

Jan. 24, 1939.

E. S. GIBSON

2,145,079

TELEPHONE SYSTEM

Filed Feb. 29, 1936

10 Sheets-Sheet 1

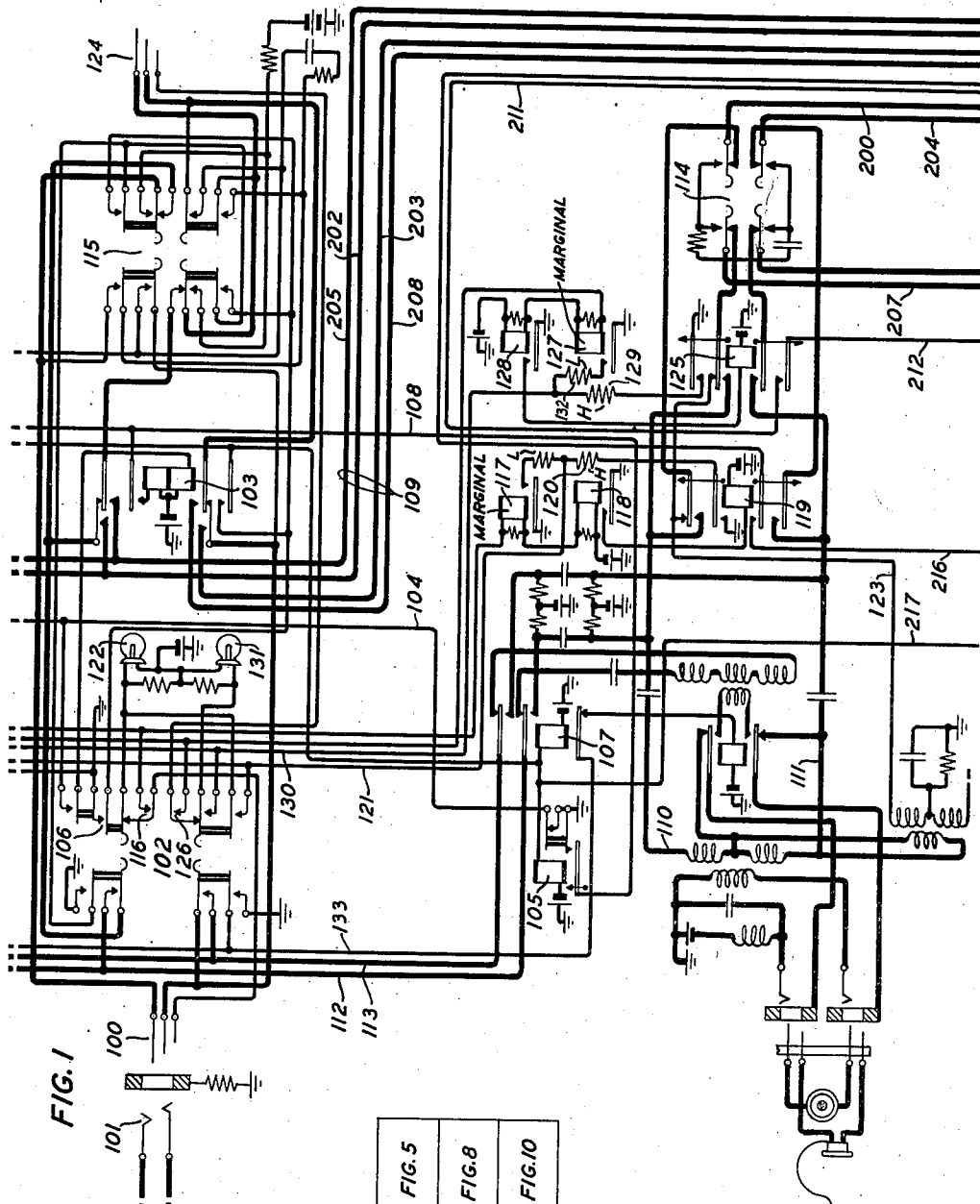


FIG. 11

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

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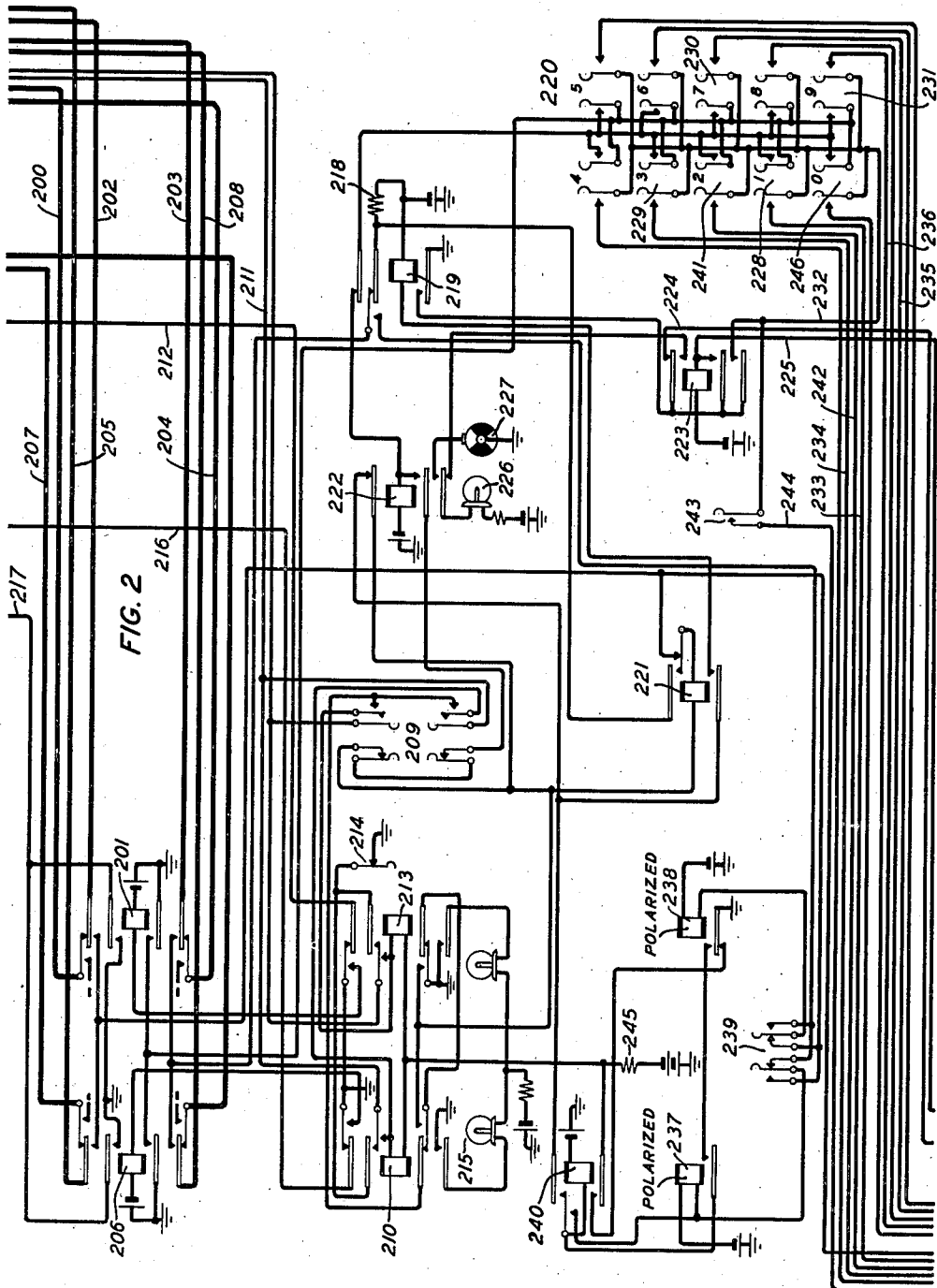
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10 Sheets-Sheet 2



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## TELEPHONE SYSTEM

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10 Sheets-Sheet 3

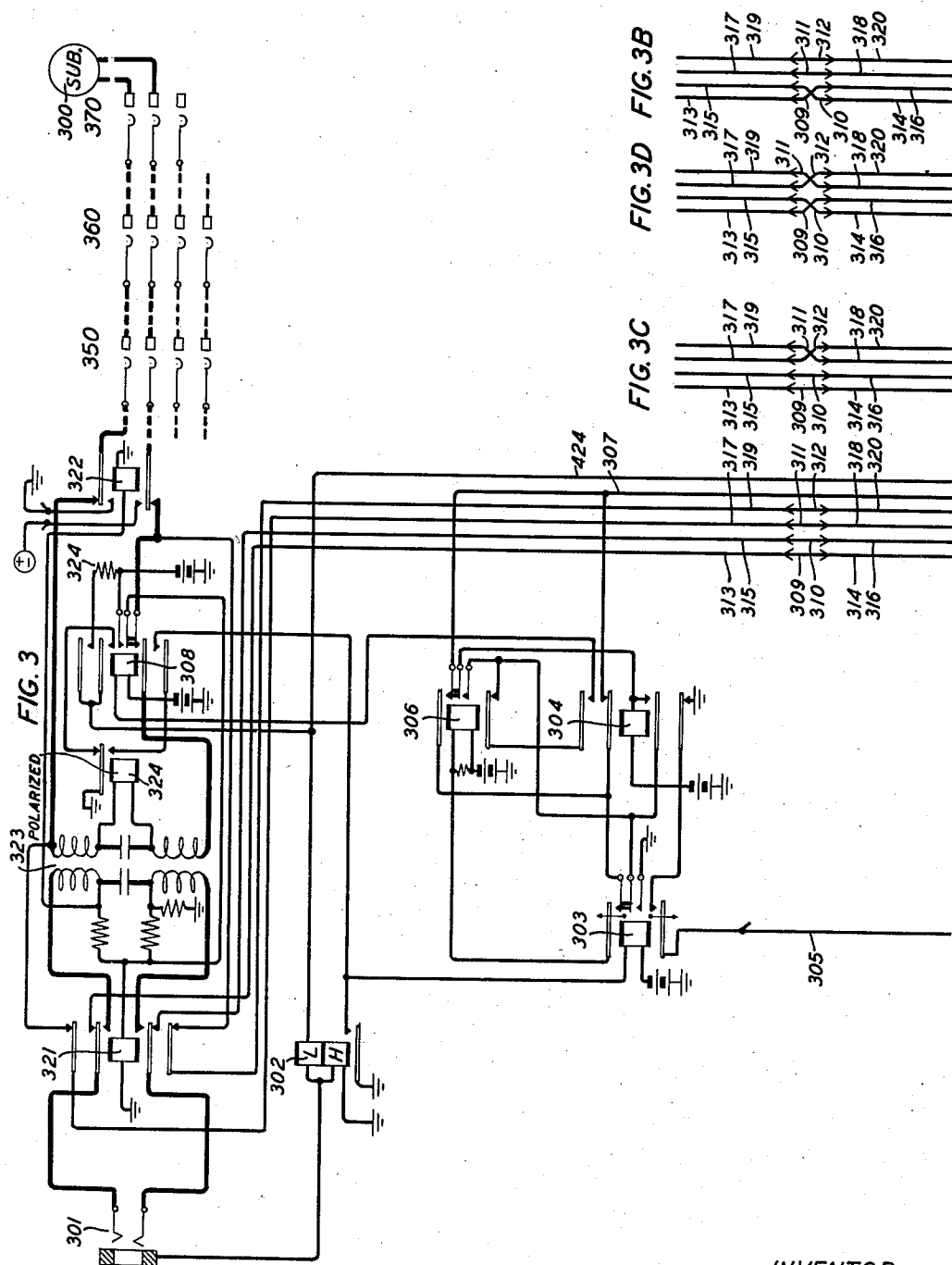


FIG. 3D FIG. 3B

**FIG. 3C**

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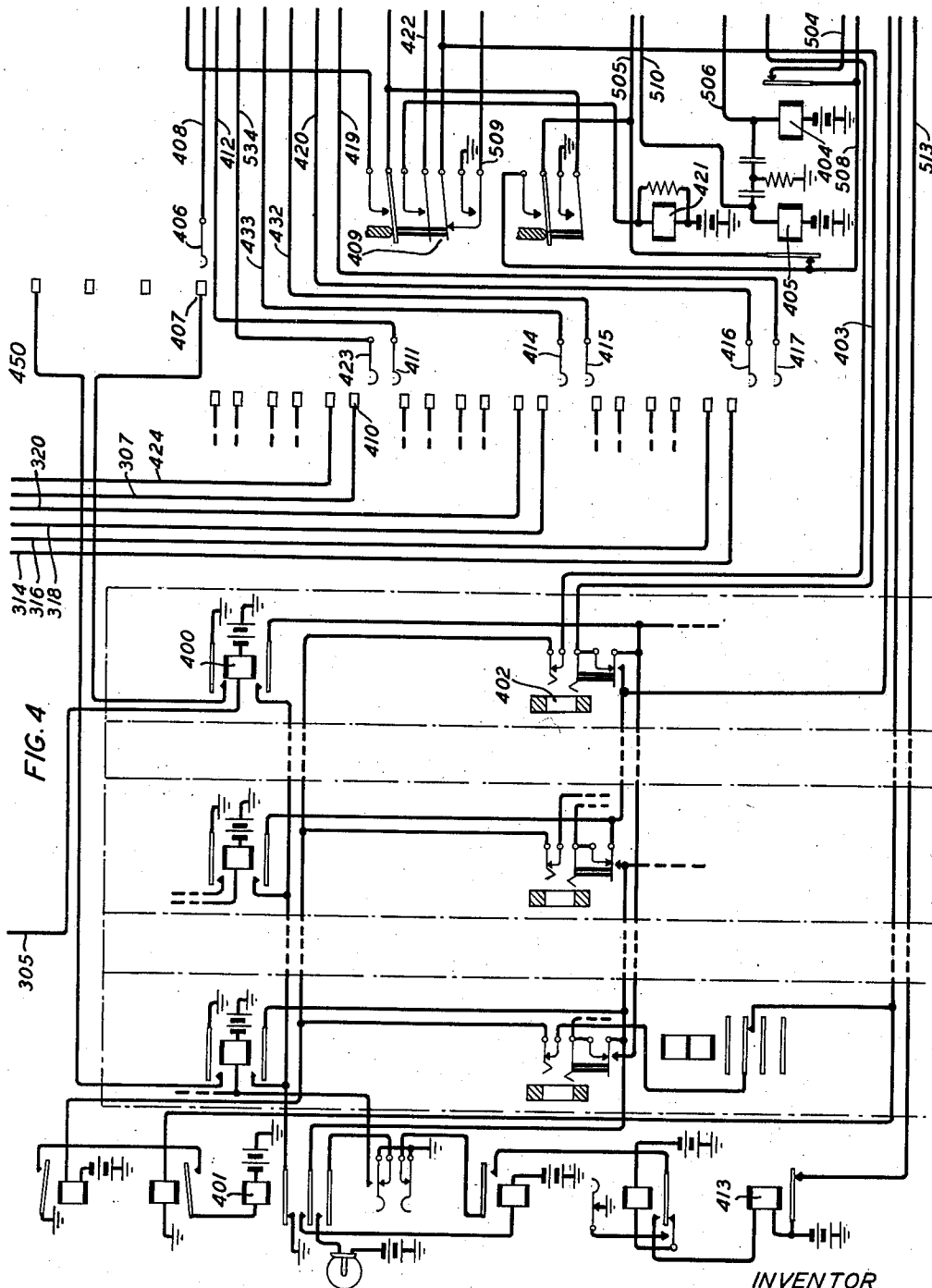
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TELEPHONE SYSTEM

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10 Sheets-Sheet 4



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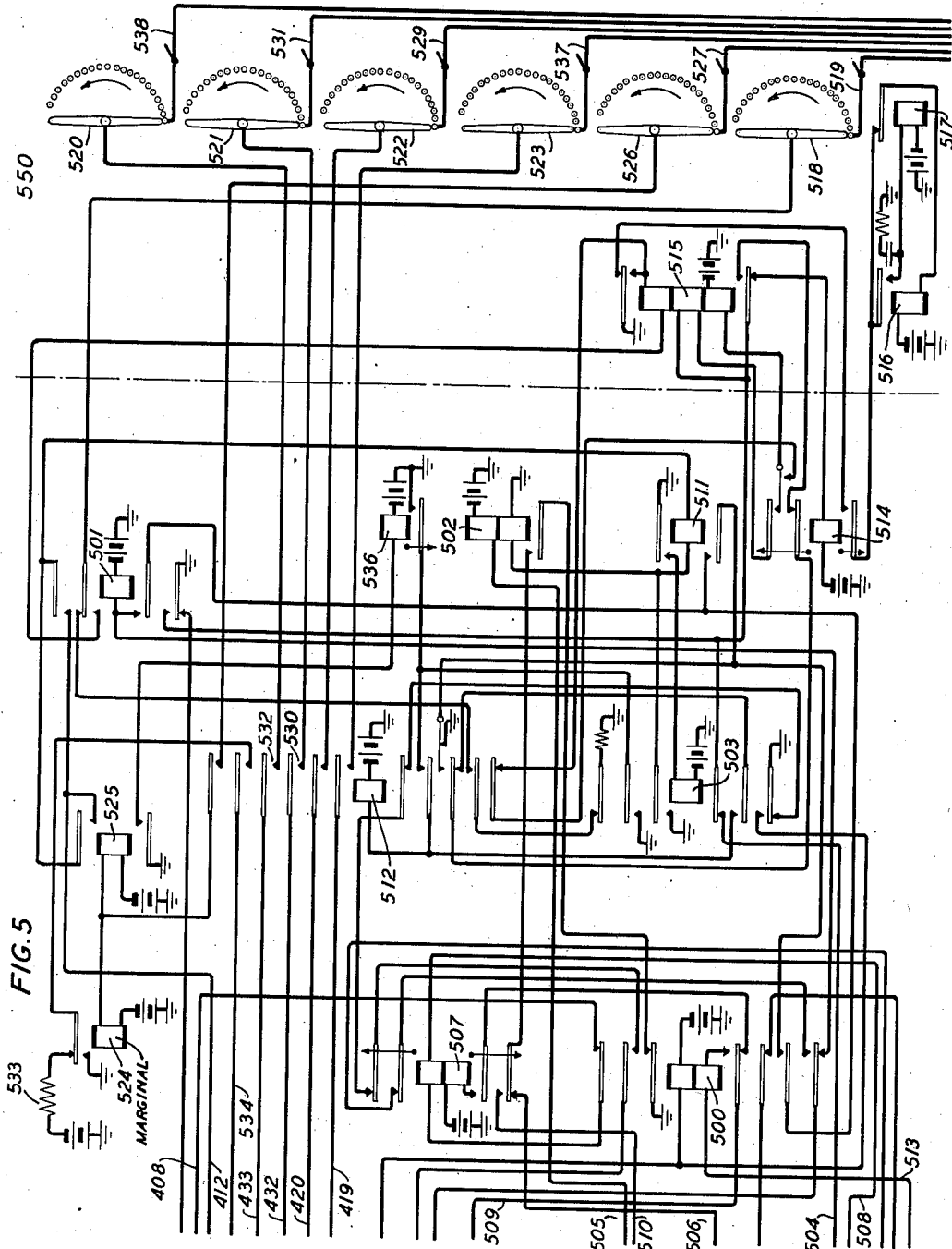
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TELEPHONE SYSTEM

Filed Feb. 29, 1936

10 Sheets-Sheet 5



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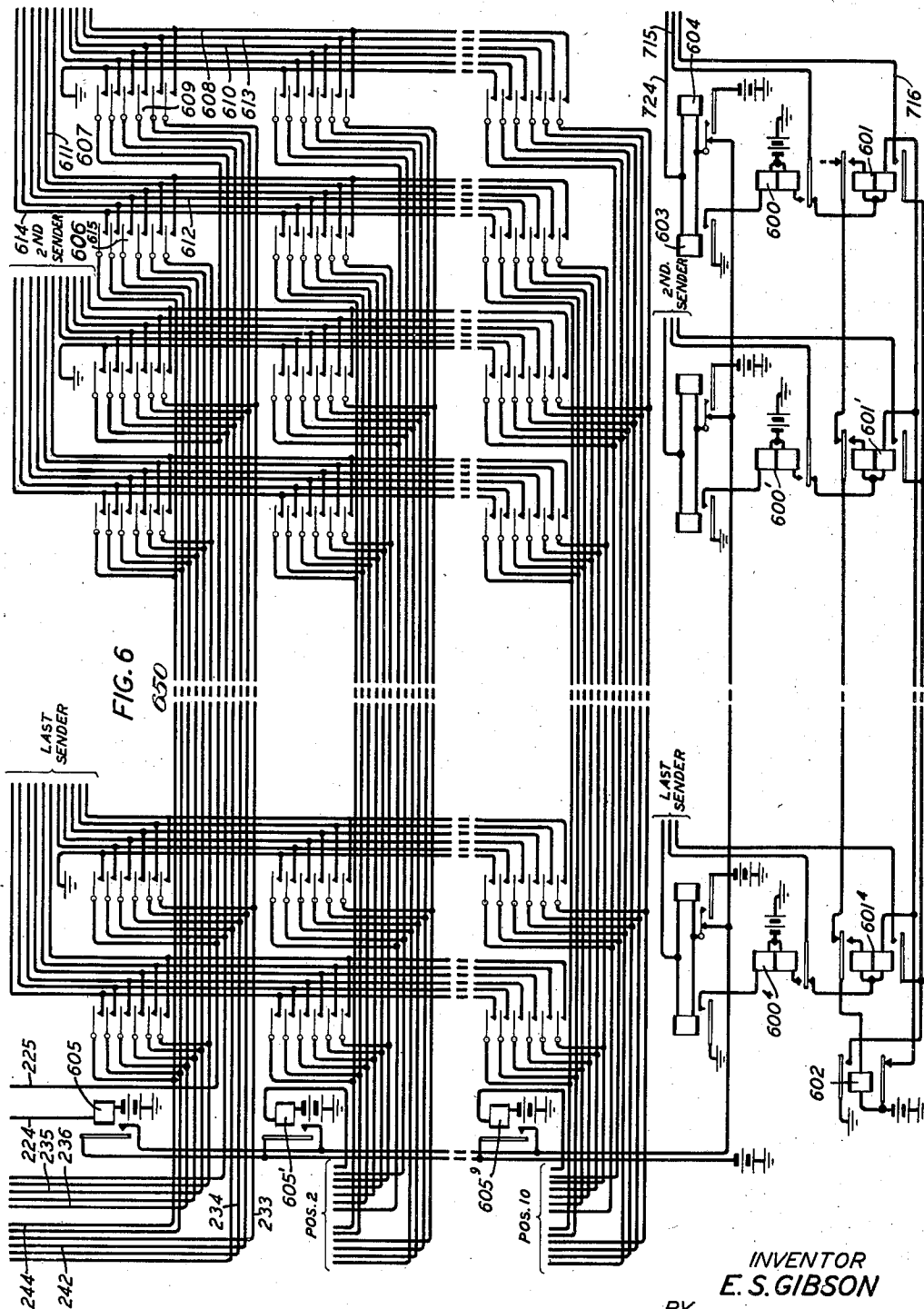
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TELEPHONE SYSTEM

Filed Feb. 29, 1936

10 Sheets-Sheet 6



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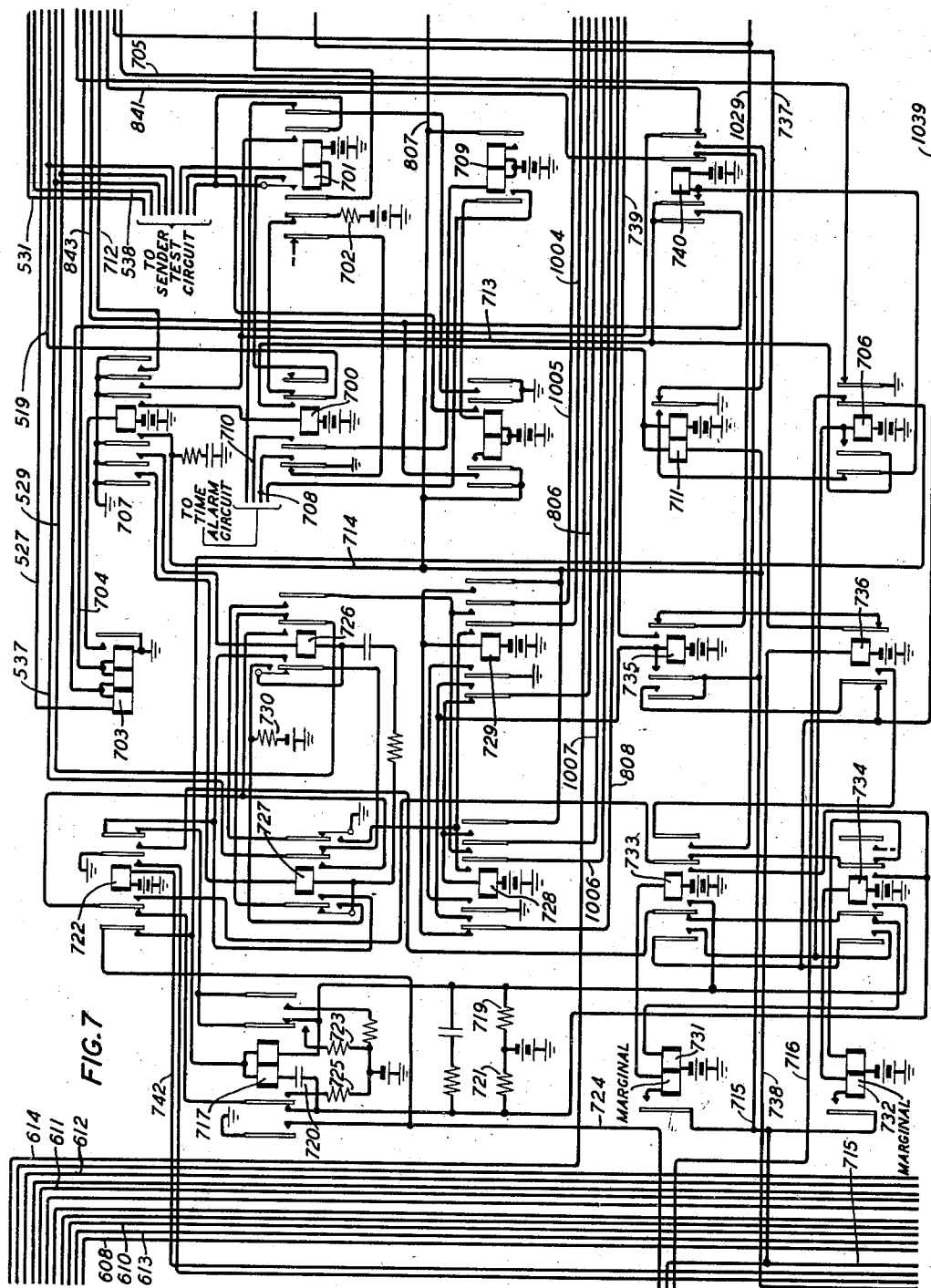
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TELEPHONE SYSTEM

Filed Feb. 29, 1936

10 Sheets-Sheet 7



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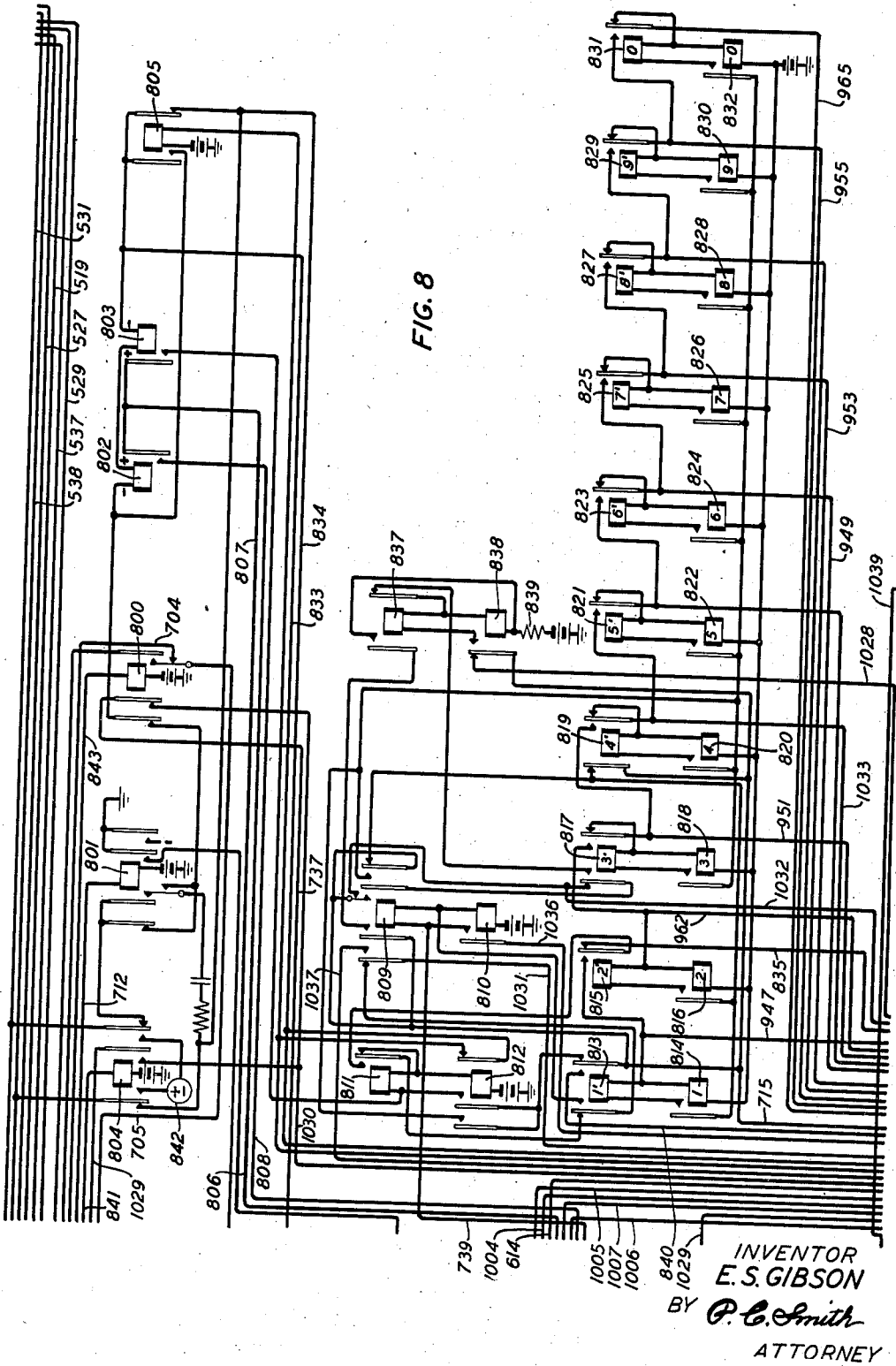
**E. S. GIBSON**

**2,145,079**

## TELEPHONE SYSTEM

Filed Feb. 29, 1936

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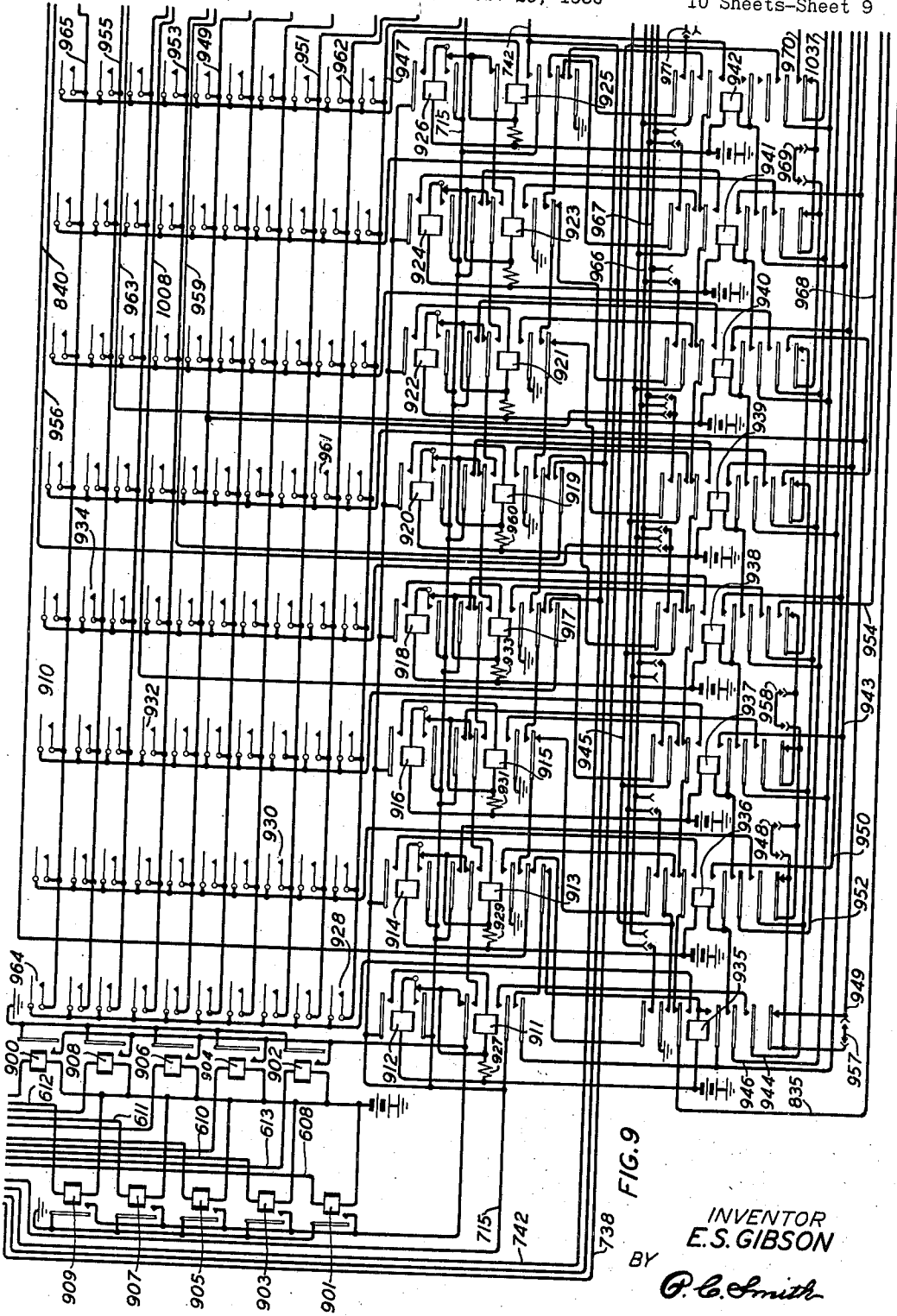
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**2,145,079**

TELEPHONE SYSTEM

Filed Feb. 29, 1936

10 Sheets-Sheet 9



**FIG. 9**

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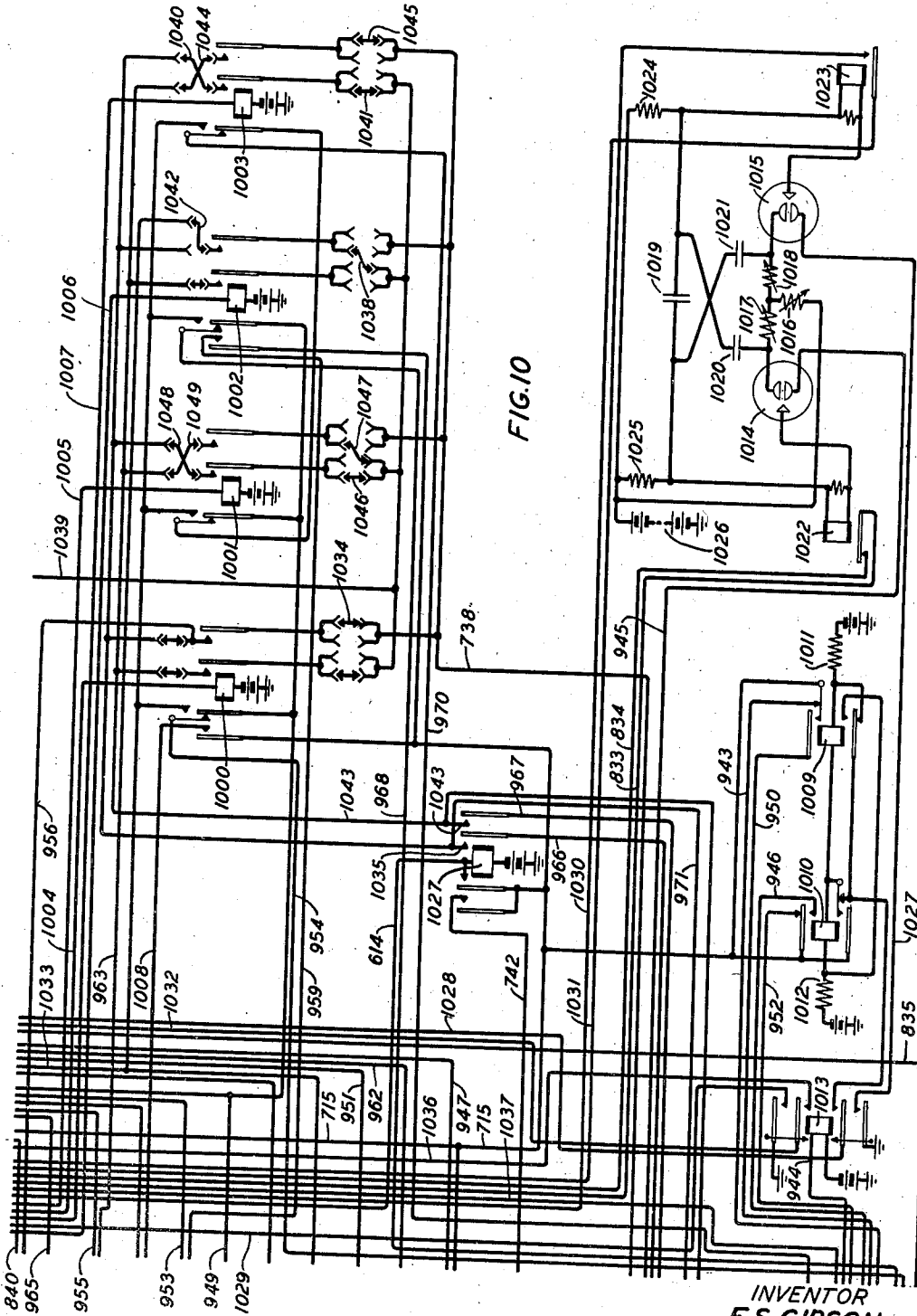
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**2,145,079**

TELEPHONE SYSTEM

Filed Feb. 29, 1936

10 Sheets-Sheet 10



**FIG. 10**

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## UNITED STATES PATENT OFFICE

2,145,079

## TELEPHONE SYSTEM

Earl S. Gibson, Ridgewood, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application February 29, 1936, Serial No. 66,397

11 Claims. (Cl. 179—90)

This invention relates to telephone systems and more particularly to systems in which connections are established by automatic selector switches under the control of a sender in which the designations of wanted lines are registered in response to the keying of digits at an operator's position.

More specifically the invention relates to a sender for enabling an operator at a toll or "A" switchboard to control the setting of selector switches to complete desired connections.

It has been heretofore proposed to provide a plurality of senders any one of which may be taken for use by any one of a plurality of operators and to provide each operator with a single set of digit keys by means of which she may cause the registration of digits of any desired line designation on the registers of the sender associated with her position.

For the purpose of registering the digits keyed by an operator, the sender is equipped with groups of register relays which in accordance with the digit registrations set up thereon control the operation of impulse transmitting means to transmit series of impulses for setting selector switches. Such a system is disclosed in Patent 1,916,760, granted July 4, 1933 to I. H. Henry.

It is the object of the present invention to provide in senders of the foregoing type a simplified digit registering mechanism and an impulse transmitting mechanism which may be readily and accurately adjusted to transmit impulses at a desired speed and with a desired ratio between make and break periods.

In accordance with the present invention, the sender comprises a digit registering device of the cross-bar type having a capacity for registering all of the digits of any desired line designation, impulse generating and counting means comprising two gaseous conductor tubes, means for enabling the operator to control the cross-bar register from a single set of digit keys to successively register the several digits of the line designation keyed by the operator and means for causing the impulse generating and counting means to successively transmit series of impulses in accordance with the digits registered.

The cross-bar register may for example be of the type disclosed in the Patent No. 2,021,329 granted on Nov. 19, 1935 to J. N. Reynolds, and comprises five horizontal bars and as many vertical bars as are necessary to register the maximum number of digits of any line designation or as illustrated eight digits. Two selecting magnets are provided for rotating each horizontal

bar in a clockwise or counter-clockwise direction, there thus being ten selecting magnets. An individual holding magnet is provided for rotating each vertical bar. On each side of each vertical bar is a horizontal row of sets of contact springs there being as many sets of springs in each row as there are vertical bars or eight sets of springs in each row. There are thus eighty sets of springs coordinately arranged in ten horizontal rows corresponding to the ten selecting magnets and eight vertical rows corresponding to the eight holding magnets. Any contact set may be operated by the operation of one of the selecting magnets to rotate a horizontal bar toward the horizontal row in which a particular contact set is located followed by the operation of a holding magnet to rotate a vertical bar corresponding to the vertical row in which the contact set is located. Each vertical row of ten sets of contact springs serves as a register for registering one of the digits of any subscriber's line designation.

To register the several digits of a subscriber's line designation, keys of an operator's set corresponding to the numerical values of the digit are successively operated. Each operation of a key causes the operation of that one of the selecting magnets which has the same numerical value. Associated with each holding magnet is a transfer relay, the holding magnets and associated transfer relays serving as a steering switch to enable successively keyed digits of a line designation to be successively registered on contact sets of successive vertical rows. Thus in response to the depression of a key for the first digit, one of the ten selecting magnets is operated followed by the operation and locking of the first holding magnet, then followed by the release of the operated selecting magnet when the key is released. During the time that the selecting and holding magnets are both operated, one of the ten contact sets of the first vertical row corresponding to the numerical value of the first digit keyed is operated and held operated by the first holding magnet after the selecting magnet releases. The release of the selecting magnet permits the transfer relay associated with the operated holding magnet to operate in the locking circuit of the magnet preparing the register for registering the next digit to be keyed. In response to the keying of the second digit one of the ten selecting magnets is again operated followed by the operation and locking of the second holding magnet and the release of the operated selecting magnet, thus operating a contact set

of the second vertical row corresponding to the numerical value of the second digit. This contact set is held operated by the second holding magnet after the selecting magnet releases and the transfer relay associated with the second holding magnet is operated to prepare the register for registering the next digit. In a similar manner the several digits are registered.

The invention has been illustrated herein as applicable to a system in which an idle one of a plurality of identical senders is associable with any one of a plurality of operators' positions by means of a link circuit. The link circuit has access to all of the senders and to all trunks outgoing from the operator's position and thus when any operator plugs a cord circuit of his position into the jack of an outgoing trunk, an idle link circuit is started to select the seized trunk and to connect it with an idle sender thereby establishing circuits from that operator's position to the sender and from the sender to the selector switch in which the trunk terminates. Such a system is disclosed in the patent to Henry hereinbefore referred to. Since in accordance with the present invention it is necessary to provide eleven operating leads from the key-set of the operator's position to the selecting magnets of the register of the sender which is connected to the operator's position, the setting of the sender register cannot be controlled over the circuits extending through the link circuit, trunk and cord circuit and therefore an auxiliary key-set connector is provided. This connector is also a cross-bar switch of the same general character as the cross-bar register. The five horizontal bars of the key-set connector are operable by ten selecting magnets which are controllable from the key-set circuits of ten operators' positions and the ten vertical bars are operable by ten holding magnets. One hundred sets of contact springs are provided arranged coordinately in ten vertical rows of ten sets each, each horizontal row of contact sets being allocated to one of the ten operators' positions and the vertical rows of contact sets being allocated in pairs to five senders. Thus by the operation of the selecting magnet allocated to any one of the ten operators' positions followed by the operation of the two holding magnets allocated to any one of five senders, two contact sets are operated whereby eleven operating leads may be extended from the key-set circuit of that operator's position to the register sender. It is thus possible to operatively associate the key-set of any one of ten operators' positions with the cross-bar register of any one of five senders. For determining which one of the five senders shall be connected with an operator's position, an allotter is associated with the connector and with all five senders, the allotter functioning upon the association of a sender with an operator's position over the link circuit to allot the holding magnets allocated to that sender for operation in response to the operation of the selecting magnet allocated to that operator's position.

In accordance with a further feature of the invention, an impulser having gaseous discharge tubes is provided for transmitting impulses in accordance with the digits registered on the sender register. The impulser comprises two gaseous discharge tubes of the cold cathode type, one tube controlling the operation and release of a pulsing relay which opens and closes the impulsing loop extending to a selector switch while the other tube operates a counting relay to control

a counting circuit to count the impulses transmitted. The control cathode of each tube is connected through adjustable resistances to the positive terminal of a source of current and through a condenser to the anode of the other tube. The anode of the first tube is connected through the winding of the pulsing relay and a resistance to the positive terminal of the source of current. The anode of the second tube is connected through the winding of the pulse counting relay and a resistance to the positive terminal of the source of current and the anodes of both tubes are connected together by a third condenser. The second cathode of each tube is arranged to be connected to the grounded or negative terminal of the source of current when it is desired to start the tubes. For example, to start the impulser ground is first connected to the second cathode of the first tube followed almost immediately by the connection of ground to the second cathode of the second tube. The first tube thereupon ionizes operating the impulsing relay and then the second tube ionizes operating the counting relay. Because of the interconnected condensers, when the second tube ionizes the first tube is caused to deionize thus releasing the impulsing relay. After an interval the first tube reionizes thereby causing the second tube to deionize and release the impulse counting relay. After a further interval the second tube reionizes thereby causing the first tube to deionize and release the impulse counting relay. After a further interval the first tube reionizes and the preceding cycle of operations is repeated, the two tubes ionizing alternately at a rate which is determined by the condenser timing circuits.

The impulse counting relay of the impulser controls the operation of successive relays of a counting relay train, the number of relays operated during the transmission of each series of impulses being determined by the operated contact set in the vertical row of the register which is at the time associated therewith. For successively controlling the counting and transmission of the successive digits of a registered line designation, the vertical rows of contact sets of the register are successively associated with the train of counting relays by a group of transfer relays serving as an outpulsing steering switch.

For a more complete understanding of the invention reference may be had to the following detailed description taken in connection with the attached drawings in which:

Fig. 1 shows an operator's cord circuit for extending connections to dial switching offices and a portion of the equipment of an operator's position;

Fig. 2 shows the operator's key-set and the remaining equipment of her position;

Fig. 3 shows a trunk circuit of one group or class terminating in a jack accessible to the operator's cord circuit of Fig. 1, and in a first selector switch and the diagrammatic representation of other selector switches and a called subscriber's line;

Figs. 3B, 3C and 3D show modified strapping necessary when the trunk circuit belongs to other groups or classes;

Figs. 4 and 5 taken together show a link circuit for associating a sender such as is disclosed in Figs. 7 to 10, inclusive, with the trunk circuit of Fig. 3. In Fig. 4 the trunk finder and in Fig. 5 the sender-finder of the link are disclosed;

Fig. 6 shows a key-set connector for associating the key-set of any one of a plurality of oper-

ators' positions such as is shown in Fig. 2 with any one of a plurality of senders such as is disclosed in Figs. 7 to 10, inclusive;

Figs. 7 to 10, inclusive, show a sender circuit; Fig. 7 showing control relay equipment; Fig. 8 disclosing further control relays and the impulse counting relays; Fig. 9 showing the registering equipment; and Fig. 10 showing further control relays and the impulsing apparatus; and

Fig. 11 is a diagram showing the manner in which the several figures of the drawings should be assembled to disclose the complete embodiment of the invention.

The trunk finder 450 shown in Fig. 4 may be of the well-known Strowger type having both rotary and vertical stepping movements but, being used as a hunting switch, is also equipped with a vertical commutator and commutator brush. In addition, it is equipped with additional brushes to afford other points of access to control conductors extending to trunk circuits.

The sender-finder 550 of Fig. 5 is of the well-known step-by-step rotary type having no definite normal position and always remains standing when idle on the terminals of the sender last used in extending a connection.

The selector switches disclosed diagrammatically in Fig. 3 may be of the well-known Strowger type responsive to directive impulses transmitted thereto from the sender. As heretofore stated the register equipment of the sender shown in Fig. 9 and the key-set connector disclosed in Fig. 6 are of the cross-bar type, such, for example, as shown in the patent to J. N. Reynolds hereinbefore referred to.

#### *Answering a call from an incoming trunk*

It will first be assumed that a call is incoming to the operator's position of Fig. 1 over the trunk jack 101 and that the operator answers the call by inserting plug 100 of her cord circuit into jack 101. She then depresses her cord key 102 to the right or talking position. A circuit is thereupon established from battery through the lower winding of relay 103, the uppermost right contacts of key 102, conductor 104 to ground at the normal contacts of relay 105. Relay 103 upon energizing closes at its lower contact a circuit extending from ground at contact 106 of key 102, over the lower contact of relay 103, in parallel to battery through the windings of relays 105 and 107. These relays thereupon operate, relay 105 removing ground from conductor 104 to prevent another cord relay such as relay 103 from operating and connecting ground to conductor 108, whereupon a circuit is established through the upper inner contacts and upper winding of relay 103 to battery to hold relay 103 locked so that as long as key 102 is in its operated position, relay 103 individual to the cord circuit and relay 105 common to the cord circuits of the operator's position are held operated. Relay 103 splits the cord circuit and associates the group of conductors 109 with the cord circuit.

The operation of relay 107 connects the tip and ring talking conductors 110 and 111 of the operator's headset circuit, over conductors 112 and 113 extending to the left or monitoring contacts of key 102 and opens conductor 133. If at this time the key 102 of another cord circuit of the position is operated to the left or monitoring position, the operator will be able to talk or listen on both cord circuits but will be able to split, transfer or key pulse on only the cord circuit, the listening key 102 of which has been

operated to the right or talking position. The functions of the splitting key 114, talking and monitoring key 102, and ringing key 115 for enabling the operator to talk, monitor or ring on either end of the cord circuit are fully described in Patent 1,675,956, granted July 3, 1928 to L. F. Porter and will not therefore be discussed in detail herein.

Upon the operation of key 102 a circuit is also established from high resistance ground on the sleeve of jack 101, over the sleeve of plug 100, contact 116 of key 102 to battery through the windings of relays 117 and 118. Relay 118, upon operating, closes an obvious circuit for relay 119. Relay 117 being marginal does not operate at this time. At its inner upper contact relay 119 connects ground through high resistance 120 to conductor 121 to prevent a false operation of the rear cord supervisory lamp 122 should the operator depress a talking key of another cord of her position to the talking position, either accidentally or otherwise, with such cord circuit normal. At its upper back contact relay 119 disconnects the busy test conductor 123 of the operator's headset from the tip of answering plug 100 and at its outermost upper and lower front contacts establishes a talking circuit which may be traced from conductor 110 over the uppermost front contact of relay 119, the upper normal contacts of splitting key 114, conductor 200, the uppermost normal contact of relay 201, conductor 202, the uppermost alternate contacts of relay 103, the upper right normal contacts of key 115, over the tip contacts of plug 100 and jack 101, thence over the toll trunk returning over the ring contacts of jack 101 of plug 100, the inner lower alternate contacts of relay 103, conductor 203, the lower back contact of relay 201, conductor 204, the right lower normal contacts of key 114, the lower front contact of relay 119 to conductor 111. The operator is now enabled to receive instructions over the toll trunk for the further extension of the connection.

Having received instructions and it having been assumed that a connection is desired with the subscriber's line 300, the operator proceeds to test the trunks extending to the office in which the line 300 terminates by touching the tip of the plug 124 to the sleeves of the trunks. A circuit is thereupon established from the tip of plug 124 over the inner lower left normal contact of key 115, the uppermost front contact of relay 103, conductor 205, the upper back contact of relay 206, conductor 207, the upper left normal contact of key 114, the upper back contact of relay 125, to the test lead 123. It will be assumed that the trunk terminating in jack 301 tests idle and that the operator on receiving no busy click in her headset, inserts the plug 124 into jack 301. A circuit is thereupon established from ground through the lower high resistance winding of the trunk sleeve relay 302 over the sleeves of jack 301 and plug 124, contacts 126 of key 102 to battery through the windings of relays 127 and 128. Due to the high resistance of relay 302, marginal relay 127 does not operate at this time, but relays 128 and 302 both operate. With relay 128 operated, an obvious circuit is established for relay 125 which thereupon operates, opening the connection between the tip of plug 124 and the test conductor 123 and establishing a talking path from the tip and ring conductors 110 and 111 of the operator's headset circuit to the left normal contacts of splitting key 114, thence over normal contacts

of relay 206, alternate contacts of relay 103, to the tip and ring contacts of plug 124. At its upper front contact, relay 125 also connects ground through high resistance 129, to conductor 130 for preventing the false operation of the front supervisory lamp 131 should the operator depress a talking key of another cord of her position to the talking position either accidentally or otherwise with such cord circuit normal.

10 *Starting a link circuit to hunt for the selected trunk*

Relay 302 of the trunk circuit upon operating establishes an obvious circuit for relay 303 which in turn establishes a start circuit for starting an idle link in search of the trunk which has been taken for use and in search of an idle sender. This start circuit may be common, for example, to a group of ten trunks and extends from ground at the lower back contact of relay 304, lower front contact of relay 303, conductor 305, through the winding of group relay 400 of the link circuit which has first choice access to the group of trunks in which the selected trunk is located. Relay 400 upon energizing connects ground over its upper contact to segment 407 of the group commutator of the trunk finder 450, corresponding to the bank level in which the selected trunk appears, in the case assumed, the first or lowermost segment, and establishes a circuit from ground at the back contact of relay 401 over the lower contacts of relay 400, the lower normal contacts of make busy jack 402, conductor 403, the lowermost back contact of relay 500 to battery through the winding of relay 501. Relay 501 energizes in this circuit and establishes a circuit for relay 502 extending from ground over the lower front contact of relay 501, inner lower back contact of relay 503, conductor 504, back contacts of vertical magnet 404 and rotary magnet 405, conductor 505, to battery through the upper winding of relay 502.

With relay 502 operated a circuit is now established for the vertical magnet 404 of the trunk finder 450 which may be traced from battery through the winding of magnet 404, conductor 506, the lower back contact of relay 507, contact of relay 502, to ground at the inner upper back contact of relay 500. Magnet 404 upon operating opens at its back contact the circuit of relay 502, whereupon relay 502 in turn de-energizes opening the circuit of magnet 404. Thus magnet 404 and relay 502 reciprocally control each other to cause magnet 404 to step the brushes of finder 450 vertically step by step, until the commutator brush 406 engages the grounded segment 407. When this occurs a circuit is established for relay 507 extending from ground on segment 407, brush 406, conductor 408, the uppermost back contact of relay 500, the upper winding of relay 507, conductor 508, the back contact of rotary magnet 405, conductor 505, to battery through the upper winding of relay 502. Relays 502 and 507 operate in this circuit, relay 507 locking over its lower winding and inner lower front contact, inner lower back contact of relay 500, conductor 509 to ground at the lower alternate contacts of vertical off-normal springs 409, which closed when the trunk finder 450 took the first step off normal. Relay 507 at its lower back contact also opens the operating circuit of the vertical magnet 404.

75 With both relays 502 and 507 energized, a cir-

cuit is now established for the rotary magnet 405 extending from battery through the winding of magnet 405, conductor 510, the lowermost front contact of relay 507, the contacts of relay 502 to ground at the innermost upper back contact of relay 500. Magnet 405 upon energizing opens at its back contact the previously traced circuit extending through the upper winding of relay 502 whereupon relay 502 deenergizes, in turn opening the circuit of magnet 405. Thus magnet 405 and relay 502 reciprocally control each other to cause magnet 405 to step the brushes of the finder 450 over the terminals of the first bank level to which they were previously raised until the set of terminals is reached in the level to which the selected trunk is connected. Thereupon a circuit is established from battery through the winding of trunk relay 306, upper front contact of relay 303, upper back contact of relay 304, conductor 307, bank terminal 410, brush 411, conductor 412, upper front contact of relay 501, winding of relay 511 to ground through the lower winding of relay 502. Relays 306, 502 and 511 operate in this circuit, relay 511 closing an obvious circuit for relay 503 and a locking circuit for relay 501 extending from battery through the winding and inner lower front contact of relay 501, the lower contacts of relay 511 to ground at the intermediate lower normal contacts of relay 512 for holding relay 501 operated after relay 500 operates as later described. Relay 503 upon operating closes at its innermost upper contact a shunt around the lower winding of relay 502 causing the release of relay 502, closes at its lower front contact an obvious operating circuit through the upper winding of relay 500 and at its lower intermediate contact prepares a circuit for relay 512. Relay 500 upon operating locks from off-normal ground on conductor 509 over its innermost lower front contact and lower winding, conductor 513 to battery at the back contact of relay 413 and at its upper and innermost lower back contacts opens the initial operating and locking circuits of relay 507. Relay 507 thereupon releases.

At the trunk circuit relay 306 upon operating establishes an operating circuit for relay 304 which extends from battery through the winding of relay 304, inner upper front contact of relay 306 to ground at the inner upper front contact of relay 303. Relay 304 operates and locks over its lower front contact to ground at the inner upper front contact of relay 303, removes ground at its lower back contact from start conductor 305, at its upper back contact opens the initial operating circuit of relay 306 and at its upper front contact prepares the operating circuit of relay 308. Following the operation of relay 304, relay 306 is held operated over a circuit extending from battery through its winding, the upper front contact of relay 303, the upper front contact of relay 306, thence over conductor 307 to ground as previously traced. When ground is removed from start conductor 305, group relay 400 releases if there is at the time no other trunk in the same group in a selective condition.

*Hunting for an idle sender*

At the time relay 501 operated immediately following the starting of the link circuit, a circuit was also established for relay 514 extending from battery through the winding of relay 514 over the lower back contact of said relay 515 to ground at the lower front contact of relay 501. At its

upper front contact relay 514 establishes a saturating circuit for the test relay 515 which may be traced from battery through the lower winding of relay 515, front contact of relay 514, through the middle winding of relay 515 to ground at the lower front contact of relay 501. Relay 515 does not, however, become energized sufficiently to operate its contacts. At its lower contact relay 514 establishes a circuit for stepping relay 516 of the sender-finder 550 which extends from battery through the winding of relay 516, back contact of stepping magnet 517, lower contact of relay 514 to ground at the upper back contact of test relay 515. Relay 516 upon energizing connects the winding of the stepping magnet 517 to ground at the back contact of relay 515, whereupon magnet 517 energizes, opening the circuit of stepping relay 516. Magnet 517 and relay 516 thus reciprocally control each other thereby advancing the brushes of the sender-finder 550 step by step in search of an idle sender. As soon as a terminal set is reached to which an idle sender is connected, a circuit becomes established for test relay 515 extending from ground through the middle winding of test relay 515, the upper front contact of relay 514, the lowermost back contact of relay 512, the upper winding of relay 515, innermost upper front contact of relay 501, brush 518, conductor 519, inner right back contact of relay 700, inner left back contact of relay 701 to battery through resistance 702, it being assumed that the sender of Figs. 7 to 10, inclusive, is at the time idle. Relay 515 now receiving current through all of its windings operates quickly, locking in a circuit extending from ground over its upper front contact and upper winding, thence as traced to battery at the back contact of relay 701, opening at its upper back contact the operating circuits of relay 516 and magnet 517 and opening at its lower back contact, the operating circuit of relay 514.

After an interval as measured by its slow releasing characteristics, relay 514 deenergizes and if at this time the trunk finder has completed its operation and relay 503 has operated, a circuit is established for relay 512 extending from battery through the winding of relay 512, the lower intermediate front contact of relay 503, the lower intermediate back contact of relay 512, the upper back contact of relay 514, the lower front contact of relay 515, to ground at the lower front contact of relay 501. Relay 512 upon energizing closes a holding circuit for itself before it opens its operating circuit, extending from battery through its winding, its innermost lower front contact to ground at the upper front contact of relay 503, opens at its intermediate lower back contact its own initial operating circuit, transfers the locking circuit of relay 501 from ground at the intermediate normal contacts of relay 512 to ground over the upper back contact of relay 514, the lower front contact of relay 515, and the lower front contact of relay 501, connects brushes 414 to 417 inclusive of finder 450 to brushes 520 to 523 inclusive of the sender-finder 550, establishes a circuit extending in parallel through the windings of relay 524 and 525 over its upper front contact, brush 526, conductor 527, through the left and intermediate windings of relay 703, conductor 704, the right normal contacts of relay 800, conductor 705, to ground at the outer right back contact of relay 706 and at its next to upper contact connects battery through high resistance 553, the back contact of relay 524, conductor 534,

brush 423, conductor 424 through the upper winding of relay 302 to the sleeve of jack 301 for the purpose of marking the trunk busy so long as the link circuit is engaged therewith. Relays 525 and 703 operate in the circuit traced but relay 524 being marginal does not operate. At its upper contact relay 525 bridges the upper contacts of relay 501 in the holding circuit of relays 511 and 306 to hold the latter relays operated following the release of relay 501 and at its lower contact establishes an obvious circuit for relay 536 which closes an alternative holding circuit for relay 512 for holding relay 512 operated following the release of relay 503.

At the sender upon the operation of relay 703, an obvious circuit is closed for relay 707 which in turn closes an obvious circuit for relay 700. Relay 700 disconnects battery through resistance 702 to make the sender busy to other sender-finders, connects ground over its outer left front contact to the start lead 708 extending to the sender time alarm circuit and connects the left winding of the sender time alarm relay 709 to conductor 710 and over its right front contact prepares a circuit for relay 711. Relay 707 at its middle right and inner left front contacts, connects ground to conductors 713 and 714 for providing locking ground for control relays of the sender and at its outer right contact establishes a circuit over conductor 712 through the winding of relay 801 to battery. Relay 801 operates to perform functions later described.

With ground connected to conductor 714 a circuit is now established for controlling the allotter circuit shown in the lower portion of Fig. 6. This allotter circuit comprises a pair of relays individual to each sender, in the case assumed five pairs of relays individual respectively to five senders, relays 600 and 601 being individual to the sender disclosed, relays 600' and 601' to the second sender and relays 600<sup>4</sup> and 600<sup>4</sup> the last or fifth sender, the relays individual to the other two intermediate senders not being disclosed. Relay 602 of the allotter circuit is common to all of the five senders. Since it has been assumed that the sender disclosed was idle at the time of its seizure, when ground is connected to the conductor 714 upon the operation of relay 707, a circuit is completed from conductor 714 over conductor 715, back contact of relay 600, lower winding of relay 601 to battery at the back contact of relay 602. Relay 601 operates and locks in a circuit from ground on conductor 715, back contact of relay 600, upper winding and upper front contact of relay 601, back contacts of relays 601' to 601<sup>4</sup>, winding of relay 602 to battery. Relay 602 operates in this locking circuit opening the initial operating circuit of relay 601 and the operating circuits of other relays 601' etc. and connecting ground over its front contact, the lower front contact of relay 601, conductor 716, right back contact of relay 706, thence in parallel through the right winding of relay 717, high resistance 719, to 48-volt battery and through the left winding of relay 717, condenser 720, high resistance 721 to 48-volt battery. If the operator has not at this time prepared her key-set circuit for key pulsing, relay 717 does not operate since the charging current flowing through the left winding of relay 717 and condenser 720 produces a flux in opposition to the flux produced by the right winding of relay 717 and cannot operate by the energization of its right winding alone.

Since the connection to be established is one



requiring key pulsing control over the plug 124 of the cord circuit, the operator will operate her pulsing key 209 to the lower position and since it will be recalled that relay 125 has operated, a circuit is now established from battery resistance 245, through the winding of relay 210, inner lower right contacts of key 209, conductor 211, lower contact of relay 125, conductor 212, upper normal contacts of relay 213 to ground. Relay 210 operates, locking over its inner upper front contacts to ground at release key 214 or to ground on conductor 211, closing at its lower front contact the circuit of the front key pulsing lamp 215, removing ground from conductor 216 at its upper normal contacts to prevent the operation of relay 213 should the key 209 be operated to its upper position in error, and closing at its upper alternate contacts, an obvious circuit for relay 206. Relay 206 upon operating transfers the tip and ring conductors 205 and 208 extending from the tip and ring contacts of plug 124 from the operator's headset to the key-set circuit, at its inner upper front contact connects holding ground over conductor 217 to the windings of relays 105 and 107 to hold these relays operated so long as the key-set circuit remains associated with the cord circuit, and at its inner lower front contact supplies ground to the inner active contacts of the keys of key-set 220.

#### Registering the class indication

The trunks to which the sender has access are arranged in groups in accordance with the number of digits required to complete a call and further subdivision in grouping may be made as follows: trunks requiring immediate ringing from the sender and trunks not requiring such immediate ringing; trunks requiring 0.6 second timing between the successive transmission of series of impulses and trunks requiring 0.4 second timing between the transmission of series of impulses. Each group may consist of trunks for which the sender is required to pulse out several different numbers of digits under the control of the operator's start key 243. The sender determines the class of the call at the time of its seizure by the polarity encountered on conductors 314, 316, 318 and 320 of the trunk to which it is connected.

The sender is arranged to function with four classes of trunks, the class relays 1000 to 1003, inclusive, being provided to register these classes. Any class may require a fixed number of digits to be keyed or a variable number of digits, automatic start of ringing or no ringing; 0.6 second or 0.4 second timing between any two series of impulses transmitted to set selector switches. The polarity connected to conductors 314, 316, 318 and 320 extending from each trunk to the sender through the link circuit is determined by the arrangement of straps 309 to 312, inclusive.

With the sender now associated with the trunk circuit, the following relays of the sender may or may not be operated dependent on the strapping in the trunk circuit. If battery is connected to conductor 314, relay 726 operates over a circuit from conductor 314, brush 417, conductor 419, inner upper front contact of relay 512, brush 523, conductor 537, inner right back contact of relay 727, left normal contacts and winding of relay 726 to ground at the middle left front contact of relay 707. If battery is connected to conductor 316, relay 727 operates in a circuit from conductor 316, brush 416, conductor 420, next to inner upper front contact of relay 512, brush 522, conductor 529, inner right back contact of relay 726,

left normal contacts and winding of relay 727 to ground at the outer left front contact of relay 707. If battery is connected to conductor 318 and ground to conductor 320, relay 802 operates in a circuit from battery on conductor 318, brush 415, conductor 432, contact 530 of relay 512, brush 521, conductor 531, right back contact of relay 804, inner left front contacts of relay 801, outer left back contact of relay 800, windings of polarized relays 802 and 803 in series, back contact of relay 805, left back contact of relay 804, conductor 538, brush 520, contact 532 of relay 512, conductor 433, brush 414, to ground on conductor 320, polarized relay 803 not receiving current in the proper direction to operate. Relay 802 in turn closes a circuit from battery, winding of relay 728, left back contact of relay 729, conductor 806, contact of relay 802, conductor 807 to ground on conductor 714. If battery is connected to conductor 320 and ground to conductor 318, current flows through the windings of polarized relays 802 and 803, in such a direction as to operate relay 803 which in turn closes a circuit from battery through the winding of relay 729, left back contact of relay 728, conductor 808, contact of relay 803 to ground over conductors 807 and 714. Either relay 728 or 729 upon operating locks over its outer right front contact to ground on conductor 714. Either relay 726 or 727 upon operating locks in a circuit from ground at a left contact of relay 707 through its winding and outer left alternate contacts to battery through resistance 730.

Circuits for class relays 1000 to 1003, inclusive, are closed as follows: with relays 727 and 729 operated, class relay 1000 is operated in a circuit from battery through its winding, conductor 1004, inner right front contact of relay 729, right alternate contacts of relay 727 to ground; with relays 726 and 729 operated, class relay 1001 is operated in a circuit from battery through its winding, conductor 1005, middle right front contact of relay 729, outer right front contact of relay 726, outer right normal contacts of relay 727 to ground; with relays 727 and 728 operated, class relay 1002 is operated and a circuit through its winding, conductor 1006, inner right front contact of relay 728 to ground at the outer right alternate contacts of relay 727; and with relays 726 and 728 operated, class relay 1003 is operated in a circuit from battery through its winding, conductor 1007, middle right front contact of relay 728, outer right front contact of relay 726, to ground at the outer right normal contacts of relay 727.

In the case assumed, the trunk of Fig. 3 is of a fixed four digit class requiring immediate ringing from the sender only in case the call is being completed by an inward toll operator and requiring a short interval of 0.4 second between the last two impulse series which are to be transmitted therefrom to set the connector switch and consequently straps 309 to 312 are connected as shown: to connect conductor 314 to conductor 313 and thence over the inner upper back contact of relay 321, tips of jack 301 and plug 124, left normal contacts of key 115, inner upper front contact of relay 103, conductor 205, upper front contact of relay 206, normal contacts and windings of relay 221, inner lower alternate contacts of relay 210 to ground at the inner lower normal contacts of relay 213; to connect conductor 316 to conductor 315 and thence over the inner lower back contact of relay 321, rings of jack 301 and plug 124, the inner lower front contact of relay 75



203, conductor 208, the lower front contact of relay 206 to 24-volt battery through the inner upper normal contacts of relay 219 and the low resistance 218; to connect conductor 318 to conductor 317, thence over the upper back contact of relay 321, the upper back contact of relay 322 through one winding of the control relay (not shown) of the first selector 350 in which the trunk of Fig. 3 terminates; and to connect conductor 320 to conductor 319, thence over the lower back contact of relay 321, the lower back contact of relay 322 to battery through the other winding of the control relay of first selector 350. Thus as above described, sender relays 727, 729 and class relay 1000 are operated.

With relay 727 operated the circuit previously traced from 24-volt battery at the key-set circuit to conductor 529 is now extended over the right back contact of relay 726, inner left front contact of relay 727, right back contact of relay 722 to the right back contact and right winding of relay 717, thence as traced to ground on conductor 716 and the circuit previously traced from ground through the normal contacts and winding of relay 221 at the key-set circuit to conductor 537, is now extended over the inner right front contact of relay 727, the inner left back contact of relay 722, left back contact of relay 717, condenser 720, left winding of relay 717, thence as traced to ground. This latter circuit serves as a discharge path for condenser 720 which now discharges through the left winding of relay 717. This discharge current now aiding the current flowing through the right winding of relay 717, relay 717 operates establishing a holding circuit for itself from 24-volt battery through low resistance 723, right alternate contacts and right winding of relay 717, outer left back contact of relay 722 to ground at its outer left contact and connecting ground over its outer left front contact to conductor 724 preparatory to operating the holding magnets 603 and 604 of the key-set connector switch 650 which magnets are allocated to the sender disclosed.

At its inner left back contact relay 717 disconnects condenser 720 and 48-volt battery through high resistance 721 from the circuit previously traced through the winding of relay 221 at the key-set circuit and at its inner left front contact connects 24-volt battery through low resistance 725 to this circuit causing the operation of relay 221. Relay 221 upon operating locks over its upper alternate contacts to battery through resistance 218 and establishes an operating circuit for relay 219 extending from battery, winding of relay 219, lower front contact of relay 221, upper back contact of relay 222, inner lower alternate contacts of relay 219, inner lower normal contacts of relay 213 to ground. At its lower front contact, relay 219 establishes a circuit from ground over the upper back contact of relay 223, conductor 224, to battery through the winding of horizontal magnet 605 of switch 650 which operates. Horizontal magnet 605 identifies the particular calling operator's position in the key-set connector switch 650, magnet 605<sup>1</sup> to 605<sup>9</sup> similarly identifying nine other operators' positions.

Magnet 605 upon operating rotates a horizontal bar of the switch into a position which is effective to cause the operation of contact sets in the uppermost horizontal row of contact sets and at its contact completes the operating circuit of the holding magnets 603 and 604 which may now be traced from battery, front contact of magnet 605,

normal contacts of magnet 604, windings of magnets 603 and 604 in parallel, conductor 724 to ground at the outer left front contact of relay 717. Magnet 604 upon operating connects locking battery to the windings of the magnets 603 and 604 so that they are now independent of the continued operation of magnet 605 and both magnets also rotate the vertical bars of the switch controlled thereby which in cooperation with the vertical bar operated by magnet 605 causes the operation of the contact sets 606 and 607 to their closed positions. These contact sets are held operated by the magnets 603 and 604 after the subsequent restoration of the horizontal bar through the release of magnet 605. Holding magnet 603 upon operating also establishes an obvious circuit through the upper winding of relay 600, which operates and locks over its lower winding and front contact to ground on conductor 715. At its back contact, relay 600 opens the holding circuit of relay 601, thus releasing relays 601 and 602 freeing the allotter circuit. The operation of the contact sets extends ten conductors from the outside passive contacts of the key-set 220 to the horizontal magnets 900 to 909, inclusive, of the sender register switch 910 of Fig. 9 and a conductor from start key 243 to the winding of relay 1027 of Fig. 10, and establishes a circuit from ground over the upper contact of contact set 607, conductor 225 to battery through the winding of relay 223. Relays 1027 and 223 operate, relay 223 opening the operating circuit of magnet 605 which releases thus restoring the operated horizontal bar of switch 650 and opening the initial operating circuit of magnets 603 and 604.

Relay 223 upon operating locks over its inner lower front contact to ground at the lower front contact of relay 219, establishes a circuit from ground at the lower contact of relay 219 over its upper front contact and the lower back contact of relay 222 to battery through lamp 226 which lights as a signal that the keys of the key-set 220 are now connected with the register of the selector sender and supplies operating ground from the lower contact of relay 219 over its lower front contact and conductor 232 to the outer active contacts of the keys of key-set 220 and to the active contact of start key 243.

Should the operator depress a key of the key-set 220 before the sender is attached and relay 219 has operated, relay 222 is operated in a circuit extending from battery, winding of relay 222, upper back contact of relay 219, inner contact of the operated key-set key to ground at the inner lower front contact of relay 206. Relay 222 upon operating locks over its inner lower front contact and the left normal contacts of key 209, the inner lower alternate contacts of relay 210 and the inner lower normal contacts of relay 213 until key 209 is reoperated and, at its lower front contact, establishes a flashing circuit for lamp 226 through interrupter 227. The flashing of lamp 226 indicates to the operator that she has prematurely depressed a key-set key. She will therefore proceed to reoperate key 209 thereby releasing relay 222 and await the steady lighting of lamp 226 as a signal that a sender has become connected to her key-set.

#### Keying the called line designation

It will be assumed that the operator in order to establish a connection to line 300, the designation of which is the four digit number 1379, depresses keys 228, 229, 230 and 231 in the order

named. Upon the depression of key 228 to register the thousands digit 1, ground from conductor 232 is connected over the outer contacts of key 228, conductor 233, lowermost contact of contact set 607, conductor 603, winding of horizontal magnet 901 to battery. Magnet 901 upon operating rotates the lowermost No. 1 horizontal bar of the register switch 910 and closes a circuit from ground over its front contact, back contact of transfer relay 911, lower normal contacts and winding of vertical magnet 912 to battery. Magnet 912 operates, locks over its lower alternate contacts to ground on conductor 715, connects ground from conductor 715 over its upper front contact through the winding of transfer relay 911, resistance 927 to battery and rotates the first vertical bar of switch 910. Relay 911 does not operate at this time since its winding is shunted by ground potential applied over the front contact of magnet 901 and the upper back contact of relay 911 to a point between resistance 927 and the winding of relay 911. With the lowermost horizontal bar and the first vertical bar of switch 910 both operated, the contact set 928 is operated and held operated under the control of magnet 912 after magnet 901 releases to return the operated horizontal bar to normal when the operated key 228 is released. When magnet 901 releases, the shunting ground is removed from the winding of transfer relay 911 and it now operates.

When the operator depresses key 229 to register the hundreds digit 3, ground from conductor 232 is connected over the outer contacts of key 229, conductor 234, contact 609 of contact set 607, conductor 610, winding of horizontal magnet 903 to battery. Magnet 903 upon operating rotates the No. 3 horizontal bar of switch 910 and closes a circuit from ground over its front contact, upper front contact of transfer relay 911, upper back contact of transfer relay 913, lower normal contacts and winding of vertical magnet 914 to battery. Magnet 914 operates, locks over its lower alternate contacts to ground on conductor 715, connects ground from conductor 715 over its upper front contact through the winding of transfer relay 913 and resistance 929 to battery and rotates the second vertical bar of switch 910. Relay 913 does not operate at this time since its winding is shunted by ground applied over the front contact of magnet 903, the upper front contact of relay 911 and the upper back contact of relay 913 to a point between the resistance 929 and the winding of relay 913. With the No. 3 horizontal bar and the second vertical bar of switch 910 both operated, the contact set 930 is operated and held operated under the control of magnet 914 after magnet 903 releases to return the operated horizontal bar to normal when the operated key 229 is released. When magnet 903 releases, the shunting ground is removed from the winding of transfer relay 913 and it now operates.

When the operator depresses key 230 to register the tens digit 7, ground from conductor 232 is connected over the right contacts of key 230, conductor 235, the next to the lower contacts of contact set 606, conductor 611, winding of horizontal magnet 907 to battery. Magnet 907 upon operating rotates the No. 7 horizontal bar of switch 910 and closes a circuit from ground over its front contact, upper front contact of transfer relay 911, inner upper front contact of transfer relay 913, upper back contact of transfer relay 915, lower normal contacts and winding of vertical magnet 916 to battery. Magnet 916

operates, locks over its lower alternate contacts to ground on conductor 715, connects ground from conductor 715 over its upper front contact through the winding of transfer relay 915, resistance 931 to battery and rotates the third vertical bar of switch 910. Relay 915 does not operate at this time since its winding is shunted by ground potential applied over the front contact of magnet 907, the upper front contact of relay 911, the inner upper front contact of relay 913 and the upper back contact of relay 915 to a point between resistance 931 and the winding of relay 915. With the No. 7 horizontal bar and the third vertical bar of switch 910 both operated, the contact set 932 is operated and held operated under the control of magnet 916 after magnet 907 releases to return the operated horizontal bar to normal when the operated key 230 is released. When magnet 907 releases the shunting ground is removed from the winding of transfer relay 915 and it now operates.

When the operator depresses key 231 to register the units digit 9, ground from conductor 232 is connected over the right contacts of key 231, conductor 236, contacts 615 of contact set 606, conductor 612, winding of horizontal magnet 909 to battery. Magnet 909 upon operating rotates the No. 9 horizontal bar of switch 910 and closes a circuit from ground over its front contact, upper front contact of transfer relay 911, inner upper front contacts of transfer relays 913 and 915, inner upper back contact of transfer relay 917, lower normal contacts and winding of vertical magnet 918 to battery. Magnet 918 operates, locks over its lower normal contacts to ground on conductor 715, connects ground from conductor 715 over its upper front contact through the winding of transfer relay 917 and resistance 933 to battery and rotates the fourth vertical bar of switch 910. Relay 917 does not operate at this time since its winding is shunted by ground potential applied over the front contact of magnet 909, upper front contacts of relays 911, 913 and 915 and the upper back contact of relay 917 to a point between the resistance 933 and the winding of relay 917. With the No. 9 horizontal bar and the fourth vertical bar of switch 910 both operated, the contact set 934 is operated and held operated under the control of magnet 918 after magnet 909 releases the operated horizontal bar to normal, when the operated key 231 is released. When magnet 909 releases, the shunting ground is removed from the winding of transfer relay 917 and it now operates.

Since it was assumed that class relay 1000 was operated indicating a call of the four digit fixed class, when transfer relay 917 operates, a circuit is established from ground on conductor 715, outer left front contact of class relay 1000, conductor 1008, lower front contact of transfer relay 917, conductor 742, winding of relay 722 to battery. Relay 722 operates, releases relay 717 and disconnects the armatures of relay 717 from conductors 529 and 537 and connects these conductors to the right operating windings of relays 731 and 732. The release of relay 717 opens the locking circuits of magnets 603 and 604 of key-set connector switch 650 thereby restoring this switch to normal.

A circuit is now established from 24-volt battery through the winding of polarized relay 237 at the key-set circuit, left normal contacts of key 239, upper alternate contacts of relay 219, lower front contact of relay 206 thence as traced

to conductor 529, right back contact of relay 726, inner right front contact of relay 727, right front contact of relay 722, inner left back contact of relay 733, inner left back contact of relay 734, right winding of relay 731, to 48-volt battery. A second circuit is established from 24-volt battery through the winding of polarized relay 238 at the key-set circuit, right normal contacts of key 239, upper front contact of relay 206, thence as traced to conductor 537, inner right front contact of relay 727, left front contact of relay 722, right back contact of relay 733, right back contact of relay 734, right winding of relay 732 to 48-volt battery. Polarized relays 237 and 238 both operate, but relays 731 and 732 being marginal do not. With relays 237 and 238 both operated, a circuit is established from ground over their front contacts to battery through the winding of relay 240 which relay operates and locks over its upper front contact, upon back contact of relay 222, to ground over the inner lower alternate contacts of relay 210 and the inner lower normal contacts of relay 213 and at its upper front contact connects ground to the winding of polarized relay 237 for holding it operated and over the circuit previously traced through the right winding of marginal relay 731 in the sender.

Relay 731 now operates and locks in a circuit from ground on conductor 715, contact and left winding of relay 731, winding of relay 733 to battery. Relay 733 operates, opening the circuit through the operating winding of relay 731 and the winding of polarized relay 237, and the circuit through the operating winding of relay 732 and the winding of polarized relay 238. Polarized relay 238 now releases but relay 237 is held operated under the control of relay 240. Relay 238 upon releasing establishes a shunt circuit around the winding of relay 210 which may be traced from ground, back contact of relay 238, lower front contact of relay 240, winding and inner upper front contact of relay 210 to ground at release key 214 or ground on conductor 211, whereupon relay 210 releases in turn releasing relays 206, 219, 221, 237, 223 and 240. Relay 210 upon releasing also opens the circuit of key pulsing guard lamp 215 which becomes extinguished as a signal that registration of the keyed number has been completed. If the talking key 102 has been restored, the circuit of relays 105 and 107 will at this time be opened since their alternative holding circuit through the inner upper front contact of relay 206 is now broken and relay 105 upon releasing will open the holding circuit of cord relay 103, disconnecting the tip and ring contacts of plug 124 from the conductors extending from the operator's key pulsing circuit and establishing the continuity of the talking circuit between the tip and ring contacts of plug 100 and the tip and ring contacts of plug 124. The key set is now completely disconnected from the cord circuit and from the sender and may be used with another cord circuit of the operator's position to control the setting up of another connection.

#### *Transmission of impulses to selector switches*

Returning to a consideration of the sender, it will be recalled that transfer relay 911 operated when the first digit was registered on the register switch 910. A circuit was therefore established from battery through the winding of steering relay 935, lower back contact of transfer relay 913, lower front contact of transfer relay

911, conductor 943, upper normal contacts of relay 1009 to ground on conductor 715. Relays 935 to 942, inclusive, are steering relays for the outpulsing circuit and shift the pulsing control from the register contacts of one vertical row of switch 910 to the next vertical row after the impulses for one digit are all sent out. Relay 935 upon operating locks over its inner lower front contact, conductor 943, upper normal contacts of relay 1009, to ground on conductor 715 independent of transfer relay 913, establishes an operating circuit for relay 1013, extending from battery, winding of relay 1013, conductor 944, lower front contact of relay 935, inner lower front contact of relay 911 to ground on conductor 715, prepares the operating circuit of the next steering relay 936, and connects ground potential over its middle upper front contact and conductor 945 to the lower control electrode of tube 1014.

Initially neither tube 1014 nor tube 1015 is ionized and positive potential is applied from battery 1026 to the upper or control electrode of tube 1014 through resistances 1016 and 1017 and to the upper or control electrode of tube 1015 through resistances 1016 and 1018 and condensers 1019, 1020 and 1021 are uncharged. The tube circuits are so arranged that when the impulser is to be started, tube 1014 is ionized before tube 1015 can ionize, that is a pulse is sent out through the operation of impulsing relay 1022 before an impulse is counted through the operation of impulse counting relay 1023. When, as previously described ground is connected to the lower control electrode of tube 1014, this tube ionizes across the gap between its control electrodes and current flows through the two resistances 1016 and 1017. The resulting drop of potential across these resistances causes the condenser 1020 to charge in a circuit from ground on conductor 945 across the ionized gap between the control electrodes through condenser 1020, resistance 1024 to the positive terminal of source 1026. Also as a result of the breaking down of the gap between the control electrodes, the main gap between the lower electrode and the anode ionizes and current flows from grounded conductor 945 across the main gap through the winding of impulsing relay 1022, resistance 1025 to the positive terminal of battery 1026. The drop in potential across resistance 1025 now causes condenser 1019 to assume a charge.

As soon as relay 1013 operates after an interval determined by its slow to operate characteristic, ground is connected over conductor 1027 to the lower control electrode of tube 1015 causing tube 1015 to ionize across the gap between its control electrodes. The main gap between the lower control electrode and the anode is also ionized and current flows from ground on conductor 1027 across the main gap through the winding of impulse counting relay 1023, resistance 1024 to the positive terminal of battery 1026. The drop of potential across both resistances 1024 and 1025 is now the same. The result is that the same potential is now applied to both terminals of condenser 1019 and this condenser discharges through resistances 1024 and 1025 and lowers the potential on the anode of tube 1014 below the value required to sustain ionization across the main gap of this tube and also the lowering of the potential across resistances 1016 and 1018 upon the ionization of the

control gap of tube 1015 charges condenser 1021 and lowers the potential on the upper of control electrode of tube 1014 below the ionizing potential. Tube 1014 therefore deionizes and releases relay 1022. When the main gap of tube 1015 becomes ionized the potential at the point of juncture between condenser 1020 and resistance 1024 is lowered to a point such that both terminals of condenser 1020 have the same potential. Condenser 1020 therefore discharges in a path through resistances 1024, 1016 and 1017. As condenser 1020 discharges the potential on the upper control electrode of tube 1014 becomes less negative. After a time which is determined by the constants of the condenser discharge circuit, the potential on the control electrode of tube 1014 becomes sufficiently less negative for the tube 1014 to again ionize. The above cycle of operations is now repeated; when tube 1014 again ionizes tube 1015 deionizes; after a definite delay tube 1015 again ionizes and tube 1014 deionizes. In this manner tubes 1014 and 1015 ionize and deionize alternately under the control of condenser 1019 at a rate which is determined by the constants of the timing circuits controlled by condensers 1020 and 1021.

When relay 1013 operated, it established a circuit for relay 1010 extending from ground on conductor 715, back contact of relay 838, conductor 1028, inner lower front contact of relay 1013, lower normal contacts and winding of relay 1010 through resistance 1012 to battery and in a branch of this circuit through the winding of relay 1009 and resistance 1011 to battery. Relay 1010 operates and locks over its lower alternate contacts to ground on conductor 715 and connects direct ground from conductor 715 to the winding of relay 1009. Relay 1009 does not operate, however, since its winding is shunted over its lower back contact so long as relay 838 remains unoperated. Relay 1010 upon operating establishes an operating circuit for steering relay 936 which may be traced from battery, winding of relay 936, next to inner lower front contact of relay 935, conductor 946, upper front contact of relay 1010 to ground on conductor 715. Relay 936 operates but is without function at this time.

The first operation of impulsing relay 1022 resulting from the initial ionization of tube 1014 is without effect. When tube 1015 ionizes for the first time, it deionizes tube 1014 releasing relay 1022 and operates relay 1023. A circuit is thereupon established from ground at the upper front contact of relay 1013, conductor 1029, back contact of relay 735, right back contact of relay 736, conductor 737, inner left back contact of relay 800, conductor 1030, contacts of impulse counting relay 1023, conductor 1031, left back contact of relay 809, left back contact of relay 813, right back contact of relay 811, winding of relay 812 to battery. Relay 812 operates and locks in a circuit through its winding and the winding of relay 811 in series, inner left front contact of relay 812, right back contact of relay 813, to ground on conductor 715, but the winding of relay 811 being shunted so long as impulse counting relay 1023 remains operated, relay 811 does not operate. Relay 812 upon operating establishes a circuit for the pulse help relay 805 extending from battery through the winding of this relay, inner left front contact of relay 812, right back contact of relay 813 to ground on conductor 715 and at its right contact opens a shunt around the contacts of impulsing relay 1022, thereby rendering relay 1022 effective to

transmit impulses. The outpulsing circuit is now established from the upper winding of the control relay of the first selector 350, thence as traced to conductor 531, right back contact of relay 804, left front contacts of relay 801, outer left back contact of relay 800, left front contact of relay 805, conductor 833, back contact of impulsing relay 1022, conductor 834, left back contact of relay 804, conductor 538, thence as traced to battery through the lower winding of the control relay of the first selector 350.

Tube 1015 deionizes following the deionization of tube 1014 and releases relay 1023 which removes the shunt from the winding of relay 811. Relay 811 now operates. The operation of relays 811 and 812 has thus been effective to absorb the first impulse produced by impulsing relay 1022. Tube 1014 now reionizes operating relay 1022 which is now effective to open the outpulsing circuit just traced, whereupon the first selector advances its brushes one step vertically in the well-known manner. Tube 1015 reionizes following the ionization of tube 1014, reoperating relay 1023 which now closes a circuit from ground as previously traced to conductor 1030, contacts of relay 1023, conductor 1031, left back contact of relay 809, left back contact of the No. 1' counting relay 813, front contact of relay 811, back contact of the No. 2' counting relay 815, conductor 835, inner upper front contact of steering relay 935, contact set 928 of switch 910, conductor 947, winding of the No. 1 counting relay 814 to battery. Relay 814 operates and locks through its winding and the winding of the No. 1' counting relay 813 in series, front contact of relay 814, left back contact of relay 819 to ground on conductor 715, but relay 813 being shunted does not operate. When tube 1015 reionizes, tube 1014 deionizes and releases relay 1022 to reestablish the outpulsing circuit followed by the deionization of tube 1015 and the release of relay 1023. Relay 1023 upon releasing opens the shunt around the winding of relay 813 and the latter relay now operates releasing relays 811, 812 and 805. Upon the release of relay 812, the shunt around the contacts of impulsing relay 1022 is closed rendering relay 1022 ineffective to transmit further impulses over the outpulsing circuit and with relay 805 released the outpulsing circuit extends as traced to conductor 531 thence over the right back contact of relay 804, left front contacts of relay 801, outer left back contact of relay 800, windings of polarized relays 802 and 803, back contact of relay 805, left back contact of relay 804, conductor 538, thence as traced. The continued functioning of tubes 1014 and 1015 is now effective to measure a 0.6 second time delay interval during which the first selector hunts for an idle trunk in the first level to which its brushes were advanced.

On the next ionization of tube 1015 and the operation of relay 1023, a circuit is established from ground on conductor 1030, contacts of relay 1023, conductor 1031, left back contact of relay 809, left front contact of the No. 1' counting relay 813, winding of relay 810 to battery. Relay 810 operates and locks in series with relay 809, front contact of relay 810, conductor 1036, inner upper front contact of relay 1013, conductor 1032, inner right normal contacts of relay 809 to ground on conductor 715, but relay 809 being shunted does not operate. On the next deionization of tube 1015 and the release of relay 1023, relay 809 operates and establishes a new holding circuit for itself and relay 810 as traced

over conductor 1032, left back contact of the No. 1 relay 835 stopping the action of the tubes

On the next ionization and deionization of the connection of ground to the lower control tubes 1014 and 1015 with relay 813 operated, relays 809 and 810 are operated and locked in the manner previously described. When relay 809 operates with relay 837 operated, a circuit is established from ground on conductor 715 over the inner left front contact of relay 809, front contact of relay 837 to a point between the winding of relay 838 and resistance 839 causing the shunting of relays 837 and 823 which now release. Relay 838 upon releasing connects ground from conductor 715 over its back contact, conductor 1028, inner lower front contact of relay 1013, lower front contact of relay 1009 to a point between the winding of relay 1010 and resistance 1012 thereby causing the release of relay 1010. With relay 1010 released, relay 1009 is held operated over the lower normal contacts of relay 1010 and the inner lower front contact of relay 1013 to ground on conductor 1028 and a circuit is established for operating steering relay 937. This circuit may be traced from battery, winding of relay 937, next-to-inner lower front contact of relay 936, conductor 952, upper back contact of relay 1010 to ground on conductor 715.

On the next ionization of tube 1015 and operation of relay 1023, with steering relay 937 operated, a circuit is established from ground on conductor 1030, contacts of relay 1023, conductor 1031, outer left front contact of relay 809, conductor 1037, lower back contacts of steering relays 938 to 942, inclusive, straps 958, 948 and 957, conductor 949, back contact of the No. 6' counting relay 823, winding of the No. 6 counting relay 824 to battery. Relay 824 operates and locks through the winding of relay 823, its own front contact, the outer right front contact of relay 809 to ground on conductor 715. On the deionization of tube 1015 and the release of relay 1023, relay 823 operates. In response to succeeding energizations and releases of relay 1023 under the control of tube 1015, counting relays 822, 821, 820 and 819 are successively operated and locked under the control of relay 809. Relay 819 upon operating opens the locking circuit of relays 813 to 816, inclusive, which now release. On the next energization of relay 1023 following the operation of counting relay 819, counting relay 818 operates followed by the operation of counting relay 817 upon the next release of relay 1023. Relay 817 upon operating with relay 809 operated, establishes the operating circuit of relay 838 which locks as before described in series with the winding of relay 837 and at its back contact removes ground from conductor 1028 thereby releasing relay 1009. Relay 817 upon operating with relay 809 operated also opens the locking circuit of relays 809 and 810 which then release in turn opening the locking circuits of the operated counting relays 817 to 824, inclusive, and removing the shunt from the winding of relay 837 which now operates. Relay 1009 upon releasing opens the locking circuit of steering relay 936 which now releases and establishes a locking circuit for steering relay 937 extending from battery, winding and inner lower front contact of relay 937, conductor 943, upper normal contacts of relay 1009 to ground on conductor 715.

If the third digit has been registered at this time relay 1013 will not release upon the release of steering relay 936, but will be held operated over a circuit extending through its winding, conductor 944, the next-to-lower front contact of relay 937, upper front contact of transfer relay 915 to ground on conductor 715 and will maintain

the connection of ground to the lower control electrode of tube 1015. Ground will also be supplied to the lower control electrode of tube 1014 over conductor 945, the middle upper front contact of relay 937 and the inner lower front contact of transfer relay 915. Tubes 1014 and 1015 will therefore continue to ionize and deionize in alternation in the manner previously described. If the third digit has not been registered, relay 1013 will release following the release of relay 936 stopping the action of the tubes until the third digit has been registered.

With the third digit 7 registered and relays 915, 937 and 1013 operated, the tubes function in the manner described to cause the successive operation of relays 812 and 811 to absorb the first impulse generated by the operation of impulsing relay 1022 and to prepare the outpulsing circuit by the operation of relay 805. On the next ionization of tube 1014 following the operation of relays 805 and 811, relay 1022 operates to open the outpulsing circuit whereupon the connector 370 advances its brushes one step vertically in the well-known manner. Tube 1015 reionizes following the ionization of tube 1014, reoperating relay 1023 which now closes a circuit from ground as previously traced to conductor 1030, contacts of relay 1023, conductor 1031, left back contact of relay 809, left back contact of the No. 1' counting relay 813, front contact of relay 811, back contact of the No. 2' counting relay 815, conductor 835, inner upper back contacts of relay 935 and 936, inner upper front contact of relay 937, contact set 932, conductor 953, back contact of the No. 7' counting relay 825, winding of the No. 7 counting relay 826 to battery. Relay 826 operates and locks in a circuit through the winding of relay 825, front contact of relay 826, outer left front contact of relay 812, right back contact of the No. 1' counting relay 813 to ground on conductor 715. When tube 1015 reionizes, tube 1014 deionizes and releases relay 1022 to reclose the outpulsing circuit followed by the deionization of tube 1015 and the release of relay 1023. Relay 1023 upon releasing permits relay 825 to operate in the locking circuit of relay 826.

In response to successive ionizations and deionizations of tubes 1014 and 1015, relay 1022 operates and releases to transmit five further impulses over the outpulsing circuit and counting relays 824, 823, 822, 821, 820, 819, 818, 817, 816 and 815 operate and lock in response to the energizations and releases of relay 1023, all of these relays with the exception of relays 816 and 815 locking under the control of relays 812 and 813 and relays 816 and 815 locking in a circuit extending over the front contact of relay 816, the outer right back contact of relay 809 to ground on conductor 715. In response to the next ionization of tube 1014 and the operation of relay 1022, a seventh impulse is transmitted to the connector and in response to the next ionization of tube 1015 with counting relay 815 operated, a circuit is established from ground on conductor 1030 over the contacts of relay 1023, conductor 1031, left back contact of relay 809, left back contact of relay 813, front contact of relay 811, front contact of relay 815, winding of the No. 1 counting relay 814 to battery. Relay 814 operates and locks through its winding and the winding of relay 813, front contact of relay 814, outer right back contact of relay 809 to ground on conductor 715, but relay 813 being shunted does not operate. Upon the following deionizations of tubes 1014 and 1015 and the consequent release of relays 1022



over conductor 1032, left back contact of the No. 3' counting relay, inner right alternate contacts of relay 809 to ground on conductor 715. On the next ionization of tube 1015 and operation of relay 1023, a circuit is now established from ground on conductor 1030, contacts of relay 1023, conductor 1031, outer left front contact of relay 809, conductor 1037, lower back contacts of steering relays 937 to 942, inclusive, straps 948 and 957, conductor 949, back contact of the No. 6' counting relay 823, winding of the No. 6 counting relay 824 to battery. Relay 824 operates and locks through the winding of relay 823, its own front contact, the outer right front contact of relay 809 to ground on conductor 715. On the deionization of tube 1015 and the release of relay 1023, relay 823 operates in this locking circuit. In response to succeeding energizations and releases of relay 1023, under the control of tube 1015, counting relays 822, 821, 820 and 819 are successively operated and locked under the control of relay 809 in the well-known manner. Relay 819 upon operating opens the locking circuit of relays 813 and 814 which now release, since with relay 809 operated there is no alternative locking circuit for them over the outer right back contact of relay 809. On the next energization of relay 1023 following the operation of counting relay 819, counting relay 818 operates, followed by the operation of relay 817 upon the next release of relay 1023. Relay 817 upon operating with relay 809 operated closes the operating circuit of relay 838 extending from battery through resistance 839, winding of relay 838, back contact of relay 837, left front contact of relay 817, inner right alternate contacts of relay 809 to ground on conductor 715. Relay 838 operates, locking in series with relay 837 and over its front contact to ground on conductor 715 and removing ground from conductor 1028 thereby opening the shunt around the winding of relay 1009 which now operates. Relay 837 being shunted does not operate in the locking circuit of relay 838 so long as relay 809 remains operated.

Relay 817 upon operating with relay 809 operated, opens the locking circuit of relays 809 and 810 which now release in turn opening the locking circuits of the operated counting relays 817 to 824 inclusive and removing the shunt from the winding of relay 837 which now operates. Relay 1009 upon operating, at its upper normal contacts opens the locking circuit of steering relay 935 which releases and, at its upper alternate contacts establishes a holding circuit for steering relay 936 which may be traced through the winding and inner lower front contact of relay 936, conductor 950, alternate contacts of relay 1009 to ground on conductor 715.

If the second digit has been registered at this time, relay 1013 will not release upon the release of steering relay 935, but will be held operated over a circuit extending through its winding, conductor 944, the next to lower front contact of relay 936, upper front contact of transfer relay 913 to ground on conductor 715 and will maintain the connection of ground to the lower control electrode of tube 1015. Ground will also be supplied to the lower control electrode of tube 1014 over conductor 945, the middle upper front contact of relay 936, and the inner lower front contact of transfer relay 913. Tubes 1014 and 1015 will therefore continue to ionize and deionize in alternation in the manner previously described. If, however, the second digit has not been registered relay 1013 will release following the re-

lease of relay 935 stopping the action of the tubes until the second digit has been registered.

With the second digit 3 registered and relays 913, 936 and 1013 operated, the tubes function in the manner described to cause the successive operation of relays 812 and 811 to absorb the first impulse generated by the operation of impulsing relay 1022 and to prepare the outpulsing circuit by the operation of relay 805. On the next ionization of tube 1014 following the operation of relays 805 and 811, relay 1022 operates to open the outpulsing circuit whereupon the second selector 360 advances its brushes one step vertically in the well-known manner. Tube 1015 re-ionizes following the ionization of tube 1014, re-operating relay 1023 which now closes a circuit from ground as previously traced to conductor 1030, contacts of relay 1023, conductor 1031, left back contact of relay 809, left back contact of the No. 1' counting relay 813, front contact of relay 811, back contact of the No. 2' counting relay 815, conductor 835, inner upper back contact of relay 935, inner upper front contact of relay 936, contact set 930 of switch 910, conductor 951, back contact of the No. 3' counting relay 817, winding of the No. 3 counting relay 818 to battery. Relay 818 operates and locks in a circuit through the winding of relay 817, front contact of relay 818, outer left front contact of relay 812, right back contact of the No. 1' counting relay 813 to ground on conductor 715. When the tube 1015 re-ionizes tube 1014 deionizes and releases relay 1022 to reclose the impulsing circuit followed by the deionization of tube 1015 and the release of relay 1023. Relay 1023 upon releasing permits counting relay 817 to operate in the locking circuit of relay 818.

In response to the next ionizations and deionizations of tubes 1014 and 1015 a second impulse is transmitted to the second selector 360 by the operation and release of impulsing relay 1022 and the counting relays 816 and 815 are operated through the operation and release of relay 1023 in the manner described. In response to the next ionization of tube 1014 and the operation of relay 1022 a third impulse is transmitted to the second selector and in response to the next ionization of tube 1015 with counting relay 815 operated a circuit is established from ground on conductor 1030 over the contacts of relay 1023, conductor 1031, left back contact of relay 809, left back contact of relay 813, front contact of relay 811, front contact of relay 815, winding of the No. 1 counting relay 814 to battery. Relay 814 operates and locks through its winding and the winding of relay 813, front contact of relay 814, outer right back contact of relay 809 to ground on conductor 715 but relay 813 being shunted does not operate. Upon the following deionizations of tubes 1014 and 1015 and the consequent release of relays 1022 and 1023 the outpulsing circuit is closed and relay 813 is permitted to operate in the locking circuit of relay 814. The operation of relay 813 now releases relays 811 and 812, counting relays 817 and 818 and relay 805, relay 805 reestablishing the outpulsing circuit through the windings of relays 802 and 803 and relay 812 shunting the contacts of impulsing relay 1022 to render them ineffective to transmit further impulses over the outpulsing circuit. The continued functioning of tubes 1014 and 1015 is now effective to measure a time delay interval of 0.6 second during which the second selector hunts for an idle trunk in the third bank level to which its brushes have been raised.

On the next ionization and deionization of the connection of ground to the lower control tubes 1014 and 1015 with relay 813 operated, relays 809 and 819 are operated and locked in the manner previously described. When relay 809 operates with relay 837 operated, a circuit is established from ground on conductor 715 over the inner left front contact of relay 809, front contact of relay 837 to a point between the winding of relay 838 and resistance 839 causing the shunting of relays 837 and 823 which now release. Relay 838 upon releasing connects ground from conductor 715 over its back contact, conductor 1028, inner lower front contact of relay 1013, lower front contact of relay 1009 to a point between the winding of relay 1010 and resistance 1012 thereby causing the release of relay 1010. With relay 1010 released, relay 1009 is held operated over the lower normal contacts of relay 1010 and the inner lower front contact of relay 1013 to ground on conductor 1028 and a circuit is established for operating steering relay 937. This circuit may be traced from battery, winding of relay 937, next-to-inner lower front contact of relay 936, conductor 952, upper back contact of relay 1010 to ground on conductor 715.

On the next ionization of tube 1015 and operation of relay 1023, with steering relay 937 operated, a circuit is established from ground on conductor 1030, contacts of relay 1023, conductor 1031, outer left front contact of relay 809, conductor 1037, lower back contacts of steering relays 938 to 942, inclusive, straps 958, 948 and 957, conductor 949, back contact of the No. 6' counting relay 823, winding of the No. 6 counting relay 824 to battery. Relay 824 operates and locks through the winding of relay 823, its own front contact, the outer right front contact of relay 809 to ground on conductor 715. On the deionization of tube 1015 and the release of relay 1023, relay 823 operates. In response to succeeding energizations and releases of relay 1023 under the control of tube 1015, counting relays 822, 821, 820 and 819 are successively operated and locked under the control of relay 809. Relay 819 upon operating opens the locking circuit of relays 813 to 816, inclusive, which now release. On the next energization of relay 1023 following the operation of counting relay 819, counting relay 818 operates followed by the operation of counting relay 817 upon the next release of relay 1023. Relay 817 upon operating with relay 809 operated, establishes the operating circuit of relay 838 which locks as before described in series with the winding of relay 837 and at its back contact removes ground from conductor 1028 thereby releasing relay 1009. Relay 817 upon operating with relay 809 operated also opens the locking circuit of relays 809 and 810 which then release in turn opening the locking circuits of the operated counting relays 817 to 824, inclusive, and removing the shunt from the winding of relay 837 which now operates. Relay 1009 upon releasing, opens the locking circuit of steering relay 936 which now releases and establishes a locking circuit for steering relay 937 extending from battery, winding and inner lower front contact of relay 937, conductor 943, inner normal contacts of relay 1009 to ground on conductor 715.

If the third digit has been registered at this time relay 1013 will not release upon the release of steering relay 936, but will be held operated over a circuit extending through its winding, conductor 944, the next-to-lower front contact of relay 937, upper front contact of transfer relay 915 to ground on conductor 715 and will maintain

the connection of ground to the lower control electrode of tube 1015. Ground will also be supplied to the lower control electrode of tube 1014 over conductor 945, the middle upper front contact of relay 937 and the inner lower front contact of transfer relay 915. Tubes 1014 and 1015 will therefore continue to ionize and deionize in alternation in the manner previously described. If the third digit has not been registered, relay 1013 will release following the release of relay 936 stopping the action of the tubes until the third digit has been registered.

With the third digit 7 registered and relays 915, 937 and 1013 operated, the tubes function in the manner described to cause the successive operation of relays 812 and 811 to absorb the first impulse generated by the operation of impulsing relay 1022 and to prepare the outpulsing circuit by the operation of relay 805. On the next ionization of tube 1014 following the operation of relays 805 and 811, relay 1022 operates to open the outpulsing circuit whereupon the connector 370 advances its brushes one step vertically in the well-known manner. Tube 1015 reionizes following the ionization of tube 1014, reoperating relay 1023 which now closes a circuit from ground as previously traced to conductor 1030, contacts of relay 1023, conductor 1031, left back contact of relay 809, left back contact of the No. 1' counting relay 813, front contact of relay 811, back contact of the No. 2' counting relay 815, conductor 835, inner upper back contacts of relay 935 and 936, inner upper front contact of relay 937, contact set 932, conductor 953, back contact of the No. 7' counting relay 825, winding of the No. 7 counting relay 826 to battery. Relay 826 operates and locks in a circuit through the winding of relay 825, front contact of relay 826, outer left front contact of relay 812, right back contact of the No. 1' counting relay 813 to ground on conductor 715. When tube 1015 reionizes, tube 1014 deionizes and releases relay 1022 to reclose the outpulsing circuit followed by the deionization of tube 1015 and the release of relay 1023. Relay 1023 upon releasing permits relay 825 to operate in the locking circuit of relay 826.

In response to successive ionizations and deionizations of tubes 1014 and 1015, relay 1022 operates and releases to transmit five further impulses over the outpulsing circuit and counting relays 824, 823, 822, 821, 820, 819, 818, 817, 816 and 815 operate and lock in response to the energizations and releases of relay 1023, all of these relays with the exception of relays 816 and 815 locking under the control of relays 812 and 813 and relays 816 and 815 locking in a circuit extending over the front contact of relay 816, the outer right back contact of relay 809 to ground on conductor 715. In response to the next ionization of tube 1014 and the operation of relay 1022, a seventh impulse is transmitted to the connector and in response to the next ionization of tube 1015 with counting relay 815 operated, a circuit is established from ground on conductor 1030 over the contacts of relay 1023, conductor 1031, left back contact of relay 809, left back contact of relay 813, front contact of relay 811, front contact of relay 815, winding of the No. 1 counting relay 814 to battery. Relay 814 operates and locks through its winding and the winding of relay 813, front contact of relay 814, outer right back contact of relay 809 to ground on conductor 715, but relay 813 being shunted does not operate. Upon the following deionizations of tubes 1014 and 1015 and the consequent release of relays 1022



and 1023, the outpulsing circuit is closed and relay 813 is permitted to operate. The operation of relay 813 now releases relays 811, 812, counting relays 817 to 826 inclusive and relay 805. Relay 805 reestablishes the outpulsing circuit through the windings of relays 802 and 803 and relay 812 shunts the contacts of impulsing relay 1022 to render them ineffective to transmit further impulses over the outpulsing circuit. The continued functioning of tubes 1014 and 1015 is now effective to measure a delay interval for enabling the connector to become conditioned to respond to a second series of impulses.

On the next ionization and deionization of tubes 1014 and 1015 with relay 813 operated, relays 809 and 810 are operated and locked in the manner previously described. When relay 809 operates with relay 837 operated, a circuit is established from ground on conductor 715 over the inner left front contact of relay 809, front contact of relay 837, to a point between the winding of relay 838 and resistance 839 causing the shunting of relays 837 and 838 which now release. Relay 838 upon releasing connects ground from conductor 715 over its back contact, conductor 1028, inner lower front contact of relay 1013, lower normal contacts and winding of relay 1010, resistance 1012 to battery and through the winding of relay 1009 and resistance 1011 to battery. Relay 1010 operates and locks over its lower alternate contact to ground on conductor 715, but the winding of relay 1009 being shunted so long as ground is connected to conductor 1028, does not operate. At its upper back contact, relay 1010 opens the initial energizing circuit of steering relay 937 and at its upper front contact establishes an operating circuit for steering relay 938 extending from battery, winding of relay 938, next to inner lower front contact of relay 937, conductor 946, upper front contact of relay 1010 to ground on conductor 715.

On the next ionization of tube 1015 and operation of relay 1023, with steering relay 938 operated, a circuit is established from ground on conductor 1030, contacts of relay 1023, conductor 1031, outer left front contact of relay 809, conductor 1037, lower back contacts of steering relays 939 to 942 inclusive, lower front contact of steering relay 938, conductor 954, inner left alternate contacts of class relay 1000, conductor 1033, right back contact of the No. 4' counting relay 819, winding of the No. 4 counting relay 820 to battery. Relay 820 operates and locks through the winding of relay 819, its own front contact, the outer right front contact of relay 809 to ground on conductor 715. On the deionization of tube 1015 and the release of relay 1023, relay 819 operates and at its left contact, opens the locking circuit of counting relays 813 to 816 inclusive, which now release. On the next energization of relay 1023, following the operation of counting relay 819, counting relay 818 operates followed by the operation of counting relay 817. Relay 817 upon operating with relay 809 operated establishes the operating circuit of relay 838 which locks as before described in series with the winding of relay 837 and at its back contact removes ground from conductor 1028 thereby permitting the operation of relay 1009. Relay 817 upon operating with relay 809 operated also opens the locking circuit of relays 809 and 810 which then release in turn opening the locking circuits of the operated counting relays 817 to 820 inclusive and removing the shunt from the winding of relay 837 which now operates. Relay 1009 upon oper-

ating opens the locking circuit of steering relay 937 which now releases and establishes a locking circuit for steering relay 938 which may be traced from battery, winding and inner lower front contact of relay 938, conductor 950, upper alternate contacts of relay 1009 to ground on conductor 715.

If the fourth digit has been registered at this time, relay 1013 will not release upon the release of steering relay 937, but will be held operated over a circuit extending through its winding, conductor 944, the next to lower front contact of relay 938, upper front contact of transfer relay 917, to ground on conductor 715 and will maintain the connection of ground to the lower control electrode of tube 1015. Ground will also be supplied to the lower control electrode of tube 1014 over conductor 945, the next to upper front contact of relay 938 and the inner lower front contact of transfer relay 917. Tubes 1014 and 1015 will therefore continue to ionize and deionize in alternation in the manner previously described. If the fourth digit has not been registered relay 1013 will release following the release of relay 937 stopping the action of the tubes until the fourth digit has been registered.

With the fourth digit 9 registered and relays 917, 938 and 1013 operated, the tubes function in the manner described to cause the successive operation of relays 812 and 811 to absorb the first impulse generated by the operation of impulsing relay 1022, and to prepare the outpulsing circuit by the operation of relay 805. On the next ionization of tube 1014 following the operation of relays 805 and 811, relay 1022 operates to open the outpulsing circuit whereupon connector 370 advances its brushes one step in a rotary direction over the terminals of the seventh level to which they were previously raised. Tube 1015 reionizes following the ionization of tube 1014, reoperating relay 1023, which now closes a circuit from ground as previously traced to conductor 1030, contacts of relay 1023, conductor 1031, left back contact of relay 809, left back contact of the No. 1' counting relay 813, front contact of relay 811, back contact of the No. 2' counting relay 815, conductor 835, inner upper back contacts of steering relays 935, 936 and 937, inner upper front contact of steering relay 938, contact set 934, conductor 955, back contact of the No. 9' counting relay 829 to battery through the winding of the No. 9 counting relay 830. Relay 830 operates and establishes a circuit through the winding of relay 829, front contact of relay 830, outer left front contact of relay 812, right back contact of the No. 1' counting relay 813 to ground on conductor 715. When tube 1015 reionizes, tube 1014 deionizes and releases relay 1022 to reclose the outpulsing circuit followed by the deionization of tube 1015 and the release of relay 1023. Relay 1023 upon releasing permits relay 829 to operate in the locking circuit of relay 830.

In response to successive ionizations and deionizations of tubes 1014 and 1015, relay 1022 opens and closes the outpulsing circuit to transmit seven further impulses and counting relays 828, 827, 826, 825, 824, 823, 822, 821, 820, 819, 818, 817, 816, and 815 operate and lock in response to the energizations and releases of relay 1023. All of these relays with the exception of relays 816 and 815 locking under the control of relays 812 and 813 and relays 816 and 815 locking in a circuit extending over the front contact of relay 816, the outer right back contact of relay 809 to ground on conductor 715. In response to the next ionization of tube

1014 and the operation of relay 1022, a ninth impulse is transmitted to the connector and in response to the next ionization of tube 1015, with counting relay 815 operated, a circuit is established from ground on conductor 1030 over the contacts of relay 1023, conductor 1031, left back contact of relay 809, left back contact of relay 813, front contact of relay 811, front contact of relay 815, winding of the No. 1 counting relay 814 to battery. Relay 814 operates and locks through its winding and the winding of relay 813, front contact of relay 814, outer right back contact of relay 809 to ground on conductor 715, but relay 813 being shunted does not operate. Upon the following deionizations of tubes 1014 and 1015 and the consequent release of relays 1022 and 1023, the outpulsing circuit is closed and relay 813 is permitted to operate. The operation of relay 813 now releases relays 811 and 812, counting relays 817 to 830 inclusive, and relay 805, relay 805 re-establishing the outpulsing circuit through the windings of relays 802 and 803 and relay 812 shunting the contacts of impulsing relay 1022 to render them ineffective to transmit further impulses over the outpulsing circuit.

Since the class relay 1000 has been operated and strap 1034 is connected to indicate that only a four digit number has been registered, when relay 813 operates, a circuit is established from battery, winding of relay 736, conductor 738, strap 1034, outer right front contact of class relay 1000, conductor 956 strapped to the upper front contact of relay 938, upper front contact of relay 938, lower back contact of transfer relay 919, front contacts of transfer relays 917, 915 and 913, conductor 840 to ground at the right front contact of relay 813. The tubes 1014 and 1015 continue to function, but since relay 736 upon operating opens the circuit previously traced over which ground was supplied to conductor 1030, the operation and release of relay 1023 under the control of tube 1015 is without effect.

When reversed battery is received from the selector 360, which may be of the well-known toll transmission type, as an indication that the subscriber's line 300 has been seized, relay 802 operates over the impulsing loop in turn closing a circuit from battery, winding of relay 735, outer left front contact of relay 729, conductor 806, contacts of relay 802, conductor 807, conductor 714 to ground. Relay 735 operates and locks over its own left front contact to ground on conductor 714, closes a circuit from ground at the upper front contact of relay 1013, over conductor 1029, right front contact of relay 735, conductor 739, windings of relays 809 and 810 in series to battery, and closes a circuit from battery, winding of ringing relay 804, conductor 841, inner right back contact of relay 740, outer right front contact of relay 733, left front contact of relay 735 to ground on conductor 714. The operation of relay 804 applies ringing current from the source 842 to the outpulsing circuit and thence to the called line and connects ground from the upper front contact of relay 1013 over conductor 1029, inner right contact of relay 804 to conductor 1030 to render relay 1023 effective to count time during which ringing current is applied to the called line.

Relay 809 upon operating connects ground from conductor 715 over its inner left front contact, the front contact of relay 837 to a point between the winding of relay 838 and resistance 839 thereby shunting the windings of relays 837 and 838

which relays now release connecting ground to conductor 1028 and thereby shunting down relay 1010. Relay 1010 upon releasing opens at its upper front contact the initial operating circuit of relay 938 and at its upper back contact establishes an operating circuit for steering relay 939 which extends from battery winding of relay 939, next to inner lower front contact of relay 938, conductor 952, back contact of relay 1010 to ground on conductor 715. On the next ionization of tube 1015 and operation of relay 1023 with steering relay 938 operated, a circuit is established from ground on conductor 1030, contacts of relay 1023, conductor 1031, outer left front contact of relay 809, conductor 1037, lower back contacts of steering relays 940 to 942 inclusive, lower front contact of steering relay 939, conductor 968, inner left normal contacts of class relay 1002, conductor 949, right back contact of the No. 6 counting relay 823, winding of the No. 6 counting relay 824 to battery. Relay 824 operates and locks through the winding of relay 823, its own front contact, the outer right front contact of relay 809 to ground on conductor 715. On the deionization of tube 1015 and the release of relay 1023, relay 823 operates. In response to further operations and releases of relay 1023, counting relays 822, 821, 820 and 819 are operated and when relay 819 operates it opens at its left contacts the locking circuit of counting relays 813 to 816 inclusive, which now release. On the next energization of relay 1023, following the operation of counting relay 819, counting relay 818 operates followed by the operation of counting relay 817. Relay 817 upon operating with relay 809 operated causes the reoperation of relay 838 as previously described and the release of relay 1009. Relay 1009 upon releasing opens the locking circuit of steering relay 938 which now releases and closes the locking circuit of steering relay 939. Since the transfer relay 919 is not operated, relay 1013 releases stopping the functioning of the tubes 1014 and 1015.

When counting relay 813 releases it opens the operating circuit of relay 736 which in turn opens the circuit of ringing relay 804 to terminate ringing. With relay 1013 released, ground is removed from conductor 1029 thus releasing relays 809 and 810 in turn releasing counting relays 817 to 824 inclusive and permitting the operation of relay 837 in the locking circuit of relay 838. At its left back contact, relay 736 establishes a circuit for relay 706 extending from battery, winding of relay 706, outer left front contact of relay 733, left back contact of relay 736, outer left front contact of relay 735 to ground on conductor 714. Relay 706 operates and locks over its inner left front contact to ground on conductor 713 and at its outer right back contact opens a shunt of the right high resistance winding of relay 703, which extends from ground, right winding of relay 703, conductor 704, normal contacts of relay 800, conductor 705 to ground at the outer right back contact of relay 706. The current now flowing through the windings of relays 703, over conductor 527, brush 526, upper contact of relay 512 to battery through the windings of relays 524 and 525 at the link circuit is reduced to such extent that relay 525 releases in turn releasing relays 511 and 536. Relay 511 releases relay 503 and relay 536 releases relay 512.

With relays 503 and 512 released a circuit is now closed for release magnet 421 of trunk finder 450 which may be traced from battery through

the winding of magnet 421, the intermediate springs of off-normal contact 409, conductor 422, the intermediate upper contacts of relay 500, the upper back contacts of relay 507, the innermost lower back contact of relay 512 to ground at the lower back contact of relay 503. Magnet 421 upon energizing releases finder 450 to normal, whereupon the off-normal contacts 409 are opened, releasing magnet 421 and relay 500. All operated apparatus of the link circuit, with the exception of sender-finder 550, has been restored to normal. Finder 550, being of the non-restoring type, remains in the position into which it was last set and starts from that position to hunt for an idle sender on the next call. Upon the release of relay 512 the previously traced circuit through the winding of relay 703 of the sender is opened and relay 703 releases in turn releasing relays 700, 707 and 801. With these relays released off-normal ground is removed at the sender and all other operated relays of the sender release.

When relay 525 of the link circuit releases, it opens the previously traced holding circuit of relay 366 which now releases and with relays 303 and 304 both operated, establishes a circuit from battery, winding of relay 308, upper front contact of relay 304, lower back contact of relay 306, inner upper front contact of relay 303 to ground. Relay 308 operates and establishes a holding bridge extending over the upper back contact of relay 322, upper right winding of repeating coil 323, winding of relay 324, lower right winding of repeating coil 323, middle lower front contact of relay 308, over the lower back contact of relay 322, for holding the operated selector switches, connects battery through resistance 324 over its upper front contact, the upper winding of sleeve relay 302 to make the trunk circuit test busy while the operator changes cord circuits, if necessary, and establishes over its inner lower front contact an obvious operating circuit for relay 321. Relay 321 upon operating disconnects the conductors 313, 315, 317 and 318 from the tip and ring conductors of the trunk circuit and completes the speech transmission circuit from the cord circuit to the selector switch 350.

With relay 308 operated a circuit is established from ground at the back contact of relay 324, inner upper front contact of relay 308 through the windings of relay 302 to ground thus shunting the high resistance winding of relay 302. Marginal relay 127 of the cord circuit now operates shunting the high resistance 129 by a low resistance 132 and causing supervisory lamp 131 to light in a circuit from battery, lamp 131, middle lower right alternate contact of key 102, conductor 130, resistance 132, front contact of relay 127 to ground or if the key 102 has been restored, the lamp 131 is lighted in a circuit from ground on the sleeve contact of plug 124, inner lower right normal contact of key 102, lamp 131 to battery. When the called subscriber answers relay 324 operates removing the shunting ground from the high resistance winding of trunk sleeve relay 302, thereby releasing cord relay 127 to extinguish the lamp 131 or if the key 102 has been restored, extinguishing the lamp 131 by the inclusion of the high resistance winding of relay 302 in the circuit thereof. The circuits are now in condition for conversation. Inasmuch as the present invention is not directly concerned with the supervisory features of the cord circuit and the manner in which the established connection is released, no description thereof is deemed necessary.

*Call to a subscriber's line requiring the keying and transmission of five digits without immediate ringing from the sender*

It will now be assumed that the connection is to be completed from an operator's position to a subscriber's line requiring the setting of three selector switches and a connector and that no immediate ringing is to be applied from the sender. In this case the operator will plug into a trunk similar to that disclosed in Fig. 3 with the exception that straps 309 to 312, inclusive, will be connected as shown in Fig. 3C and the trunk will terminate in a first selector of the well-known Strowger type. When the operator plugs into the trunk an idle sender is seized and the sender register is associated with the operator's key-set over the key-set connector switch 650 in the manner previously described. With the strapping as shown in Fig. 3C relays 727 and 802 operate, relay 802 in turn causing the operation of relay 728 over a circuit extending from ground on conductor 807, front contact of relay 802, conductor 806, right back contact of relay 729, winding of relay 728 to battery. Relay 728 operates and locks over its outer right front contact to ground on conductor 714. With relays 727 and 728 operated, class relay 1002 is operated indicating that a five digit number is to be keyed. In the manner previously described the operator is given a signal by the lighting of lamp 226 when the sender is ready to register the digits of the wanted line number and she then proceeds to key the digits which in this case will be assumed to be 13792, by depressing keys 228, 229, 230, 231 and 241 in the order named.

The first four digits are registered in the manner previously described, transfer relay 917 of the sender operating upon the release of key 231 when the fourth digit has been registered. In response to the depression of key 241 for the fifth and last digit 2, a circuit is established from ground on conductor 232, left contacts of key 241, conductor 242, next to lowermost contact of contact set 607, conductor 613, winding of horizontal magnet 902 to battery. Magnet 902 upon operating rotates the No. 2 horizontal bar of switch 910 and closes a circuit from ground over its front contact, the inner upper front contacts of transfer relays 911, 913, 915 and 917, inner upper back contact of transfer relay 919, lower normal contacts and winding of vertical magnet 920 to battery. Magnet 920 operates, locks over its lower alternate contacts to ground on conductor 715, connects ground from conductor 715 over its upper front contact through the winding of transfer relay 919 and resistance 960 to battery, and rotates the fifth vertical bar of switch 910. Relay 919 does not operate at this time since its winding is shunted by ground applied over the front contact of magnet 902, the inner upper front contacts of relays 911, 913, 915 and 917 and the inner upper back contact of relay 919 to a point between the winding of relay 919 and resistance 960. With the No. 2 horizontal bar and the fifth vertical bar of switch 910 both operated, the contact set 961 is operated and held operated under the control of magnet 920 after magnet 902 releases to return the operated horizontal bar to normal when the operated key 241 is released. When magnet 902 releases, the shunting ground is removed from the winding of transfer relay 919 and it now operates.

Since it was assumed that class relay 1002 was operated indicating a call of a five digit fixed

class, when transfer relay 919 operates a circuit is established from ground on conductor 715, outer left front contact of class relay 1002, conductor 959, lower front contact of transfer relay 919, conductor 742, winding of relay 722 to battery. Relay 722 operates and in the manner previously described the operator's key-set circuit is disconnected from the cord circuit and relays 731 and 733 of the sender are operated. The sender now proceeds to transmit impulses in accordance with the first three digit registrations to set selector switches in the manner previously described, except that following the transmission of the third digit 7 at which time steering relay 938 is operated, a 0.6 second time interval is counted since class relay 1000 is not operated. The circuit controlled by impulse counting relay 1023 in this case extends from ground on conductor 1030, contacts of relay 1023, conductor 1031, outer left front contact of relay 809, conductor 1037, lower back contacts of steering relays 939 to 942 inclusive, lower front contact of steering relay 938, conductor 954, inner left back contact of class relay 1000, conductor 949, back contact of the No. 6' counting relay 823, winding of the No. 6 counting relay 824 to battery. Following the termination of the timing interval relay 1009 operates, opening the locking circuit of steering relay 937, which relay releases, and closing the locking circuit of steering relay 938. Impulses in accordance with the fourth registered digit are then transmitted. Following this a 0.4 second delay interval is measured.

At the beginning of the measurement of this interval, relays 809 and 810 are operated. Relay 809 upon operating causes the shunting down of relays 837 and 838 and the consequent release of relay 1010 in the manner previously described. Relay 1010 upon releasing opens the initial operating circuit of steering relay 938 and closes the operating circuit of steering relay 939 which may be traced from battery through the winding of relay 939, next-to-inner lower front contact of steering relay 938, conductor 952, upper back contact of relay 1010 to ground on conductor 715. The circuit over which the counting relays are controlled for measuring the time interval, with class relay 1002 operated, may now be traced from ground on conductor 1030, contacts of relay 1023, conductor 1031, outer left front contact of relay 809, conductor 1037, lower back contacts of steering relays 940 to 942 inclusive, lower front contact of steering relay 939, conductor 958, inner left alternate contacts of class relay 1002, conductor 1033, right back contact of the No. 4' counting relay 819 to battery through the winding of the No. 4 counting relay 820. At the end of this timing interval relays 809 and 810 become released in turn operating relays 837 and 838, relay 838 upon operating causing the release of relay 1009. With relay 1009 released the steering relay 938 is released and a locking circuit is established for steering relay 939.

If the fifth digit has been registered the sender proceeds to transmit and count impulses in the manner described except that the counting relay control circuit now extends from ground on conductor 1030, contacts of relay 1023, conductor 1031, left back contact of relay 809, left back contact of relay 813, right front contact of relay 811, back contact of relay 815, conductor 935, inner upper front contacts of steering relays 935 to 938 inclusive, inner upper front contact of steering relay 939, contacts set 961, conductor 962, winding of the No. 2 counting relay 816 to battery.

After two impulses have been transmitted for the fifth digit 2, relays 813 and 814 will have operated, relay 813 in operating releasing relays 811 and 812 and relay 805 to perform the functions previously described.

Since class relay 1002 has been operated to indicate that only a five digit number has been registered and to indicate that immediate ringing is not necessary, when relay 813 operates a circuit is established from ground on conductor 715, right front contact of relay 813, conductor 840, front contacts of transfer relays 913, 915, 917 and 919, lower back contact of transfer relay 921, upper front contact of steering relay 939, strapped to conductor 963, strap 1042, outer right front contact of class relay 1002, strap 1038, conductor 1039, outer left front contact of relay 733, winding of relay 706 to battery. Relay 706 operates and from this point the circuits function as described, the link circuit releasing, the operated relays of the sender releasing and the cut through relays 308 and 321 of the trunk circuit operating to cut through a talking circuit from the trunk jack to the first selector.

#### *Establishment of connections in variable class D*

It will be assumed that the operator upon answering the call is informed by the calling subscriber that a connection is required involving the keying of a one digit number and that the operator therefore plugs the cord circuit plug 124 into the jack of a trunk circuit similar to Fig. 3 but with the straps 309 to 312 inclusive connected as shown in Fig. 3D. When the trunk is seized an idle sender is associated therewith and with the strapping as shown in Fig. 3D relays 726 and 802 operate, relay 802 in turn causing the operation of relay 728. With relays 726 and 728 operated, the class relay 1003 is operated indicating that the trunk seized belongs in a group over which calls requiring the setting of a variable number of selectors may be established and that immediate ringing may or may not be required. In the manner previously described, the operator is given a signal by the lighting of lamp 226 when the sender is ready to register the digits of a wanted line number and she then proceeds to key the digit.

It being assumed that the operator keys a single digit 0, the operation and release of the digit key results in the operation of horizontal magnet 900, vertical magnet 912, transfer relay 911, steering relays 935 and 936 and relays 1013 and 1010 as previously described. The operation of magnets 900 and 912 cause the closure of cross-point contacts 964. The sender now proceeds to transmit a series of ten impulses in the manner described, the impulse counting relay 1023 starting the counting of impulses by first operating the No. 0 counting relay 832 in a circuit which may be traced from ground on conductor 1030, contacts of relay 1023, conductor 1031, left back contact of relay 809, left back contact of relay 813, right front contact of relay 811, back contact of relay 815, conductor 935, inner upper front contact of steering relay 935, contacts 964, conductor 965, back contact of the No. 0' counting relay 831, winding of the No. 0 counting relay 832 to battery. In response to the repeated operation and release of relay 1023, the counting relays are successively operated until the No. 1' counting relay 813 is operated when ten impulses will have been transmitted.

Having keyed the single digit of the wanted line number, the operator depresses the start key 243, 75

establishing a circuit from ground on conductor 232, contacts of key 243, conductor 244, upper contacts of contact set 606, conductor 614, winding of relay 1027 to battery. Relay 1027 operates and locks over its inner left front contact to ground on conductor 715 and, at its outer left front contact connects ground to conductor 742 thereby operating relay 722. Relay 722 upon operating dismisses the key-set from the cord circuit and since straps 314 and 316 of Fig. 3D have been connected to reverse the conductors 314 and 316 with respect to conductors 313 and 315, with relay 726 operated relays 731 and 733 are operated.

When relay 813 operates with class relay 1003 and relay 1027 both operated, a circuit is established from ground on conductor 715, right front contact of relay 813, conductor 840, next-to-lower back contact of transfer relay 913, upper front contact of steering relay 935 strapped to conductor 966, inner right contact of relay 1027, conductor 1035, strap 1040, inner right contact of class relay 1003, strap 1041, conductor 1039, outer left front contact of relay 733, winding of relay 706 to battery. Relay 706 upon operating functions to release the sender and link circuit and to cause the trunk circuit to cut through the talking connection immediately without waiting for the application of ringing current from the sender.

It will now be assumed that the operator keys two digits instead of one and then operates start key 243. In this case in response to the keying of the two digits, two horizontal magnets of the register switch 910 are successively operated and released and the vertical magnets 912 and 914, transfer relays 911 and 913, steering relays 935 and 936 and relays 1013, 1010 are all operated and remain operated upon the termination of keying, and the start relay 1027 is operated by the operation of the start key 243 in turn operating relay 722. Relay 722 functions in the manner previously described.

The first series of impulses is then transmitted and counted in accordance with the value of the first digit keyed as determined by the operated contact set of the first vertical row of register switch 910 in the manner previously described. After the transmission of the first series of impulses, a 0.6 second interval is counted as previously described. The circuit for controlling the counting relays for counting this interval extending in this case from ground on conductor 1030, contacts of relay 1023, conductor 1031, outer left front contact of relay 809, conductor 1037, lower back contacts of steering relays 937 to 942, inclusive, straps 948 and 957, conductor 949, right back contact of the No. 6' counting relay 823 to battery through the winding of the No. 6 counting relay 824.

After the transmission of the first series of impulses, steering relay 935 is released and steering relay 936 is locked. The second series of impulses is then transmitted in accordance with the value of the second digit keyed as determined by the operated contact set of the second vertical row of register switch 910 in the manner previously described. When the No. 1' counting relay 813 operates, when the last impulse of the second series has been transmitted, with start relay 1027 and class relay 1003 both operated, a circuit is established from ground on conductor 715, right front contact of relay 813, conductor 840, middle lower front contact of transfer relay 913, lower back contact of transfer relay 915, up-

per front contact of steering relay 936 strapped to conductor 966, inner right contact of relay 1027, conductor 1035, strap 1040, inner right contact of class relay 1003, strap 1041, conductor 1039, outer left front contact of relay 733, winding of relay 706 to battery. Relay 706 upon operating functions to release the sender and link circuit and to cut through the talking connection immediately without waiting for the application of ringing current from the sender.

Should the operator key a six digit number and then depress start key 243, six horizontal magnets of the register switch 910 will be successively operated and released and the vertical magnets 912, 914, 916, 918, 920 and 922, transfer relays 911, 913, 915, 917, 919 and 921, steering relays 935 and 936 and relays 1013, 1010, 1027 and 722 will be operated and will function in the manner previously described.

The first two series of impulses in accordance with the digit registrations are then transmitted and a 0.6 second delay interval is measured after the transmission of each series. The third series of impulses is then transmitted following which a 0.6 second delay interval is measured. The circuit for controlling the counting relays for counting this interval extends from ground on conductor 1030, contacts of relays 1023, conductor 1031, outer left front contact of relay 809, conductor 1037, lower back contacts of steering relays 939 to 942 inclusive, lower front contact of steering relay 938, conductor 954, left normal contacts of class relay 1000, conductor 949, right back contact of the No. 6' counting relay 823 to battery through the winding of the No. 6 counting relay 824. Following the measurement of this delay interval, the fourth series of impulses is transmitted and a further delay interval of 0.6 seconds is measured. The circuit for controlling the counting relays extends at this time from ground on conductor 1030, contacts of relay 1023, conductor 1031, outer left front contact of relay 809, conductor 1037, lower back contacts of steering relays 940 to 942 inclusive, lower front contact of steering relay 939, conductor 966, left normal contacts of class relay 1002, conductor 949 and thence as traced to battery through the winding of the No. 6 counting relay 824. Following the measurement of this delay interval, the fifth series of impulses is transmitted and a further delay interval of .6 second is measured. The circuit for controlling the counting relays extends at this time from ground as traced to conductor 1037, lower back contacts of steering relays 942 and 941, lower front contact of steering relay 940, conductor 949 and thence as traced to battery through the winding of the No. 6 counting relay 824. The sixth and last series of impulses is then transmitted.

When the No. 1' counting relay 813 operates after the last impulse of the sixth series has been transmitted, with start relay 1027 and class relay 1003 both operated, a circuit is established from ground on conductor 715, right front contact of relay 813, conductor 840, front contacts of transfer relays 913, 915, 917, 919 and 921, lower back contact of transfer relay 923, upper front contact of steering relay 940, strapped to conductor 966, inner right contact of relay 1027, conductor 1035, strap 1040, inner right contact of class relay 1003, strap 1041, conductor 1039, outer left front contact of relay 733, winding of relay 706, to battery. Relay 706 upon operating functions to release the sender and link circuit and to cut through the talking connection imme-



diately without waiting for the application of ringing current from the sender.

Should the operator key a seven digit number and depress start key 243, seven horizontal magnets of the register switch 910 will be successively operated and released and the vertical magnets 912, 914, 916, 918, 920, 922 and 924, transfer relays 911, 913, 915, 917, 919, 921 and 923, steering relays 935 and 936 and relays 1013, 1010, 1027 and 722 are all operated and function in the manner previously described.

The first five series of impulses in accordance with the digit registrations are then transmitted and a 0.6 second delay interval is measured after the transmission of each series in the manner previously described. The sixth series of impulses is then transmitted following which a 0.6 second delay interval is measured, the circuit for controlling the counting relays extending as traced from conductor 1037, lower back contacts of steering relay 942, strap 969, lower front contact of steering relay 940, conductor 949 and thence as traced to battery through the winding of the No. 6 counting relay 824. The seventh and last series of impulses is then transmitted.

When the No. 1' counting relay 813 operates after the last impulse of the seventh series has been transmitted, with start relay 1027 and class relay 1003 both operated, a circuit is established from ground on conductor 715, right front contact of relay 813, conductor 840, front contacts of transfer relays 913, 915, 917, 919, 921 and 923, lower back contact of transfer relay 925, upper front contact of steering relay 941, strapped to conductor 966, inner right front contact of relay 1027, conductor 1035, strap 1040, inner right front contact of class relay 1003, strap 1041, conductor 1039, outer left front contact of relay 733, winding of relay 706 to battery. Relay 706 upon operating functions to release the sender and link circuit and to cut through the talking connection immediately without waiting for the application of ringing current from the sender.

Should the operator key an eight digit number, the maximum which the sender is arranged to register, the depression of the start key 243 being unnecessary in this case, eight horizontal magnets of the register switch 910 are successively operated and released. The vertical magnets and transfer relays are all operated, and the steering relays 935 and 936 and relays 1013 and 1010 are operated in the manner previously described. Transfer relay 925 which operates following the keying of the last digit, connects ground over its inner lower front contact to conductor 742 for operating relay 722 which functions in the manner described. The first six series of impulses in accordance with the digit registrations are then transmitted and a 0.6 second delay interval is measured after the transmission of each series in the manner described. The seventh series is then transmitted following which a 0.4 second delay interval is measured, the circuit for controlling the counting relays, extending as traced to conductor 1037, lower front contact of steering relay 942, conductor 970, left alternate contacts of class relay 1003, conductor 1033, right back contact of the No. 4' counting relay 819, to battery through the No. 4 counting relay 820. The eighth and last series of impulses is then transmitted.

When the No. 1' counting relay 813 operates after the last impulse of the eighth series has been transmitted with class relay 1003 operated, a circuit is established from ground on conductor

715, right front contact of relay 813, conductor 840, front contacts of all transfer relays, upper front contact of steering relay 942 strapped to conductor 971, conductor 1035, strap 1040, inner right front contact of class relay 1003, strap 1041, conductor 1039, outer left front contact of relay 733, winding of relay 706 to battery. Relay 706 upon operating functions to release the sender and link circuit and to cut through the talking connection immediately without waiting for the application of ringing current from the sender.

Should an inward toll operator plug into the trunk jack and key a three digit number with class relay 1003 operated, and then depress start key 243, three horizontal magnets of switch 910 will be successively operated and released. The vertical magnets 912, 914 and 916, transfer relays 911, 913 and 915, steering relays 935 and 936 and relays 1013, 1010, 1027 and 722 are all operated and function in the manner previously described. In this case relays 731 and 733 are operated from the key-set circuit as previously described to indicate that the call has come from an inward toll operator's position. The first two series of impulses are transmitted and a .6 second delay interval is measured after each impulse series in the manner previously described. The third and last impulse series is then transmitted.

When the No. 1' counting relay 813 operates after the last impulse of the third series has been transmitted with start relay 1027 and class relay 1003 both operated, a circuit is established from ground on conductor 715, right front contact of relay 813, conductor 840, front contacts of transfer relays 913 and 915, lower back contact of transfer relay 917, upper front contact of steering relay 937, strapped to conductor 967, outer right contact of relay 1027, conductor 1043, strap 1044, outer right contact of class relay 1003, strap 1045, conductor 738, winding of relay 736 to battery. From this point the sender functions to transmit current from the ringing source 842, to measure off a predetermined interval during which ringing current is applied, after which relay 706 operates to cause the release of the sender and link circuit and to cut through the trunk circuit as previously described in connection with the first call discussed.

Should the toll operator key a four digit number followed by the operation of start key 243, the circuits will function to transmit impulses as previously described in connection with the first call discussed except that since class relay 1000 is not at this time operated, a 0.6 second interval will be counted after the transmission of the third series of impulses. The counting relay control circuit extends in this case from ground applied to conductor 1037, lower back contacts of steering relays 939 to 942 inclusive, lower front contact of steering relay 938, conductor 954, left normal contacts of class relay 1000, conductor 959, thence as traced to battery through the winding of the No. 6 counting relay 824. During the transmission of the fourth impulse series, at which time the steering relay 938, is operated, when the No. 1' counting relay 813 operates, a circuit is established from ground, right front contact of relay 813, conductor 840, front contacts of transfer relays 913, 915, and 917, lower back contact of transfer relay 919, upper front contact of steering relay 938, strapped to conductor 967, outer right front contact of relay 1027, conductor 1043, thence as traced to battery through the winding of relay 736. From this point the sender functions to transmit current