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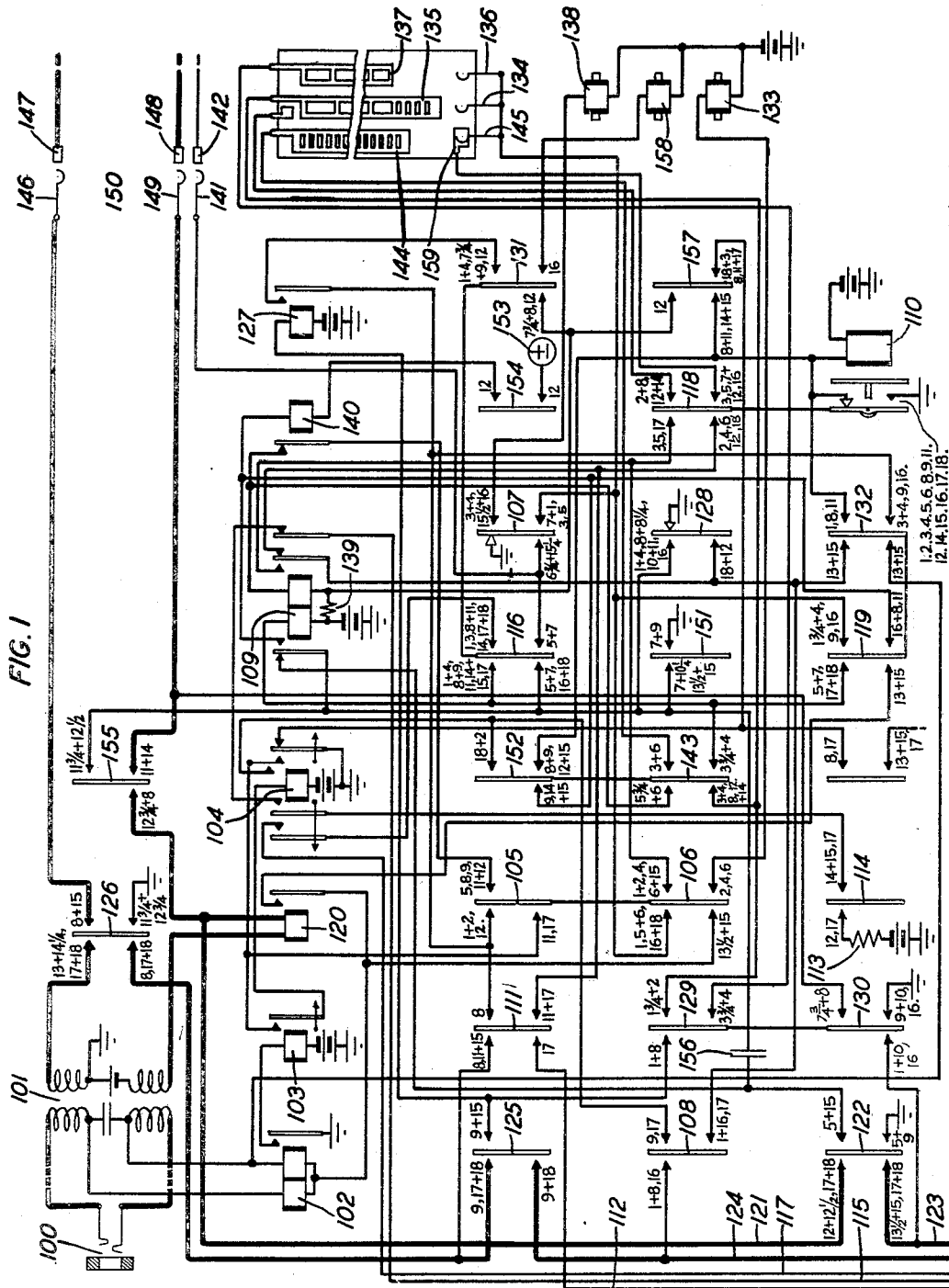
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1,930,255

TELEPHONE SYSTEM

Filed April 27, 1932

11 Sheets-Sheet 1



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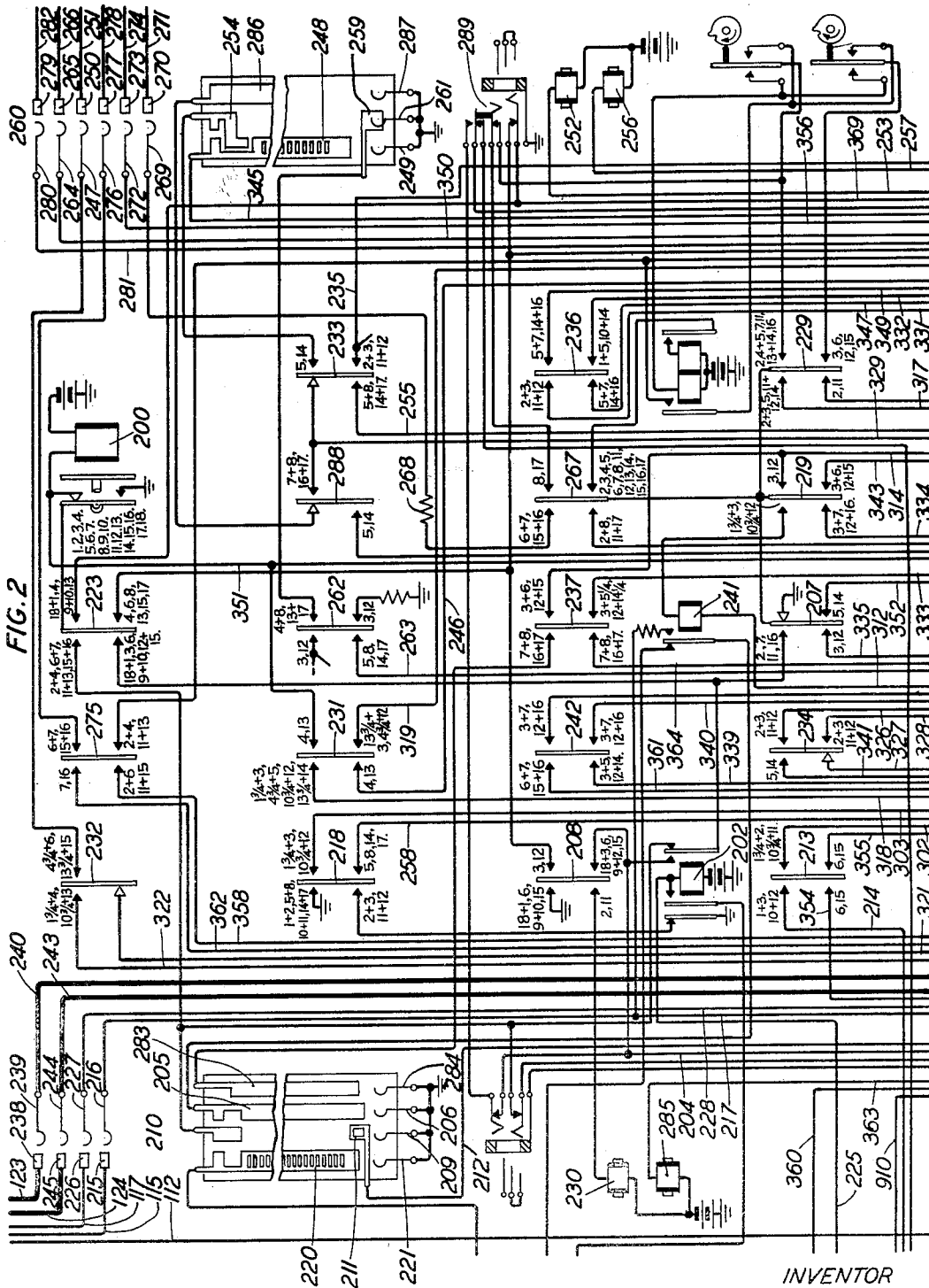
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11 Sheets-Sheet 2



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11 Sheets-Sheet 3

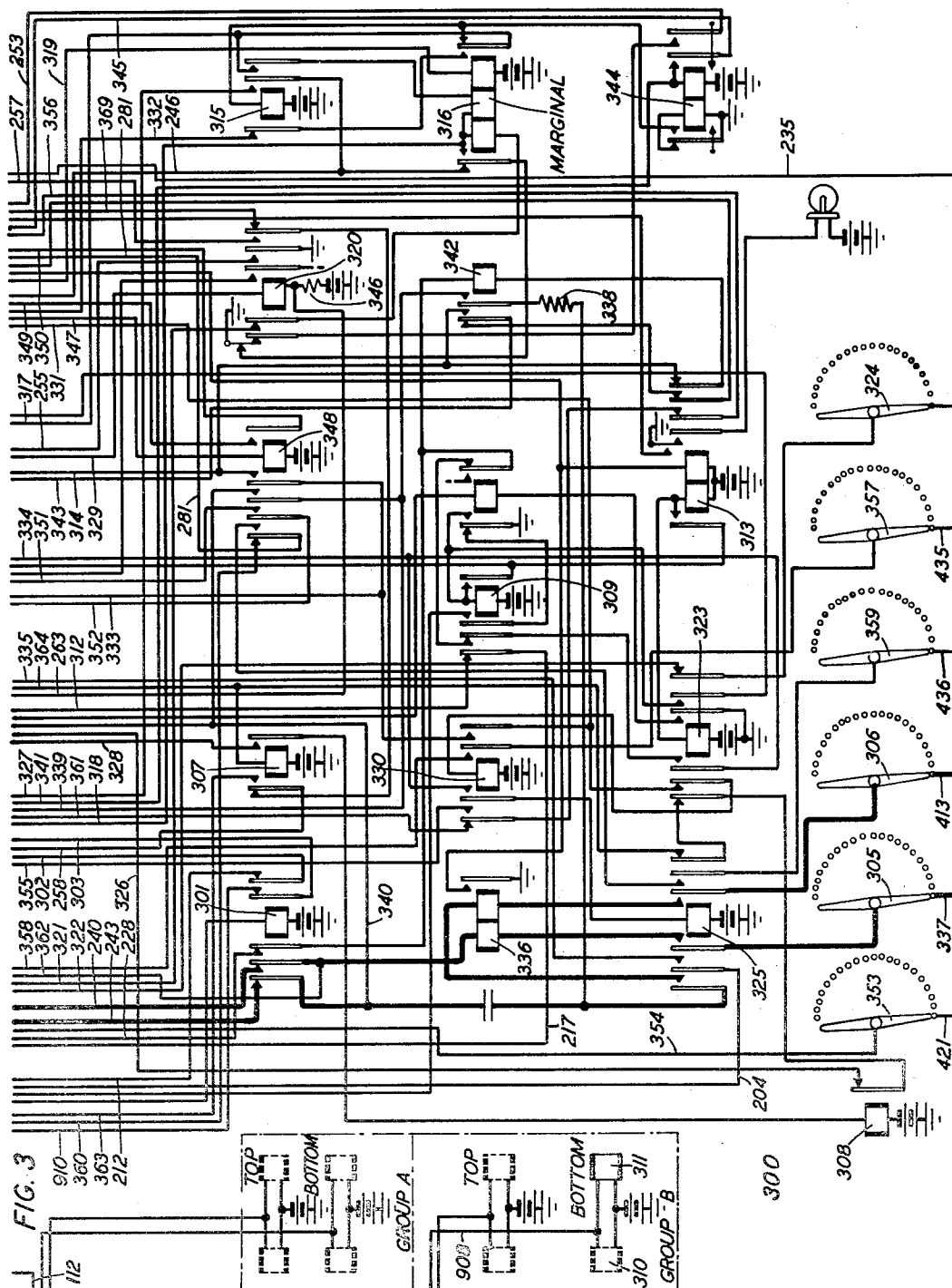


FIG. 3

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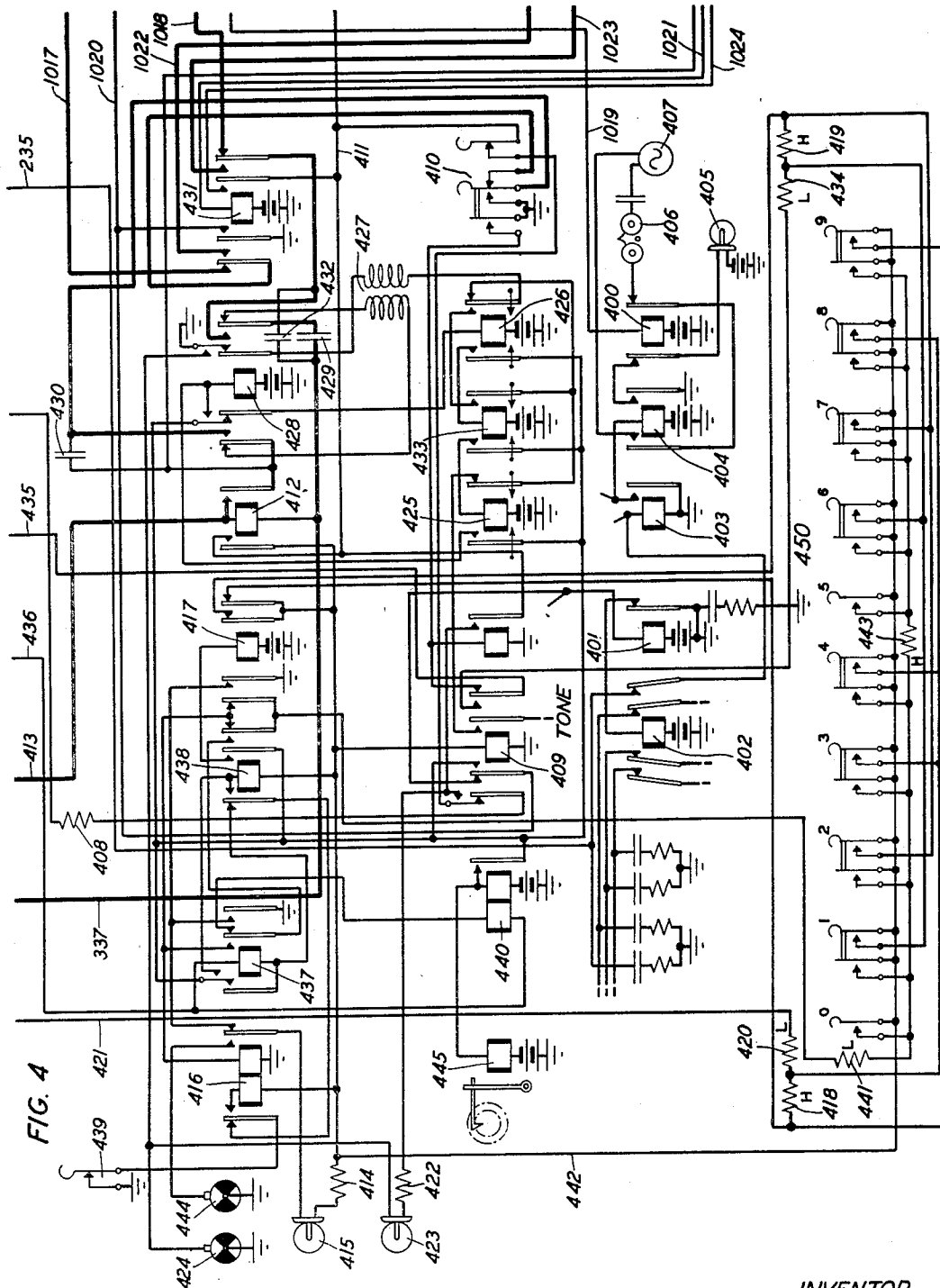
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11 Sheets-Sheet 4



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11 Sheets-Sheet 5

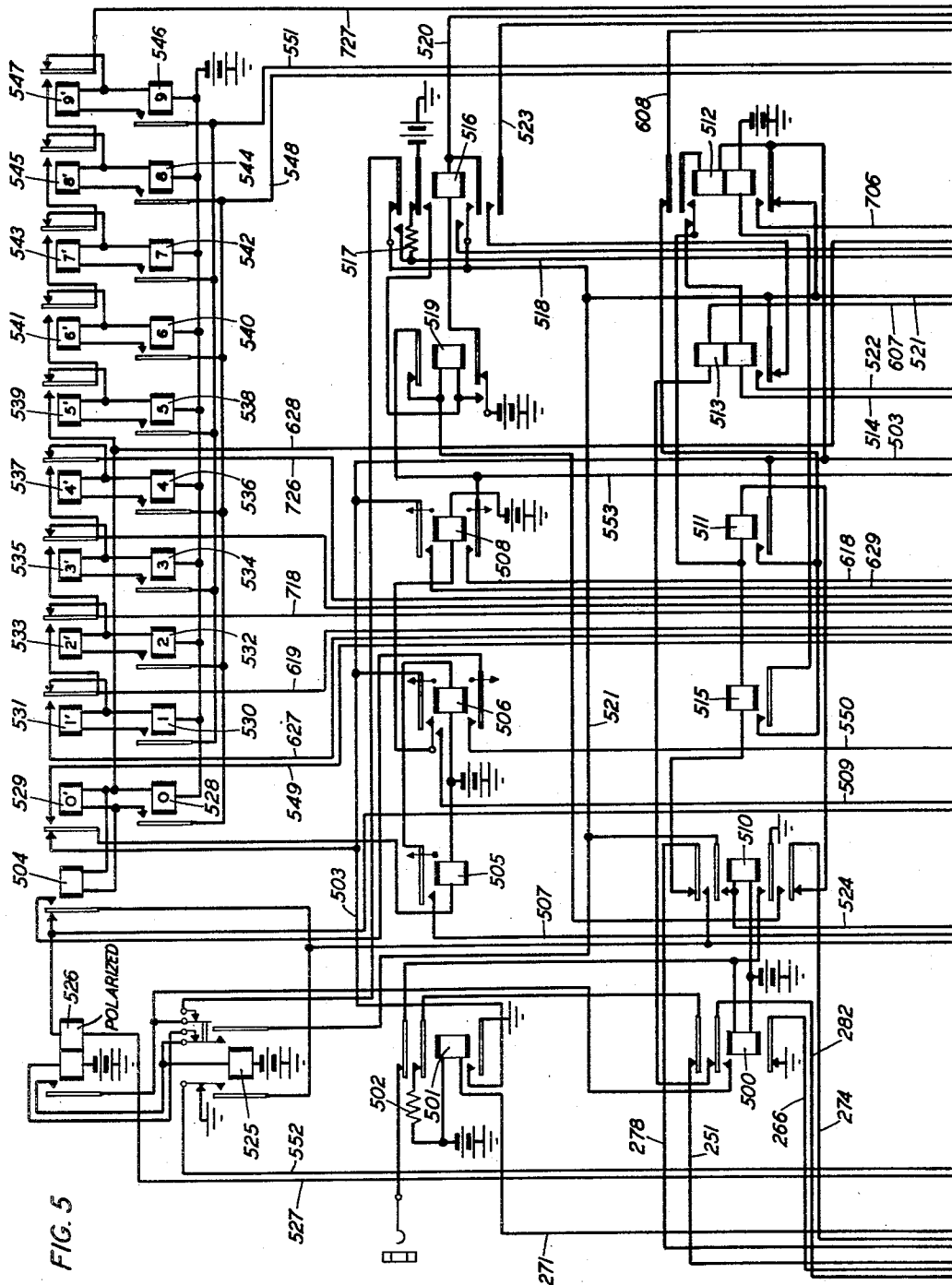


FIG. 5

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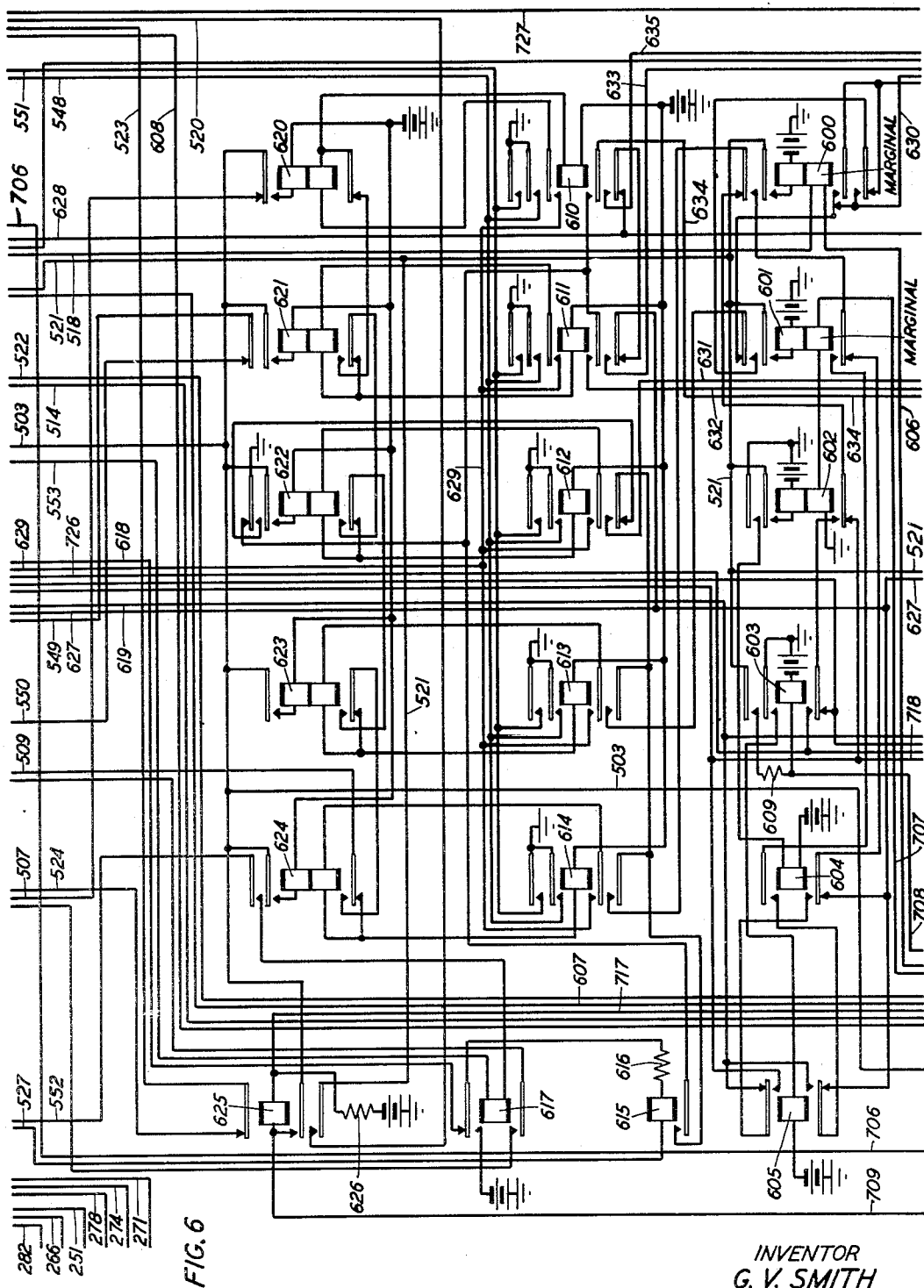
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11 Sheets-Sheet 6



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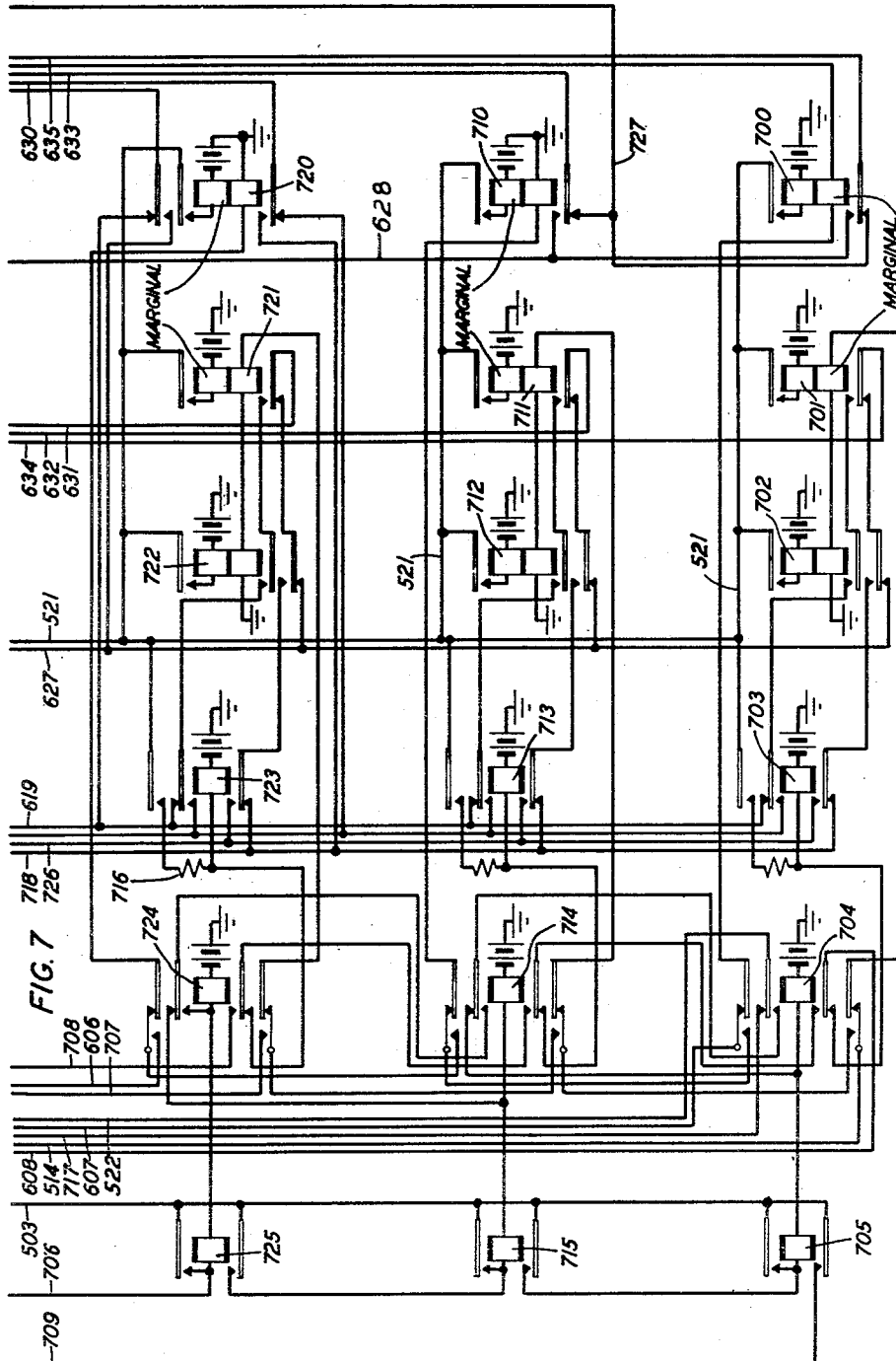
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11 Sheets-Sheet 7



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11 Sheets-Sheet 8

FIG. 12

FIG. 1	FIG. 5
FIG. 2	FIG. 6
FIG. 3	FIG. 7
FIG. 4	FIG. 10
FIG. 11	FIG. 12

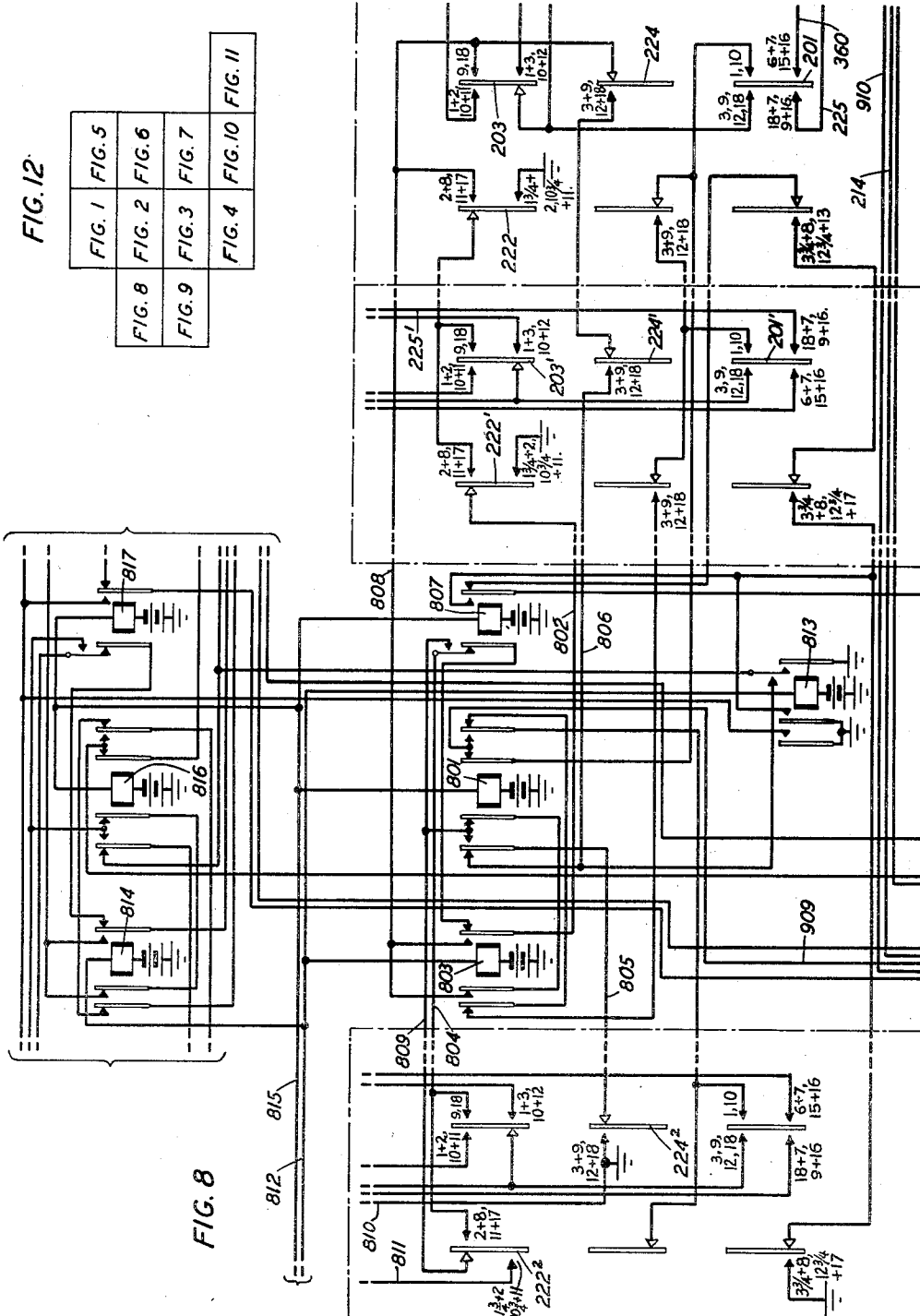


FIG. 8

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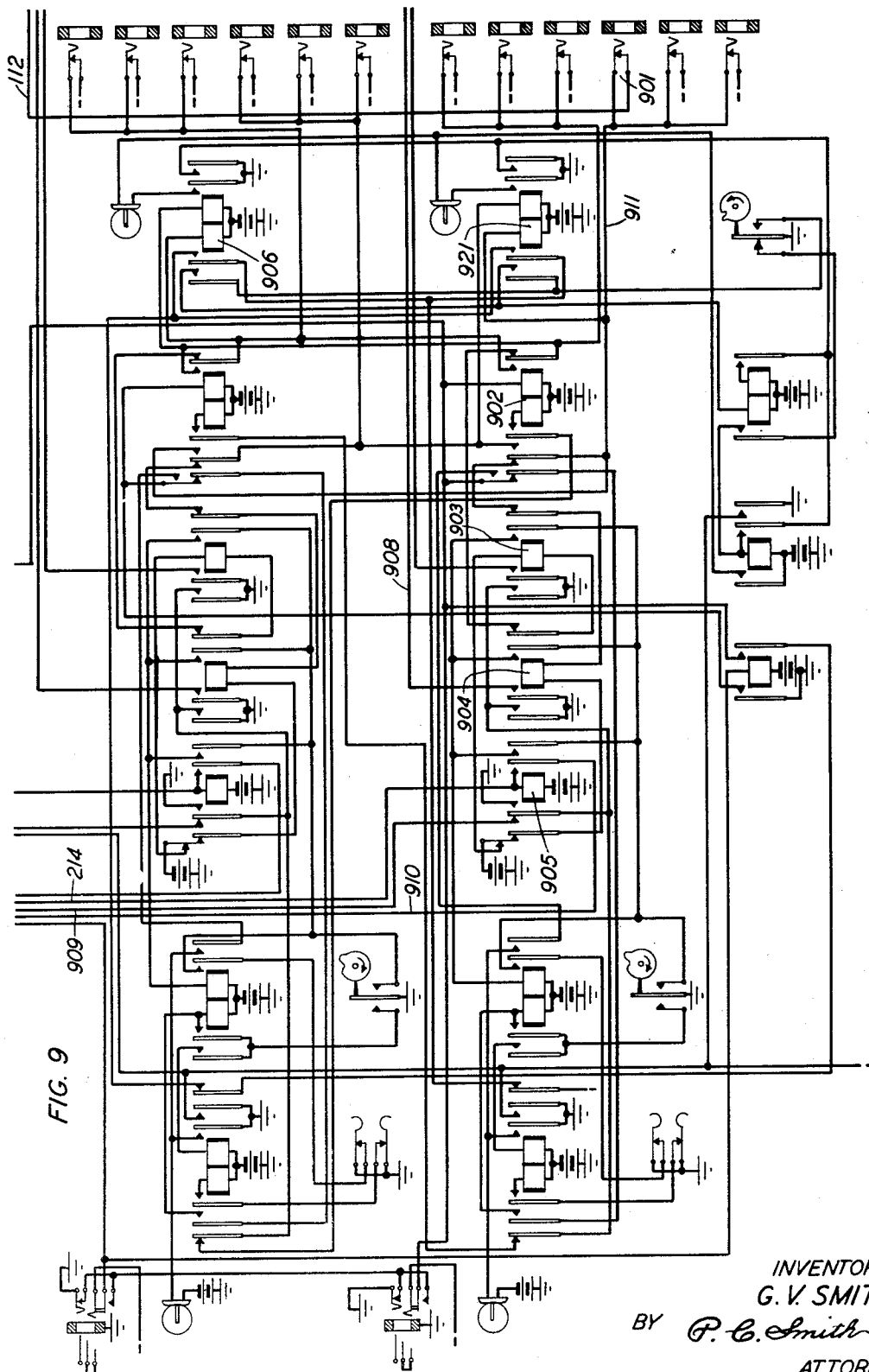
G. V. SMITH

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TELEPHONE SYSTEM

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11 Sheets-Sheet 9



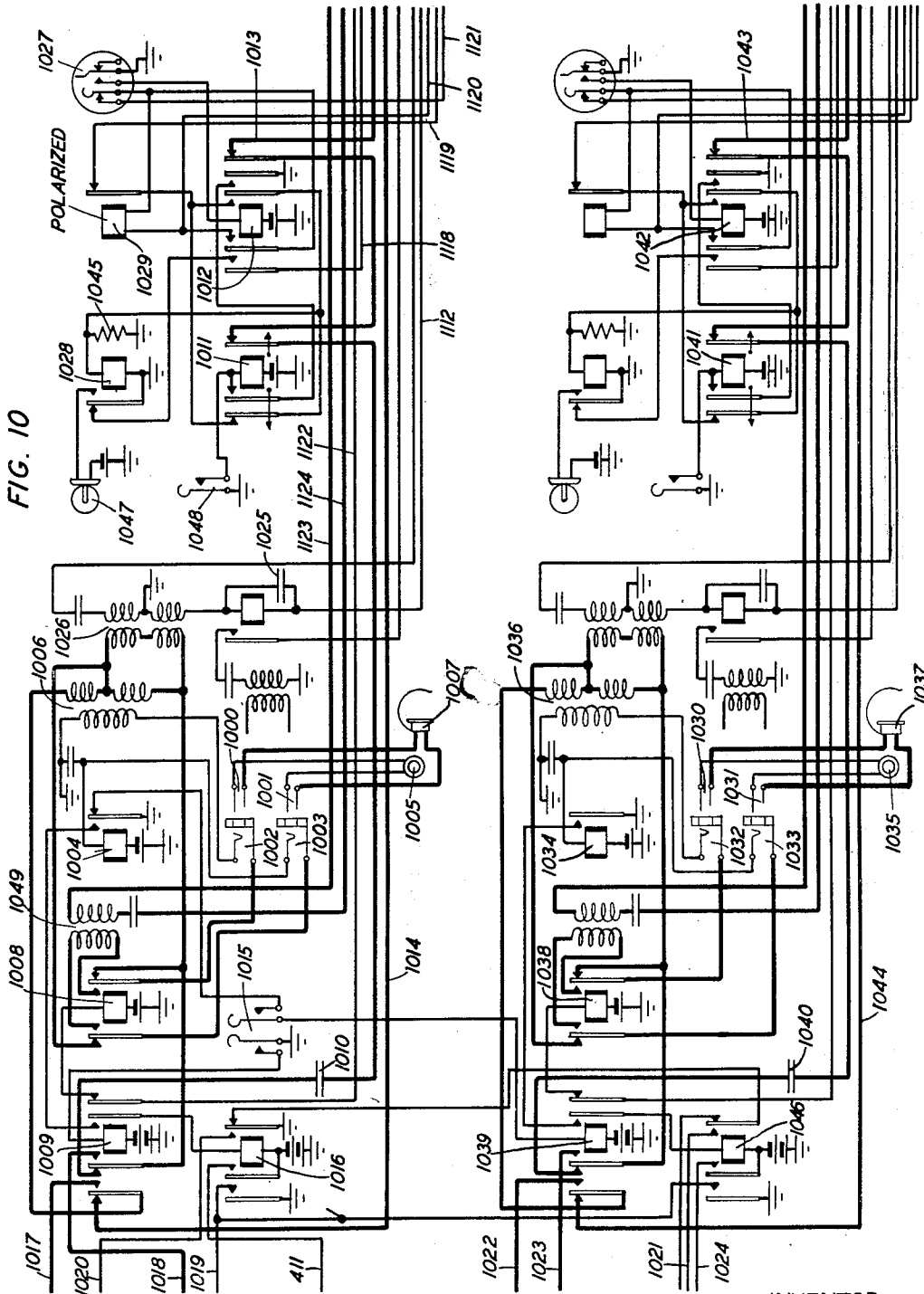
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11 Sheets-Sheet 10



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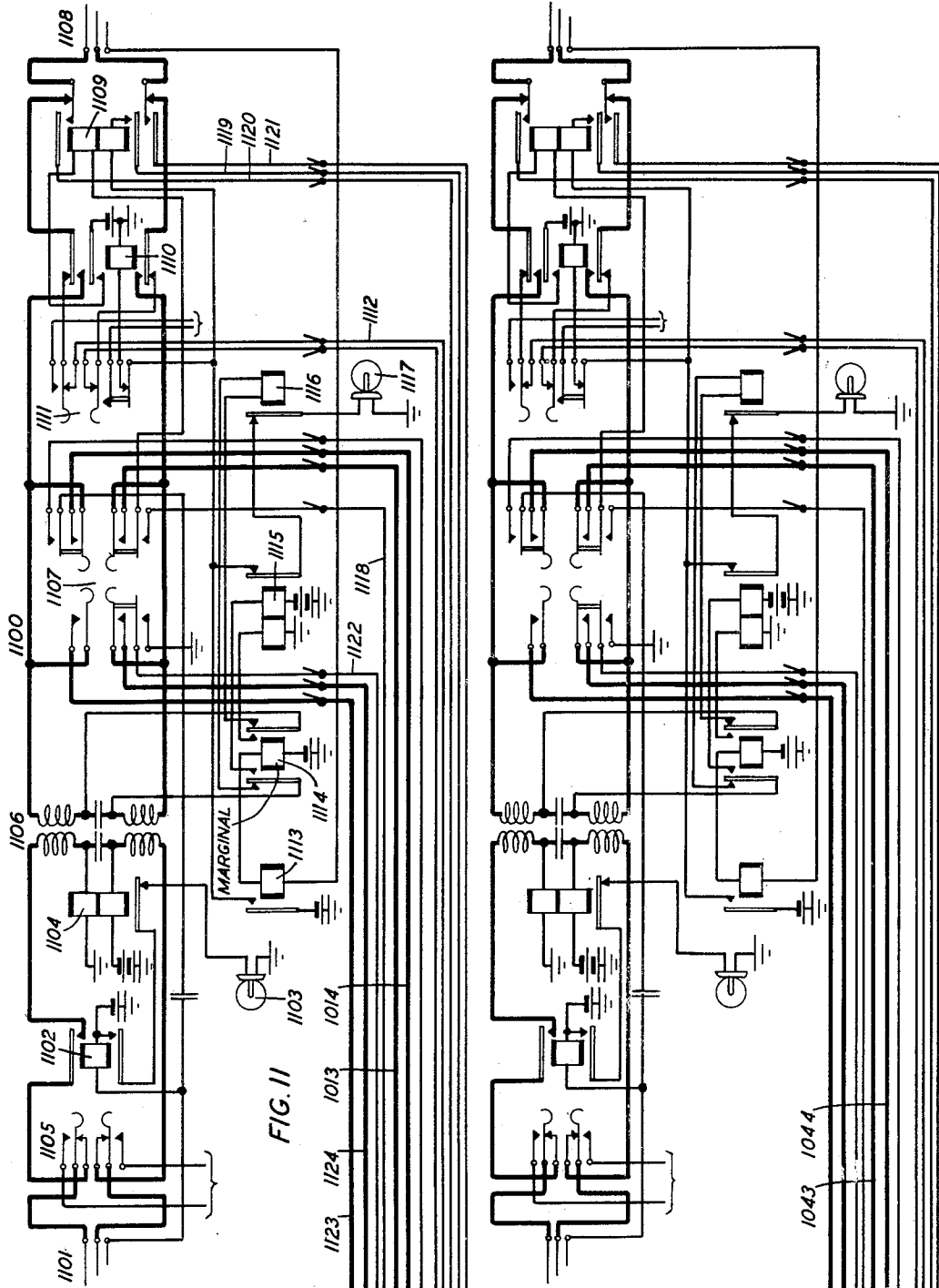
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TELEPHONE SYSTEM

Filed April 27, 1932

11 Sheets-Sheet 11



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UNITED STATES PATENT OFFICE

1,930,255

TELEPHONE SYSTEM

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Application April 27, 1932. Serial No. 607,695

11 Claims. (Cl. 179—27)

This invention relates to telephone exchange systems and more particularly to dial switching systems in which operators are employed for extending calls originating in manual offices of the exchange area to subscribers' lines in a dial switching office and in which operators are employed for giving special service to subscribers such as service on intercepted calls.

In some offices it is desirable because of economical reasons to combine the positions of A operators who attend to intercepted calls and call distributing B operators' positions upon a single switchboard. In such a combined switchboard, it is possible to secure the greatest operating efficiency by enabling the B operator whose position is adjacent to an A operator's position on the same switchboard, to assist in handling intercepted calls at such times as calls incoming to her position for termination in the dial switching equipment of the office in which she is located are few, or to permit an intercepting A operator, whose position is adjacent to a call distributing B operator's position, to handle calls for intercepted service on her own position and calls incoming for termination on the B operator's position at such times as the B position is vacated, for example, at night. It is therefore, the object of the invention to increase the efficiency of a dial switching office by combining A and call distributing B operators' positions upon a single switchboard and to provide grouping circuits whereby adjacent A and B operators may assist each other.

In accordance with the invention, several arrangements of adjacent A and B operators' positions upon a single switchboard may be made. Three of such arrangements which are typical, are as follows:

The A operator's position which is adjacent to a call distributing B operator's position may be supplied with the usual cord circuits by means of which the operator may answer calls for assistance such as intercepted calls and extend such calls as directed by the calling subscribers. The A operator's telephone set of such a position is normally arranged for connection to any cord circuit of the position by the operation of the listening key of the cord circuit which the operator employs to answer a call. The adjacent call distributing B operator's position may be of the type disclosed in Patent No. 1,753,348, granted April 8, 1930 to J. B. Newsom, in which calls from manual offices of the exchange area are incoming on trunk circuits terminating in the office in which the A and B operators are located

in selector switches. These trunks are associateable by means of three-way link circuits with the position circuits of B operators and senders common to all B operators' positions of the office. Whenever a call is incoming on one of the trunk circuits, such trunk circuit is automatically connected by a link circuit with an idle sender and with an idle B operator's position, the B operator being listened-in automatically to receive instructions for terminating the call. Should the B operator's position which is adjacent to an A operator's position be vacated, for example, at night, such position is normally rendered unselectable to incoming trunk calls. In accordance with the present invention, however, a key is provided on the B operator's keyshelf which is accessible to the adjacent A operator, which the A operator may depress when the B position is vacated and a call exists on a trunk incoming to the B position thereby causing the disconnection of the A operator's telephone set from normal association with the cord circuits of her position, the connection of the telephone set with the position circuit of the vacated B position and causing the B position to again become selectable whereby a call on a trunk incoming thereto becomes automatically connected to the A operator's telephone set.

The B position which is adjacent to an A position may in accordance with a further modification of the invention be provided with A cord circuits in addition to the B position equipment hereinbefore described, so that the B operator's position serves as a combined A and B position. In this case the B operator's telephone set is normally arranged for answering calls on the A cord circuits of the combined position and incoming trunk calls are normally barred from the position. If, however, an incoming trunk call is awaiting attention the B operator may by depressing a grouping key disconnect her telephone set from association with her A cord circuits and render her position selectable to the incoming trunk call whereby her telephone set may be automatically connected to the trunk circuit. Should this combined A and B position be vacated, the A operator whose position is adjacent, may by depressing the grouping key disconnect her telephone set from its normal association with cord circuits at her position and render the adjacent combined A and B position selectable to incoming trunk calls whereby an incoming trunk call may be automatically connected to such A operator's telephone set.

When it is not desirable to permit an A oper-

ator to assist in answering calls incoming to an adjacent B position, the B position may be arranged as a combined A and B position in which the operator's telephone set of the combined position is normally associated for answering calls with the A cord circuits of the position, incoming trunk calls being barred. Should a call be incoming on a trunk circuit to this position, the operator may by depressing a position key, disassociate her telephone set from her A cords and render her telephone set automatically selectable to the incoming trunk call.

For the purposes of illustration, the invention has been disclosed as applied to a system in which a B operator's position is provided with A cord circuits so that the B operator's position serves as a combined A and B position and in which the combined position if vacated by the operator is arranged to be grouped with an adjacent A operator's position by the depression of a grouping key. The combined position is then rendered selectable to incoming trunk calls whereby an incoming trunk call may be automatically connected to the operator's telephone set of the adjacent A position. The invention will be more clearly understood from a consideration of the following description taken in connection with the drawings in which:

Fig. 1 shows a trunk circuit incoming to the combined A and B operator's position from a distant office and terminating in an incoming selector circuit;

Figs. 2 and 3 show a link circuit, Fig. 2 showing in the left portion thereof a trunk finder and in the right portion thereof a sender finder; and Fig. 3 showing an operator's position finder;

Fig. 4 shows a B operator's position circuit; Figs. 5, 6 and 7 taken together show a B operator's sender;

Fig. 8 shows portions of other link circuits; Fig. 9 shows the start circuit for initiating the operation of a link circuit;

Fig. 10 shows in the upper portion thereof the "B" operator's telephone and dialing circuits and in the lower portion thereof an adjacent A operator's telephone and dialing circuits;

Fig. 11 shows in the upper portion thereof a cord circuit at the B operator's position and in the lower portion thereof a cord circuit of an adjacent A operator's position; and

Fig. 12 shows the manner in which Figs. 1 to 11 inclusive should be arranged.

The B operator's telephone set shown in the upper portion of Fig. 10 is normally arranged for use with cord circuits such as the one shown in the upper portion of Fig. 11 which the B operator may use to answer calls incoming from calling subscribers' lines requiring intercepted or special service. To complete such calls the operator plugs into an outgoing trunk jack and dials the required number on her position dial shown in the upper portion of Fig. 10. Should there be, however, a call incoming from a distant office over an incoming trunk such as is shown in Fig. 1 which would be barred from the position as long as her telephone set is associated with cord circuits, the operator may by the operation of a grouping key, shown in Fig. 10, render her position selectable to such incoming call whereby her telephone set may be automatically connected to the incoming trunk circuit. For completing a call of this character the operator uses her keyset shown in the lower portion of Fig. 4 to set the registers of a sender such

as is shown in Figs. 5 to 7 inclusive whereupon the sender proceeds to set the incoming selector in which the incoming trunk circuit terminates and a final selector, not shown, to select the desired line. The final selector may be of the type well-known in the art. The B operator may thus function as a B operator or as an A operator dependent upon whether terminating or originating calls are incoming to her position. Her position thus functions as a combined A and B position.

It is often desirable during periods of light traffic to vacate such combined position and, in accordance with the present invention, this is made possible by providing facilities to enable an operator who normally serves only as an A operator, but whose position may be placed adjacent to the B operator's position on the same switchboard, to handle incoming calls requiring the services of the B operator. In the lower portion of Fig. 10 the telephone and dialing circuits of such an adjacent A operator's position are disclosed. These circuits are normally associable with cord circuits such as the cord circuit shown in the lower portion of Fig. 11 for handling incoming calls requiring the services of an A operator. At such times as an adjacent combined position is vacant and incoming trunk calls are barred from such combined position, the adjacent A operator by depressing the grouping key shown in Fig. 10, may when there is an incoming trunk call render the combined position selectable and her telephone set automatically associable for answering such an incoming call.

Trunk call incoming to combined position from distant office

In general a subscriber originating a call is answered by an operator known as an A operator who after receiving the called line number, calls upon a B operator for assistance. She does this by inserting the calling plug of her cord circuit in a jack individual to a trunk circuit which terminates in an incoming selector controlled by the B operator's equipment. The insertion of the plug in the jack causes the trunk finder of a link circuit to hunt for the incoming selector associated with the jack. As soon as the trunk finder has been started, the B operator's position finder is operated to select an idle B operator's position. When both have been found two tones called "zip" tones are transmitted from the B position to the A position and the A operator's headset is connected with the B operator's headset so that she may inform the operator of the wanted number. As soon as the idle position is found, the sender finder of the link circuit is actuated to find an idle sender. When this has been found the B operator is signaled and she then operates the keys of her keyset in accordance with the wanted line number. The number is recorded in the sender after which the position is disconnected from the trunk circuit and the sender is connected with the incoming selector to control the setting of that selector and through it the setting of the final selector. When the selectors have been positioned the link circuit is disconnected and the established circuit is placed under the control of the A operator.

In order to insure quickness and continuity of service, distribution of wear, etc., the trunks terminating in the incoming selectors and the link circuits are arranged in groups. The trunks appear before the trunk finders of the link circuit in the bank of a panel type switch frame.

The bank is divided once horizontally into two panels and each panel is divided vertically into two sections so that the terminals in the upper half of one section may be cross-connected to the terminals of the lower half of the other section. The trunks appearing in the bottom half of one section are known as the A group of trunks and those appearing in the bottom half of the other section, as the B group of trunks. Each link circuit is represented at the switch frame by a set of brushes, the links terminating in brushes having access to the section of the panel bank in which the A trunks appear at the bottom are called the A group of links and those terminating in brushes having access to the other section are called the B group. Each brush rod carries two sets of brushes, one for each panel. The brush rods are arranged on both sides of the panel and the rods on the two sides are driven by different motors. A call on a trunk in the A group will ordinarily initiate the operation of an A link and a call on a trunk in the B group will initiate the operation of a B link. However, the start circuit is so arranged that if all A links become busy and a call is initiated on an A trunk, a B link may be used and vice versa. Likewise, if the trunk finder of the A link fails to find a trunk, a B link will be summoned. If the motor which drives the brush rods of one side of the panel stops, the link circuits on that side are rendered non-usable and the link circuits on the other side continue operation.

A detailed description of the manner in which calls incoming from a distant office are served by the B operator of a combined position will first be given. When the distant A operator plugs into the jack 100 of a trunk extending to the office in which the B operator's position is located, a loop circuit is established from the tip of the jack, over the upper left winding of repeating coil 101, the windings of relay 102, the lower left winding of repeating coil 101 to the ring of jack 100 thus causing the operation of relay 102. Relay 102 causes the operation of slow-to-release relay 103 which in turn closes a circuit from battery, winding of slow-to-release relay 104, contact of relay 103, lower contact of cam 105, (the sequence switch 110 normally standing in position 17 when the trunk is selectable) upper left contact of cam 106 to ground over the lower right and upper left contacts of cam 107. Relay 104 upon operating locks over its right front contact directly under the control of relay 103. Relay 104 indicates to the start circuit of Fig. 9 that a call has been originated, that is, relay 104 closes a start circuit extending from ground at its inner right front contact, right contacts of cam 108, inner right back contact of relay 109, lower contacts of cam 111, conductor 112 to the contacts of jack 901. Jack 901 is individual to the group of ten trunks to which the trunk of Fig. 1 belongs. From jack 901 the start circuit extends to conductor 911 which is common to the trunks of the subgroup B of the bottom panel of trunk finder 210 in which the trunk appears and thence by three circuits to battery. One circuit extends through the left winding of relay 921 to battery; a second circuit extends over the inner left back contact of relay 902, right back contact of relay 903, winding of relay 904 and the outer left back contact of relay 905 to battery; while a third circuit extends from the winding of relay 904, outer left back contact of relay 905, winding of relay 903, right back contact of relay 904, right

back contact of relay 902 to battery through the right winding of relay 906.

Relay 904 which is individual to the B group of trunks in the bottom panel of finder 210 and relay 921 which is common to the A and B groups of the bottom panel operate in these circuits, but relays 903 and 906 being shunted by battery at the left back contact of relay 905 do not operate. Relay 904 upon operating connects ground over its outer left front contact, the inner left back contact of relay 905 to start conductor 909 for starting a link in search of the calling incoming trunk circuit. It also connects ground over conductor 908 to operate tripping magnets 310 and 311 in preparation for tripping the bottom set of brushes which belong to the selector finder of the B link allotted to serve the present call. The operation of these magnets, as is well known, operates all of the trip fingers of the group, but only the brushes on the brush rod moved will be tripped. Relay 904 also opens the circuit of relay 903. Relay 921 in operating starts a timing operation for the purpose of transferring the call to the other subgroup of links if it is not extended within a predetermined length of time and for operating an alarm signal if the call cannot be handled. The operation of the alarm arrangement not being pertinent to the present invention, will not be described herein.

The sequence switches of busy links stand in any position from 2 to 8 or 11 to 17 inclusive. If the link circuit is awaiting assignment, the sequence switch stands in position 9 or 18, while the sequence switch of the link assigned for use stands in position 1 or position 10. Assuming that the link shown in Fig. 2 is the next one to be used and therefore has its sequence switch standing in position 1, the circuit traced as above described to conductor 909 may be further traced over the inner right back contact of relay 801, upper right and lower left contacts of cam 201, conductor 225 to battery through the winding of relay 202. Relay 202 operates, preparing a locking circuit for itself over its inner left front contact, lower contacts of cam 203, back contact of relay 241, commutator strip 205, brush 206 to ground. Relay 202 also closes a circuit from ground over the upper left and lower right contacts of cam 208, right front contact of relay 202, lower left contact of cam 223, winding of sequence switch magnet 200 to battery. Sequence switch 200 advances to position 2 in this circuit.

When the sequence switch reaches position 13/4, ground is connected over the lower right and upper left contacts of cam 222 to the next link. If the next link is in either position 9 or 18 awaiting assignment, this circuit is extended over the upper right and lower left contacts of cam 203' and the upper left and lower right contacts of cam 201', conductor 225 of such link to battery through the winding of a relay of such link corresponding to relay 202 which upon operating advances the link sequence switch into position 1 or 10 awaiting a call. If the next link is in any position 2 to 8 or 11 to 17, the ground is extended over the upper contacts of cam 222' of such link to assign the next link in the series, but if it too is busy, the ground will be further extended over conductor 802, right back contact of relay 803, left back contact of relay 807, conductor 804 to the next link in the series. If this link and succeeding links are busy, it will be extended over cam 222' of the last link in the series. If this also is busy, the first link to return to the awaiting assignment position will be allotted either

from ground applied over the lower contact of cam 222² of that link in position 2, or if no link is in position 2, then from ground over the contacts of cam 224² of the last link, contacts of similar cams of other links, conductor 805, outer left back contact of relay 801, conductor 806, contacts of cam 224', contacts of similar cams of other intervening links, contacts of cam 224 where the circuit is connected to the upper contacts of cam 222 for allotting as previously described. While portions of only four links have been shown, it will, of course, be understood, that as many links will be used as the traffic requires and that the sequential relationship between links extends throughout.

With sequence switch 200 in position 2, the up-drive magnet 230 is operated in a circuit extending over the lower contacts of cam 208, right front contact of relay 202 to ground over the upper contacts of cam 207 for driving the brushes of the trunk finder 210. As the finder 210 is moved upward, magnet 311 trips the brush set. Immediately after starting upward, commutator brush 209 makes contact with segment 211 completing a circuit from ground over brush 209, segment 211, conductor 212, right back contact of relay 301, conductor 302, upper contacts of cam 213, conductor 214, winding of relay 905 to battery. Relay 905 operates and locks over its inner right front contact, conductor 910, inner right back contact of relay 301, conductor 303 to ground over the upper contacts of cam 218. Relay 905 in operating opens the operating circuit of relay 202, but that relay does not release since its locking circuit is now closed over commutator segment 205. Relay 905 opens the circuit of relay 904 permitting that relay to release in turn releasing tripping magnets 310 and 311.

The incoming selector marks itself as calling by connecting battery through resistance 113, contacts of cam 114, inner left contact of relay 104, outer right back contact of relay 109, conductor 115 to terminal 215. When the selector finder 210 reaches the set of terminals corresponding to this incoming selector, the circuit is further extended over brush 216, conductor 217, outer left back contact of relay 309, conductor 312, winding of relay 241, upper left contact of cam 219 to ground at the upper right contact of cam 207. Relay 241 operates in this circuit opening the locking circuit of relay 202. Relay 202 does not release until the brushes are properly centered, being held operated by means of a circuit from battery through the winding and left front contact of relay 202, left contacts of cam 203, commutator segment 220, brush 221 to ground. The release of relay 202 opens the circuit of up-drive magnet 230 bringing the finder to rest on the terminals leading to the calling incoming selector.

With relay 202 released, it completes a circuit from battery, winding of sequence switch magnet 200, upper left contact of cam 223, right back contact of relay 202, upper contacts of cam 207 to ground. In position 3 the locking circuit of relay 905 extends over the upper right and lower left contacts of cam 218 to ground at the left back contact of relay 202. With the sequence switch in position 3 a circuit is closed from battery, left winding of relay 109, upper contacts of cam 116, outer left contact of relay 104, conductor 117, terminal 226, brush 227, conductor 228, inner left back contact of relay 301, winding of relay 342, outer right back contact of relay 313, conductor 314, upper right contact of

cam 219 to ground at the upper right contact of cam 207. Relays 109 and 342 operate, relay 109 opening the previously traced circuit for relay 241 and closing a circuit from battery, winding of sequence switch magnet 110, upper left contact of cam 118, right front contact of relay 109, right contacts of cam 108 to ground at the right front contact of relay 104. Sequence switch 110 advances to position 18. The operation of relay 109 and the advance of sequence switch 110 removes the calling condition from conductor 112, releasing relay 921. Relay 109 remains locked in position 18 over a circuit extending from battery through its left winding, upper left and lower right contacts of cam 119, left front contact of relay 109, lower left and upper right contacts of cam 116, outer left front contact of relay 104, conductor 117 and thence as previously traced to ground. The release of relay 241 permits relay 202 to reoperate in a circuit from battery through the winding of relay 202, conductor 225, left contacts of cam 201, lower contacts of cam 203, back contact of relay 241, commutator segment 205 and brush 206 to ground. Relay 342 upon operating locks over its outer left front contact, conductor 343, the lower right contact of cam 219 to ground at cam 207.

While sequence switch 200 was in position 2, a circuit was completed from battery through the winding of relay 315, right back contact of relay 316, conductor 317, upper left contact of cam 229 to ground at cam 207, which circuit remains closed in position 3. Relay 315 in operating completes one circuit for relay 316 extending from ground at cam 207, upper left contact of cam 229, conductor 317, outer right front contact of relay 315, middle winding of relay 316, conductor 318, upper left and lower right contacts of cam 231, conductor 319, right winding of relay 316 to battery, and prepares a second circuit which extends as previously traced from ground through the middle winding of relay 316, left winding of relay 316, inner left back contact of relay 320, conductor 321, left contacts of cam 232, conductor 322, right back contact of relay 323 to brush 324 of the position finder 300. Relay 316 is marginally adjusted so that the circuit completed through its right and middle windings does not operate it, but renders it quick to operate when the circuit is completed over brush 324.

It will be assumed that the present system provides one or more B operators' positions which are arranged as combined A and B positions and that these positions are all occupied during the busy period of the day. When an operator is present at her position, she inserts her headset plugs 1000 and 1001 into the position jacks 1002 and 1003 completing a circuit from battery through the winding of relay 1004, tips of jack 1003 and plug 1001, through the headset transmitter 1005, tips of plug 1000 and jack 1002, left winding of repeating coil 1006 to ground. The headset receiver 1007 is also connected over rings of plug 1000 and jack 1002, right back contact of relay 1008, inner left back contact of relay 1009, condenser 1010, right back contacts of relays 1011 and 1012, to the tip talking lead 1013 extending to A cord circuits of the combined position and over rings of plug 1001 and jack 1002, left back contact of relay 1008, upper right winding of repeating coil 1006, outer left back contact of relay 1009 to the ring talking lead 1014 extending to A cord circuits. The B

operator with her headset plugged up thus normally functions as an A operator.

Relays 400 to 404, inclusive, are relays of a night alarm circuit common to all positions of the office. With all combined positions thus functioning normally as A positions, there will be no ground connected to conductor 1019 and relay 400 will be unoperated. There will also be no ground on conductor 1020 and relay 491 will be unoperated and consequently relay 492 will be operated. When, therefore, sequence switch 200 of the link circuit reaches position 2, a circuit will be established from battery through resistance 346, the winding of relay 320, conductor 329, upper left and lower right contacts of cam 233, conductor 235, front contact of relay 402 to ground through the winding of relay 403. Relays 320 and 403 operate, relay 320 opening the circuit which would otherwise be established upon the operation of relay 315 extending from battery, winding of relay 307, right back contact of relay 325, outer left back contact of relay 323, back contact of stepping magnet 308, conductor 326, upper right and lower left contacts of cam 234, conductor 327, inner right front contact of relay 315, left back contact of relay 316 to ground at the outer left back contacts of relay 320, and, therefore, relay 307 cannot operate to close the circuit of stepping magnet 308 and the finder 300 does not advance to hunt for an operator's position circuit. Relay 403 upon operating closes an obvious circuit for relay 404 which in turn closes a circuit for call awaiting lamp 405 extending from battery through lamp 405, left back contact of relay 400 to ground at the right front contact of relay 404 and a circuit for night alarm bell 406 extending over the right back contact of relay 400, left front contact of relay 404, through ringing generator 407.

The B operator upon hearing the night alarm bell 406 and seeing the position lamp 405 lighted, depresses her key 1015 thereby closing an obvious circuit for relay 1009 which in turn establishes a circuit extending from battery, winding of relay 1016, inner right contact of relay 1009 to ground at the front contact of relay 1004 and transfers the operator's headset receiver 1007 from the talking leads 1013 and 1014 extending to her A cord circuits to the talking leads 1017 and 1018 extending to her B position circuit. The operation of relay 1016 also connects ground to conductors 1019 and 1020 operating relays 400 and 401. Relay 400 upon operating extinguishes lamp 405 and silences the alarm bell 406 and relay 401 upon operating releases relay 402 which in turn releases relays 403, 404 and 320. Assuming that finder 300 is standing with its brushes on the terminals of a vacant position circuit, relay 320 upon releasing closes the previously traced circuit for relay 307 which operates in turn closes a circuit extending from battery, winding of stepping magnet 308, right contact of relay 307, conductor 323, lower contacts of cam 234, conductor 327, thence to ground at the back contacts of relay 320 as previously traced. Magnet 308 in operating opens the circuit of relay 307 which releases in turn releasing magnet 308 to step the position finder 300 to the next position.

It will be assumed that the brushes of finder 300 now stand upon the terminals of the position circuit shown and that the circuit previously traced through the winding of relay 316 to brush 324 now extends through resistance 408, outer left back contact of relay 409, right normal con-

tacts of key 410, conductor 411 to battery over the inner left front contact of relay 1016. Relay 316 operates and locks in a circuit from battery through its right winding, conductor 319, lower right and upper left contacts of cam 231, conductor 318, left front contact of relay 316 to ground at the left back contacts of relay 320, in parallel with the circuit previously traced from battery over brush 324, outer right back contact of relay 223, conductor 322, left contacts of cam 232, conductor 321, inner left back contact of relay 320, left winding and left front contact of relay 316 to ground at the outer left back contacts of relay 320. The connection of ground to brush 324 through the left low resistance winding of relay 316 marks the position as busy to other links. If two relays such as 316 test a position simultaneously both relays may operate, but the attempted closure of a locking circuit by one of these relays has a shunting effect on the other so that both relays release and then the faster relay reoperates and prevents the operation of the other relay and appropriates the position.

The operation of relay 316 opens the circuit of relay 315 and that relay releases. A circuit is thereupon closed from battery, winding of relay 330, inner left back contact of relay 323, conductor 331, upper left and lower right contacts of cam 236, conductor 332, left back contact of relay 315, right front contact of relay 316, conductor 317, upper left contact of cam 229 to ground at cam 207. Relay 330 operates and locks over the inner left back contact of relay 323, outer right front contact of relay 330, conductor 333, right contacts of cam 237, conductor 314, outer front contact of relay 342, conductor 343, lower right contact of cam 219 to ground at cam 207 and closes a circuit for operating relay 325 extending from battery, winding of relay 325, inner left front contact of relay 330, conductor 334, lower left contact of cam 219 to ground at cam 207. Relay 325 operates and closes a circuit extending from battery, winding of sequence switch magnet 200, lower left contact of cam 223, right front contact of relay 202, conductor 204, middle left front contact of relay 325, conductor 335, lower left contact of cam 207 to ground for advancing the sequence switch into position 4.

A circuit is now closed from battery, lower right winding of repeating coil 101, winding of supervisory relay 120, conductor 121, left contacts of cam 122, conductor 123, terminal 238 and brush 239 of trunk finder 210, conductor 240, middle left back contact of relay 301, left winding of relay 336, inner left front contact of relay 325, brush 305 of position finder 300, conductor 337, winding of relay 412, conductor 413, brush 306, inner right front contact of relay 325, right winding of relay 336, outer left contact of relay 325, resistance 338, inner front contact of relay 342, conductor 339, lower contacts of cam 242, conductor 340, outer left back contact of relay 301, conductor 243, brush 244, terminal 245, conductor 124, left contacts of cam 125, left contacts of cam 126 to ground through the upper right winding of repeating coil 101. Relay 412 operates in this circuit, but the windings of relay 336 are connected at this time differentially and relay 336 does not operate. Relay 412 upon operating closes a circuit from battery on conductor 411, left contact of relay 412, resistance 414, white-capped lamp 415, right back contact of relay 416 to ground at the inner left back contact of relay 417; connects battery over its left front contact and the right back contacts of relay 417 150

to the keyset key 450 either directly or through high resistances 418 and 419 and to conductor 421 through low resistance 420 and high resistance 418 and, through the winding of relay

5 409. Lamp 415 lights and relay 409 operates.

Relay 409 upon operating opens the circuit previously traced over brush 324 through the left winding of relay 316 thereby releasing relay 316 since the circuit previously traced through its
10 other winding was opened when sequence switch 200 advanced out of position 3. With relay 316 released, a circuit is established from battery through the winding of sequence switch magnet 200, upper right and lower left contacts of cam
15 231, conductor 246, left back contact of relay 316, to ground at the outer left back contacts of relay 320 for advancing the sequence switch into position 5. Relay 409 also connects battery through resistances 419 and 434, outer right front
20 contact of relay 409 to conductor 435 and establishes a circuit from battery on conductor 411, over the right normal contacts of key 410, outer left alternate contacts of relay 409, resistance
25 422, green-capped lamp 423 to ground through interrupter 424 for flashing lamp 423, and establishes a circuit from a source of tone current over its inner right front contact, the back contact
30 of relay 425, back contact of relay 426, right winding of tone coil 427 to ground at the inner right normal contacts of relay 428. This causes a tone current to be induced into the left winding
35 of coil 427 which is connected from conductor 413 over the right front contact of relay 412, outer left back contact of relay 428, left winding of coil 427, outer right back contact of relay 428, condenser 429 to conductor 337. The tone current
40 thus flows over the circuit previously traced through the right windings of repeating coil 101 and is induced through the left windings of this repeating coil over the circuit extending to the
45 A operator's position and to her headset. A part of this tone current also flows in a parallel circuit through condenser 430, the intermediate normal contacts of key 410, the outer left back
50 contact of relay 431, conductor 1017, outer left front contact of relay 1009, upper right winding of repeating coil 1006, left back contact of relay 1008, rings of jack 1003 and plug 1001, B operator's headset receiver 1007, rings of plug 1000 and
55 jack 1002, right back contact of relay 1008, inner left front contact of relay 1009, conductor 1018, outer right back contact of relay 431, condenser 432. Both the A and B operators hear this tone.

Relay 409 also closes a circuit extending from
60 battery, through the winding of slow-to-operate relay 426, inner left normal contacts of relay 428, inner left front contact of relay 409 to ground on conductor 1020. As soon as relay 426 operates, it opens the circuit through the right winding
65 of tone coil 427 to discontinue the tone and closes a circuit from battery through the winding of slow-to-operate relay 433, left contact of relay 426, inner left front contact of relay 409 to ground on conductor 1020. With relays 426 and
70 433 both operated, the circuit through the right winding of tone coil 427 is again established and a second tone signal is transmitted to the A and B operators' receivers. Relay 433 also closes a circuit from battery, through the winding of slow-to-operate relay 425, left contact of relay 433,
75 inner left front contact of relay 409 to ground on conductor 1020 and after an interval, relay 425 operates, again opening the circuit through the right winding of tone coil 427 to discontinue the second tone signal. At its left contact, relay

425 establishes a circuit from battery, winding of relay 428, left contact of relay 425, inner left front contact of relay 409 to ground on conductor 1020. Relay 428 operates, locking over its inner
80 left alternate contacts and the inner left front contact of relay 409 to ground on conductor 1020, opening the circuit through both windings of tone coil 427 and closing a talking circuit extending
85 from conductor 413, right front contact of relay 412, outer left front contact of relay 428, thence as traced to the B operator's headset receiver 1007, returning over the outer right front contact of relay 428, condenser 429 to conductor 337. The A operator may now converse with the B
90 operator to pass the designation of the desired line to the B operator, the A operator having been informed by the two tone or "zip" signals that the B operator is ready to receive such information.

Relay 428 upon operating also connects steady
95 ground to the circuit of lamp 423 over its inner right alternate contacts so that lamp 423 now glows steadily, and opens the circuit of relay 426 which now releases in turn releasing relays 433
100 and 425. The steady flowing of lamps 415 and 423 is an indication to the B operator that the number is to be passed to her.

It will be recalled that following the selection of the operator's position circuit, relay 316 of the link circuit released and advanced the sequence
105 switch 200 into position 5. Relay 315 now operates in a circuit extending from battery through its winding, the right back contact of relay 316, conductor 317, upper left contact of cam 229 to ground at cam 207 and establishes a circuit from
110 battery through the right winding of relay 316, conductor 319 lower right and upper left contacts of cam 231, conductor 313, middle winding of relay 316, outer front contact of relay 315, conductor 317, upper left contact of cam 229 to ground
115 at cam 207 for preparing test relay 316 for operation. A circuit is also prepared from brush 247 of the sender finder 260, right and lower left contacts of cam 232, conductor 321, inner left back contact of relay 320, left and middle windings
120 of relay 316, outer right front contact of relay 315, thence as traced to ground at cam 207. Relay 315 also closes a circuit from battery through the right winding of relay 344, conductor 341, left contacts of cam 234, conductor 327, inner
125 right front contact of relay 315, left back contact of relay 316 to ground at the outer left back contacts of relay 320. Relay 344 which is slow to operate because of its normally shunted left winding, operates and prepares a holding circuit
130 for itself over its inner right front contact, conductor 345 to centering commutator segment 248. The sender finder to which this commutator belongs normally stands in engagement with some sender which may be busy or idle and therefore
135 brush 249 will be in engagement with an insulating segment of commutator 248. Assuming that the sender is not idle, a circuit will now be closed from battery through the up-drive magnet 252, conductor 253, outer right front contact of relay
140 344 to ground at the outer left back contacts of relay 320. The sender finger 260 is moved upward under the control of magnet 252 until brush 247 engages the terminal corresponding to an idle sender which is characterized by battery through
145 a resistance of 270 ohms.

If the sender finder does not find an idle sender in its upward movement, when it reaches the top of its bank, commutator brush 261 will engage
150 segment 254 closing a circuit from ground over

brush 261 and segment 254, upper contacts of cam 233, conductor 329 to battery through relay 320 and resistance 346. Relay 320 operates, opening the circuit of up-drive magnet 252, opening the test circuit through the left and middle windings of relay 316, opening the circuit of relay 344 and locking over conductor 329, the left contacts of cam 233, conductor 255 to ground at the middle right front contact of relay 320. It also closes a circuit from battery, winding of down-drive magnet 256, conductor 257, outer right front contact of relay 320, left back contact of relay 307, conductor 258 to ground over the lower right and upper left contacts of cam 218. The sender finder is therefore restored to normal at which time a circuit is closed from ground over brush 261, normal segment 259, upper right and lower left contacts of cam 262, conductor 263, resistance 346 in shunt of the winding of relay 320, releasing that relay. The release of relay 320 opens the circuit of down-drive magnet 256, restores the circuit of relay 344, the test circuit through relay 316 and the circuit of up-drive magnet 252 so that the sender finder may seek further for an idle sender.

When an idle sender is found, the circuit previously traced through the left and middle windings of test relay 316 to brush 247 is extended over terminal 250, conductor 251, upper back contact of relay 500, inner upper back contact of relay 501, resistance 502 to battery. Relay 316 operates immediately, opening the operating circuit of relay 344 which releases as soon as its holding circuit is opened at commutator strip 248 to open the circuit of up-drive magnet 252 to bring the brushes of finder 260 to rest on the terminals of the idle sender. Relay 316 also opens the circuit of relay 315 and that relay releases. When relay 315 closes its back contact, a circuit is closed from ground over the upper left contact of cam 229, conductor 317, right front contact of relay 316, back contact of relay 315, conductor 332, lower contacts of cam 236, conductor 347, winding of relay 348 to battery. Relay 348 locks over conductor 347, the lower left and upper right contacts of cam 238, conductor 349, right contact of relay 348, conductor 350, brush 264, terminal 265, conductor 266 to ground at the lower back contact of relay 500. Relay 348 also closes a circuit from battery, winding of sequence switch magnet 200, conductor 351, next to outer left front contact of relay 348, conductor 352 to ground at the right contacts of cam 207, advancing the sequence switch to position 6 in which position relay 348 is held operated in the above traced locking circuit. Relay 348 also closes a new holding circuit for relay 330 which extends from battery, winding of relay 330, middle left back contact of relay 323, outer right front contact of relay 330, inner left front contact of relay 348, outer front contact of relay 342, conductor 343, lower right contact of cam 219 to ground at cam 207.

When sequence switch 200 reaches position 6 a circuit is closed from ground at cam 207, upper left contact of cam 267, resistance 268, brush 269, terminal 270, conductor 271 to battery through the winding of relay 501. Relay 501 operates disconnecting battery from terminal 250 for marking the sender as busy and connects ground over its front contact to off-normal ground conductor 503. Ground on conductor 503 is now extended over the back contact of relay 529, winding of relay 505 to battery. Relay 505 operates closing a circuit from battery through the winding of relay 506, front contact of relay 505, conductor 507, upper back contact of relay 620 to

ground on conductor 503. Relay 506 upon operating closes an obvious circuit for relay 508 and a circuit extending from ground on conductor 503, over the inner upper front contact of relay 506, conductor 509, back contact of relay 624 to battery through the winding of relay 614. Relays 505, 506, 508 and 614 perform no useful function at this time.

It will be recalled that battery was connected at the position circuit of Fig. 4 to conductors 421 and 435. Conductor 421 is now extended over brush 353, conductor 354, lower contacts of cam 213, conductor 355, outer left front contact of relay 330, inner right back contact of relay 313, conductor 356, brush 272, terminal 273, conductor 274, lower back contact of relay 510, winding of relay 511, inner upper normal contacts of relay 512, lower winding of relay 513, conductor 514, lower back contact of relay 704 to ground through the lower windings of relays 701 and 702, and conductor 435 is extended over brush 357, inner right front contact of relay 330, conductor 358, lower left and upper right contacts of cam 275, brush 276, terminal 277, conductor 278, upper back contact of relay 510, winding of relay 515, thence as traced to ground as previously traced through the windings of relays 513 and 701 and 702. Relays 511, 513 and 515 operate and relays 701 and 702 may also operate, but as soon as relays 511 and 515 operate relay 512 operates in a circuit from battery through its lower winding, front contact of relay 515, front contact of relay 511 to ground on conductor 503 and locks from ground on conductor 503 through its upper winding and inner upper alternate contacts in series with the circuits traced through the windings of relays 511 and 513 to battery at the position circuit, opening the previously traced circuit extending through the lower winding of relay 513 and the lower windings of relays 701 and 702 and these relays will release. Relay 512 also closes a circuit from battery through the windings of relays 724 and 725 in series, conductor 706, lower front contact of relay 512 to ground on conductor 503. Relay 725 locks itself and relay 724 over its upper contact to ground on conductor 503 and in turn extends ground from conductor 503 over its lower contact in series through the windings of relays 715 and 714 operating these relays. Relay 715 upon operating locks itself and relay 714 over its upper contact to ground on conductor 503 and at its lower contact extends ground from conductor 503 in series through the windings of relays 705 and 704. These relays operate, relay 705 locking both relays to ground on conductor 503 and extending ground on conductor 503 over its lower contact, conductor 709, winding of relay 625 to battery through resistance 626. Relay 625 operates, locking over its inner front contact to ground on conductor 503.

With relays 724, 704 and 714 operated a circuit is closed from battery, inner upper back contact of relay 516, resistance 517, conductor 518, lower winding of relay 600, conductor 606, upper alternate contacts of relays 724, 714, and 704, conductor 607, upper winding of relay 513, inner upper back contact of relay 500, conductor 282, terminal 279, brush 280, conductor 281, outer left front contact of relay 348, outer right front contact of relay 325, brush 359, conductor 436, winding of relay 437, left back contact of relay 438, right back contact of relay 416 to ground at release key 439. Relay 437 operates, locks over its outer left front contact, inner left front contact of relay 409 to ground on conductor 1020 and

closes a circuit for relay 438 extending from battery on conductor 411, left contact of relay 412, winding of relay 438, left front contact of relay 437, thence to ground as traced on conductor 1020. Relay 438 upon operating locks over its left front contact and the left back contact of relay 416 to ground at key 439, extends ground on conductor 1020 over its inner right front contact to battery through the winding of relay 417 and opens the initial operating circuit of relay 437. Relay 417 upon operating opens its right contacts thereby disconnecting battery from conductors 421 and 435 releasing relays 511, 515 and 512 in the sender. Relay 512 upon releasing closes a circuit extending from battery, lower back contact of relay 519, winding of relay 516, conductor 520, lower front contact of relay 625, conductor 521, lower back contact of relay 512 to ground on conductor 503. Relay 516 upon operating locks over its next to inner lower front contact, conductor 521, lower back contact of relay 512 to ground on conductor 503 and at its inner upper back contact removes battery from the circuit previously traced through the winding of relay 437 at the position circuit.

Relay 437 upon releasing connects conductor 606 as previously traced to conductor 436, thence through the left winding of relay 440, inner right back contact of relay 437, outer right front contact of relay 438, resistance 441 to the keyset 450 and extinguishes the white-capped lamp 415, which was maintained lighted over the outer right front contact of relay 437 after the operation of relay 417, as a signal that the sender is attached and ready to record digits of a desired line designation. For the purpose of more readily identifying the registration control circuits extending from the operator's keyset 450 to the sender, the first of these circuits which will be hereinafter referred to as the No. 1 circuit extends from resistances 419 and 434 at the position circuit, over the outer right front contact of relay 409, conductor 435, thence as traced to conductor 278 in the sender. The second circuit which will be hereinafter referred to as the No. 2 circuit extends from resistances 418 and 420, over conductor 421, thence as previously traced to conductor 274 in the sender, and the third circuit which will be hereinafter referred to as the No. 3 circuit is established from resistance 441, outer right front contact of relay 438, right back contact of relay 437, left winding of relay 440, conductor 436 and thence as previously traced to conductor 282 in the sender.

At the position circuit the No. 1 circuit may be extended through low resistance 434 and the right contacts of key No. 1 or No. 6 to conductor 442 which is connected to battery on conductor 411 over the left contact of relay 412 or through low resistance 434 and high resistance 419 and the right contacts of key No. 2 or No. 7 to conductor 442. Circuit No. 2 may be extended through low resistance 420 and the right contacts of key No. 3 or No. 8 to conductor 442 or through low resistance 420 and high resistance 418 and the right contacts of key No. 4 or No. 9 to conductor 442. Circuit No. 3 may be extended through low resistance 441 and the left contacts of keys Nos. 0 to 4 inclusive to conductor 442 or through low resistance 441 and high resistance 443 and the left contacts of keys Nos. 5 to 9 inclusive to conductor 442. From a consideration of the above it will be apparent that circuit No. 3 is completed whenever a key is depressed and that either circuit No. 1 or No. 2, or neither,

will be completed by the operation of any keys, but not both.

At the sender circuit No. 1 extends at this time from conductor 278, over the upper back contact of relay 510, winding of relay 515, inner upper normal contacts of relay 512, lower winding of relay 513, conductor 514, lower alternate contacts of relays 704, 714 and 724, conductor 707, lower windings of thousands register relays 601 and 602 to ground. Circuit No. 2 extends from conductor 274, over the lower back contact of relay 510, winding of relay 511, inner upper normal contacts of relay 512, lower winding of relay 513, thence as traced through the lower windings of relays 601 and 602 to ground. Circuit No. 3 extends from conductor 282, inner upper back contact of relay 500, upper winding of relay 513, conductor 607, upper alternate contacts of relays 704, 714 and 724, conductor 606, lower winding of thousands register relay 600, conductor 518, upper alternate contacts of relay 516, lower back contact of relay 512 to ground on conductor 503.

Should the operator depress a key before the sender has been connected to the position and the registration circuits above traced are ready, a circuit is closed from ground through the right winding of relay 416, outer right back contact of relay 438, outer left back contact of relay 417, through either low resistance 441, or both resistances 441 and 443, through the left contacts of the depressed key to battery over conductor 442. Relay 416 operates and transfers the circuit of lamp 415 from direct ground at the inner left back contact of relay 417 to ground through interrupter 444 thus warning the operator that she has started to set up the number prematurely. By operating key 439 she may release any falsely operated relays of the sender and also restore the circuit of lamp 415. When the sender is ready, lamp 415 will be extinguished as previously described and she may proceed to set up the number.

Assuming for the purposes of illustration that the called line number is 3456, the operator will successively operate keys Nos. 3, 4, 5 and 6. From the circuits above traced for the completion of the three registration circuits, it will be seen that the operation of key No. 3 extends circuits No. 2 and No. 3 to battery through low resistance. The completion of circuit No. 3 operates relay 440 which locks over its right winding and front contact to ground on conductor 1020. Relay 440 in operating extends the circuit of meter 445 to the locking ground of relay 440. Since circuit No. 3 is completed no matter which key is operated and relay 440 locks as soon as operated, it will be apparent that the depression of a key by an operator in the completion of a call will register once on the peg count meter 445.

At the sender since circuit No. 2 was completed, relays 511, 513 and 602 will be operated and since it was completed through low resistance 420 only, marginal relay 601 will be operated. The operation of relay 602 closes an obvious circuit for relay 604. The operation of relay 511 closes a circuit from ground on conductor 503, front contact of relay 511, upper back contact of relay 512, conductor 608, inner lower front contacts of relays 704, 714 and 724, conductor 708 to battery through the winding of relay 603. Relay 603 operates, locks through resistance 609, upper front contact of relay 603 to ground on conductor 521 and closes an obvious circuit for relay 605. Relays 601 and 602 lock through their upper windings and inner upper front contacts to ground on

conductor 521. The completion of circuit No. 3 through low resistance 441 alone causes the operation of marginal relay 600 which locks over its upper winding and inner upper front contact
5 to ground on conductor 521. Relay 513 also operates and closes a circuit from ground on conductor 521 over conductor 522, inner upper front contacts of relays 704, 714 and 724 to battery through the winding of relay 724. Relay 724 is
10 thus held operated, but relay 725 is shunted by ground connected to both terminals of its winding and releases. When key No. 3 is released, relay 513 releases in turn releasing relay 724. The release of relay 724 transfers the registration circuits Nos. 1, 2 and 3 to the hundreds register relays 720 to 723 inclusive.

The depression of the key No. 4 extends circuit No. 2 from battery on conductor 442, through high resistance 418, in addition to resistance
20 420, and extends circuit No. 3 from battery on conductor 442, through low resistance 441. Therefore, relays 511, 513 and 722 are operated in circuit No. 2 and relays 513 and 720 in circuit No. 3, while the operation of relay 511 closes
25 a circuit for relay 723. Relays 720 and 722 lock over their upper windings and inner upper front contacts to ground on conductor 521 and relay 723 locks through resistance 716 and its upper front contact to ground on conductor
30 521. The operation of relay 513 extends a circuit from grounded conductor 522, over the inner upper front contacts of relays 704 and 714, inner upper back contact of relay 704 to battery through the winding of relay 714 for holding
35 relay 714 operated and shunting relay 715 which releases. When key No. 4 is released, relay 714 also releases extending circuits Nos. 1, 2 and 3 to the tens register relays 710 to 713 inclusive.

The operation of key No. 5 completes circuit No. 3 through both high resistance 443 and low resistance 441 to battery on conductor 442. Therefore, relay 513 alone is operated, none of the register relays 710 to 713 being operated. The operation of relay 513 connects ground over conductor 522, the inner upper front contact of relay 704, the inner upper back contact of relay 714
45 to battery through the winding of relay 704 shunting and releasing relay 705. When the No. 5 key is released, relay 704 also releases extending the Nos. 1, 2 and 3 registration circuits to units register relays 700 to 703 inclusive.

The depression of key No. 6 completes circuit No. 3 through both high resistance 443 and low resistance 441 to battery on conductor 442 and
55 circuit No. 1 through low resistance 434 only to battery on conductor 442. Relays 515, 513, 701 and 702 operate over the No. 1 circuit, but due to the high resistance in the No. 3 circuit relay 700 does not operate, but relay 513 operates. The operation of relay 513 connects ground over conductor 522, inner upper back contact of relay 704,
60 conductor 717, resistance 626 to battery, shunting relay 625 and releasing that relay.

If the B operator depresses a wrong key and realizes it before she has depressed the last key corresponding to a particular number, she may release the sender by operating key 439. By doing so she releases relay 433 which in turn releases relay 417. Relay 417 upon releasing relights lamp
70 415 and again connects battery to the No. 1 and No. 2 registration circuits thereby causing the simultaneous operation of relays 511 and 515 in the sender which does not occur when she operates any of the numerical keys. With relays
75 511 and 515 both operated, a circuit is closed

from ground on conductor 503, front contacts of both of these relays to battery through the lower winding of relay 512. Relay 512 in operating extends the circuits of these relays through its upper alternate contacts and upper winding to
80 ground on conductor 503 and disconnects ground from conductor 521 with the result that all operated register relays release. Relay 501, however, does not release since it is held to ground at the link circuit and the sender is held busy and cannot be selected by another link. When key 439 is released, the position and sender circuits function to prepare themselves for the registration of the correct number as previously described.

When the last key of the keyset 450 is released and relay 513 releases a circuit is closed from ground on conductor 521, back contact of relay 513, lower front contact of relay 516, conductor 523, back contact of relay 625, conductor
95 524, winding of relay 510 to battery. Relay 510 operates and locks to ground on conductor 521 and closes an obvious circuit for relay 500.

The operation of relay 500 removes ground from conductor 266 thereby releasing relay 348
100 in the link circuit which in turn releases relay 330. Relay 330 in turn releases relay 325. A circuit is now established from battery, inner upper front contact of relay 516, winding of relay 519, lower front contact of relay 510, conductor 274, terminal 273, brush 272, conductor 356, inner back contact of relay 313, left back contact of relay 330, conductor 361, upper left and lower right contacts of cam 242, conductor
105 340, outer left back contact of relay 301, conductor 243, brush 244, terminal 245, conductor 124, left contacts of cam 125, left contacts of cam 126, upper right winding of repeating coil 101 to ground. Relay 519 operates locking directly from battery at its lower alternate contacts and releasing relay 516. Relay 516 upon releasing establishes a circuit extending from ground over conductor 521, upper back contact of relay 516,
110 outer right normal contacts of relay 525, inner upper front contact of relay 500, conductor 282, terminal 279, brush 280, conductor 281, outer left back contact of relay 348, conductor 360, lower contacts of cam 201, conductor 225 to battery through the winding of relay 202. Relay 202 operates and closes a circuit for advancing
125 sequence switch 200 into position 7 which may be traced from battery, winding of magnet 200, lower left contact of cam 223, right front contact of relay 202, lower right and upper left contacts of cam 208 to ground. When the sequence switch leaves position 6 the holding circuits of relays 109 and 342 are opened and these relays release, relay 109 closing a circuit for advancing sequence switch 110 into position 1
130 which extends from battery through the winding of magnet 110, lower left contact of cam 118, inner right back contact of relay 109 to ground over the lower left and right contacts of cam 128. As sequence switch 110 advances out of position 18 the circuit of relay 519 is
140 opened and relay 519 releases. The circuits of incoming selector 150, link circuit and sender are now ready for fundamental selections.

When relay 325 released it in turn released relay 412 in the position circuit which in turn released relays 409, 417, 428, 438 and 440 and extinguished lamps 415 and 423 freeing the operator's position circuit to receive another call.

With sequence switch 110 in position 1 and 150

link sequence switch 200 in position 7 a fundamental circuit may be traced from battery, winding of relay 127, left contacts of cams 129 and 130, conductor 123, terminal 238, brush 239, conductor 240, middle left back contact of relay 301, conductor 362, upper contacts of cam 275, brush 276, terminal 277, conductor 278, upper front contact of relay 510, back contact of counting relay 504, right winding of polarized overflow relay 526, conductor 527, winding of sender stepping relay 615, resistance 616, back contact of relay 617, conductor 618, lower front contact of relay 508, upper back contact of relay 519, lower front contact of relay 510, conductor 274, terminal 273, brush 272, conductor 356, inner back contact of relay 313, left back contact of relay 330, conductor 361, upper left and lower right contacts of cam 242, conductor 340, outer left back contact of relay 301, conductor 243, brush 244, terminal 245, conductor 124, upper left and lower right contacts of cam 108 to ground over the lower left and right contacts of cam 128. Relays 127 and 615 operate in this circuit, but the direction of current flowing through polarized relay 526 is not such as to cause its operation. Relay 127 upon operating closes a circuit from battery through the left winding of relay 109, upper left contact of cam 116, upper contact of cam 131, contact of relay 127, upper left contact of cam 105, upper left contact of cam 106 to ground over the lower right contact of cam 107. Relay 109 operates, locks over the circuit previously traced through its left winding to the upper left contact of cam 105, thence over the upper right contact of cam 106, inner right front contact of relay 109 to ground over the lower left contact of cam 128 and closes a circuit for advancing sequence switch 110 into position 2. This circuit extends from battery, winding of magnet 110, upper right contact of cam 132, lower right contact of cam 119, left front contact of relay 109 to ground over the upper contacts of cam 128. The initial circuit of relay 109 is opened in position 2, but that relay remains operated over the locking circuit above traced. With sequence switch 110 in position 2 a circuit is closed from battery through the winding of up-drive magnet 133, right contacts of cam 106, inner right front contact of relay 109, lower right contact of cam 128 to ground. The incoming selector is moved upward under the control of magnet 133 in a brush selection movement, intermittently closing a circuit from ground over the upper contacts of cam 128, left front contact of relay 109, right contacts of cam 119, brush 134, commutator strip 135, upper contacts of cam, 129 to battery through the winding of relay 127 holding relay 127 operated and intermittently shunting down sender stepping relay 615.

At the sender when relay 615 operates over the fundamental circuit with relay 614 operated and thousands register relays 600, 601, 602, 604 and 605 operated to register the thousands digit 3, a circuit is closed from ground at the upper back contact of relay 622, front contact of relay 615, lower front contact of relay 614, upper front contact of relay 600, lower front contact of relay 601, upper front contact of relay 604, lower front contact of relay 605, conductor 619, back contact of the No. 1' counting relay 531 to battery through the No. 1 counting relay 530. Relay 530 operates and locks over a circuit through the winding of relay 531, front contact of relay 530, conductor 551 to ground at the upper front con-

tact of relay 614, but relay 531 cannot operate being shunted by the energizing circuit of relay 530. When the intermittent circuit above described is first closed, relay 615 releases permitting relay 531 to operate. The operation of relay 531 extends the circuit controlled by relay 615 over the front contact of relay 531, conductor 627 lower back contacts of relays 611 and 610, conductor 628, winding of the No. 0 counting relay 528 to battery and upon the next operation of relay 615 relay 528 operates and locks through the windings of the No. 0' counting relay 529 and relay 504 in parallel, front contact of relay 528, conductor 548, next to upper front contact of relay 614 to ground. When the intermittent shunt is closed a second time and stepping relay 615 deenergizes, relays 504 and 529 operate. Relay 504 opens the fundamental circuit releasing relay 127 as soon as the intermittent shunt circuit above traced is opened when brush 134 engages the next insulating portion of commutator strip 135. The release of relay 127 releases relay 109, opens the circuit of up-drive magnet 133 and closes a circuit for advancing sequence switch 110 into position 3 which may be traced from battery, winding of magnet 110, lower left contact of cam 118, inner right back contact of relay 109 to ground at cam 128.

The operation of relay 529 opens the circuit of relay 505, but relay 505 is slow to release and a temporary holding circuit is completed for that relay over the front contact of relay 529, conductor 549, upper back contact of relay 621, conductor 550, lower front contact of relay 506, front contact of relay 504 over the fundamental circuit which remains completed until the shunting circuit over commutator strip 135 is opened. As soon as the shunting circuit is opened no further circuit exists for relay 505 and it releases after an interval. The purpose of this arrangement is to synchronize the operation of the sender with that of the selector and to prevent the closure of the circuits for the next selection before the sender is ready.

When relay 505 finally opens its contact relay 506 releases in turn releasing relay 508. Relay 624 not now being shunted by ground on conductor 509 which formerly caused the operation of relay 614, operates in the locking circuit of relay 614 extending from battery, winding of relay 614, lower winding of relay 624, inner lower front contact of relay 614, conductor 629 to ground on conductor 503 over the upper contact of relay 508. Relay 508 being slow to release, this locking circuit is not opened when relay 508 releases after an interval, until after relay 624 has had time to lock from battery over its upper winding and inner upper front contact to ground on conductor 503. When relay 508 finally releases, relay 614 releases removing ground from conductors 551 and 548 thereby releasing the operated counting relays 528 to 531 inclusive and relay 504. Relay 529 upon releasing again closes the circuit of relay 505 which operates, relays 506 and 508 operating in turn. A circuit is now established for relay 613 over the lower back contact of relay 623, lower front contact of relay 624, conductor 509, upper contacts of relay 506 to ground on conductor 503. Relay 613 upon operating prepares a locking circuit for itself through the lower winding of relay 623, inner lower front contact of relay 613, conductor 629, upper front contact of relay 508 to ground on conductor 503, but relay 623 being shunted does not operate at this time. Relay 613 also con-

nects ground to conductors 551 and 548 for locking the counting relays.

With relay 504 released and relay 508 operated, the fundamental circuit is again established and relays 127 and 615 reoperate. Relay 127 again causes the operation of relay 109 over a circuit extending from battery through the left winding of relay 109, upper left contact of cam 116, upper contact of cam 131, front contact of relay 127, lower right contact of cam 132, upper right contact of cam 119, lower right contact of cam 107 to ground, relay 109 upon operating, locking over the circuit just traced to the lower right contact of cam 132, thence over the lower right contact of cam 119, left front contact of relay 109 to ground over the upper contacts of cam 128 and closing a circuit for advancing sequence switch 110 into position 4. This circuit extends from battery, winding of magnet 110, upper left contact of cam 118, inner right front contact of relay 109 to ground over the lower left contact of cam 128. Upon leaving position 3 the initial operating circuit of relay 109 is opened at the lower right contact of cam 107, but relay 109 remains operated over its locking circuit. With the sequence switch in position 4 the circuit of up-drive magnet 133 is closed as before traced and an intermittent circuit is closed from ground over the upper contacts of cam 128, left front contact of relay 109, right contacts of cam 119, brush 136, commutator strip 137, lower right and left contacts of cam 129 to battery through the winding of relay 127 in shunt of the winding of the sender stepping relay 615. In positions 3 and 4 of sequence switch 110 trip magnet 138 is operated in a circuit extending from battery, through its winding and the upper contacts of cam 104 and during the initial portion of the group selection movement of the switch shaft under the control of up-drive magnet 133, the second set of brushes is tripped.

At the sender upon the operation of relay 615 with relay 613, hundreds register relay 720 and thousands register relays 600 and 601 operated as previously described, a circuit is established from ground at the upper back contact of relay 622, front contact of relay 615, lower front contact of relay 613, outer upper front contact of relay 601, lower front contact of relay 600, conductor 630, lower front contact of relay 720, conductor 713, back contact of the No. 2' counting relay 533 to battery through the winding of the No. 2 counting relay 532. Relay 532 operates and locks in a circuit through the winding of relay 533, front contact of relay 532, conductor 548 to ground at the inner upper front contact of relay 613, but relay 533 cannot operate being shunted by the energizing circuit of relay 532. When the intermittent shunt above described is first closed, relay 615 releases permitting relay 533 to operate and extend the circuit controlled by relay 615 over the back contact of the No. 1' counting relay 531 to battery through the winding of the No. 1 counting relay 530. On the next energization of relay 615, relay 530 operates and locks through the winding of the No. 1' counting relay 531, front contact of relay 530, conductor 551 to ground at the upper front contact of relay 613. Upon the next shunting of relay 615, relay 531 operates and extends the circuit controlled by relay 615 over its front contact, conductor 627, lower back contacts of relays 611 and 610, conductor 628 to battery through the winding of the No. 0 counting relay 528. Relay 528 operates on the next energization of relay 615 and locks through the windings of relays 529 and 504 in parallel to ground on conductor 548.

On the next deenergization of relay 615, relays 504 and 529 operate. Relay 504 opens the fundamental circuit releasing relay 127 as soon as the intermittent shunt above traced is opened when brush 136 engages the next insulating portion of commutator strip 137. The release of relay 127 releases relay 109 which opens the circuit of up-drive magnet 133 and closes the previously traced circuit for advancing sequence switch 110 into position 5.

In position 5 a circuit is closed from battery, resistance 139, right winding of relay 109, back contact of relay 140, right contact of cam 105, upper left contact of cam 106, lower right contacts of cam 107 to ground. Relay 109 operates, closing a holding circuit for itself over its left winding, upper left and lower right contacts of cam 119, left front contact of relay 109, lower contacts of cam 116 to sleeve brush 141, and closing the previously traced circuit for advancing sequence switch 110 into position 6. If the final selector, not shown, on the sleeve terminal 142 of which brush 141 is resting, is busy, ground will be connected to that terminal and relay 109 will be held operated to in turn close the previously traced circuit for up-drive magnet 133 to advance the selector brushes in a trunk hunting movement. When an idle final selector is found, ground will be absent from its sleeve terminal and relay 109 will release, stopping the incoming selector and advancing sequence switch 110 over the circuit previously traced through position 7 into position 8. Relay 109 is held operated until the brushes are properly centered by a circuit from battery, through resistance 139, right winding of relay 109, upper contacts of cam 143, centering strip 144, brush 145, upper contacts of cam 106, inner right front contact of relay 109, lower contact of cam 128 to ground. The release of relay 109 immediately connects ground over the right contacts of cam 122, left back contact of relay 109, lower contacts of cam 116 to sleeve brush 141 to mark the final selector busy. As soon as sequence switch 110 reaches position 6¾ ground is connected directly to brush 141, over the left contacts of cam 107, maintaining the final selector busy until the incoming selector leaves position 15¼ following its release. In position 8 control circuits are extended to the final selector which has not been shown since it may be of any standard type, for example that shown in U. S. Patent No. 1,658,829, granted February 14, 1928 to C. H. Berry. The fundamental circuit for final selections is the same as for incoming selections.

At the sender the operation of relay 529 causes relays 505, 506 and 508 to function in the manner previously described, relay 506 opening the shunt around the winding of relay 623 which now operates and locks over its upper winding and upper front contact to ground on conductor 503 before relay 508 has had time to release. As soon as relay 508 releases, the holding circuit previously traced through the winding of relay 613 and the lower winding of relay 623 is opened and relay 613 releases. Relay 613 upon releasing removes ground from conductors 551 and 548 thereby releasing the operated counting relays. Relay 529 upon releasing again closes the circuit of relay 505 which operates in turn causing the operation of relays 506 and 508. A circuit is now established for relay 612 over the lower back contact of relay 622, lower front contacts of relays 623 and 624, conductor 509, upper contact of relay 506 to ground over conductor 503, relay 612 upon op-

erating preparing a locking circuit for itself through the lower winding of relay 622, inner lower front contact of relay 612, conductor 629, upper front contact of relay 508 to ground on conductor 503, but relay 622 being shunted does not operate at this time. Relay 612 also connects ground to conductors 551 and 548 for locking the counting relays.

With relay 504 released and relay 508 operated, the fundamental circuit previously traced is closed and relays 127 and 615 operate thereover. Relay 127 upon operating closes a circuit for relay 109 extending from battery, through its left winding, upper left contact of cam 116, upper contact of cam 131, contact of relay 127, upper contacts of cam 111, lower left and upper right contacts of cam 126, brush 146, terminal 147 to the tip conductor of the final selector trunk. A parallel circuit through resistance 139 and the lower left and upper right contacts of cam 131, thence as traced to the tip trunk conductor prevents relay 109 from operating until direct ground is connected to the tip conductor following the completion of final selections. The final selector in making selections connects intermittent ground to the ring trunk conductor over terminal 148, brush 149, upper right contact of cam 130, left contact of cam 129 to battery through the winding of relay 127 holding that relay operated and shunting the stepping relay 615 of the sender in the same manner as the commutator of the incoming selector.

In the sender upon the operation of relay 615 with relay 612 and hundreds register relays 720, 722, 723 operated, a circuit is established from ground at the upper back contact of relay 622, front contact of relay 615, lower front contact of relay 612, conductor 631, lower back contact of relay 721, lower front contact of relay 722, lower front contact of relay 723, conductor 726, back contact of the No. 4' counting relay 537 to battery through the winding of the No. 4 counting relay 536. Relay 536 operates and locks through the winding of relay 537, front contact of relay 536, conductor 548 to ground at the inner upper front contact of relay 612, but relay 537 being shunted does not operate. On the first shunting of relay 615 as the final selector advances in its brush selection movement, relay 537 operates and extends the circuit controlled by relay 615 over the back contact of the No. 3' counting relay 535 to battery through the winding of the No. 3 counting relay 534. On the next energization of relay 615, relay 534 operates and locks through the winding of relay 535, front contact of relay 534, conductor 551 to ground at the upper front contact of relay 612. In this manner the counting relays 530, 531, 528, 529 and 504 operate. When relay 504 operates the fundamental circuit is opened and relay 127 releases, opening the control circuit over the tip trunk conductor of the final selector to arrest further brush selection movement of the final selector. Relay 529 upon operating causes relays 505, 506 and 508 to function as previously described, relay 506 opening the shunt around the winding of relay 622 which now operates and locks over its upper winding and inner upper front contact to ground on conductor 503 before relay 508 has had time to release. As soon as relay 508 releases, the locking circuit previously traced through the winding of relay 612 and the lower winding of relay 622 is opened and relay 612 releases. Relay 612 upon releasing removes ground from conductors 551 and 548 thereby releasing the operated counting relays.

Relay 529 upon releasing again closes the circuit of relay 505 which operates in turn causing the operation of relays 506 and 508. A circuit is now established for relay 611 extending over the lower back contact of relay 621, lower front contacts of relays 622, 623 and 624, conductor 509, upper contact of relay 506 to ground on conductor 503, relay 611 upon operating preparing a locking circuit for itself through the lower winding of relay 621, inner upper front contact of relay 611, conductor 629, upper front contact of relay 508 to ground on conductor 503, but relay 621 being shunted does not operate at this time. Relay 611 also connects ground to conductors 551 and 548 for locking the counting relays.

With relay 504 released and relay 508 operated, the fundamental circuit is again closed and relays 127 and 615 reoperate thereover for controlling final tens selection, relay 127 again closing the previously traced control circuit to the final selector and relay 615 with relay 611 operated and no tens register relays operated, closing a circuit extending from ground, upper front contact of relay 622, lower back contact of relay 612, contact of relay 615, inner lower front contact of relay 611, conductor 632, lower back contacts of tens register relays 711 and 712, conductor 627, lower front contact of relay 611, conductor 633, lower back contact of tens register relay 710, conductor 727, back contact of the No. 9' counting relay 547 to battery through the winding of the No. 9 counting relay 546. In response to the intermittent shunting of relay 615 as the final selector advances in its tens selection movement, counting relays 546, 547, 544, 545, 542, 543, 540, 541, 538, 539, 528, 529 and 504 operate in succession. When relay 504 operates the fundamental circuit is opened and relay 127 releases, opening the control circuit to the final selector to arrest further tens selection movement. At the final selector during the initial portion of the tens selection movement, the selected brush set was tripped in the well-known manner. Relay 529 upon operating causes relays 505, 506 and 508 to function as previously described, relay 506 opening the shunt around the winding of relay 621 which now operates and locks over its upper winding and upper front contact to ground on conductor 503 before relay 508 has had time to release. As soon as relay 508 releases, the previously traced holding circuit for relay 611 is opened and relay 611 releases removing ground from conductors 551 and 548 to release the operated counting relays. Relay 529 upon releasing again closes the circuit of relay 505 which in turn causes the operation of relays 506 and 508. A circuit is now established for relay 610 extending over the lower back contact of relay 620, lower front contacts of relays 621 to 624, inclusive, conductor 509, contacts of relay 506 to ground on conductor 503, relay 610 upon operating, preparing a locking circuit for itself through the lower winding of relay 620, inner upper front contact of relay 610, conductor 629, upper front contact of relay 508 to ground on conductor 503, but relay 620 being shunted does not operate at this time. Relay 610 also connects ground to conductors 551 and 548 for locking the counting relays.

With relay 504 released and relay 508 operated, the fundamental circuit is again closed and relays 127 and 615 reoperate for controlling final units selection, relay 127 again closing the previously traced control circuit to the final selector and relay 615 with relay 610 and units register relays 701 and 702 operated, closing a circuit

extending from ground, upper front contact of relay 622, lower back contact of relay 612, contact of relay 615, inner lower front contact of relay 610, conductor 634, lower front contact of units register relay 601, inner lower front contact of register relay 702, inner upper back contact of register relay 703, conductor 619, back contact of the No. 1' counting relay 531 to battery through the No. 1 counting relay 530. Relays 530 and 531 operate in the well-known manner in response to the first energization of relay 615 as the final selector advances in its units selection movement, relay 531 upon operating extending conductor 619 to conductor 627, lower back contact of relay 611, lower front contact of relay 610, conductor 635, back contact of units register relay 700, conductor 727, back contact of the No. 9' counting relay 547 to battery through the winding of the No. 9 counting relay 546.

In response to the further intermittent operation of relay 615, counting relays 546, 547, 544, 545, 542, 543, 540, 541, 538, 539, 528, 529 and 504 operate in succession. When relay 504 operates the fundamental circuit is opened and relay 627 releases, opening the control circuit to the final selector to arrest further units selection movement. Relay 529 upon operating causes relays 505, 506 and 508 to function as previously described, relay 506 opening the shunt around the winding of relay 620 which now operates and locks over its upper winding and front contact to ground on conductor 503 before relay 508 has time to release. As soon as relay 508 releases, the previously traced holding circuit for relay 610 is opened and relay 610 releases removing ground conductors 551 and 548 to release the operated counting relays. With relay 620 operated, ground is removed at the upper back contact of relay 620 from conductor 507, so that when relay 505 again operates upon the release of counting relay 529, relays 506 and 508 will not again operate for closing the fundamental circuit.

When final selections are completed, direct ground is connected at the final selector to both the tip and ring trunk conductors thus operating both relays 109 and 127 in the incoming selector. With relay 109 operated a circuit is closed for advancing sequence switch 110 into position 9 extending from battery, winding of magnet 110, upper right contact of cam 132, lower right contact of cam 119, left front contact of relay 109 to ground over the upper contacts of cam 151. With the sequence switch in position 9, battery through the winding of relay 127 is connected over the right and lower left contacts of cam 125 to conductor 124, thence as traced to conductor 274 in the sender, lower front contact of relay 510, upper back contact of relay 519, conductor 553, winding of relay 617, upper front contact of relay 624, conductor 552 to ground at the left normal contacts of relay 525. Relays 127 and 617 operate in this circuit, relay 617 closing a circuit from battery at the upper front contact of relay 617, resistance 616, winding of relay 615, conductor 527, right winding of overflow relay 526, back contact of relay 504, upper front contact of relay 510, conductor 278, thence as traced to conductor 123 and to ground at the lower contacts of cam 130. Relay 526 now receives current in the proper direction to cause its operation and it locks over its left winding, inner right normal contacts of relay 527, front contact of relay 526, outer right normal contacts of relay 526, upper back contact of relay 516 to ground on conductor 521. The locking ground for relay 526 also extends to battery through the winding of relay 526 which operates, locks over its inner right alternate contacts to ground on conductor 521, disconnects ground from conductor 552 and connects this conductor over its left alternate contacts, upper front contact of relay 510, conductor 278, thence as traced to ground at the lower contacts of cam 130 at the incoming selector.

At the incoming selector, relay 127 operates and closes a previously traced circuit through the left winding of relay 109. Relay 109 now operates closing a circuit for advancing sequence switch 110 into position 11 which may be traced from battery, magnet 110, lower contacts of cam 152, left front contact of relay 109 to ground over the upper contacts of cam 151. When the sequence switch leaves position 9, relay 109 releases and when it leaves position 10, the previously traced circuit for relays 127 and 617 is opened, relay 617 upon releasing, opening the operating circuit of relay 526 which now releases since its locking circuit was opened upon the operation of relay 525. With sequence switch 110 in position 11, a circuit is closed from battery, through resistance 139, right winding of relay 109, back contact of relay 140, right and lower left contacts of cam 105 to ground at the right front contacts of relay 104. Relay 109 operates, locking through its right winding, back contact of relay 140, right contact of cam 105, upper right contact of cam 106, inner right front contact of relay 109 to ground at cam 128 and closes a circuit for advancing sequence switch 110 into position 12. This circuit extends from battery, winding of magnet 110, upper right contact of cam 132, lower right contact of cam 119, left front contact of relay 109 to ground at the upper contacts of cam 128. Relay 109 remains locked in position 12. With sequence switch 110 in position 12, ringing current is connected/ from source 153 over the contacts of cam 154, winding of relay 140, left front contact of relay 109, right contacts of cam 155, brush 149, terminal 148, thence over the ring brushes of the final selector through the called line substation bell, returning over the tip brushes of the final selector to terminal 147, brush 146 to ground at the right contacts of cam 126. Ringing tone current is also connected from the left front contact of relay 109 through condenser 156, upper contacts of cam 122, winding of relay 120 to the lower right winding of repeating coil 101. This tone current is inductively connected to the calling subscriber's line through the connected A operator's cord circuit and the calling subscriber hears a ringing tone signal.

When the called subscriber answers, relay 140 operates, opening the holding circuit of relay 109 which releases to discontinue the application of ringing current to the called line and ringing tone to the calling subscriber's line and to advance sequence switch 110 into talking position 14. The circuit for advancing the sequence switch extends from battery, winding of magnet 110, lower left contact of cam 118, inner right back contact of relay 109 to ground over contacts of cam 128. The talking circuit to the called subscriber's line may now be traced in part from brush 146, upper contacts of cam 126, right windings of repeating coil 101, winding of relay 120, lower contacts of cam 155 to brush 149. Relay 120 operates in this talking circuit closing a

shunt around the right high resistance winding of relay 102 which may be traced from the upper terminal of this winding, lower left contacts of cams 132 and 119, front contact of relay 120 to the lower terminal of the winding of relay 102. The shunting of the high resistance winding of relay 102 increases the current flowing through the left winding of repeating coil 101 to the calling end of the A operator's cord circuit thereby giving the A operator a supervisory signal that the called subscriber has answered.

At the sender upon the release of relay 526 with relay 525 operated, ground is removed from conductor 282 releasing relay 202 in the link circuit which closes a circuit from battery, winding of sequence switch magnet 200, upper left contact of cam 223, back contact of relay 202 to ground over the upper contacts of cam 207 for advancing the sequence switch into position 8. With the sequence switch in position 8, relay 307 is operated over conductor 364, left contacts of cam 237, off-normal commutator segment 283 and brush 284 of the trunk finder 210 to ground, and a circuit is closed for down-drive magnet 285, conductor 363, left front contact of relay 307, conductor 258 to ground over the lower right and upper left contacts of cam 218. Upon reaching normal position, brush 284 leaves commutator strip 283 thus opening the circuit of relay 307 which releases and opens the circuit of down-drive magnet 285. If the sender finder 260 located an idle sender within the zone covered by commutator strip 286 with sequence switch 200 in position 8, a circuit is closed from ground, brush 287, strip 286, upper contacts of cam 288, conductor 329 to battery through the winding of relay 320 and resistance 346 and relay 320 operates. As soon as relay 307 releases, a circuit is closed from battery, winding of down-drive magnet 256, conductor 257, outer right front contact of relay 320, back contact of relay 307, conductor 258 to ground over the lower right and upper left contacts of cam 218. When the sender finder reaches normal, brush 261 closes a circuit from ground over normal segment 259, upper right and lower left contacts of cam 262, conductor 263, resistance 346 to battery, shunting down relay 320 which opens the circuit of down-drive magnet 256. With both relays 320 and 307 released, a circuit is closed for advancing sequence switch 200 into position 9 which may be traced from battery, winding of magnet 200, lower right contact of cam 223, lower normal contacts of jack 289, conductor 369, outer right back contact of relay 320, left back contact of relay 307, conductor 258, lower right and upper left contacts of cam 218 to ground.

Sequence switch 200 remains in this position awaiting assignment for the next call until the next preceding link circuit allots this link circuit for use. In the arrangement shown the link at the extreme left of Fig. 8 precedes the link shown in full in Fig. 2. When the link shown at the extreme left of Fig. 8 leaves position 1 and the relay thereof corresponding to relay 202 releases following the finding of a calling incoming selector trunk, a circuit is closed from battery, winding of relay 202 of Fig. 2, conductor 225, left contacts of cam 201, lower left and upper right contacts of cam 203, conductor 808, inner left contacts of relays 803 and 801, conductor 809, left contacts of cam 222² of the last link, conductor 811, over an extra back contact added to the relay corresponding to relay 202 of the last link, conductor 810 to ground. Relay 202 of the link of

Fig. 2 operates and closes a circuit for advancing sequence switch 200 into position 10 which may be traced from battery, winding of magnet 200, lower left contact of cam 223, right front contact of relay 202, lower right and upper left contacts of cam 208 to ground.

The link of Fig. 2 and the link represented by the cams located in the central portion of Fig. 8 are located on the front of the link frame, while the links represented by the cams at the left of Fig. 8 are located on the rear of the frame. If the motor driving the trunk finders on the rear of the frame stops, ground is connected to conductor 812 operating relays 803, 813 and 814. If the motor driving the trunk finders on the front of the frame stops, ground will be connected to conductor 815 operating relays 801, 807, 816 and 817. If the motor at the rear stops, the relation of the extreme left link of Fig. 8 to the link of Fig. 2 is assumed by the link closest to the motor start circuit on the front of the frame in their sequential arrangement. Assuming that the link in the central portion of Fig. 8 is that link, the circuit of relay 202 would extend from battery through the winding of that relay, left contacts of cam 201, upper right contact of cam 203, conductor 808, right front contact of relay 803, conductor 802, left and lower right contacts of cam 222' to ground.

When the established connection is no longer needed, the originating A operator removes her cord plug from jack 100 releasing relay 102 which in turn releases relays 103 and 104. Relay 104 upon releasing closes a circuit extending from ground at its right back contact, over the lower contacts of cam 157 through the winding of sequence switch magnet 110 for advancing the sequence switch out of position 14 into position 16. In position 16, the circuit of down-drive magnet 158 is closed over the lower right contact of cam 131, lower left contact of cam 116 to ground over the upper contacts of cam 128. When the selector brush shaft reaches normal position, a circuit is established from ground, over the lower right contact of cam 107, brush 145, normal segment 159, lower right contact of cam 118 to battery through the winding of sequence switch magnet 110 for advancing the sequence switch into position 17 which is its normal position. Upon leaving position 15 $\frac{1}{4}$ ground is removed from sleeve brush 141 at the left contacts of cam 107 thereby causing the release of the final selector. All apparatus used in the establishment of the connection is now in normal position.

Incoming trunk call handled by adjacent A operator

It will be now assumed that when a call from the A operator's position is initiated over the incoming selector trunk of Fig. 1 and the link circuit of Fig. 2 has functioned to connect with the calling trunk and the sequence switch 200 thereof is advanced from position 1 to position 2, that the B operators' positions are all vacant as signified by the removal of the operators' headset plugs from the position jacks. In this case when sequence switch 200 reaches position 2, the night alarm bell 406 is rung and position lamp 405 is lighted and relay 320 in the link circuit is operated to open the circuit which would otherwise be closed to cause the position finder 300 to hunt for a B operator's position circuit as previously described.

An A operator's position which is adjacent to the B operator's position on the same switchboard

is illustrated in the lower portion of Fig. 10. When her headset is plugged up, her transmitter 1035 is connected in a circuit from battery, winding of relay 1034, tips of jack 1033 and plug 1031, transmitter 1035, tips of plug 1030 and jack 1032, left winding of repeating coil 1036 to ground and her receiver 1037 is connected over rings of plugs 1030 and jack 1032, right back contact of relay 1038, inner left back contact of relay 1039, condenser 1040, right back contacts of relays 1041 and 1042 to the tip talking lead 1043 extending to her A cord circuits one of which is shown in the lower portion of Fig. 11, and over rings of plugs 1031 and 1033, left back contact of relay 1038, upper right winding of repeating coil 1036, outer left back contact of relay 1039 to the ring talking lead 1044 extending to her A cord circuits. The A operator thus normally functions as an A operator.

At night, however, this A operator may, in addition to her regular A calls, handle calls intended to be handled by the B operator. If such a B call comes in at night when all the B positions are vacant and the night alarm bell 406 rings, she may reach over to the adjacent B position and depress key 1015 thereby closing the circuit of relay 1009 and, as relay 1004 is not operated, the B position being vacant, a circuit is closed from ground through the back contact of relay 1004, right contacts of key 1015 to battery through the winding of relay 1039. Relay 1039 operates and with relay 1034 operated causes the energization of relay 1046. Relay 1009 upon operating does not cause the operation of relay 1016 since relay 1004 is not operated and with relay 1016 not operated and relay 1046 operated, a circuit is established from battery, through the winding of grouping relay 431, conductor 1021, right front contact of relay 1046, right back contact of relay 1016 to ground.

Relay 1039 upon operating also transfers the A operator's headset receiver 1037 from the talking leads 1043 and 1044 extending to her A cord circuits to the talking leads 1022 and 1023 extending to the adjacent B operator's position circuit shown in Fig. 4. Relay 1046 upon operating connects ground to conductor 1019 thereby operating relay 400 and relay 431 connects ground directly to conductor 1020 for operating relay 401 and extends conductor 411 over its inner right front contact, conductor 1024 to battery over the inner left contact of relay 1046. In the manner previously described relay 400 upon operating extinguishes lamp 405 and silences the alarm bell 406 and relay 401 releases relays 403, 404 and 320. The release of relay 320 now permits the position finder 300 to hunt for the position circuit of Fig. 4 which is now marked as available by battery connected to conductor 411. As soon as the position is found, relay 412 operates following which two zip tones are transmitted to the originating A operator in the manner previously described, a portion of this tone current being transmitted to the answering A operator's receiver 1037 through condenser 430, the intermediate normal contacts of key 410, the outer left front contact of grouping relay 431, conductor 1022, outer left front contact of relay 1039, upper right winding of repeating coil 1036, left back contact of relay 1008, rings of jack 1033 and plug 1031, headset receiver 1037, rings of plug 1030 and jack 1032, right back contact of relay 1038, inner left front contact of relay 1039, conductor 1023, outer right front contact of relay 431 to condenser 432. The answering A operator hears these tones. Follow-

ing the transmission of the tone signals, relay 428 operates as previously described to discontinue the application of tone current and to establish a talking circuit between the operators over which the answering A operator may receive instructions from the originating A operator as to the designation of the desired connection.

As previously described, the link circuit proceeds to connect with an idle sender and following such connection lamp 415 is extinguished as a signal that the sender is ready to register the designation of a desired connection. The answering A operator perceiving the lamp 415 extinguished then reaches over to the adjacent B position and manipulates the keys of keyboard 450 in accordance with the designation which she has received from the originating A operator. The circuit then functions in exactly the same manner as previously described.

B operator functions as an A operator

It will now be assumed that the B operator is on duty and that there are no waiting B calls and that therefore key 1015 is normal. It will further be assumed that there is a local A call requiring the B operator's attention. To answer this call she will plug the answering plug 1101 of an idle one of her cord circuits, for example, the cord circuit shown at 1100 in Fig. 11, into the answering jack, for example, of a trunk over which a local calling subscriber has become connected for the purpose of obtaining an operator's assistance in completing a desired connection. Relay 1102 will therefore be operated over sleeve of plug 1101 and will close a circuit for answering supervisory lamp 1103 over the back contact of relay 1104, but since relay 1104 also operates at this time over the tip of plug 1101, upper normal contacts of key 1105, upper front contact of relay 1102, upper left winding of repeating coil 1106 to ground through the upper winding of relay 1104 and over the ring of plug 1101, lower normal contacts of key 1105, lower left winding of repeating coil 1106 to battery through the lower winding of relay 1104, the circuit of lamp 1103 is opened at the back contact of relay 1104 and lamp 1103 does not light. The operator now throws the cord circuit listening key 1107 to the right thereby connecting the talking leads 1013 and 1014 extending from her headset receiver 1007 over the inner alternate right contacts of key 1107 to the right windings of repeating coil 1106. She may now talk with the calling subscriber to ascertain his wishes.

It has been assumed that the calling subscriber desires the operator to complete a call for him and that therefore the operator after having received the necessary instructions from the calling subscriber tests an outgoing trunk extending to the dial switching office in which the desired connection may be completed. The testing circuit extends from the sleeve of the trunk jack, not shown, tip of plug 1108, upper normal contacts of relay 1109, upper back contact of relay 1110, upper normal contacts of key 1111, conductor 1112, condenser 1025, lower right winding of repeating coil 1026 to ground. The operator receives a busy click in her receiver inductively through the left windings of coil 1026 and the windings of repeating coil 1006 if the trunk is busy. If she finds that the trunk is idle she inserts plug 1108 into the trunk jack establishing a circuit from ground over the sleeves of the jack and plug 1108, winding of sleeve relay 1113, winding of marginal sleeve relay 1114 to

battery. Due to a high resistance in the sleeve circuit of the trunk, marginal relay 1114 does not operate, but relay 1113 operates closing a circuit for relay 1110 extending over the lower normal contacts of key 1111 and a circuit for calling supervisory lamp 1117 extending from battery, contact of relay 1113, back contact of relay 1115, back contact of relay 1116 through lamp 1117 to ground. Lamp 1117 lights and remains lighted until the called subscriber answers. Relay 1110 upon operating opens the previously traced test circuit at its upper back contact.

When the operator moves her dial 1127 off normal to dial the first digit of the desired line designation, relay 1012 operates in a circuit over the off-normal contacts of the dial, short-circuiting relay 1029 over its inner left contact and with relay 1110 operated and listening key 1107 thrown to the right a circuit is closed from battery, inner upper front contact of relay 110, upper winding of relay 1109, lower alternate right contacts of key 1107, conductor 1118, outer left front contact of relay 1012, back contact of relay 1028 to ground. Relay 1109 operates and locks in a circuit from battery at the front contact of relay 1113, lower winding and inner lower front contact of relay 1109, conductor 1119, back contact of relay 1029, left back contact of relay 1011 to ground in parallel through resistance 1045 and the winding of relay 1028. Relay 1028 operates in this locking circuit opening the initial operating circuit of relay 1109 and closing the circuit of lamp 1047.

As the dial returns to normal impulses are transmitted to the trunk circuit over the tip of plug 1108, upper alternate contacts of relay 1109, conductor 1120, inner left contact of relay 1012, alternate contacts of relay 1109, conductor 1120, inner left contact of relay 1012, pulsing contacts of dial 1027, conductor 1121, lower alternate contacts of relay 1109, over the ring of plug 1108 to the trunk. As soon as the dial returns to normal again the circuit of relay 1012 is opened and relay 1012 releases. When the operator has dialed all of the digits of the desired line designation, she depresses the dial release key 1048 thereby operating relay 1011, which opens the locking circuit of relay 1109 which now releases and extends a talking circuit from the right windings of repeating coil 1106, over front contacts of relay 1110 and normal contacts of relay 1109. When the locking circuit of relay 1109 is opened, relay 1028 also releases extinguishing lamp 1047. Whenever the dial is off normal and relay 1012 is operated, or if the dial release key 1048 is operated and relay 1011 is operated, the talking lead 1013 is opened so that the operator may not hear clicks in her receiver.

If the called subscriber answers before the dial release key 1048 has been operated, relay 1029 operates over the dialing circuit, opening the locking circuit of relay 1109 whereupon relays 1109 and 1028 release. With relay 1109 released the response of the called subscriber establishes a circuit over the upper normal contacts of relay 1109, upper alternate contacts of relay 1110, upper right winding of repeating coil 1106, right back contact of relay 1114, winding of relay 1116, left back contact of relay 1114, lower right winding of repeating coil 1106, lower front contact of relay 1110, lower normal contacts of relay 1109. Relay 1116 operates in this circuit to open the circuit of lamp 1117 as a signal that the called subscriber has answered. When the operator no longer needs to listen in on the cord circuit she

restores key 1107 thereby disconnecting her headset from the cord circuit.

Should the operator desire at any time to monitor on a connection she throws the key 1107 to the left thereby establishing a circuit from ground over the lower left contacts of key 1107, conductor 1122, right back contact of relay 1009, winding of relay 1008 to battery. Relay 1008 operates connecting the left winding of monitoring repeating coil 1049 in circuit with her headset receiver 1007. A monitoring circuit now extends from the tip conductor of the cord circuit, upper left contacts of key 1107, conductor 1123, right winding of repeating coil 1049, conductor 1124, intermediate left contacts of key 1107 to the ring conductor of the cord circuit.

When the calling and called subscribers restore their receivers to the switchhooks, the supervisory relays 1104 and 1116 release, lighting lamps 1103 and 1117 as disconnect signals. The operator then takes down the cord plugs 1101 to 1108 and all apparatus used in the establishment of the connection is restored in the well-known manner.

The A operator's telephone and dialing circuit shown in the lower portion of Fig. 10 function in an exactly similar manner with the cord circuit shown in the lower portion of Fig. 11 and a detailed description thereof is therefore not necessary.

What is claimed is:

1. In a telephone system, an operator's position having a telephone set, cord circuits, talking conductors for normally associating said telephone set with said cord circuits, a listening key in each cord circuit for connecting such cord circuits with said conductors, incoming trunk circuits, a selector switch for automatically connecting any one of said trunk circuits with said telephone set but barred from making such a connection when said telephone set is associated with said conductors, and means for disassociating said telephone set from said conductors and for rendering said switch effective for connecting said telephone set with an incoming trunk circuit.

2. In a telephone system, an operator's position having a telephone set, cord circuits, talking conductors for normally associating said telephone set with said cord circuits, a listening key in each cord circuit for connecting such cord circuits with said conductors, incoming trunk circuits, a selector switch for automatically connecting any one of said trunk circuits with said telephone set but barred from making such a connection when said telephone set is associated with said conductors, and key controlled means for disassociating said telephone set from said conductors and for rendering said switch effective for connecting said telephone set with an incoming trunk circuit.

3. In a telephone system, an operator's position having a telephone set, cord circuits at said position, talking conductors for normally associating said telephone set with said cord circuits, a listening key in each cord circuit for connecting such cord circuits with said conductors, trunk circuits incoming to said operator's position, a selector switch operative upon the seizure of one of said trunk circuits for selecting said operator's position, means for barring the operation of said selector switch when said telephone set is associated with said conductors and for operating a signal, and means controlled by said operator in response to said signal for disassociating said telephone set from said conductors and for rendering said switch effective for connecting said

telephone set with said incoming trunk circuit.

4. In a telephone system, a first operator's position having a telephone set, cord circuits at said position, talking conductors for normally associating said telephone set with said cord circuits, a listening key in each cord circuit for connecting such cord circuits with said conductors, a second operator's position, trunk circuits incoming to said second position, a selector switch for automatically connecting any one of said trunk circuits with the telephone set of said first position but barred from making such a connection while said telephone set is associated with said conductors, and a key-controlled means for disassociating said telephone set from said conductors and for rendering said switch effective for connecting said telephone set with one of said incoming trunk circuits.

5. In a telephone system, a first operator's position having a telephone set, cord circuits at said position, talking conductors for normally associating said telephone set with said cord circuits, a listening key in each cord circuit for connecting such cord circuits with said conductors, a second operator's position having a telephone set, trunk circuits incoming to said second position, a selector switch for connecting any one of said trunk circuits with the telephone set of said second position, means effective when said second position is vacant for barring the connection of a trunk circuit to the telephone set of said second position, and key-controlled means for disassociating the telephone set of said first position from said conductors and for rendering said switch effective for connecting the telephone set of said first position with one of said incoming trunk circuits.

6. In a telephone system, a first operator's position having a telephone set, cord circuits at said position, talking conductors for normally associating said telephone set with said cord circuits, a second operator's position having a telephone set, cord circuits at said second position, talking conductors for normally associating said telephone set of said second position with the cord circuits thereat, trunk circuits incoming to said second position, a selector switch for automatically connecting any one of said trunk circuits with the telephone set of said second position but barred from making such a connection while the telephone set of said second position is associated with the conductors thereat, a key at said second position, means at said second position controlled by said key for disassociating the telephone set thereof from said conductors and for rendering said selector switch effective for connecting said telephone set with any one of said trunk circuits, means effective when said second position is vacant for barring the connection of a trunk circuit with the telephone set of said position, and means controlled by said key for disassociating the telephone set of said first position from the talking conductors thereat and for rendering said selector switch effective for connecting any one of said trunk circuits with the telephone set of said first position.

7. In a telephone system, a first operator's position having a telephone set, cord circuits at said position, talking conductors for normally associating said telephone set with said cord circuits, a listening key in each cord circuit for connecting said cord circuits with said conductors, a second operator's position, trunk circuits incoming to said second position, a selector switch operative upon the seizure of one of said trunk circuits for

selecting said second operator's position, means for barring the operation of said selector switch when said second operator's position is vacant and for operating a signal, and key-controlled means operated by said first operator in response to said signal for disassociating the telephone set of said first position from said conductors and for rendering said selector switch operable for connecting said telephone set with an incoming trunk circuit.

8. In a telephone system, an operator's switchboard, first and second operators' positions adjacent to each other on said switchboard, a telephone set at each position, cord circuits at said first position, talking conductors for normally associating the telephone set of said first position with said conductors when said position is occupied, incoming trunk circuits, a selector switch operative upon the seizure of one of said trunk circuits for selecting said second operator's position, means for barring the operation of said selector switch when said second operator's position is vacant and for operating a signal, and key-controlled means operative by said first operator in response to said signal for disassociating the telephone set of said first position from the talking conductors thereat and for rendering said selector switch operable for connecting the telephone set of said first position with an incoming trunk circuit.

9. In a telephone system, an operator's switchboard, first and second operators' positions adjacent to each other on said switchboard, a telephone set and cord circuits at each position, talking conductors for normally associating the telephone set of each position with the cord circuits of each position, respectively, when said positions are occupied, incoming trunk circuits, a selector switch operative upon the seizure of one of said trunk circuits for selecting said second operator's position, means for barring the operation of said selector switch when said second operator's position is occupied but busy in connection with cord circuits thereof and for operating a signal, key-controlled means operative by said first operator in response to said signal for disassociating the telephone set of said first position from the talking conductors thereof and for rendering said selector switch operable for connecting the telephone set of said first position with an incoming trunk circuit.

10. In a telephone system, an operator's switchboard, first and second operators' positions adjacent to each other on said switchboard, a telephone set and cord circuits at each position, talking conductors for normally associating the telephone set of each position with the cord circuits of each position, respectively, when said positions are occupied, incoming trunk circuits, a selector switch operative upon the seizure of one of said trunk circuits for selecting said second operator's position, means for barring the operation of said selector switch when said second operator's position is vacant and for operating a signal, and key-controlled means at said second position and operable by the operator at said first position in response to said signal for disassociating the telephone set of said first position from the talking circuits thereof and for rendering said selector switch operable for connecting the telephone set of said first position with an incoming trunk.

11. In a telephone system, an operator's switchboard, first and second operators' positions adjacent to each other on said switchboard, a telephone set at each position, cord circuits at said

first position, talking conductors for normally associating the telephone set of said first position with said conductors when said position is occupied, a keyboard at said second position, incoming trunk circuits terminating in selector switches, register senders, a link circuit comprising a trunk finder, a second finder and a position finder, means operative upon the seizure of a trunk circuit for causing said trunk finder to connect with said trunk circuit and preparing said position finder to connect with said second operator's position, means for barring the operation of said position finder if said second operator's position is vacant and for operating a signal, key-controlled means operative by said first operator in response to said signal for disassociating the telephone set of said first position from the talking conductors thereof and for rendering said position finder operable for connecting the telephone set of said first position with the connected incoming trunk circuit, means thereupon operative for causing said sender finder to select an idle sender, and means whereby the operation of said keyboard of said second position by the operator at said first position causes the setting of the registers of the selected sender.

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