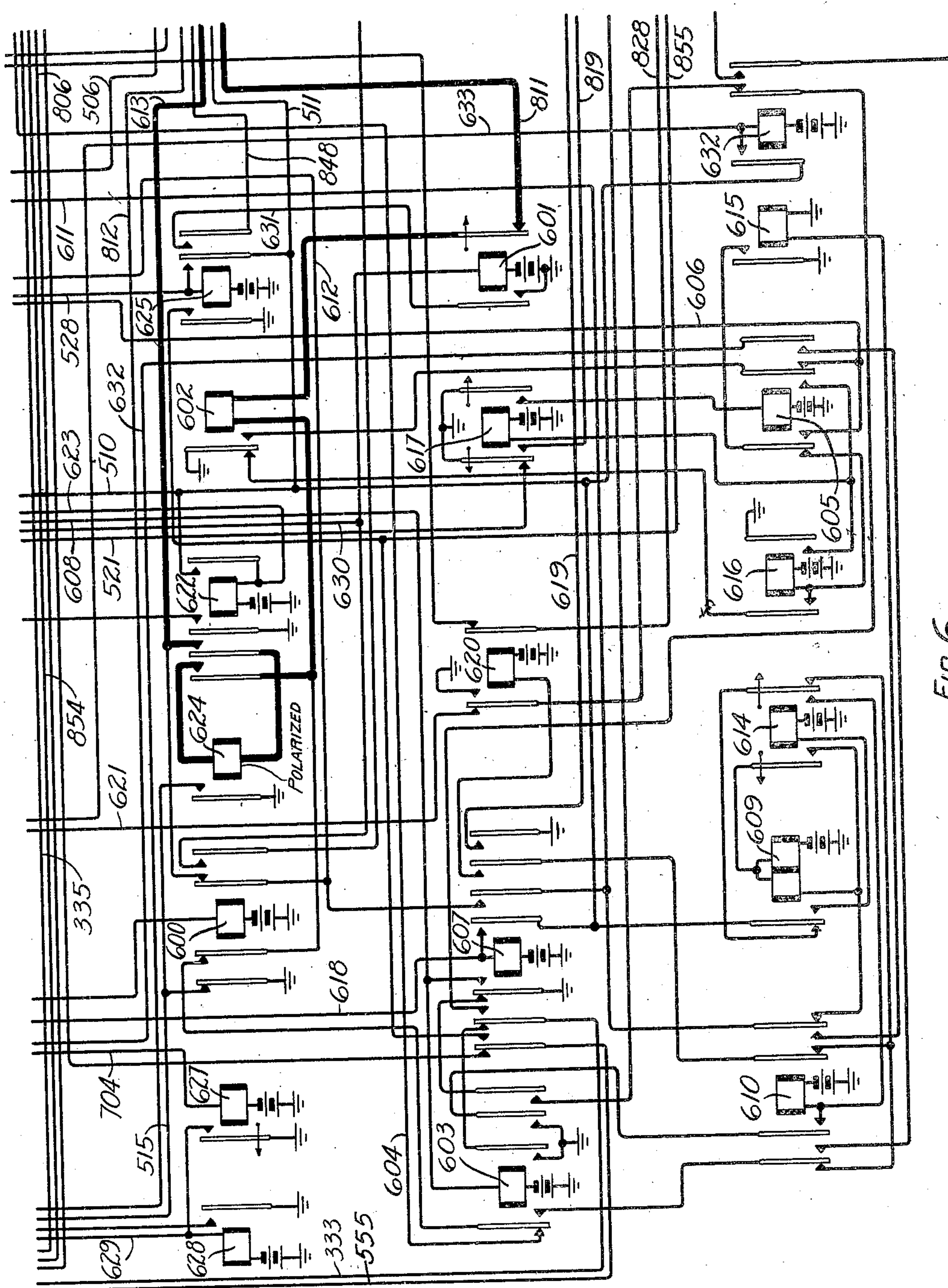


FIG. 6

INVENTORS: E. H. CLARK:
W. W. CARPENTER

BY P. C. Smith

ATTORNEY

June 24, 1930.

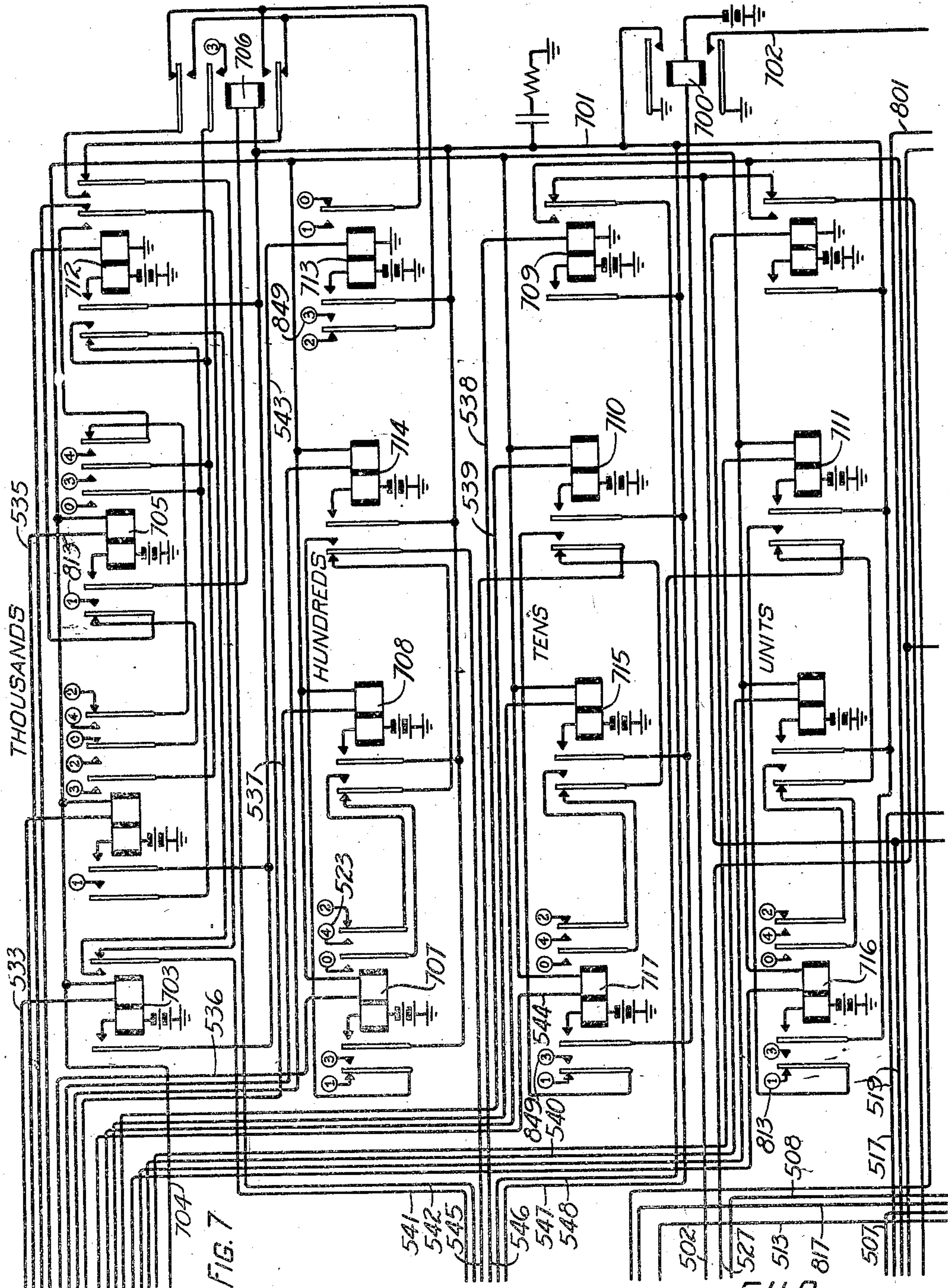
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INVENTORS: *E.H. CLARK*
W.W. CARPENTER

BY *P. C. Smith*

ATTORNEY

June 24, 1930.

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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

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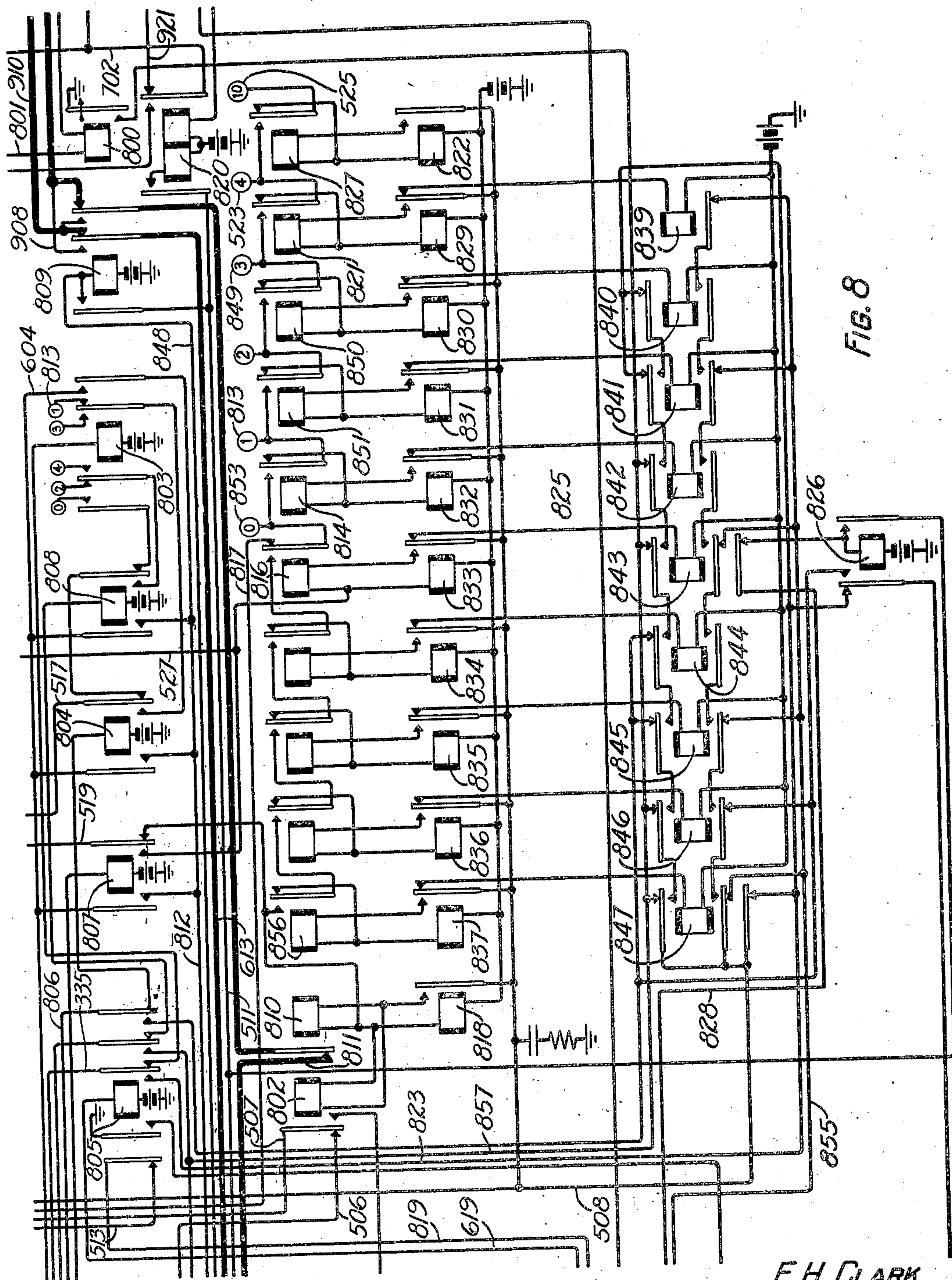


FIG. 8

INVENTORS: E. H. CLARK
W. W. CARPENTER
BY P. C. Smith
ATTORNEY

June 24, 1930.

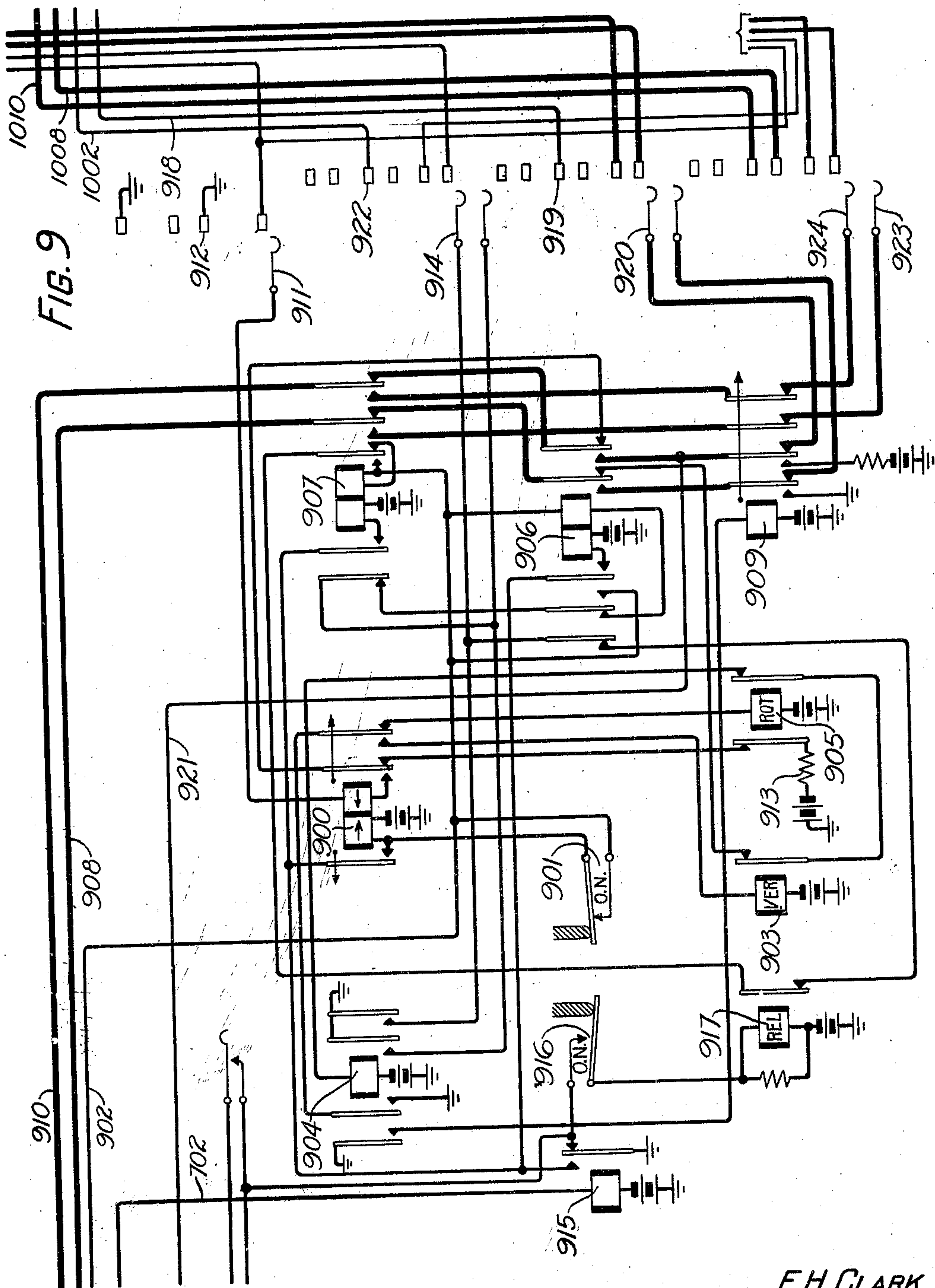
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INVENTORS: E. H. CLARK
W. W. CARPENTER
BY *P. C. Smith*
ATTORNEY

June 24, 1930.

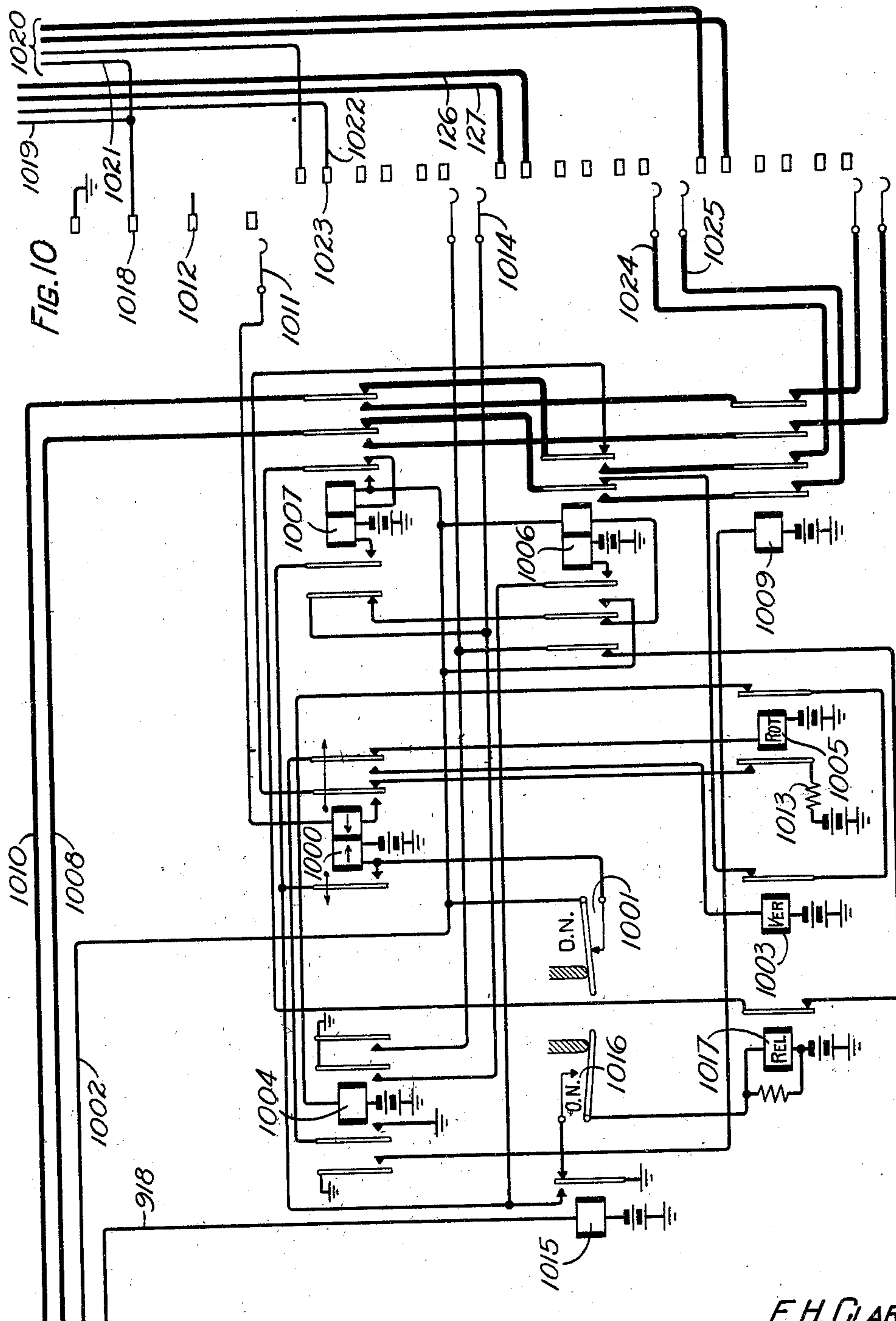
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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

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INVENTORS: E. H. CLARK
W. W. CARPENTER

BY P. C. Smith

ATTORNEY

UNITED STATES PATENT OFFICE

EDGAR H. CLARK, OF FOREST HILLS, AND WARREN W. CARPENTER, OF QUEENS VILLAGE, NEW YORK, ASSIGNORS TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

AUTOMATIC TELEPHONE-EXCHANGE SYSTEM

Application filed September 29, 1928. Serial No. 309,174.

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 originated 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 first answers the call is enabled to establish the inter-office 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 illustration, each manual office is provided with a plurality of operators' positions, each of which has access to a plurality of groups of outgoing trunks, one group leading to each of the automatic offices of the exchange area. Each position is further equipped with a sender controlling keyboard, a set of office keys, and office code registers, and a set of relay registers and indicating lamps for trunk identification purposes. In order that an idle sender common to all operators' positions may be taken for use to extend a call and associated with the key board and registers of the operator's position concerned, each position is provided with two hunting switches, the first of which hunts for an idle sender to immediately associate the operator's keyboard with the numerical registers of the sender, and the second of which assumes a similar setting from the first to extend additional controlling conductors between the registers of the position and the sender. In order that the selected sender may become associated with an idle trunk to the desired automatic office, each sender is associated with a first selector switch individual thereto which in turn has access through second selector switches to all of the trunks in the different groups extending to the several automatic offices.

In the operation of the system, the operator who answers an incoming call at the originating manual office first depresses an office key at her position corresponding to the office in which the desired line terminates and thereby causes the association of her position apparatus with an idle sender and the registration of the office code designation of the desired line on the office code register relays of her position. She may then depress keys in her keyboard to register on the numerical

registers of the sender the numerical designation of the desired line. The tens designation of the office code is then transferred to a code register in the sender and the first selector switch is set under sender control in accordance therewith, and thereupon hunts for an idle second selector to further extend the connection toward the desired interoffice trunk group. Thereafter the units designation of the office code is transferred to the code registers of the sender which is now instrumental in setting the second selector switch whereby a group of trunks to the desired office is selected. The second selector is operated further in hunting movements to find a subgroup of trunks to the desired office and an idle trunk in a selected sub-group, such selective movements being registered in the sender which in turn controls the setting of the trunk number indicating relays of the position apparatus 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 of the wanted line registered on the registers thereof in the well known manner.

Referring to the drawings, Figs. 1 to 10 inclusive, arranged in accordance with the diagram of Fig. 11 disclose so much of a telephone system embodying the principles of this invention as is necessary to a comprehensive understanding thereof.

Fig. 1 shows one of a plurality of answering operators' positions in 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, two office keys and a portion of the office code register of the operator's position shown in Fig. 1.

Fig. 3 shows sender selecting switch for associating the operator's position equipment of Figs. 2 and 4 with the sender shown in Figs. 5, 6, 7 and 8.

Fig. 4 shows a trunk number indicating equipment for indicating to the operator the number of the interoffice trunk over which the connection to the desired dial switching office is to be extended, and a group of transfer relays.

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

Fig. 8 shows control and counting relays for setting the switches of the dial switching office under the control of the registers of Fig. 7, counting relays for controlling the setting of the trunk number indicating equipment of Fig. 4, and office code register relays.

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

Fig. 11 is a diagram showing how the various figures should be arranged with relation to each other.

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 are shown in the patent to E. B. Craft and J. N. Reynolds, No. 1,123,696, issued January 5, 1915. More particularly they are of the specific type fully disclosed and described in the patent to F. A. Stearn and F. J. Scudder, No. 1,395,977, granted Nov. 1, 1921.

The sender selector switches 300 and 350 and the steering switches 500 and 550 are of the rotary single motion step-by-step type driven by stepping magnets from terminal to terminal and so arranged that the brushes are moved forward to the next set of terminals upon the deenergization of the corresponding stepping magnet. Switches 300 and 350 have no definite normal position.

The selector switches of Figs. 9 and 10 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 and each therefore has a capacity of 200 trunks. More specifically, 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 211 of ten non-locking digit keys upon which the operator may write up the numerical digits of wanted line numbers, a plurality of office keys only two of which 200 and 206 have been disclosed, and two groups of code register relays. As many office keys are provided at each operator's position as there are dial switching offices in the exchange area to which the manual office has access. Each group of code register relays comprises eight relays, only the first and last of each such group having been disclosed in order to simplify the drawing. The register relays of one group register the tens code letter of an office designation and the relays of the other group register the units code letter. By suitable interconnections with the office keys it is possible by the depression of a single key to register the first two letters of the office designation corresponding to such key. 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. Similarly the depression of key 206 registers the office designation AT for the office ATchinson on the tens register relay 207 and on the units register relay 201.

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 the plug 102 of one of her cord circuits in 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, resistance 108, resistance 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 398 and that therefore by the depression of key 200 the No. 2 units code register relay 201 and the No. 2 tens code register relay 202 are operated over a circuit extending from battery through the right winding of relay 201, the left contact of key 200, the right winding of relay 202 to ground at the right back contact of relay 203. Relays 201 and 202 both energize closing a mutual locking circuit for each other extending from battery through the left winding and inner

left contact of relay 201, the left winding and inner left contact of relay 202, to ground at the left back contact of release relay 205. At its right contact key 200 closes a circuit from ground over the left back contact of relay 203 to battery through the winding of relay 204. Relay 204 operates and locks from battery through its winding, winding of relay 203, the front contact of relay 204 to ground at the outer right contact of relay 201. Relay 203 does not operate in this locking circuit until the key 200 is released since its winding is shunted by ground at the right contact thereof. Relay 203 upon operating opens the initial operating circuit of all register relays to prevent the operation of other register relays at this time. The code register relays prepare circuits for the transfer of the office code number to the sender as will hereinafter be described.

Seizure of an idle sender

The code relay 201 also establishes a circuit from ground at its outer right contact over conductor 208 to battery through the winding of relay 301. It will first be assumed that the set of terminals upon which the brushes of the sender selector 300 are standing is connected with an idle sender. When therefore relay 201 energizes, ground on conductor 208 is connected through the right winding of relay 307, the left back contact of relay 304, test brush 308 to battery through the winding of a relay corresponding to relay 501, Fig. 5, of such idle sender. Since full battery potential exists on the test terminal upon which the brush 308 is resting, relay 307 energizes and locks from ground at the left contact of relay 301, the front contact of relay 307 to battery through its right winding. At its normal contacts relay 307 opens the circuit for relay 304 thereby preventing the operation of relay 304 to close the circuit of stepping magnet 309. The selector 300 therefore does not advance and the sender which is then connected to the set of terminals upon which the brushes thereof are standing, is taken for use. Since ground is now connected to the test terminal upon which the brush 308 is standing through the right winding of relay 307 from conductor 208, the potential on such test terminal is reduced to mark the sender as busy to other sender selectors.

It will now be assumed that the sender connected to the first set of terminals of the selector 300 is busy and that the test potential encountered by brush 308 is reduced to such an extent that relay 307 does not energize. When therefore relay 301 operates, a circuit is established for relay 304 extending from ground at the left contact of relay 301, the normal contacts of relay 307, the right back contact of relay 306 to battery through the winding of relay 304. Relay 304 energizes and locks through its inner left front contact

over brush 308, the test terminal upon which it is resting, the multiple thereof, brush 308 of another sender selector resting thereon, the right winding of relay 307 of the operator's position connected with such busy sender to ground at such operator's position. At its inner right contact relay 304 closes an obvious self-interrupting circuit for magnet 309 which operates and advances the brushes of selector 308 to the next set of terminals. At its outer right front contact relay 304 closes a circuit extending from ground thereat over the left back contact of relay 303 to battery through lamp 302 for lighting the lamp. Lamp 302 glows steadily so long as the selector 300 is advancing in search of an idle sender. At its left back contact relay 304 opens the circuit of relay 307 to prevent its operation until after an idle sender has been found and at its outer left front contact relay 304 closes a circuit extending in parallel through the winding of time measure relay 306 and the winding of relay 310 to battery. Relay 310 upon energizing disconnects the key strip 211 from the brushes 312, 313, 314 and 315 to prevent the false operation of any sender registers should the operator through error depress a key while the brushes of selector 300 are passing over terminals associated with busy senders and connects the key strip 211 to battery through the left winding of relay 303. Should the operator at this time depress a key, relay 303 will operate to switch lamp 302 from steady ground to interrupted ground through the fast interrupter 316. The operator noting the flickering of lamp 302 is apprised of the fact that she has started to record the wanted line designation too soon.

Relay 306, which is slow to release, opens at its right contact the initial energizing circuit of relay 304. So long as the brush 308 encounters the test terminals of busy senders, relay 304 remains locked and the circuit of magnet 309 remains established thereby to continue the advance of selector 300. As soon as the terminals of an idle sender are encountered, which it will be assumed is the set of terminals appearing as the third set in the banks of selector 300, relay 304 will receive no locking ground and since relay 306 is holding its initial energizing circuit open, relay 304 will release opening the circuit of magnet 309. Relay 307 now energizes in the circuit previously traced from ground on conductor 208, the right winding of relay 307, the left back contact of relay 304, brush 308, conductor 334, to battery through the winding of relay 501 of the selected sender. Should two sender selectors simultaneously select the same sender and two relays such as 307 be connected in the previously traced circuit in parallel, neither relay 307 would energize and as soon as the time measure relay 306 releases the previously traced circuit of relay 304 would

be again established to advance the selector 300 in search of another sender.

Upon the release of relay 306 and the energization of relay 307, a circuit is established from battery through the winding of relay 317, the back contact of stepping magnet 318 of selector 350, the back contact of relay 319, the left contact of relay 306, the front contact of relay 307 to ground at the left contact of relay 301. Relay 317 energizes and at its front contact extends its own operating circuit through the winding of stepping magnet 318. Magnet 318 energizes opening the circuit of relay 317 which releases in turn opening the circuit of magnet 318. Relay 317 and magnet 318 thus operate reciprocally to cause the step-by-step advance of the brushes of selector 350. When the selector has advanced to a position corresponding to the position assumed by the selector 300, a circuit is closed for relay 319 extending from battery through the winding of relay 319, brush 320 and terminal 321 of selector 350, conductor 322, terminal 323 and brush 324 of selector 300, the left contact of relay 306 and thence to ground as traced at the left contact of relay 301. Relay 319 energizes opening at its back contact the stepping circuit of selector 350 to arrest its further advance and closing at its front contact a circuit for relay 325 extending from battery through the winding of relay 325, the front contact of relay 319, the left contact of relay 306, thence to ground as traced. Relay 325, at certain of its front contacts, connects the control conductors 331, extending to the sender selected by the selector 300 over the brushes 326 to 330 inclusive of selector 350 to contacts of the transfer relays associated with the trunk number indicator of Fig. 4. At its outer right contact relay 325 connects locking ground to conductor 332 for a purpose to be hereinafter described.

The lamp 302 is at this time disconnected from direct ground and connected over the left back contact of relay 303, the right back contact of relay 304, the right contact of relay 301 to ground through the interrupter 305, and lamp 302 flashes as an indication to the operator that an idler sender has been associated with her position apparatus and that she may proceed to set the sender registers to record the number of the desired line.

Relay 501 upon energizing prepares several circuits. At its outer left contact it connects ground to conductor 502 extending to battery through the winding of relay 700 and over brush 503 and the first terminal of steering switch 550 to battery through the winding of relay 504. Relays 700 and 504 both energize, relay 700 connecting ground to conductor 701 for furnishing locking ground for the register relays of Fig. 7 and also connecting ground over its lower contact to conductor 702, thence to battery through the winding of relay 915 of the first selector shown in Fig.

9. Relay 915 of the selector in turn connects holding ground for locking relays of the selector and opens at its back contact one point in the operating circuit of release magnet 917.

5 Relay 504 upon energizing connects locking ground to connector 508 for locking operated counting relays of Fig. 8. At its inner left contact relay 501 connects ground to conductors 509, 510 and 511 for furnishing locking ground to relays of Figs. 5, 6 and 8 and at its

10 inner right contact connects ground to conductor 801, thence through the winding of relay 800, conductor 902, off normal contacts 901 of the first selector, thence to battery through the left winding of relay 900. Relay

15 900 operates in this circuit but relay 800 being low wound does not operate. Relay 900 upon operating locks over its left front contact to ground at the front contact of relay 915 independently of the off-normal contacts 901, and

20 prepares an operating circuit for the vertical magnet 903. At its outer right contact relay 501 establishes a circuit extending from battery through the winding of stepping magnet

25 512 of steering switch 550, thence over conductor 513, outer right front contact of relay 504, conductor 506, the left back contact of relay 802, conductor 507, the outer right contact of relay 501, the normal terminal and

30 brush 514 of switch 550, conductor 515 to ground at the outer left contact of relay 600. Magnet 512 energizes preparatory to advancing the brushes of steering switch 550 one step.

35 *Setting code register for first office code letter*

As soon as the sender selector 350 has been positioned circuits are effective for setting

40 the relays 803, 804, 807 and 808 of the office code register of the sender. It will first be assumed that both a first and second selector such as shown in Figs. 9 and 10 are to be

45 operated to select a trunk to the desired dial switching office in response to the office code letters CA, the letter C corresponding to the digit 2. For this purpose the armature contacts of the tens office code relay 202 of Fig. 2 which was operated in response to the de-

50 pression of the office key 200 are cross-connected in such a manner as to operate the code register relay 804 of the sender over a circuit extending from battery through the winding of relay 804, the outer right back contact of

55 relay 805, conductor 806, brush 328 of selector 350, the inner left contact of relay 325, conductor 400, the intermediate left contact of transfer relay 401, conductor 402 to ground at the intermediate right contact of relay 202.

60 In order to register digits corresponding to all of the code letters used in office codes, four register relays 803, 804, 807 and 808 are employed in the sender, which may be operated individually and in combination

65 over circuits extending in the manner previ-

ously traced for relay 804 to grounded armature contacts of the code register relays of Fig. 2. To enable a better understanding of the manner in which the code digits may be registered in the sender the following chart 70 has been prepared.

	405	402	404	403
2	804			
3	808			
4	803	804		
5	803		808	
6		804		807
7			808	807
8	803	804		807
9	803		808	807

The vertical column of figures at the left of the chart indicates the digits corresponding to office code letters that may be registered by the office code relays. The numbers in the sub-divisions of the chart opposite this vertical column indicate the relays of the sender register which are operated for the corresponding digits to be registered and the

85 numbers above each vertical column of the chart indicate the conductors of Fig. 2 which must be variously grounded by the register relays of Fig. 2 to operate the register relays of the sender. Thus, for example, if the

90 digit 8 is to be registered, by reading horizontally across the chart it will be apparent that register relays 803, 804 and 807 must be operated in combination and that to operate

95 these relays a code relay of Fig. 2 must be operated which will ground conductors 405, 402 and 403.

With the register relay 804 operated a pulsing circuit extending from the first selector of Fig. 9 may be traced from battery,

105 winding of relay 904, back contact of rotary magnet 905, back contact of vertical magnet 903, inner right back contact of relay 906, intermediate right back contact of relay 907, conductor 908, outer right back contact of

110 relay 809, back contact of the counting relay 810, conductor 811, back contact of relay 601, winding of relay 602, inner left back contact of relay 600, left back contact of relay 603, conductor 604, left contact of relay 804, con-

115 ductor 812, normal terminal of brush 514 of steering switch 550, conductor 515 to ground at the outer left contact of relay 600. Relays 602 and 904 energize in this circuit, relay 602 upon energizing closing a circuit from

120 ground at its front contact, the right back contact of relay 605, conductor 606, brush 516 and normal terminal of switch 550, conductor 517, right front contact of register

125 relay 804, right back contact of register relay 803, counting relay lead 813, right back contact of counting relay 814, winding of counting relay 832 to battery. Relay 832 energizes and locks through the winding of

130 relay 814 over the front contact of relay 832

to ground on conductor 508, but relay 814 does not energize until relay 602 deenergizes and removes the shunting ground from its winding.

At the selector of Fig. 9 upon the energization of relay 904, a circuit is closed for the vertical magnet 903 from battery through the winding of magnet 903, the outer right front contact of relay 900 to ground at the inner left front contact of relay 904. Relay 904 also closes an obvious circuit for relay 909 which disconnects the tip and ring brushes of the selector during its vertical selection movement. Magnet 903 energizes and at its contact opens the previously traced pulsing circuit through the winding of relay 904 and the winding of relay 602. The selector switch is thus stepped vertically one step opening at the off-normal contact 901 the initial energizing circuit of relay 900. Upon the opening of the pulsing circuit and the deenergization of pulsing relay 602, the shunt around counting relay 814 is opened and such relay energizes in the locking circuit of relay 832 extending the counting relay lead 813 over its front contact, the back contact of counting relay 816, conductor 817, brush 518 and normal terminal of steering switch 550, conductor 519, the right back contact of register relay 807 to battery through the winding of counting relay 818. Relay 818 energizes upon the next closure of the pulsing circuit and the consequent energization of relay 602, and locks through the winding of relays 802 and 810 in parallel over the front contact of relay 818 to ground on conductor 508.

At the selector, relay 904 reenergizes and in the manner previously described causes the advance of the selector shaft another step, again opening the pulsing circuit. When the pulsing circuit is again opened and relay 602 deenergizes relays 802 and 810 energize, relay 810 opening the pulsing circuit extending as previously traced to the first selector, and relay 802 opening the previously traced circuit extending through the winding of magnet 512. Magnet 512 now deenergizes advancing the brushes of steering switch 550 one step into engagement with the second set of terminals of the arcs to which they have access.

When the steering switch leaves position 1 the circuit of relay 504 is opened and such relay releases removing ground from conductor 508 thereby releasing the operated counting relays. A circuit is now established for relay 603 extending from battery through the winding of said relay, conductor 608, the second position terminal and brush 503 of steering switch 550 to ground at the outer left contact of relay 501. Relay 603 energizes establishing a circuit for transfer relay 401 extending from battery through the winding of such relay, the inner right

back contact of transfer relay 406, the intermediate right contact of relay 325, brush 326 of switch 350 and the terminal upon which it is resting, conductor 333, the intermediate left back contact of relay 607 to ground at the inner right contact of relay 603. Relay 401 operates closing a locking circuit for itself from battery through its winding, the winding of relay 406, the right front contact of relay 401, to ground on conductor 332. Relay 406 does not energize in this locking circuit, however, so long as relay 603 remains energized. At its back contacts relay 401 disconnects the conductors 402 to 405 inclusive, extending to contacts of the tens code register relays of Fig. 2 from the group of conductors 331 extending to the code register relays of the sender. The operated code register relay 804 thereupon releases.

With relay 504 deenergized a circuit is now established for relay 609 extending from battery through both windings thereof, the outer right back contact of relay 610, conductor 611, the back contact of relay 504, conductor 612, the right back contact of relay 600, conductor 613, the inner right back contact of relay 809, conductor 910, the outer right back contact of relay 907, the outer right back contact of relay 906, the inner right front contact and right winding of relay 900 which is wound differentially to the left winding of such relay, commutator brush 911, to ground on terminal 912 of the commutator corresponding to the second vertical level of the lower bank of the first selector which level of terminals has been assumed to be connected to trunks terminating in second selectors such as the one shown in Fig. 10. Relay 609 operates in this circuit and closes a circuit for relay 614 extending from battery, winding of relay 614, front contact of relay 609 to ground on conductor 510. Relay 614 upon operating shunts at its left front contact, the left winding of relay 609 which thereupon increases the current flowing through the right winding of relay 900, whereupon relay 900 differentially releases removing the vertical magnet 903 from the control of stepping relay 904. Relay 900 also connects the right winding of relay 609 over the circuit previously traced to the inner right back contact of relay 900 thence to battery through resistance 913 over the back contact of rotary magnet 905. Relay 609 thereupon releases and at its front contact opens the previously traced circuit of relay 614. Since relay 614 is slow to release a circuit is momentarily closed upon the release of relay 609 from ground on conductor 510 over the back contact of relay 609, the right front contact of relay 614 to battery through the winding of relay 610 which thereupon energizes and locks to ground at the intermediate right contact of relay 603.

Relay 610 upon energizing opens the circuit of relay 609 at its outer right back contact and at its outer right front contact closes a circuit for relay 615 extending from ground therethrough over the right front contact of relay 610, conductor 611, the back contact of relay 504, conductor 612, thence as traced to battery through resistance 913 at the first selector. Relay 615 operates in turn operating relay 616 over a circuit extending from battery through the winding of relay 616, the left back contact of relay 605 to ground at the contact of relay 615. Relay 616 upon operating locks over its left contact to ground at the back contact of pulsing relay 602 and at its right contact establishes an obvious circuit for relay 617 which relay in turn establishes a circuit for magnet 512 of the steering switch 550 extending from battery through the winding of magnet 512 over conductor 513, the left back contact of relay 805, conductor 819 to ground at the left front contact of relay 617. Relay 617 also at its right contact closes an obvious circuit for relay 605.

A circuit is now established for the stepping relay 904 of the first selector extending from battery through the winding of relay 904, back contacts of rotary magnet 905 and vertical magnet 903, back contacts of relays 906 and 907, conductor 908, outer right back contact of relay 809, back contact of counting relay 810, conductor 811, back contact of relay 601, winding of sender pulsing relay 602, inner left contact of relay 600, left front contact of relay 603, the left front contact of relay 610, the right front contact of relay 605, conductor 632, the second position terminal and brush 514 of steering switch 550, conductor 515 to ground at the outer left contact of relay 600. Relays 904 and 602 operate in this circuit. Relay 904 upon energizing closes the circuit of relay 909 to disconnect the tip and ring brushes of the selector during its hunting movement and closes the circuit of rotary magnet 905 which may be traced from battery through the winding of magnet 905, the outer right back contact of relay 900 to ground at the inner left contact of relay 904. Magnet 905 upon energizing in turn opens the previously traced circuit for relays 904 and 602, relay 904 in turn opening the circuit of magnet 905. Thus relay 904 and magnet 905 cooperate with each other to cause the step-by-step rotation of the first selector brushes over the selected second level in search of an idle second selector.

At the sender upon the energization of pulsing relay 602 the holding circuit of relay 616 is opened at the back contact of relay 602 and relay 616 deenergizes in turn opening the initial energizing circuit of relay 617. Relay 617 being slow to release, however, does not release before a holding circuit is established therefor from battery through its

winding, the inner right front contact of relay 605 to ground at the front contact of relay 602. Therefore as long as relay 602 continues to receive impulses of current due to the hunting movement of the first selector, relay 617 is held energized and in turn maintains relay 605 operated. Relay 615 is at this time deenergized since its operating circuit was opened at the back contact of rotary magnet 905 upon the first energization of magnet 905 and the initial operating circuit of relay 616 is therefore opened at the contact of relay 615.

When an idle second selector is found a circuit is established for relay 1015 extending from battery, winding of relay 1015, conductor 918, terminal 919, brush 920, next to inner back contact of relay 909, conductor 921, back contact of relay 820, to ground on conductor 702. Relay 1015 energizes connecting locking ground for the relays of the second selector and opening at one point the circuit of release magnet 1017. Another circuit is also established from battery, through the left winding of relay 1000, off-normal contacts 1001, conductor 1002, terminal 922, brush 914, the outer left back contact of relay 906, the back contact of release magnet 917, inner right back contact and right winding of relay 907, conductor 902, winding of relay 800, conductor 801, to ground at the inner right front contact of relay 501. Relays 1000 and 907 operate in this circuit but due to its small number of turns relay 800 does not operate. Relay 1000 upon operating locks over its left contact to ground at the front contact of relay 1015 and at its outer right front contact prepares the operating circuit of the vertical magnet 1003. Relay 907 upon operating locks over its left front contact to ground at the front contact of relay 915, at its left back contact opens the energizing circuit for relay 906, and at its inner right back contact opens its own initial energizing circuit, and connects the trunk conductors 908 and 910 over its outer and intermediate right front contacts, over right back contacts of relay 909, ring and tip brushes 923 and 924 to the second selector trunk conductors 1008 and 1010. At its inner right front contact relay 907 connects ground on conductor 902, over the back contact of release magnet 917, the outer left back contact of relay 906, brush 914, terminal 922 to conductor 1002. At its intermediate right back contact relay 907 also opens the circuit previously traced through the windings of relays 904 and 602 whereupon these relays are released.

Pulsing relay 602 upon releasing opens the holding circuit of slow to release relay 617, which in turn releases relay 605. Relay 617 upon releasing also opens the circuit of magnet 512 which advances the brushes of steering switch 550 into contact with the third po-

sition terminals of their associated arcs. As soon as the steering switch leaves position 2 the circuit of relay 603 is opened and that relay releases opening the shunt around the winding of transfer relay 406 which thereupon operates in the locking circuit of transfer relay 401. Relay 603 also opens the holding circuit of relay 610 which releases. With the steering switch in position 3 the previously traced circuits for relay 504 and stepping magnet 512 are again established and magnet 512 energizes preparatory to advancing the steering switch another step.

It has been assumed that the second code letter registered on the code register relays of the operator's position was A having a numerical equivalent of 2, and that the units register relay 201 was energized by the depression of key 200. The armature contacts of relay 201 are cross-connected to conductors 407 to 410 inclusive in such a manner that conductor 408 is grounded to operate the office code register relay 804 of the sender over a circuit extending from battery, through the winding of relay 804, the outer right back contact of relay 805, conductor 806, brush 328 of selector 350, the inner left contact of relay 325, conductor 400, the intermediate left contact of transfer relay 406, the intermediate left front contact of transfer relay 411, conductor 408 to ground at the inner right contact of relay 201. It is to be noted in this connection that the sender code register relays 803, 804, 807 and 808 are operated singly and in combination in accordance with the foregoing table over conductors 407 to 410 inclusive to register the units code digit in the same manner as previously described in connection with the registration of the tens code digit.

With the register relay 804 operated a pulsing circuit extending from the second selector of Fig. 10 may be traced from battery, winding of relay 1004, back contacts of rotary magnet 1005, and vertical magnet 1003, inner right back contact of relay 1006, intermediate right back contact of relay 1007, conductor 1008, brush 923, next to outer right back contact of relay 909, intermediate right front contact of relay 907, conductor 908, outer right back contact of relay 809, back contact of counting relay 810, conductor 811, back contact of relay 601, winding of relay 602, inner left back contact of relay 600, left back contact of relay 603, conductor 604, left contact of relay 804, conductor 812, third position terminal and brush 514 of steering switch 550, conductor 515, to ground at the outer left contact of relay 600. Relays 602 and 1004 energize in this circuit, relay 602 closing a circuit from ground at its front contact, over the right back contact of relay 605, conductor 606, brush 516 and the third position terminal of switch 550, conductor 517, right front contact of register relay 804, right back contact

of relay 803, counting relay lead 813, right back contact of counting relay 814, winding of counting relay 832 to battery. Relay 832 energizes and locks through the winding of relay 814, over the front contact of relay 832, to ground on conductor 508, but the relay 814 does not energize until relay 602 deenergizes and removes the shunting ground from its winding.

At the selector of Fig. 10 upon the energization of relay 1004 a circuit is closed for the vertical magnet 1003 from battery, through the winding of magnet 1003, the outer right front contact of relay 1000, to ground at the inner left front contact of relay 1004. Relay 1004 also closes an obvious circuit for relay 1009 which disconnects the tip and ring brushes of the selector during its vertical selective movement. Magnet 1003 energizes and at its contact opens the previously traced pulsing circuit through the winding of relay 1004 and the winding of relay 602. The selector switch is stepped vertically one step opening at the off-normal terminal 1001, the initial energizing circuit of relay 1000. Upon the opening of the pulsing circuit and the deenergization of pulsing relay 602, the shunt around the counting relay 814 is opened and such relay energizes in the locking circuit of relay 832, extending the counting relay lead 813 over its front contact, back contact of counting relay 816, conductor 817, brush 518, and the third position terminal of steering switch 550, conductor 519, the right back contact of register relay 807, to battery through the winding of counting relay 818. Relay 818 energizes upon the next closure of the pulsing circuit and the consequent energization of relay 602 and locks through the windings of relays 802 and 810 in parallel, over the front contact of relay 818 to ground on conductor 508.

At the selector, relay 1004 reenergizes and in the manner previously described causes the advance of the selector shaft another step again opening the pulsing circuit. When the pulsing circuit is again opened and relay 602 deenergizes relays 802 and 810 energize, relay 810 opening the pulsing circuit extending as previously traced to the second selector and relay 802 opening the previously traced circuit extending through the winding of magnet 512. Magnet 512 now deenergizes advancing the brushes of steering switch 550 one step into engagement with the fourth set of terminals of the arcs to which they have access.

When the steering switch leaves position 3 the circuit of relay 504 is opened and such relay releases removing ground from conductor 508, thereby releasing the operated counting relays. A circuit is now established for advancing steering switch 550 into position 5 extending from battery, through the winding and back contact of magnet 512, the

fourth position terminal and brush 514 of the steering switch, conductor 515 to ground at the outer left contact of relay 600. With the steering switch in position 5 a circuit is established for relay 505 extending from battery, through the winding of relay 505, the fifth position terminal and brush 520 of the steering switch, conductor 521, to ground at the left back contact of relay 617. Relay 505 upon energizing closes a circuit for magnet 512 preparatory to advancing the steering switch 550 into position 6. This circuit extends from battery, through the winding of magnet 512 to ground at the front contact of relay 505. A circuit is also closed for relay 522 extending from battery, winding of relay 522, the fifth position terminal and brush 503 of steering switch 550, to ground at the outer left contact of relay 501. Relay 522 upon energizing extends its own operating ground to relay 504 which thereupon energizes.

A circuit is also established for relay 607 extending from battery, through the winding of said relay, conductor 618, the fifth terminal and brush 514 of the steering switch, conductor 515 to ground at the outer left contact of relay 600. Relay 607 upon energizing locks over its inner right contact to ground on conductor 510, closes at its inner left front contact an obvious circuit for relay 603, at its outer right contact closes a circuit extending over conductor 619, to battery through the winding of relay 805 and at its next to outer right contact establishes a circuit extending from battery, through the winding of relay 620, contact of relay 607, inner right back contact of relay 610, right back contact of relay 614, left back contact of relay 609, to ground on conductor 510. Relay 805 at its right back contacts disconnects the code register relays 804, 808 and 803 from conductors of the group 331 extending to the operator's position equipment and connects such conductors to contacts of the train of counting relays designated 825 in Fig. 8. Relay 804 now deenergizes. Relays 620 and 607 being now energized a circuit is established extending from ground at the front contact of relay 620, right back contact of relay 632, the intermediate left front contact of relay 607, conductor 333, brush 326, intermediate right contact of relay 325, inner right front contact of transfer relay 406, inner right back contact of transfer relay 412, winding of transfer relay 411 to battery. Relay 411 energizes closing a locking circuit for itself through its winding and the winding of transfer relay 402, the right front contact of relay 411 to ground on conductor 332, but relay 412 being shunted by ground on conductor 333 does not operate at this time.

It will now be assumed that the group of terminals which is selected by the second selector of Fig. 10 extending to the distant of-

office 122 comprises 40 trunks appearing in the second and third levels of the banks of the second selector and as, in response to the second code letter A, the switch shaft of the second selector has positioned its brush sets opposite the second level of each bank, the commutator brush 1011 will now be standing on commutator segment 1012. Should all of the trunks in the second level of both banks be busy there will be no ground potential connected to the segment 1012 and the circuit to be hereinafter traced from the brush 1011 through the right winding of relay 1000 will not be effective to differentially release relay 1000. As a consequence, with the steering switch 550 in position 5 and relay 603 energized, a circuit is completed from battery, through the winding of relay 1004, thence as previously traced through the winding of pulsing relay 602, the inner left back contact of relay 600, the left front contact of relay 603, the left back contact of relay 610, the right back contact of relay 614, the left back contact of relay 609, to ground on conductor 510. Relay 1004 energizes and again closes the previously traced circuit for the vertical magnet 1003 which in turn opens the pulsing circuit through the windings of relays 602 and 1004 just traced, relay 1004 in turn opening the circuit of magnet 1003. Thus magnet 1003 is operated and released to advance the switch shaft one step vertically to position the switch brushes opposite the third level of terminals in its banks.

At the sender, relay 602 upon energizing establishes a circuit from ground at its front contact, over the right back contact of relay 605, conductor 606, brush 516 and its fifth terminal, counting relay lead 523, the back contact of counting relay 821 to battery, through the winding of counting relay 829. Relay 829 energizes locking itself through the winding of relay 821, the front contact of relay 829, to ground on conductor 508, but relay 821 does not energize until relay 602 deenergizes. When relay 602 deenergizes upon the operation of vertical magnet 1003, counting relay 821 operates. It will be assumed that when the second selector has stepped to position its brush sets opposite the third level of its banks that the commutator brush 1011 encounters ground potential on the terminal 1018 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, the trunk 136, 137 being the first in the group of ten trunks appearing in the third level of the upper bank of the second selector, and trunk 126, 127 being the tenth in such group. In a similar manner ten other trunks extending to the office 122 appear in the terminals of the third level of the lower bank of the second selector. It

will be noted that so long as any trunk in this group is idle, ground will be connected to the commutator terminal 1018, over conductor 1019, the outer back contact of the cut-off relay of such trunk, for example relay 131, and over the outer back contact of the sleeve relay of such trunk, for example relay 130. Similarly so long as any trunk in the other group of ten, one trunk of which is indicated at 1020, is idle, ground will be connected to the conductor 1021 also connected to terminal 1018. Thus the brush 1011 upon encountering ground potential establishes a circuit from such ground, over brush 1011, right winding and inner right contact of relay 1000, the outer right back contact of relay 1006, the outer right back contact of relay 1007, conductor 1010, brush 924, outer back contact of relay 909, outer right front contact of relay 907, conductor 910, inner right back contact of relay 809, conductor 613, right back contact of relay 600, next to inner right front contact of relay 607, outer right back contact of relay 610, to battery through both windings of relay 609. Relay 609 energizes establishing a circuit for relay 614 from battery, winding of relay 614, front contact of relay 609 to ground on conductor 510. Relay 614 at its left contact shunts the left winding of relay 609, thereby reducing the resistance of the circuit previously traced through the right winding of relay 1000, so that the right winding of this relay receives sufficient current to cause the differential release thereof. Relay 1000 upon releasing opens the operating circuit of the vertical magnet to prevent further vertical stepping of the second selector.

Partial registration of tens digit of trunk number

Relay 609 upon energizing opens the circuit of relay 620 which releases in turn opening the shunt around the winding of transfer relay 412 which now energizes in the locking circuit of relay 411. At its right back contact relay 620 also prepares a circuit for relay 826, extending from ground at the right contact of relay 522, right back contact of relay 620, conductor 828, to the lower armature of relay 843, this relay being now energized, however, since the second selector has taken but one vertical step and relay 843 releasing to complete the circuit above traced, through the winding of relay 826 only when the selector takes more than five vertical steps. At this time the relays 413 to 416 inclusive of the tens trunk number registers are operated in accordance with the released condition of relays of the group 825. Since counting relay 829 has been operated, relay 839 whose circuit extends from battery through the back contact of relay 829 to ground on conductor 508 is released and a circuit for register relay 416 is closed from

battery winding of relay 416, outer left back contact of transfer relay 420, the outer left front contacts of transfer relays 412 and 406, the inner right front contact of relay 325, brush 327, conductor 555, the outer right front contact of relay 607, conductor 855, the back contact of relay 839, the front contacts of relays 840 to 847 inclusive to ground on conductor 508. Relay 416 energizes and locks to ground over its lower winding and contact, conductor 418, outer right back contact of relay 205, conductor 322 to ground at the outer right contact of relay 325.

When relay 1000 deenergizes the circuit previously traced through relay 609 is opened at the inner right front contact of relay 1000 and relay 609 deenergizes in turn opening the energizing circuit of relay 614. Relay 614 being slow to release momentarily closes a circuit for relay 610 before it releases extending from battery, winding of relay 610, right front contact of relay 614, left back contact of relay 609 to ground on conductor 510. Relay 610 upon energizing locks over its inner left front contact to ground at the intermediate right front contact of relay 603, at its outer right back contact opens the initial energizing circuit of relay 609 and at its outer right front contact establishes a circuit for relay 615, extending from battery, resistance 1013, left back contact of rotary magnet 1005, inner right back contact of relay 1000, thence as traced to the next to inner right front contact of relay 607, the outer right front contact of relay 610 to ground through the winding of relay 615.

Relay 615 upon energizing closes a circuit for relay 616, extending from battery, through the winding of relay 616, the left back contact of relay 605, to ground at the contact of relay 615, relay 616 locking to ground at the back contact of relay 602 and closing an obvious circuit for relay 617 which in turn closes a circuit for relay 605. Relay 605 upon energizing opens the initial operating circuit of relay 616, and relay 617 upon energizing opens at its left back contact the circuit for relay 505 which in turn deenergizes opening the circuit of magnet 512 to advance the steering switch 550 out of position 5 into position 6.

As soon as the steering switch leaves position 5 the circuit of relay 522 is opened at brush 503 in turn opening the circuit of relay 504. Relay 504 upon deenergizing unlocks the operating counting relays. With the steering switch in position 6, a circuit is established for the stepping magnet 512 extending from battery through the winding and contacts of magnet 512, the sixth position terminal and brush 514 of steering switch 550, conductor 515 to ground at the outer back contact of relay 600, causing the steering switch to advance into position 7. A circuit is now established for relay 524 extending from bat-

tery through such relay, the seventh position terminal and brush 514 of the steering switch 550, conductor 515, to ground at the outer left contact of relay 600. A circuit is also established from battery through the winding of relay 504, the seventh position terminal and brush 503 to ground at the outer left contact of relay 501, and a circuit is also established for counting relay 822 extending from battery through the winding of relay 822, the back contact of counting relay 827, lead 525, the seventh position terminal and brush 516 of the steering switch, conductor 606, the left front contact of relay 605 to ground at the front contact of relay 615. Relay 822 energizes, locking through the winding of relay 827 and the front contact of relay 822 to ground on conductor 508 but relay 827, being shunted at the contact of relay 615, does not operate.

Relay 524 upon energizing, locks over its inner right contact to ground on conductor 509, establishing a circuit for relay 505 extending from battery, winding of relay 505, inner right back contact of relay 526 to ground at the inner left contact of relay 524 and establishes a circuit for transfer relay 418 extending from battery through the winding of relay 418, the inner right back contact of transfer relay 419, the inner right front contact of relays 412 and 406, the intermediate right contact of relay 325, brush 326, conductor 333, the intermediate left front contact of relay 607, the right back contact of relay 632, the left back contact of relay 620, conductor 621, the left back contact of relay 526 to ground at the outer right contact of relay 524. Transfer relay 418 energizes in this circuit and locks through the winding of relay 419 over the inner front contact of relay 418 to ground on conductor 332, but relay 419 does not energize until ground is removed from conductor 333. Relay 505, upon energizing establishes a circuit for magnet 512 extending from battery through such magnet to ground at the front contact of relay 505 preparatory to advancing steering switch 550 into position 8.

A pulsing circuit is now established between the sender and the second selector which may be traced from battery through the winding of relay 1004, thence as previously traced to conductor 908, the back contact of relay 810, conductor 811, the back contact of relay 601, the winding of pulsing relay 602, the inner left back contact of relay 600, the left front contact of relay 603, the outer left front contact of relay 610, the outer right front contact of relay 605, conductor 632 to ground at the outer left contact of relay 524. Relays 602 and 1004 energize in this circuit, relay 602 opening the locking circuit of relay 616 which thereupon releases. The release of relay 616 opens the initial energizing circuit of relay 617, but relay 617

remains locked over the inner right front contact of relay 605 to ground at the front contact of relay 602. At the selector, upon the energization of relay 1004, with relay 1000 deenergized, a circuit is established for the rotary magnet 1005 extending from battery, winding of magnet 1005, the outer right back contact of relay 1000 to ground at the inner left contact of relay 1004. Relay 1004 also establishes a circuit for relay 1009 to disconnect the tip and ring brushes during the rotary hunting movement of the selector. Upon the closure of its circuit, magnet 1005 energizes, opening the circuit previously traced through the windings of relay 1004 and relay 602. Relay 1004 upon deenergizing opens the circuit of magnet 1005 which thereupon deenergizes, again establishing the pulsing circuit. Thus relay 1004 and magnet 1005 reciprocally control each other, the magnet 1005 advancing the switch shaft step by step in search of an idle trunk.

Upon the first energization of magnet 1005, the circuit of relay 615 is opened at the left back contact thereof and relay 615 releases, removing the shunt from the winding of counting relay 827, whereupon relay 827 energizes. Upon the next deenergization of magnet 1005 relay 615 again operates, connecting ground at its front contact to the counting relay lead 525, thence over the front contact of counting relay 827, the back contact of counting relay 821 to battery through the winding of relay 829. In this manner the second selector advances step by step operating a counting relay pair at each step until, if the switch still continues to hunt, the counting relay pair 816, 832 becomes operated. In the present case it will be assumed that the trunks having an even tens number terminate in the lowermost banks of second selectors and the trunks having an odd tens number terminate in the upper banks of second selectors, and that all trunks terminating in the upper banks have their tip and ring conductors reversed. For example, trunks 0 to 9, 20 to 29, etc., terminate in the lower bank of the second selector of Fig. 10 and trunks 10 to 19, 30 to 39, etc., terminate in the upper bank, it will further be assumed that the selector hunts to the end of its rotary movement and finds the last trunk 126, 127, numbered 39 and appearing in the last terminal set of the third level of the upper bank thereof, idle. When counting relay 814 operates after the selector has taken five steps, the lead 525 becomes extended over the front contact of relay 814, the back contact of relay 816, conductor 817, brush 518 and the seventh terminal of steering switch 550, conductor 527 to battery through the winding of counting relay 833. Upon the tenth rotary step of the second selector, the counting relay 837 becomes operated and locks through the winding of relay 856.

At the selector, upon the test brush 1014 encountering the test terminal of the idle trunk 126, 127 a circuit is established from battery, through the right winding of cut-off relay 121, the inner right back contact of sleeve relay 120, conductor 1022, test terminal 1023, brush 1014, the left back contact of relay 1007, the intermediate left back contact and right winding of relay 1006, conductor 1002, terminal 922, brush 914, the outer left back contact of relay 906, the back contact of release magnet 917, the inner right front contact of relay 907, conductor 902, the winding of relay 800, conductor 801 to ground at the inner right contact of relay 501. Relays 1006 and 121 energize in this circuit, relay 121 locking over its inner right front contact to conductor 1022 independent of relay 121, and relay 1006 locking from battery through its left winding and inner left front contact to ground at the front contact of relay 1015. At its outer left back contact, relay 1006 opens the operating circuit of relay 1007, at its inner left back contact opens its own operating circuit and at its intermediate left front contact connects conductor 1002 over the outer left back contact of relay 1007 to test brush 1014. At its right front contacts, relay 1006 extends conductors 1010 and 1008 over the outer right and intermediate right back contacts of relay 1007, the inner right back contacts of relay 1009 to the tip and ring brushes 1024 and 1025. Also, at its inner right back contact, relay 1006 opens the circuit previously traced through the windings of relays 1004 and 602 and at its outer right back contact opens the previously traced circuit of relay 615.

40 *Registration of units digit of trunk number*

Since the second selector has taken ten steps and counting relays 822, 829 to 837 have operated, all of the relays of the group 825 which operated in circuits extending from ground on conductor 508 over the back contacts of counting relays 829 to 837 inclusive prior to their energization, to battery through the windings of relays 837 to 847 inclusive release. The release of relay 847 prepares three circuits for later operating units trunk number register relays of the operator's position equipment. One of these circuits extends from ground on conductor 508, over the lowermost back contact of relay 847, conductor 823, the inner right front contact of relay 805, conductor 335, brush 330, the outer left contact of relay 325, the outer right front contacts of relays 406 and 412, to the outer right armature of relay 419. A second circuit extends from ground over on conductor 508, over the upper back contact of relay 847, conductor 857, the intermediate right front contact of relay 805, conductor 854, brush 329, the intermediate left contact of relay 325, the inner left front contacts of relays 406 and

412, to the inner left armature of relay 419. A third circuit extends from ground on conductor 508, over the innermost lower back contact of relay 847, conductor 855 to the outer right front contact of relay 607. These circuits are closed to battery through the windings of relays 423, 424 and 426 of the units trunk number register upon the later energization of the transfer relay 419. The first circuit is extended by the energization of relay 419 over the outer right front contact of relay 419, the outer right back contact of relay 420 to battery through the upper winding of relay 423. The second circuit is extended by the energization of relay 419 over the inner left front contact of relay 419, the inner left back contact of relay 420 to battery through the upper winding of relay 424. The third circuit is extended from the outer left front contact of relay 607, conductor 555, brush 327, the inner right front contact of relay 325, the outer left front contacts of relays 406, 412 and 419, the outer left back contact of relay 420 to battery through the upper winding of register relay 426. The register relays upon operating lock over their lower windings and lower front contacts to ground on conductor 418.

Upon the opening of the circuit through the winding of relay 602, the holding circuit of relay 617 is opened whereupon relay 617 deenergizes, opening the circuit of relay 605 which also deenergizes. Relay 617 upon releasing now establishes a circuit for relays 526 and 600 in parallel which extends from battery through the windings of these relays, the seventh position terminal and brush 520 of steering switch 550, conductor 521 to ground at the left back contact of relay 617. Relay 526 upon energizing locks over its inner left front contact to ground on conductor 509 and holds relay 600 operated over the same locking path. Relay 526, at its right back contact now opens the circuit of relay 505 which after an interval measured by its slow releasing characteristic opens the circuit of magnet 512, thus advancing the steering switch into position 8. At its outer left back contact relay 526 also disconnects ground from conductor 333 thus permitting the transfer relay 419, to operate in the locking circuit of transfer relay 418. The circuits previously traced for the units register relays are at this time closed. With relay 505 deenergized and relay 526 energized, ground is connected from the back contact of relay 505 over the outer left front contact of relay 526, thence as traced over conductor 333, inner right front contact of transfer relay 419, the inner right back contact of transfer relay 421 to battery through the winding of transfer relay 420. Relay 420 energizes and locks through the winding of relay 421 and the right front contact of relay 420 to ground on conductor 332, but relay 421 does not operate

in this locking circuit until ground is removed from conductor 333. The operating circuits of the units register relays of Fig. 4 are now opened by the operation of relay 420.

5 As soon as the steering switch leaves position 7 the circuit of relay 504 is opened and the locking circuits of all operated counting relays are opened, releasing such relays. A circuit is also established for relay 622, with
10 the steering switch in position 8, extending from battery through the winding of relay 622, conductor 623, the position 8 terminal and brush 503 of the steering switch to ground at the outer left contact of relay 501, relay
15 622 upon energizing locking over its right contact to ground on conductor 510. A circuit is also established from battery through the winding and contact of magnet 512, the eighth position terminal and brush 520 of
20 the steering switch 550, conductor 521 to ground at the back contact of relay 617 advancing the steering switch into position 9. A fundamental circuit is now established from ground at the incoming selector 123,
25 over trunk conductor 127, brush 1024, thence as previously traced to conductor 910, the inner back contact of relay 809, conductor 613, the intermediate left contact of relay 622, the winding of polarized relay 624, the
30 outer left contact of relay 622, the winding of relay 602, the back contact of relay 601, conductor 811, the back contact of counting relay 810, the outer back contact of relay 809, conductor 908, thence as traced to brush
35 1025, trunk conductor 126 to battery through the control relay (not shown) at the incoming selector 123. If the incoming selector is in condition to be operated at this time, relays 624 and 602 operate, since the trunk 126,
40 127 has its conductors reversed relay 602 being without function. Relay 624 upon operating over the fundamental circuit previously traced closes a circuit from ground at its contact, over conductor 515, brush 514
45 and the ninth position terminal of steering switch 550, conductor 528 to battery through the winding of relay 625. Relay 625 operates in this circuit and locks over its inner right contact to ground on conductor 510. The operation of relay 625 at this time indicates to
50 the sender that a trunk terminating in the upper bank of the second selector has been seized. From position 9, the steering switch advances into position 10 over the same circuit which advanced it into position 9.
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With the steering switch in position 10, a circuit is established for relay 504 extending from battery through the winding of relay 504, the tenth position terminal and brush 503
60 of the steering switch to ground at the outer left contact of relay 501. Relay 504 upon energizing closes a circuit for magnet 512 extending from battery through the winding of this magnet, the right front contact of relay
65 504, conductor 506, back contact of counting

relay 802, conductor 507, inner left front contact of relay 622 to ground. With the steering switch in position 10, relay 602, which was energized over the fundamental circuit previously traced, is now effective to establish a counting relay controlling circuit which will be hereinafter traced.

A circuit is also closed for relay 632 extending from battery winding of relay 632, conductor 633, the tenth position terminal and brush 520, conductor 521 to ground at the back contact of relay 617. Relay 632 locks to ground conductor 510 over its left contact, connects ground from the left front contact of relay 805, over the right front contact of relay 632 to the left armature of relay 820, and at its right back contact removes operating ground from the winding of transfer relay 420 whereupon relay 421 energizes. With relay 625 energized indicating that a trunk
85 terminating in the upper bank of the second selector has been seized, a circuit is now established for relay 440 extending from battery through the upper winding of relay 440, the outer left front contact of transfer relay 421,
90 the outer left front contacts of transfer relays 419, 412 and 406, the inner right contact of relay 325, thence as traced to conductor 555 to ground at the left contact of relay 625. Relay 440 upon energizing locks over its inner lower front contact and lower winding to ground on conductor 418.

Trunk number indication

Circuits are also established at this time for lighting the lamps of the trunk number indicator to indicate to the operator the number of the trunk selected. It has been assumed that relays 416 and 440 of the tens trunk number register and relays 423, 424 and 426 of the units trunk number register have been operated. With transfer relay 421 operated a circuit may now be traced for the No. 0 hundreds lamp 434, extending from battery through the lamp 434, the intermediate right front contact of transfer relay 421, the outer right front contacts of relays 419, 412 and 406, the outer left contact of relay 325, brush 330, conductor 335, the inner right front contact of relay 805, conductor 823, the left back contact of relay 826, the right front contact of relay 632 to ground at the inner left front contact of relay 805. A circuit is also established for the No. 3 tens lamp 436, extending from battery through the lamp 436, the intermediate upper front contact of relay 440, the intermediate upper back contact of relay 413, the intermediate upper back contact of relay 414, the inner upper back contact of relay 415, the upper front contact of relay 416, to ground at the outer right front contact of transfer relay 421. A circuit is also established for the No. 9 units lamp 439 extending from battery through the lamp 439, the inner upper front contact of relay 423, the intermediate upper
130

front contact of relay 424, the inner upper back contact of relay 425, the upper front contact of relay 426 to ground at the outer right front contact of transfer relay 421. The lighted lamps now indicate the trunk number 039. The operator may at her leisure plug the cord plug 118 into the jack 119 of the indicated trunk.

All the foregoing circuit operations have resulted from the depression of an office key by the operator. While this has been transpiring, the operator has proceeded to depress the digit keys to register the numerical designation of the wanted line in the sender shown on Fig. 7 as soon as the lamp 302 flashes indicating that an idle sender has been attached to her position equipment. It has been assumed that the number of the desired line in the office 122 is 3981. The operator, therefore, first depresses the No. 3 digit key 212 to register the thousands digit 3. At its left contact, key 212 establishes a circuit from ground over conductor 213, the outer left back contact of relay 310, brush 312, conductor 336, brush 529 of the steering switch 500, and its first position terminal, conductor 533, right winding of thousands register relay 703, conductor 704 to battery through the winding of relay 627. Relays 703 and 627 operate, relay 703, locking over its left winding and left contact to ground on conductor 701. Relay 627, upon energizing, closes an obvious circuit for relay 628, and a circuit in parallel therewith over conductor 629 to battery through magnet 534 of steering switch 500 preparatory to advancing such switch into position 2. A second circuit is also established by the depression of key 212 extending from ground over the right contact thereof, conductor 214, inner right back contact of relay 310, brush 314, conductor 337, brush 531 and first position terminal of steering switch 500, conductor 535, right winding of thousands register relay 705 to battery through the winding of relay 627. Relay 705 upon energizing locks through its left winding and inner left front contact, winding of relay 706 to ground on conductor 701. Relay 706 energizes in this circuit.

Upon the release of key 212, the previously traced circuit extending through the winding of relay 627 is opened, relay 628, however, remaining energized over its winding, the back contact of magnet 534 to ground at the front contact of relay 628 thereby maintaining the winding of magnet 534 energized over its back contact and the front contact of relay 628 until magnet 534 fully energizes whereupon relay 628 releases, and magnet 534 advances the brushes of steering switch 500 into contact with the second position terminals of their respective arcs.

The operator then proceeds to depress the No. 9 key 215 to register the hundreds digit 9. At its left contact, key 215 establishes a circuit extending from ground through the

right winding of hundreds register relay 713, conductor 543, brush 532 and the second position terminal of steering switch 500, conductor 338, brush 315, the outer right back contact of relay 310, conductor 216, the left contact of key 215, conductor 213, the outer left back contact of relay 310, brush 312, conductor 336, brush 529 and its second position terminal, conductor 536, the right winding of hundreds register relay 707, conductor 704 to battery through the winding of relay 627. Relays 707 and 713 energize and lock over their left windings and inner left contacts to ground on conductor 701 and relay 627 energizes as before. Key 215 at its right contact establishes a second circuit from ground over conductor 217, inner left back contact of relay 310, brush 313, conductor 339, brush 530 and the second position terminal of steering switch 500, conductor 537, right winding of hundreds register relay 708, conductor 704, to battery through the winding of relay 627. Relay 627 in turn causes the energization of relay 628 and of magnet 534. Register relay 708 locks over its left winding and inner left contact to ground on conductor 701. Upon the release of key 215, relays 627 and 628 release in turn releasing magnet 534 to advance steering switch 500 into position 3.

In response to the depression of the No. 8 key 218 for registering the tens digit 8, a circuit is established from ground through the right winding of the tens register relay 709, conductor 538, the third position terminal and brush 532 of steering switch 500, conductor 338, brush 315, the outer right back contact of relay 310, conductor 216, the left contact of key 218, conductor 213, the outer left back contact of relay 310, brush 312, conductor 336, brush 529 and its third position terminal, conductor 544, the right winding of register relay 717, conductor 704 to battery through the winding of relay 627. Relay 627, 717 and 709 energize, relays 714 and 709 locking over their left windings and inner left front contacts to ground on conductor 701. A second circuit is established from ground over the right contact of key 218, conductor 214, inner right back contact of relay 310, brush 314, conductor 337, brush 531 and the third position terminal of steering switch 500, conductor 539, right winding of register relay 710, conductor 704 to battery through the winding of relay 627. Relays 710 and 627 energize, relay 710 locking over its left winding and inner left front contact to ground on conductor 701 and relay 627 closing circuits for relay 628 and magnet 534 preparatory to advancing steering switch 500 into position 4. Upon the release of key 218, the circuit of relay 627 is opened in turn releasing magnet 534 to advance the steering switch.

In response to the depression of the No. 1 units key 219, ground is connected over conductor 214, the inner right back contact of re-

lay 310, brush 314, conductor 337, brush 531 and the fourth position terminal of steering switch 500, conductor 540, right winding of units register relay 711, conductor 704, to battery through the winding of relay 627. Relays 711 and 627 energize, relay 627 closing the circuits of relay 628 and magnet 534 preparatory to advancing steering switch 500 out of position 4, and relay 711 locking over its left winding and inner left contact to ground on conductor 701. Upon the release of key 219 the steering switch advances into position 5. The numerical registers of the sender have now been set and since the steering switch 550 of the sender has at this time advanced into position 10 for controlling incoming brush selection such selector control now proceeds.

It will be recalled that the fundamental circuit has been established and that relay 602 has been energized thereover in series with the control relay of the incoming selector 123. Relay 602 now closes a counting relay control circuit which may be traced from ground at the front contact of relay 602, the right back contact of relay 605, conductor 606, brush 516 and the tenth position terminal of steering switch 550, conductor 541, the right front contact of thousands register relay 703, the inner right back contact of register relay 712, the outer left front contact of register relay 705, lead 813, the back contact of counting relay 814 to battery through the winding of counting relay 832. Relay 832 energizes and locks through the winding of relay 814 over its own front contact to ground on conductor 508, but relay 814 does not energize until the commutator of the incoming selector places a shunting ground around the winding of relay 602 as soon as the incoming selector reaches its first brush selection position. This selector switch action is well known in the art and it is thought need not be fully described herein. When such shunting ground is applied, relay 602 deenergizes, removing ground from lead 813 whereupon relay 814 energizes extending the lead 813 over its front contact, the back contact of counting relay 816, conductor 817, brush 518 and its tenth position terminal, conductor 519, the back contact of relay 807 to battery through the winding of counting relay 818. Upon the further advance of the incoming selector shaft and the removal of the shunt around the winding of relay 602 by the commutator of the selector, relay 602 again energizes, completing the circuit of relay 818 which energizes and locks through the windings of relays 802 and 810 in parallel over the front contact of relay 818 to ground on conductor 508. Upon the next deenergization of relay 602 relays 802 and 810 operate in this locking circuit.

Relay 810 upon energizing opens the fundamental circuit arresting the further move-

ment of the incoming selector and advancing the sequence switch thereof into position for operating the brush tripping magnet. Relay 802 upon energizing opens the circuit of relay 504 which deenergizes, in turn opening the circuit of magnet 512 to advance steering switch 550 into position 11 and to remove ground from conductor 508 to thereby release all operated counting relays. A circuit is now closed for relay 601 extending from battery, winding of relay 601, outer right front contact of relay 600, front contact of relay 802, conductor 507 to ground at the inner left contact of relay 622 which is effective to hold relay 601 energized to in turn hold the fundamental circuit open until relay 504 has caused the release of the counting relays. As soon as the steering switch advances into position 11, relay 601 is maintained energized from battery through its winding, conductor 630, the eleventh position terminal and brush 503 of steering switch 550 to ground at the outer left contact of relay 501.

Upon the energization of relay 601 a circuit is closed for reversing relay 809 extending over conductor 848 the outer right contact of relay 625, conductor 631, to ground at the left contact of relay 601. Relay 809 upon energizing locks over its left contact to ground on conductor 511. As soon as the steering switch reaches position 11 a circuit is closed to advance it into position 12 extending from battery through the winding and contacts of magnet 512, the eleventh position terminal and brush 520, conductor 521 to ground at the left back contact of relay 617. The circuit of relay 601 is now opened and this relay deenergizes again establishing the fundamental circuit extending to the incoming selector 123 whereupon relay 602 and the control relay of the selector energize, the control relay of the selector preparing the selector circuit for incoming group selection and relay 602 establishing a circuit for controlling the counting relays of the sender. The polarized relay 624 is at this time not energized since relay 809 has now reversed the connection of trunk conductors 908 and 910 with respect to the winding of relay 624. With the steering switch 550 in position 12, a circuit as previously traced is established for relay 504 for supplying locking ground to the counting relays.

With relay 602 energized, a circuit is now closed from ground at the front contact of relay 602, over the inner right back contact of relay 605, conductor 606, brush 516 and its twelfth position terminal, conductor 542, the outer right back contact of the thousands register relay 712, the lower front contact of relay 706, the outer left front contact of hundreds register relay 713, lead 849, the back contact of counting relay 850 to battery through the winding of counting relay 830.

Relay 830 energizes and locks through the winding of relay 850 and over its own front contact to ground on conductor 508 but relay 850 being shunted over the contact of relay 602 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 the group selection, the selector commutator intermittently shunting the sender pulsing relay 602 as the tripped set of brushes approaches each group selection position. Upon the first shunting of relay 602 it deenergizes, permitting the operation of counting relay 850 which thereupon extends the lead 849 over its front contact and the back contact of counting relay 851 to battery through the winding of counting relay 831 upon the next energization of relay 602. In the manner previously described, the pairs of counting relays are successively operated until relays 818, 810 and 802 operate, at which time the incoming selector shaft will have advanced into such a position as to position the second set of brushes thereof upon the lowermost set of terminals in the fourth group to which said brush set has access. Relay 810 upon operating opens the fundamental circuit thereupon 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 five hundred lines, 3500 to 3999, inclusive. Relay 802 upon energizing opens the circuit of magnet 512 which deenergizes and advances steering switch 550 into position 13. Upon leaving position 12, relay 504 releases, in turn unlocking all operated counting relays. In the manner previously described, relay 601 is operated over the front contact of relay 802 until relay 802 releases, following the release of relay 504, and is held operated over the thirteenth position terminal and brush 503 of the steering switch 550 until it leaves position 13. In position 13 the previously traced circuit over brush 520 is closed to advance the steering switch 550 into position 14 thereby reoperating relay 504, releasing relay 601 and reestablishing the fundamental circuit.

With the fundamental circuit again established, pulsing relay 602 and the control relay of the final selector are operated, the control relay of the final selector preparing the circuits thereof for brush selection and the pulsing relay 602 closing a counting relay control circuit extending from ground at the front contact of relay 602, thence as traced to brush 516 and its fourteenth position terminal, conductor 545, the back contact of hundreds register relay 714, the outer front contact of hundreds register relay 708, the outer front contact of hundreds register relay 707, lead 523, the back contact of counting relay 821

to battery through the winding of counting relay 829. Relay 829 energizes and locks through the winding of relay 821 and its own front contact to ground on conductor 508, but relay 821 being shunted at the front contact of relay 602 does not energize. As the brush shaft of the final selector advances in its brush selection movement, the commutator thereof intermittently shunts the sender pulsing relay 602. Upon the first shunting of relay 602, such relay deenergizes, permitting counting relay 821 to operate to extend the operating lead 523 over its front contact and the back contact of counting relay 850 to battery through the winding of relay 830. In the well known manner, in response to the advance of the final selector shaft, pairs of counting relays are successively operated until relays 818, 810 and 802 operate, at which time the selector switch will have advanced to a position to trip the fifth set of brushes having access to lines 3900 to 3999, inclusive. Relay 810 upon operating opens the fundamental circuit thereby arresting the advance of the final selector and causing circuit changes thereat to prepare for tripping the selected set of brushes. Relay 802 upon energizing opens the circuit of magnet 512 which thereupon advances the steering switch 550 into position 15. Upon leaving position 14, relay 504 releases, in turn unlocking all operated counting relays. In the manner previously described relay 601 is operated over the front contact of relay 802 until relay 802 releases, following the release of relay 504 and is held operated over the fifteenth position terminal and brush 503 of steering switch 550 until it leaves position 15. In position 15 the previously traced circuit over brush 520 is closed to advance the steering switch 550 into position 16 thereby reoperating relay 504, releasing relay 601 and reestablishing the fundamental circuit.

With the fundamental circuit again established, pulsing relay 602 and the control relay of the final selector are operated, the control relay of the final selector starting the final selector in its tens selection movement tripping the selected set of brushes. The pulsing relay 602 now closes a counting relay control circuit for controlling the tens selection movement of the final selector extending from ground at the front contact of relay 602, thence as traced to brush 516 and its sixteenth position terminal, conductor 546, the outer front contact of tens register relay 710, the outer left front contact of tens register relay 717, counting relay lead 849, the back contact of counting relay 850 to battery through the winding of relay 830. Relay 830 energizes and locks through the winding of relay 850 and its own front contact to ground on conductor 508, but relay 850 does not energize since it is at the time shunted over the front contact of pulsing re-

lay 602. As the brush shaft of the final selector advances in its brush selection movement, the commutator thereof intermittently shunts the sender pulsing relay 602. Upon the first shunting impulse, relay 602 deenergizes, permitting counting relay 850 to operate and to extend the operating lead 849 over the front contact of relay 850, the back contact of relay 851 to the counting relay 831. In the well known manner in response to the advance of the final selector shaft, pairs of counting relays are successively operated until relays 814 and 832 operate when the lead 849 becomes extended over the front contact of relay 814, conductor 817, brush 518 and the sixteenth position terminal of steering switch 550, conductor 547, the right front contact of tens register relay 709, which always operates when the tens digit registered is greater than four, conductor 527 to battery through the winding of counting relay 833. The remaining counting relays are then successively operated as the final selector advances in its tens selection movement until relays 818, 810 and 802 operate at which time the tripped brush set of the final selector will be positioned beneath the first terminal of the ninth tens group in which lines 3980 to 3989 terminate. Relay 810 upon operating opens the fundamental circuit thereby arresting the advance of the final selector. Relay 802, upon energizing, opens the circuit of magnet 512 which deenergizes and advances the steering switch 550 into position 17. Upon leaving position 16, relay 504 releases, in turn unlocking all operated counting relays. In the manner previously described, relay 601 is operated following the release of relay 504 and is held operated over the seventeenth position terminal and brush 503 of the steering switch 550 until it leaves position 17. In position 17 the previously traced circuit over brush 520 is closed to advance the steering switch 550 into position 18 thereby reoperating relay 504, releasing relay 601 and reestablishing the fundamental circuit.

With the fundamental circuit again established, pulsing relay 602 and the control relay of the final selector are operated, the control relay of the final selector starting the the final selector in its units section movement. Pulsing relay 602 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 602, thence as traced to brush 516 and its eighteenth position terminal, conductor 548, the outer front contact of units register relay 711, the left back contact of the units register relay 716, counting relay lead 813, the back contact of counting relay 814 to battery through the winding of relay 832. Relay 832 energizes and locks through the winding of relay 814 and its own front contact to ground on conductor 508, but relay 814 does

not operate as its windings is shunted over the front contact of pulsing relay 602. As the brush shaft of the final selector advances, the commutator thereof intermittently shunts the stepping relay 602 thereby causing the operation of successive counting relays until relays 818, 810 and 802 energize, at which time the tripped set of brushes will have been positioned upon the terminal of the wanted line 125. Relay 802 upon energizing opens the circuit of magnet 512 which thereupon advances steering switch 550 into position 19. Relay 810 opens the fundamental circuit thereby arresting the further advance of the final selector. Upon leaving position 18, steering switch 550 opens the circuit of relay 504 which deenergizes in turn releasing all operated counting relays. In the manner previously described, relay 601 is operated over the front contact of relay 802 until relay 802 releases following the release of relay 504 and is held operated over the nineteenth position terminal and brush 503 of the steering switch until it leaves position 19.

In position 19 a circuit is established for advancing the steering switch 500 out of position 4 extending from battery through the winding and contacts of magnet 534, the nineteenth position terminal and brush 520 of steering switch 550, conductor 521 to ground at the left back contact of relay 617. The steering switch 500 thereupon advances into position 7 where a circuit is established for magnet 512 of steering switch 550 extending from battery, winding of magnet 512, conductor 513, the seventh position terminal and brush 549 of steering switch 500 to ground. As the steering switch 500 continues to advance through position 9, into position 10, the circuit of magnet 512 is opened and magnet 512 deenergizes, advancing steering switch 550 into position 20 thereby opening the circuit of magnet 534 arresting steering switch 500 in position 10. As soon as steering switch 550 leaves position 19, the circuit of relay 601 is opened and the fundamental circuit is again established. In position 20 the previously traced circuit for relay 504 is again established to furnish locking ground for the counting relays and to operate the stepping magnet 512 preparatory to advancing the steering switch 550 into position 21.

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 602 and the control relay of the incoming selector, relay 602 at this time establishing a circuit for counting relay 818 extending from ground at the front contact of relay 602, thence as traced to brush 516, counting relay operating lead 853, the back contact

of counting relay 816, conductor 817, brush 518 and the twentieth position terminal of steering switch 550, conductor 519, the back contact of relay 807 to battery through the winding of relay 818. Relay 818 operates and locks through the windings of relays 802 and 810 in parallel but the latter relays being shunted over the contact of relay 602 do not operate until the sequence switch of the incoming selector advances under the control of the controlling relay thereof to open the fundamental circuit and release relay 602. When the sequence switch of the incoming selector advances and relay 602 deenergizes, relays 802 and 810 operate.

Relay 810 upon operating opens the fundamental circuit and relay 802, upon operating, opens the circuit of magnet 512 to advance the steering switch 550 into position 21. The circuit of relay 504 is now opened to release relays 818, 810 and 802. Upon the operation of relay 802, relay 601 again operates, but releases as soon as relay 802 releases to again establish the fundamental circuit. Upon the reestablishment of the fundamental circuit at the incoming selector, the control relay of the incoming selector and relays 602 and 624 of the sender operate. Relay 624 operates at this time because the fundamental circuit has been reversed at the incoming selector in the well known manner. The testing of the wanted line 125 by the final selector and the application of ringing current thereto if such line is found to be idle proceeds in the well known manner after which the talking circuit from the wanted line to the trunk conductors 126 and 127 is established.

Operator completes connection by plugging into indicated trunk jack

When the operator plugs into jack 119, in accordance with the indicated trunk number, 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, at its inner right front contact connecting the right non-inductive winding of relay 121 in parallel with the right winding of relay 121, over the circuit previously traced to ground through the winding of relay 800. Relay 800 now receives sufficient current to energize and at its contact connects ground over conductor 857, the intermediate front contact of relay 805, conductor 854, brush 329, the intermediate left contact of relay 325, the inner left contacts of transfer relays 406, 412, 419 and 421, conductor 422 to battery through the winding of release relay 205.

Release of operator's equipment

Relay 205 energizes, opening the holding circuits of register relays 201 and 202. Relay 202 in turn opens the holding circuits of re-

lays 203, 204, 301, 307 and 501 which in turn release. Relay 205 also removes holding ground from conductors 332 and 418 thereby releasing the operated relays of the trunk number indicator and the transfer relays of Fig. 4. The release of relay 501 opens the locking circuits of all operated relays of the sender whereupon such relays release. The release of relay 501 also closes the stepping circuit of magnet 512 extending from battery through the winding of magnet 512 and the contacts thereof, brush 553 and the strapped terminals of its arc to ground at the intermediate right back contact of relay 501 whereby the steering switch 550 is advanced into normal position. A circuit is also established from ground at the back contact of relay 501 over brush 554 and the strapped terminals of its arc, to battery through the contacts and winding of magnet 534 for advancing steering switch 500 into normal position. All apparatus of the operator's position equipment and of the sender is now restored to a condition for handling a subsequent call.

Upon the release of relay 700 following the release of relay 501 ground is removed from conductor 702 thereby releasing relay 915 which at its back contact closes a circuit for the release magnet 917 of the first selector extending from battery through the winding of magnet 917, off-normal contacts 916 to ground at the back contact of relay 915. Magnet 917 upon energizing releases the selector in the well known manner, the circuit of magnet 917 being opened when the switch shaft reaches normal through the opening of contacts 916. Relay 700 also removes ground from conductor 921 thereby releasing relay 1015 of the second selector which is a similar manner operates release magnet 1017 to restore the second selector.

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, a plurality of senders common to said operators' positions for operating said switching mechanism, means for associating any position with an idle one of said senders, and a single train of selector switches for associating a selected sender with an idle trunk in any desired ones of said trunk groups.

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 of said positions corresponding to said plurality of offices, a plurality of senders common to said operators' positions for operating said switching mechanism, means for associating any position with an idle one of said senders, a train of selector switches, and

means controlled by said office keys for directing said selector switches to associate a selected sender with an idle trunk in any desired ones of said trunk groups.

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 and terminating therein in switching mechanism, office keys at each of said positions corresponding to said plurality of offices, an office code register at each position controlled by said keys, a plurality of senders common to said operators' positions for operating said switching mechanism, means for associating any position with an idle one of said senders, selector switches, and means controlled by said office code register for directing said selector switches to associate a selected sender with an idle trunk in any desired ones of said trunk groups.

4. 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 of said positions corresponding to said plurality of offices, a plurality of senders common to said operators' positions for operating said switching mechanism, an office code register in each sender, means for associating any position with an idle one of said senders, means under the control of said keys for controlling the register of an associated sender, selector switches, and means controlled by said register for directing said selector switches to associate said sender with an idle trunk in any desired ones of said trunk groups.

5. 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, a plurality of senders common to said positions for operating said switching mechanism, means for associating any position with an idle sender, step-by-step selector switches, and means controlled from said sender to direct said switches to select an idle trunk in any desired ones of said trunk groups.

6. 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 of said positions corresponding to said plurality of offices, office code register relays at each position controlled by said keys for registering the office code digits of office designations, a plurality of senders common to said operators' positions for operating said switching mechanism, means for associating any position with an idle one of said senders, an office code register in each sender,

means under the control of said register relays for successively transferring to said sender register the digits of an office code, selector switches, and means controlled successively by said sender register for directing said selector switches to associate said sender with an idle trunk in any desired ones of said trunk groups.

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 of said positions corresponding to said plurality of offices, a plurality of senders common to said operators' positions for operating said switching mechanism, means for associating any position with an idle one of said senders, trunk selecting mechanism, and means controlled by said office keys for directing said selecting mechanism to associate a selected sender with an idle trunk in any desired ones of said trunk groups.

8. In an automatic telephone exchange system, an operator's position, a plurality of offices, a group of trunks outgoing to each of said offices, office keys at said position corresponding to said plurality of offices, a selector switch having vertical and rotary selective movements for connecting said operator's position with a desired trunk group, said switch having two sets of brushes and corresponding banks of terminals and having access to trunks in the same trunk group over a plurality of levels of both of said trunks, means controlled by said office keys to direct the brushes of said switch to the first level in which trunks of a desired trunk group terminate, and means for thereafter further causing said switch to hunt for a level in which an idle trunk of the selected group terminals and for an idle trunk terminating in such level in either of its banks.

9. In an automatic telephone exchange system, a plurality of operators' positions, an indicating mechanism for each position, a plurality of offices, a group of trunks outgoing to each of said offices and terminating therein in switching mechanism, a plurality of senders common to said operators' positions for operating said switching mechanism, means for associating any position with an idle one of said senders, a single train of selector switches for associating a selected sender with an idle trunk in any desired ones of said trunk groups, and means controlled through the selection of an idle trunk to indicate the number of the trunk selected on said indicating mechanism.

10. In an automatic telephone exchange system, a plurality of operators' positions, an indicating mechanism at each position, a plurality of offices, a group of trucks outgoing to each of said offices and terminating therein in switching mechanism, a plurality of send-

ers common to said operators' positions for operating said switching mechanism, means for associating any position with an idle one of said senders, a single train of selector switches for associating a selected sender with an idle trunk in any desired ones of said trunk groups, and means in said sender controlled through the selection of an idle trunk to control said indicating mechanism to indicate the number of the trunk selected.

11. In an automatic telephone exchange system, a plurality of operators' positions, an indicating mechanism at each position, a plurality of offices, a group of trunks outgoing to each of said offices and terminating therein in switching mechanism, a plurality of senders common to said positions for operating said switching mechanism, means for associating any position with an idle sender, step-by-step selector switches, means in said sender for controlling said switches to select a group of trunks extending to a desired office, means to further operate one of said switches to hunt for an idle trunk in the selected group, and means controlled in the hunting operation of said latter switch to control said indicator to indicate the number of the trunk selected.

12. In an automatic telephone exchange system, an operator's position, a plurality of offices, a group of trunks outgoing to each of said offices, a trunk number indicating mechanism at said position, a selector switch having vertical and rotary selection movements for connecting said operator's position with a desired trunk group, said switch having two sets of brushes and corresponding banks of terminals and having access to trunks of the same trunk group over a plurality of levels of both of its banks, means controlled from said position to direct the brushes of said switch to the first level in which trunks of a desired trunk group terminate, means for thereafter further causing said switch to hunt for a level in which an idle trunk of the selected group terminates and for an idle trunk terminating in such a level in either of its banks, and means operable through the hunting movements of said switch to operate said mechanism to indicate the number of the idle trunk so selected.

13. In an automatic telephone exchange system, an operator's position, a plurality of offices, a group of trunks outgoing to each of said offices, a trunk number registering mechanism at said position, a selector switch having vertical and rotary selection movements for connecting said operator's position with a desired trunk group, said switch having two sets of brushes and corresponding banks of terminals and having access to trunks of the same trunk group over a plurality of levels of both of its banks, means controlled from said position to direct the brushes of said switch to the first level in which trunks of a desired

trunk group terminate, means for thereafter further causing said switch to hunt for a level in which an idle trunk of the selected group terminates and for an idle trunk terminating said level in either of its banks, means operative through the hunting movements of said switch to operate said registering mechanism to record the extent of the level and terminal hunting movements of said switch and the bank in which the selected trunk terminates, and an indicator controlled by said register to indicate the number of the trunk so selected.

14. In an automatic telephone exchange system, an operator's position, a plurality of offices, a group of trunks outgoing to each of said offices, a trunk number registering mechanism at said position, a selector switch having vertical and rotary selection movements for connecting said operator's position with a desired trunk group, said switch having two sets of brushes and corresponding banks of terminals and having access to trunks of the same group over a plurality of levels of both of its banks, the trunks terminating in one bank having reversed battery potential thereon, means controlled from said position to direct the brushes of said switch to the first level in which trunks of a desired trunk group terminate, means for thereafter further causing said switch to hunt for a level in which an idle trunk of the selected group terminates and for an idle trunk terminating in such level in either of its banks, means operative through the hunting movements of said switch to operate said registering mechanism to record the extent of the level and terminal hunting movements of said switch, means operative in accordance with the polarity of the trunk selected to register in said mechanism the bank in which the selected trunk terminates, and an indicator controlled by said register to indicate the number of the trunk so selected.

15. In an automatic telephone exchange system, a plurality of operators' positions, an indicating mechanism at each position, a plurality of offices, a group of trunks outgoing to each of said offices and terminating therein in switching mechanism, a plurality of senders common to said positions for operating said switching mechanism, means for associating any position with an idle sender, selector switches, means in said sender including a train of counting relays for controlling said switches to select a group of trunks extending to a desired office, means to further operate one of said switches to hunt for an idle trunk in the selected group, means controlled in the hunting operation of said latter switch to record on said counting relays the extent of such hunting operation, and means controlled by said relays to

control said indicator to indicate the number of the trunk so selected.

15. In an automatic telephone exchange system, a plurality of operators' positions, an indicating mechanism at each position, a plurality of offices, a group of trunks outgoing to each of said offices and terminating therein in switching mechanism, a plurality of senders common to said positions for operating said switching mechanism, means for associating any position with an idle sender, selector switches, means in said sender including a train of counting relays for controlling said switches to select a group of trunks extending to a desired office, means to further operate one of said switches to hunt for an idle trunk in the selected group, means controlled in the hunting operation of said latter switch to record on said counting relays the extent of such hunting operation, a register in said sender operative in accordance with the record established on said counting relays, and means controlled by said register to control said indicator to indicate the number of the trunk so selected.

17. 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, a plurality of senders common to said operators' positions for operating said switching mechanism, a sender selecting switch individual to each position for associating an idle sender therewith, a second selecting switch individual to said position directed in its hunting movement by said first selecting switch to extend additional control conductors from said position to the selected sender, and selector switches for associating a selecting sender with an idle trunk in any desired ones of said trunk groups.

In witness whereof, we hereunto subscribe our names this 28th day of September, 1928.

EDGAR H. CLARK.

WARREN W. CARPENTER.