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TELEPHONE EXCHANGE SYSTEM

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FIG. 16

FIG. 2	FIG. 1	FIG. 3		
FIG. 4	FIG. 8	FIG. 12		
FIG. 5	FIG. 9	FIG. 13		
FIG. 6	FIG. 10	FIG. 14		
FIG. 7	FIG. 11	FIG. 15		

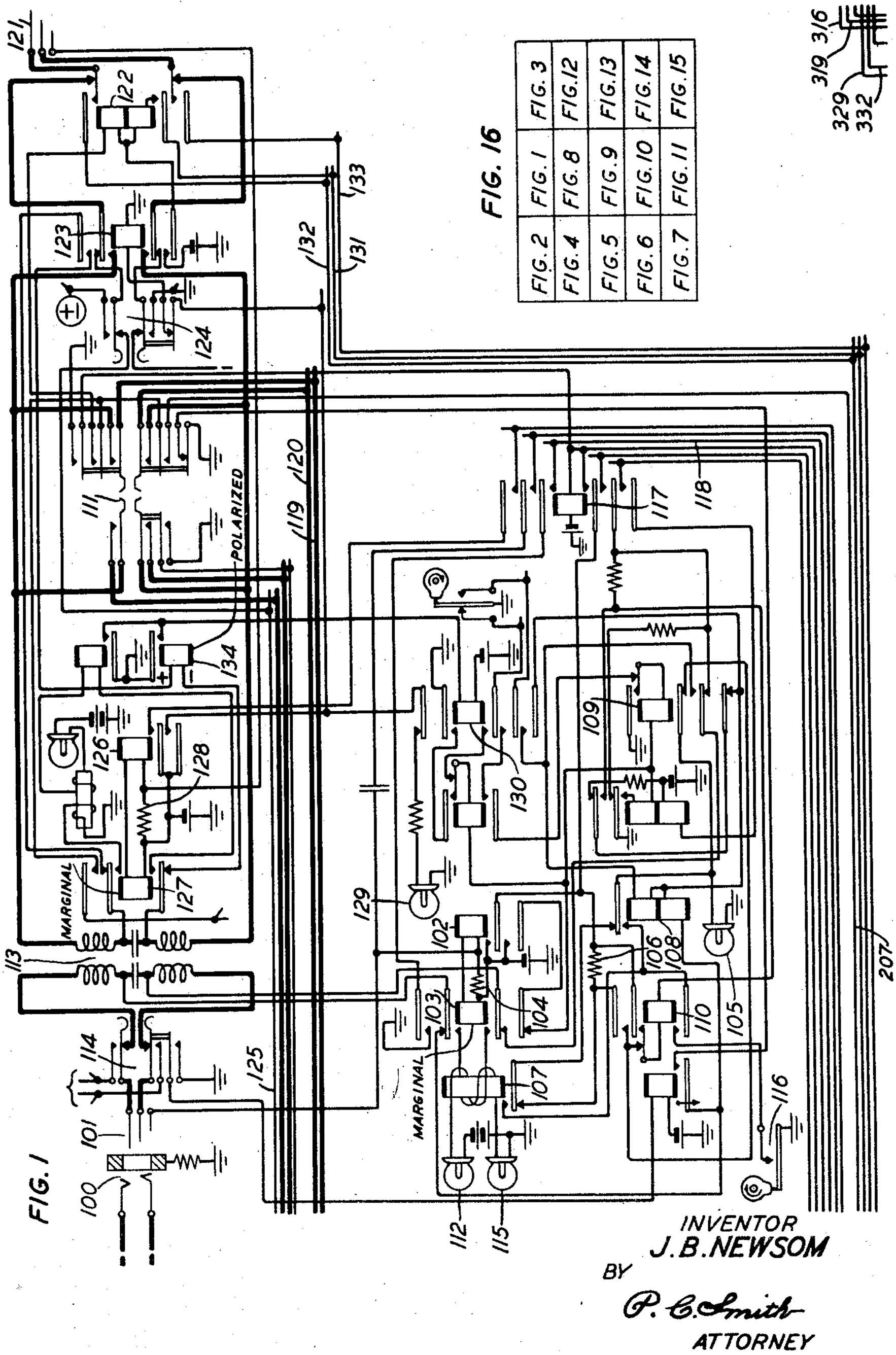

FIG. 1

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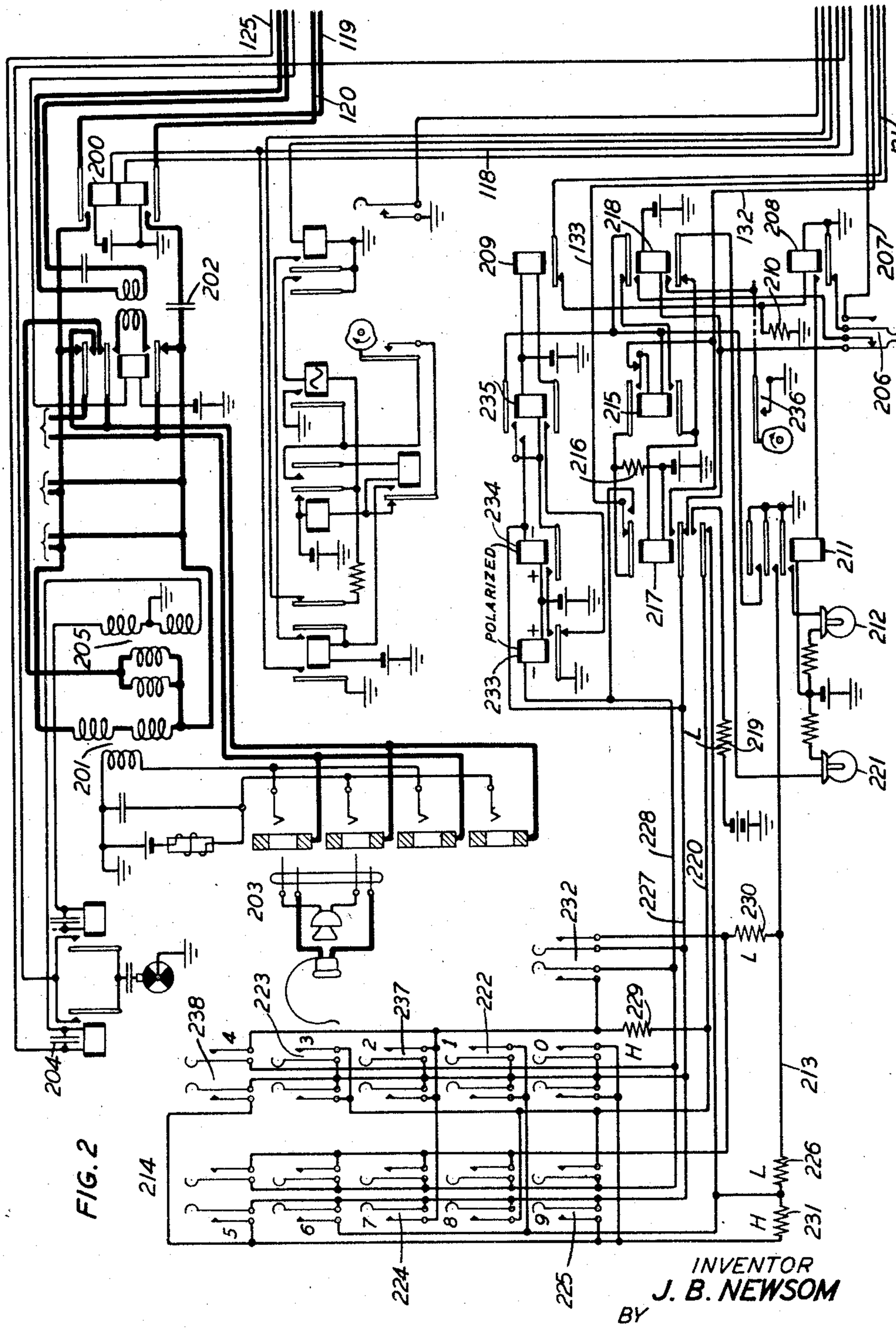

FIG. 2

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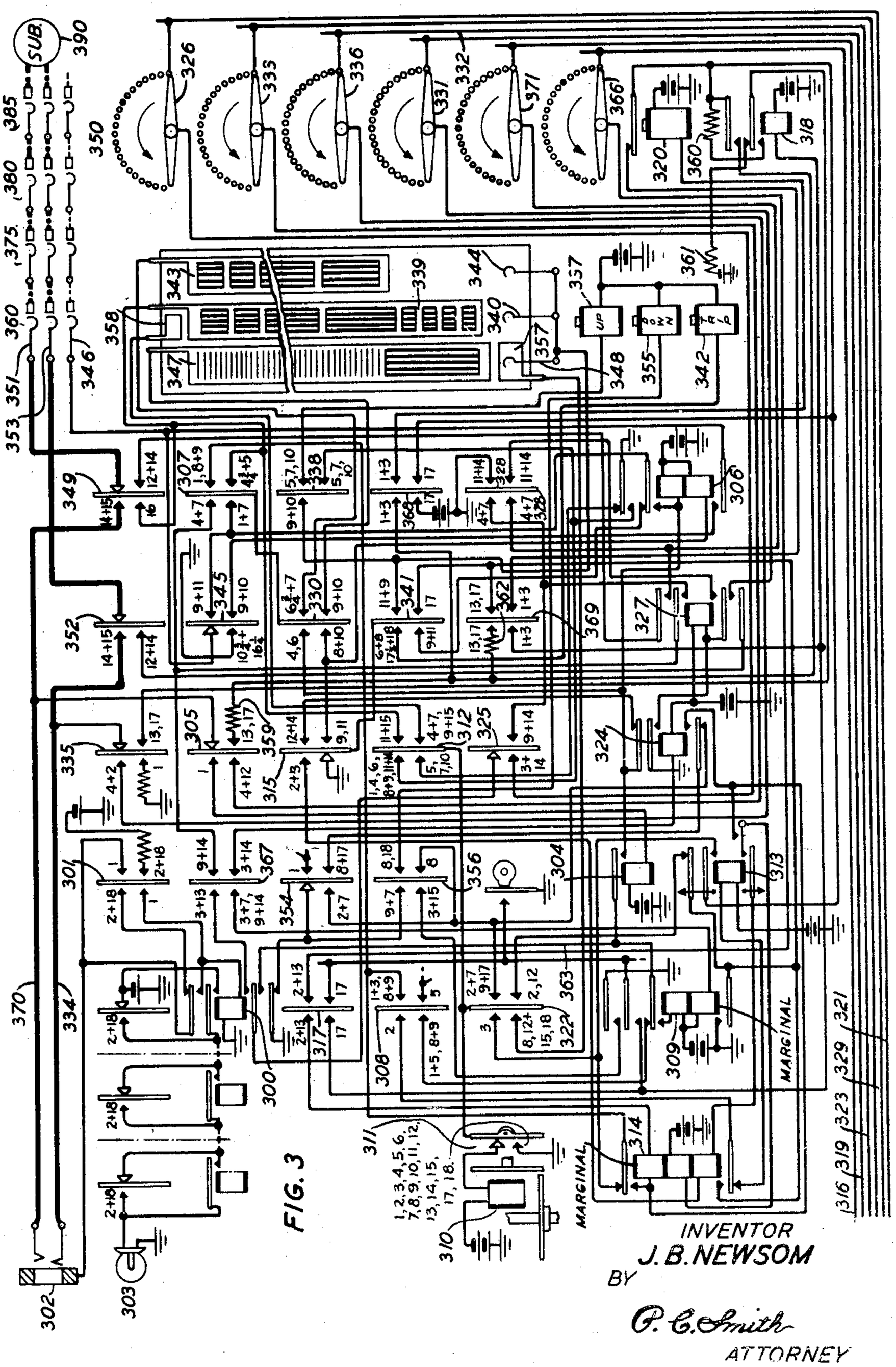

FIG. 3

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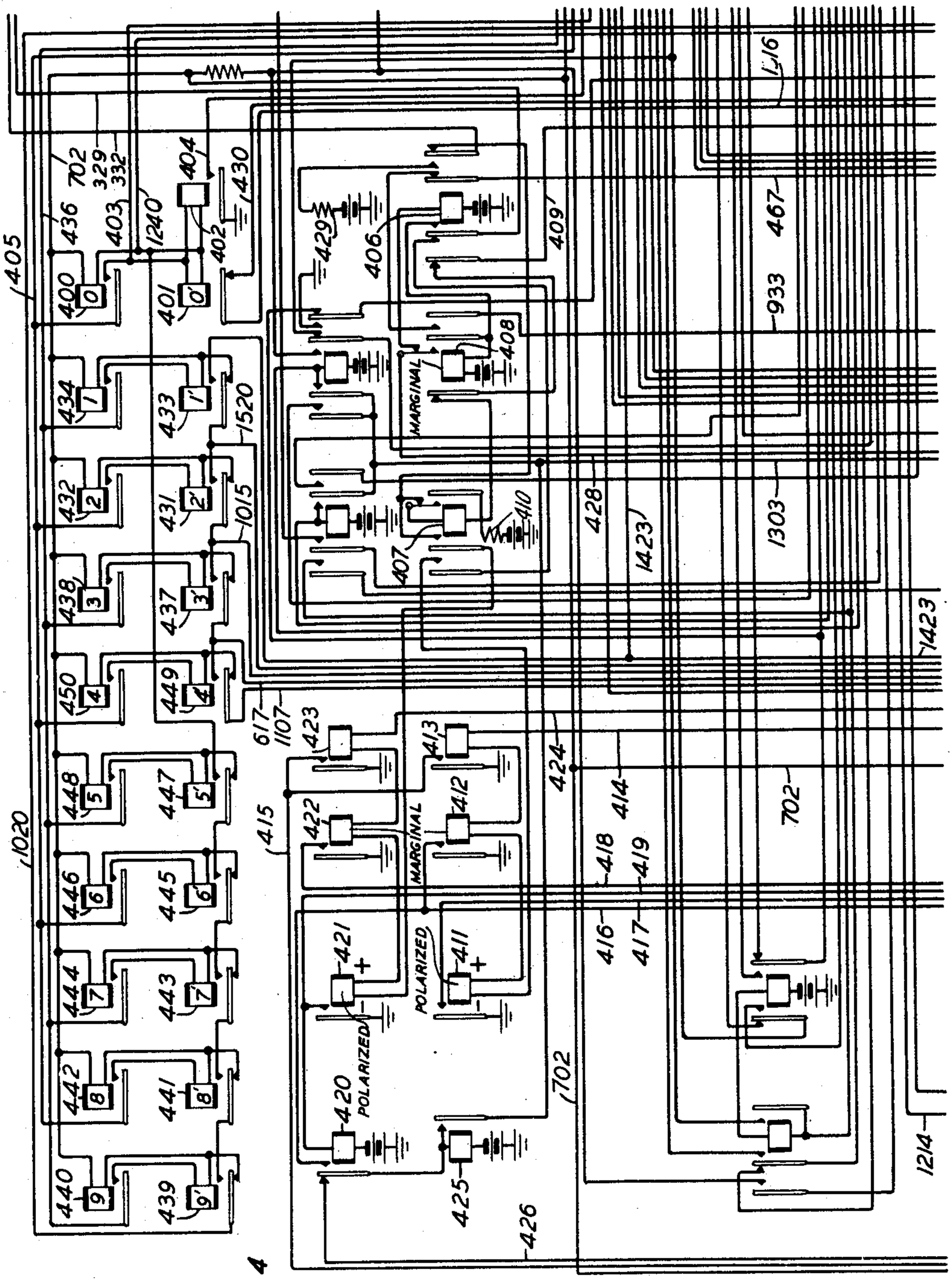

FIG. 4

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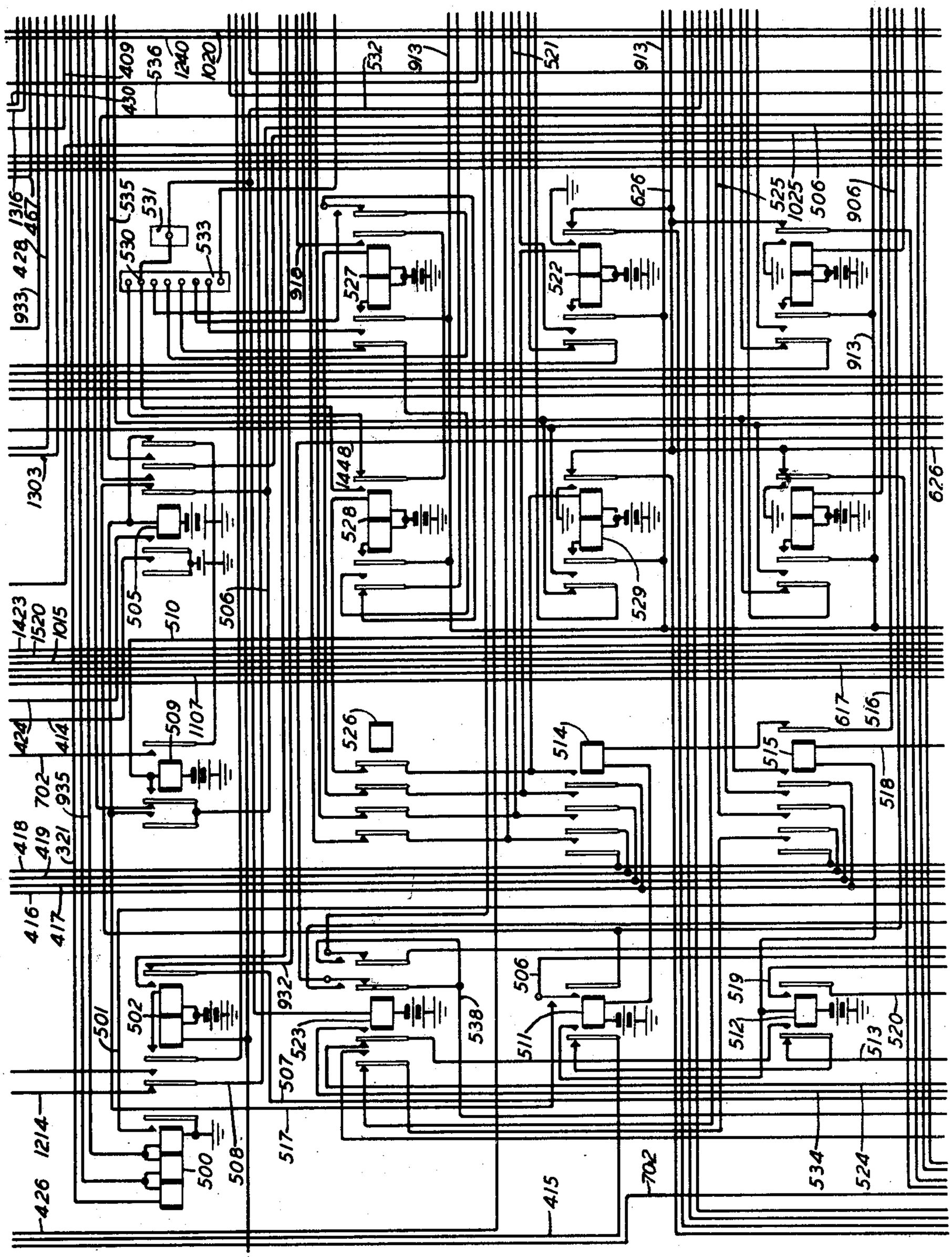

FIG.5

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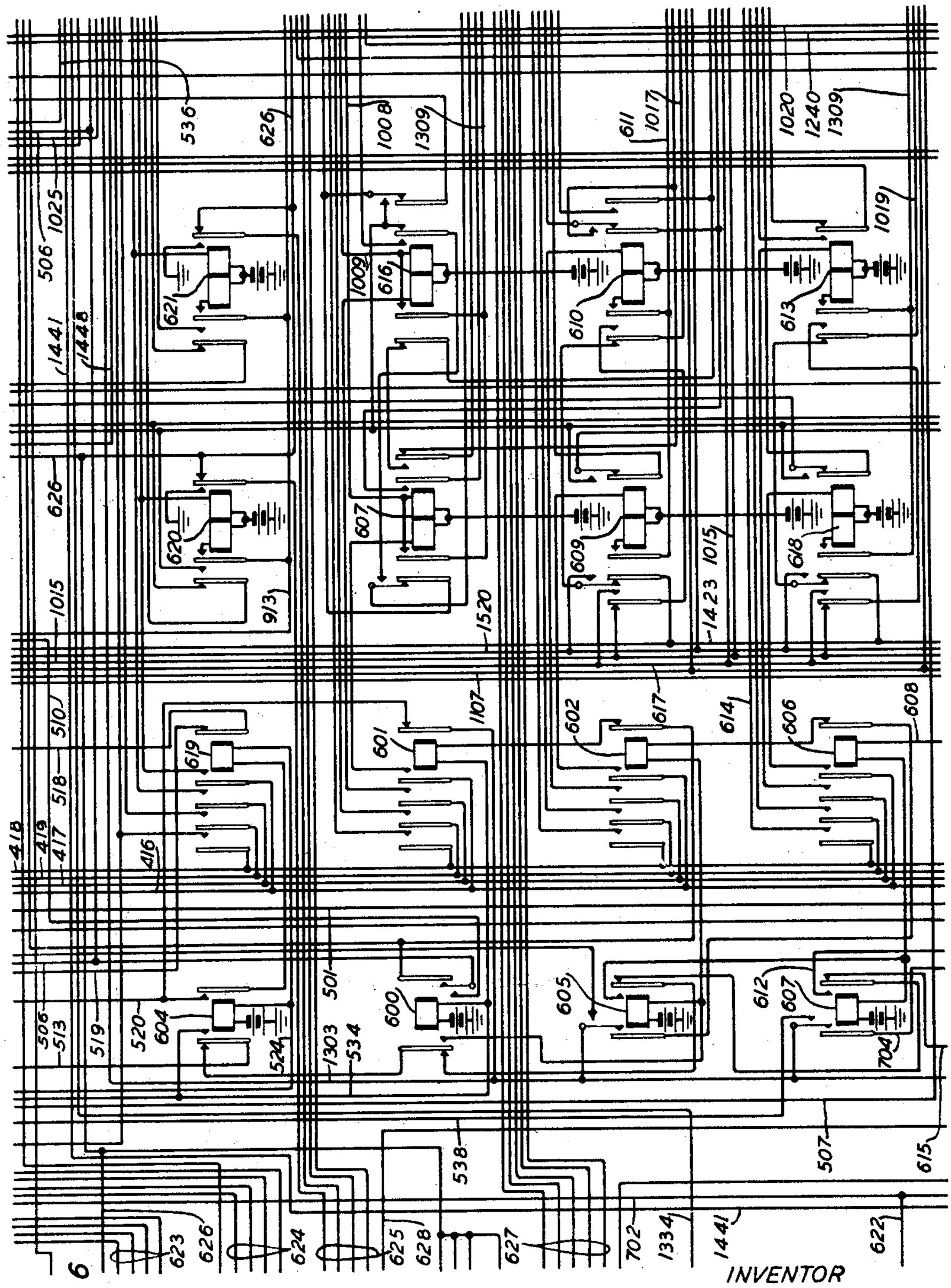

FIG. 6

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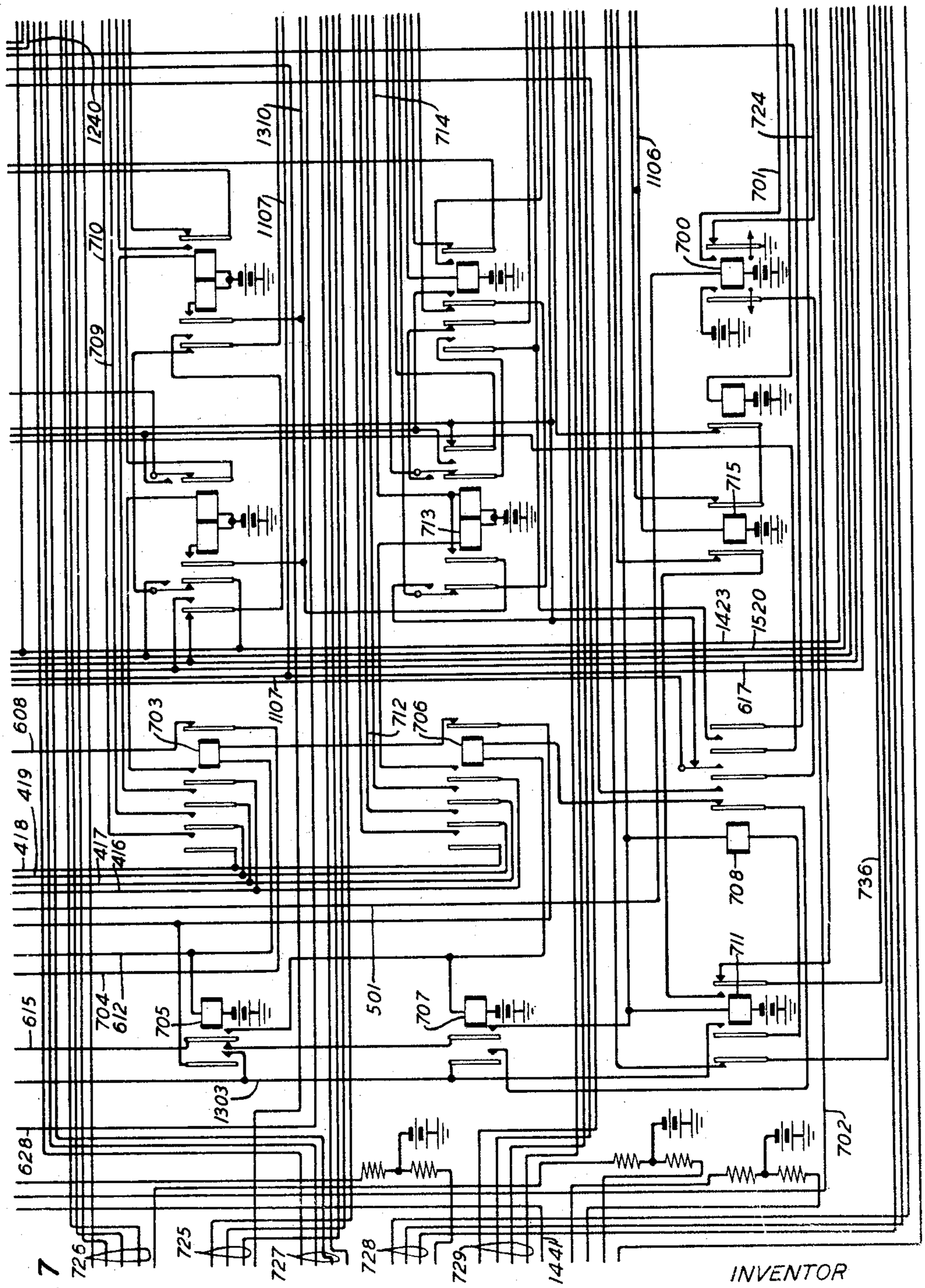

FIG. 7

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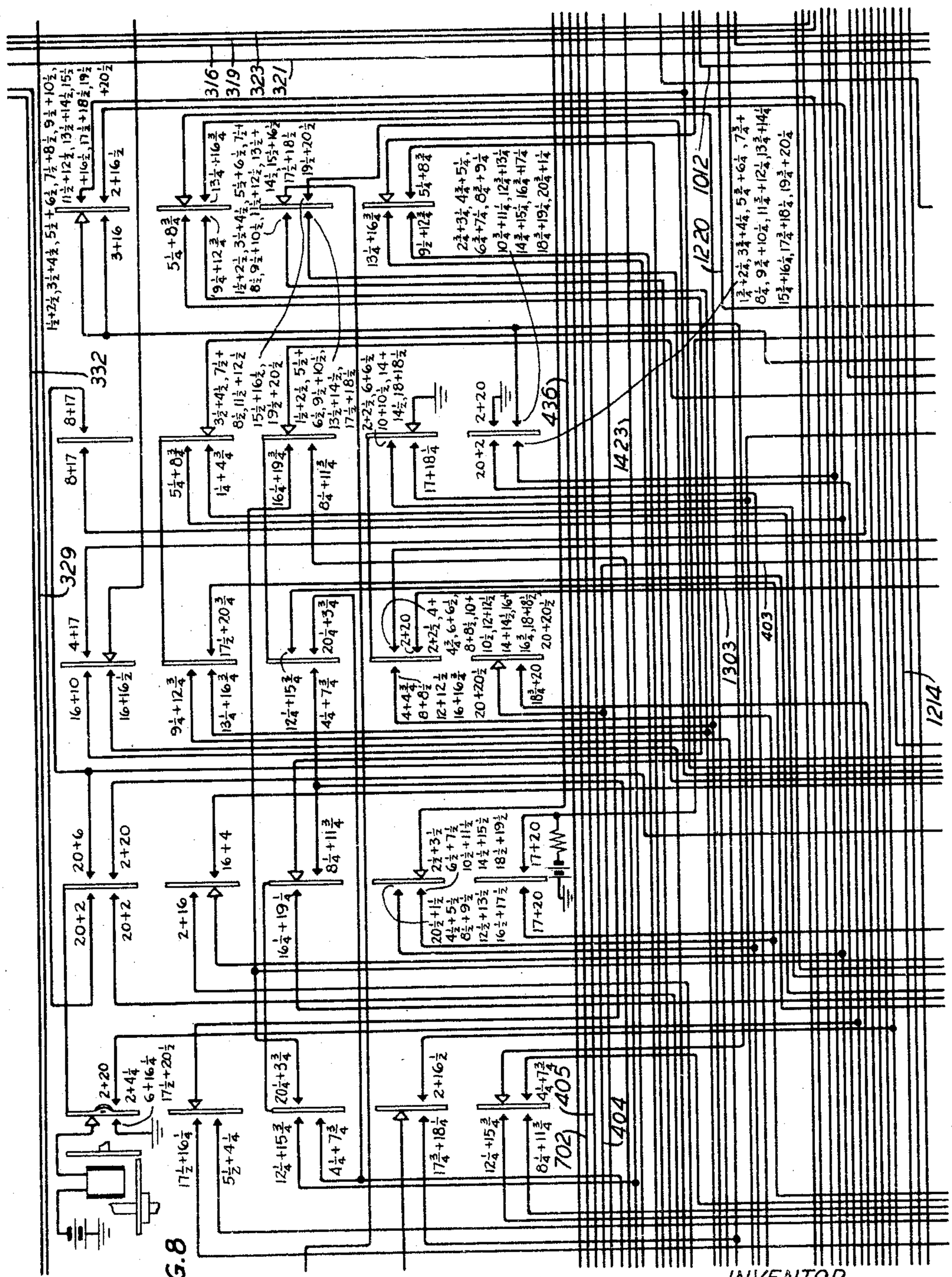

FIG. 8

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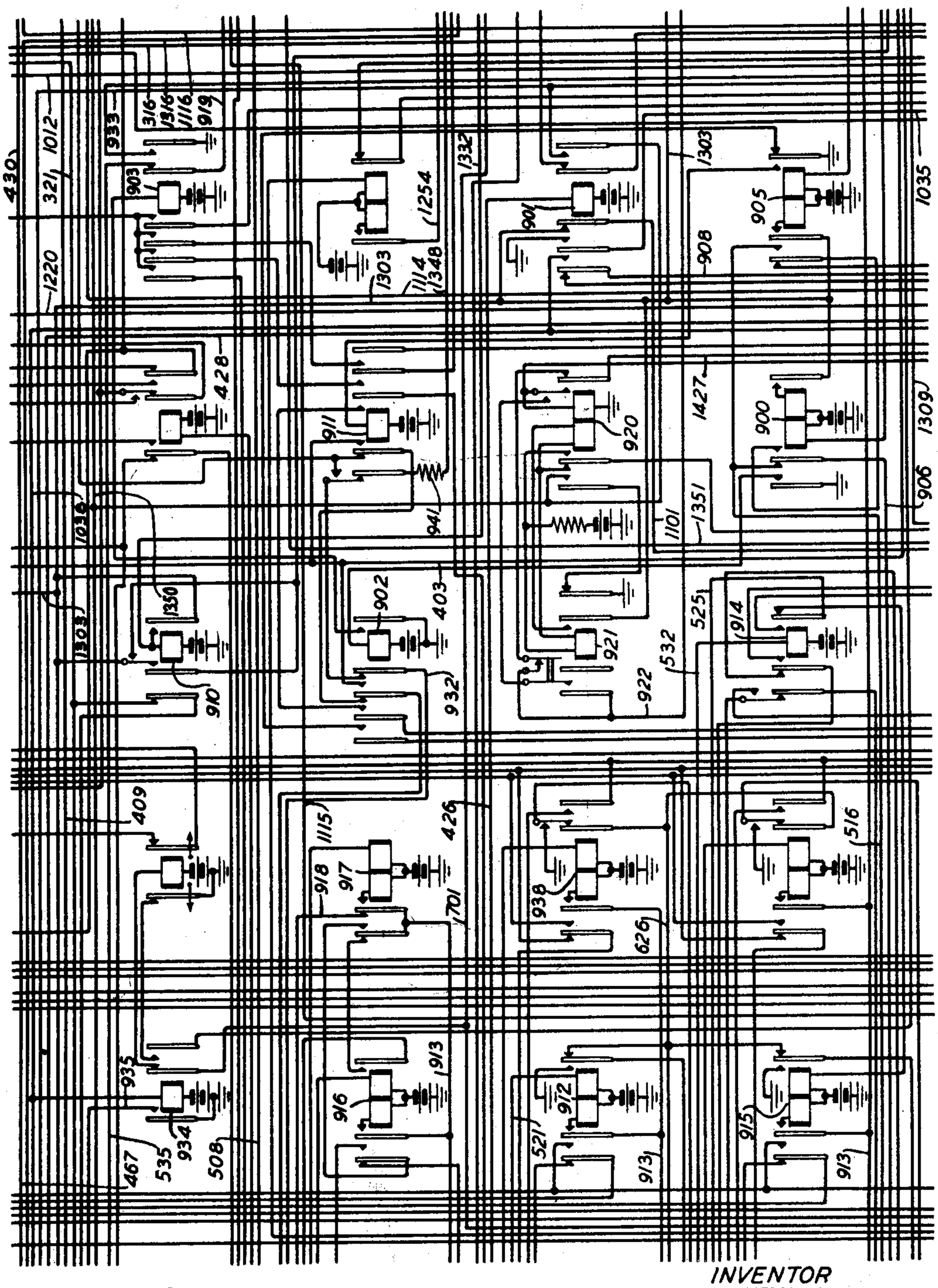

FIG. 9

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FIG. 10

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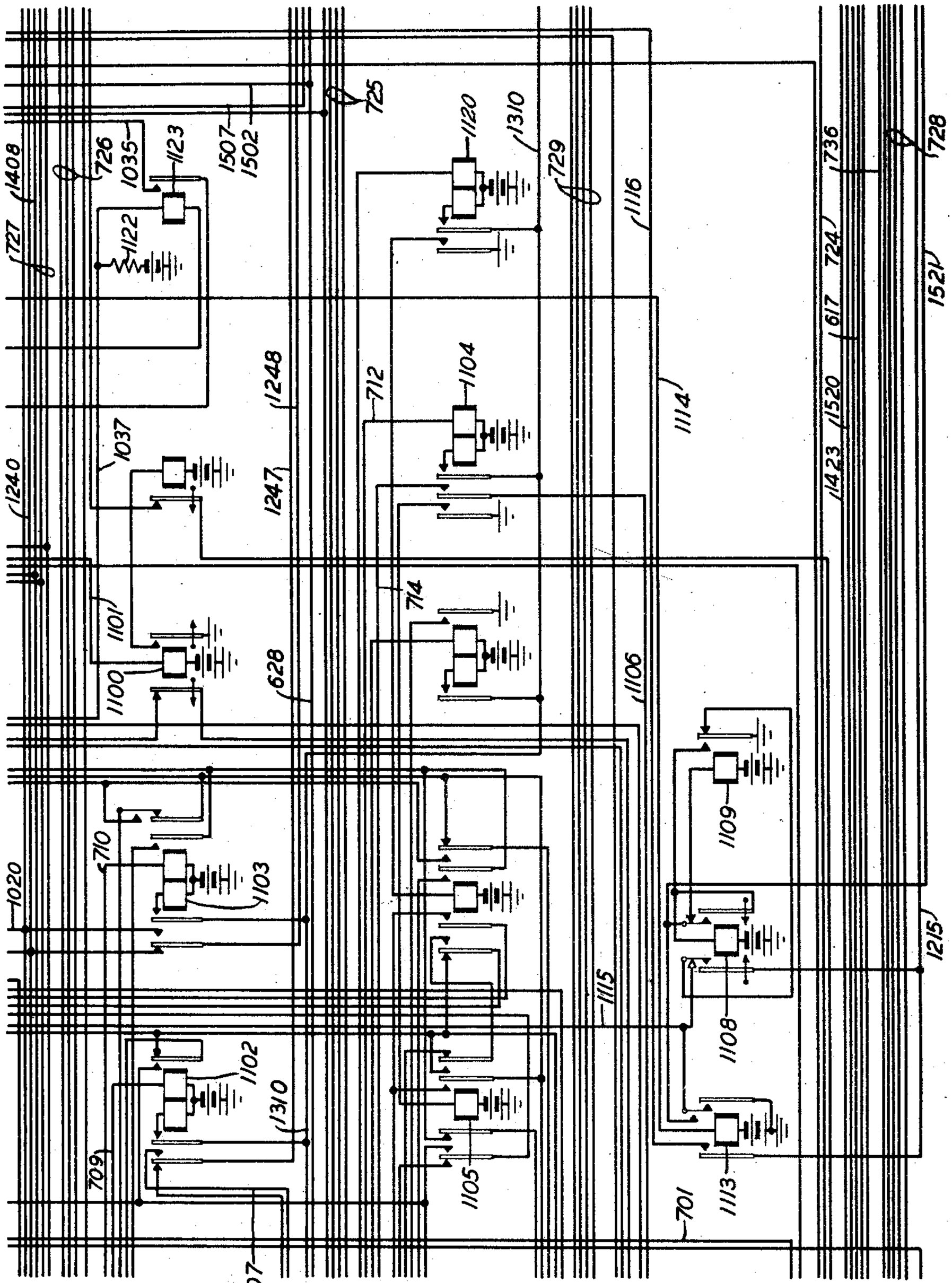

FIG. 11

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TELEPHONE EXCHANGE SYSTEM

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FIG. 12

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TELEPHONE EXCHANGE SYSTEM

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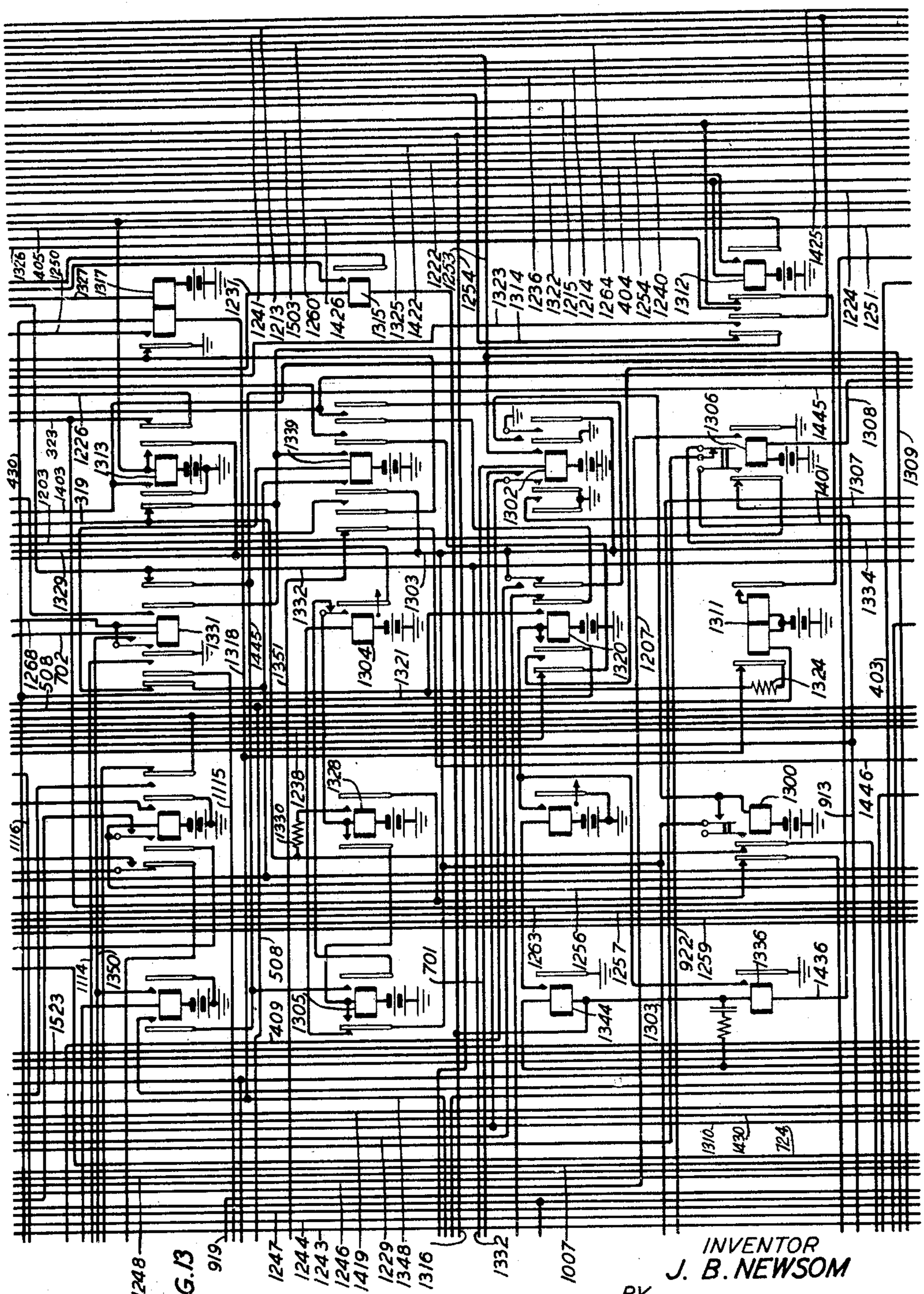

FIG. 13

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TELEPHONE EXCHANGE SYSTEM

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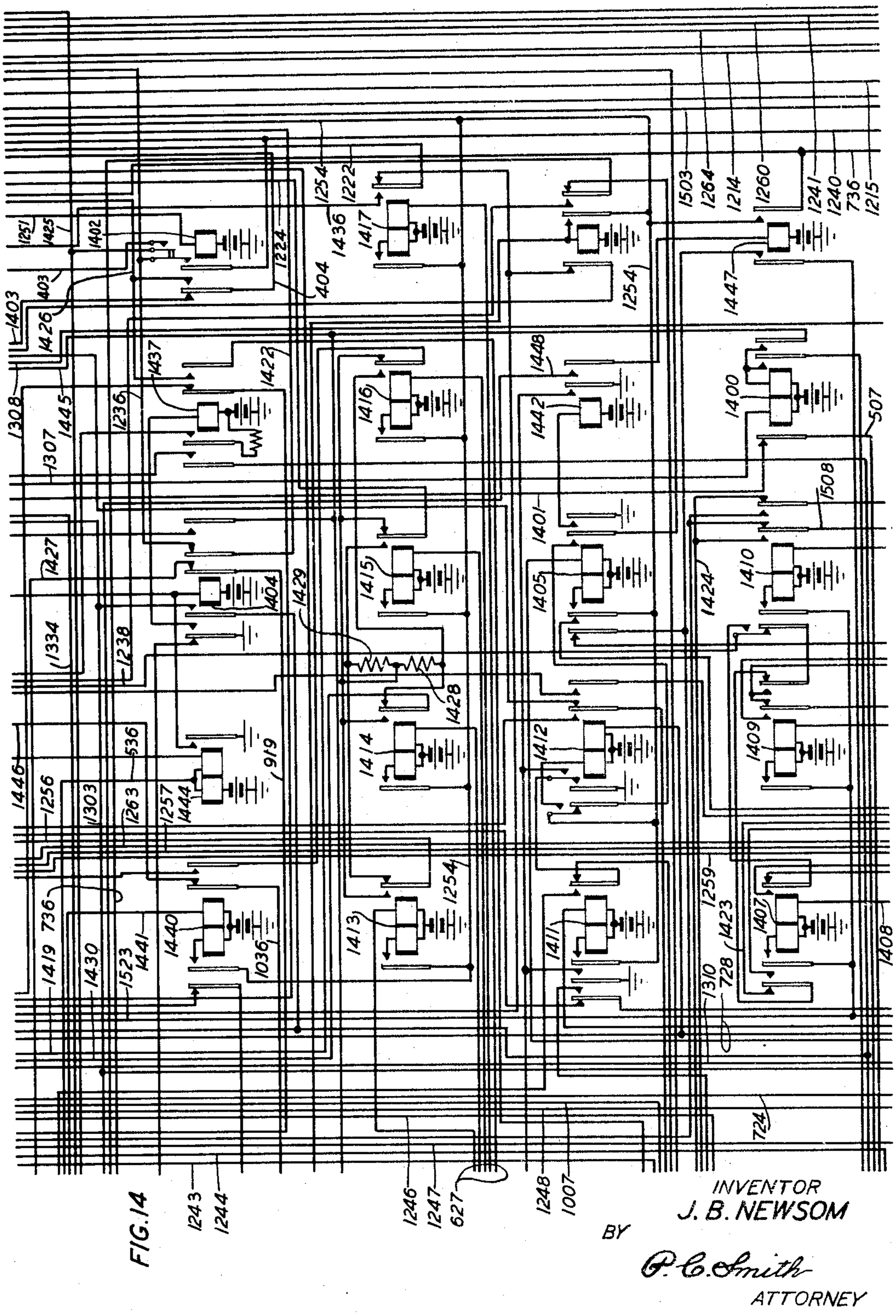

FIG. 14

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TELEPHONE EXCHANGE SYSTEM

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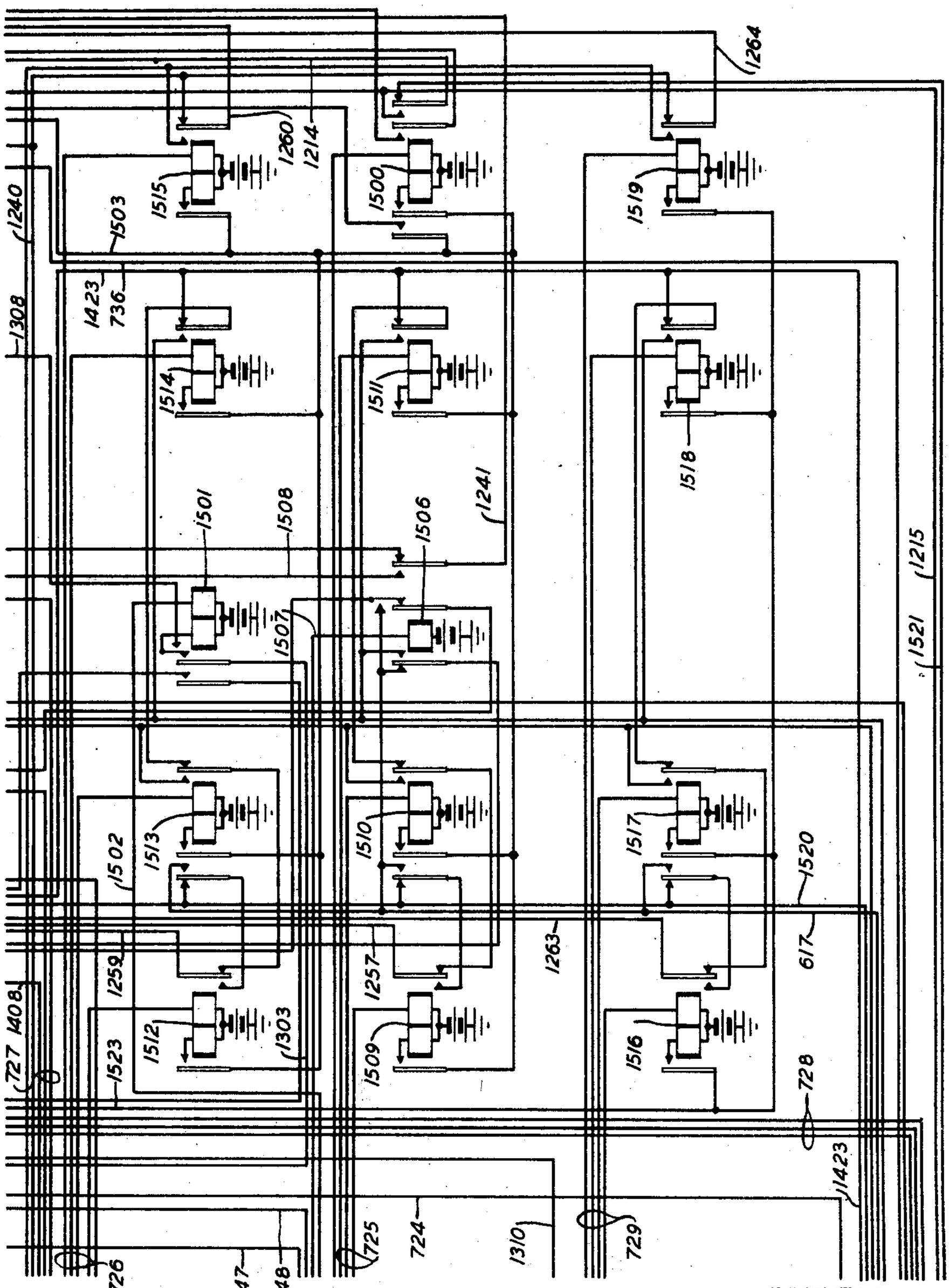

FIG. 15

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Patented Feb. 14, 1933 1,897,069

UNITED STATES PATENT OFFICE

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TELEPHONE EXCHANGE SYSTEM

Application filed March 18, 1932. Serial No. 599,611.

This invention relates to a dial switching telephone system and more particularly to a district selector link circuit for enabling an operator at a dial switching "A" switchboard to extend connections from her switchboard through the aid of a sender accessible to the link circuits. The object of the invention is to enable the transmission of a recorder signal to the operator in the event that difficulty is encountered either in the selector switches or in the sender used to establish a connection, so that the operator may take down the partially established connection and try to establish a new connection.

In a dial switching telephone system in which the present invention is designed to be employed, calls may arrive requiring the assistance of an operator. Such calls are automatically routed to an operator's position, at which position are cord circuits for answering such calls. The operator upon receiving such a call and answering it with one of the cord circuits of her position, ascertains from the calling subscriber the number of the line desired. She then plugs the calling end of the cord circuit into the jack of a trunk circuit of the proper character for terminating the desired connection. If, for example, the desired line terminates in another office of the exchange area, the trunk circuit which the operator selects will terminate in a district selector.

The trunk circuit or district selector link circuit in accordance with the present invention, is provided with a sender selector switch which is started as soon as the operator plugs into the jack of the trunk circuit and associates the trunk circuit with an idle sender. The operator's position may be equipped with a calling dial or a keyset for causing the registration of a desired line number in the sender. In the present embodiment of the invention, the operator's position equipment disclosed is provided with a ten button keyset and accordingly the sender is arranged to be controlled from the keyset. A sender of this type is disclosed in the copending application of W. B. Strickler, Serial No. 599,684, filed March 18, 1932.

After the operator has plugged a cord circuit into the trunk circuit, with her talking key still thrown, her keyset becomes associated over the tip and ring conductors of the cord circuit and trunk circuit with the sender as soon as she operates her keyset key. Her keyset then becomes locked to the cord circuit until released therefrom by the sender following the completion of registration, or until released by the action of the trunk circuit if it becomes necessary to inform the operator to reestablish the connection because of the failure of apparatus used to function properly.

Should it become necessary to signal the operator to reestablish a connection, this can only be done after her dial or keyset has been disconnected from the cord circuit since the supervisory relay of the cord circuit is not connected over the calling plug of the cord circuit while the dial or keyset is connected. The necessity for giving the operator a reorder signal may arise because of one of several conditions. In the establishment of a desired connection the district selector may, in hunting for an idle trunk extending to the office of the desired subscriber, or in hunting for an idle office selector, find all such trunks busy and thus advance its brushes to an overflow position in its bank, or the office or incoming selector similarly may find no free outgoing trunk in the desired group outgoing therefrom and advance to an overflow position, or the district selector may not be arrested properly in its brush or group selection movements and thus advance to the tell-tale position at the top of the terminal bank, or other selectors employed may advance to tell-tale or overflow positions, or the sender may fail to advance properly, or the operator may key a wrong or blank code of a connection which cannot be established over the district link circuit, or she may prematurely depress the start key or her keyset. If any of these latter conditions arise, the sender transmits to the district link circuit a signal which informs the district link circuit that the operator should be signaled to reorder the connection.

In accordance with the present invention, whenever the district selector link circuit re-

ceives such a reorder signal from the sender, or an overflow or tell-tale signal, an impulse from a 48-volt battery is transmitted from the district link circuit to the operator's position which is instrumental in causing the disassociation of the keyset from the cord circuit and the connection of the supervisory relay of the cord circuit with the trunk circuit. Thereupon a loop circuit through the supervisory relay of the cord circuit to interrupted ground and battery in the trunk circuit is established whereby the supervisory lamp of the cord circuit is flashed as a reorder signal.

The manner in which the invention functions will be more evident from the following detail description taken in connection with the accompanying drawings in which:

Fig. 1 shows an operator's cord circuit for answering special service and intercepting calls;

Fig. 2 shows the operator's telephone and keyset circuit;

Fig. 3 shows an outgoing trunk circuit which terminates in a district selector and a sender selector for connecting the trunk circuit with an idle sender, and the schematic representation of an office, an incoming and a final selector and a called subscriber's line;

Figs. 4 to 15, inclusive, show the circuits of a sender; Fig. 4 showing the counting relays for controlling the setting of selector switches in accordance with digits registered in the sender and other control relays;

Figs. 5, 6, 7, 9, 10 and 11 shows registers for registering digits keyed by the operator and additional control relays;

Fig. 8 shows an impulsing switch for transmitting code impulses in accordance with registered digits for setting call indicator apparatus of manual offices or registering apparatus of tandem senders in tandem offices to which a connection may be established;

Fig. 12 shows a steering or sender control sequence switch;

Fig. 13 shows control relays;

Figs. 14 and 15 show the selection controlling registers and additional control relays; and

Fig. 16 is a diagram showing the manner in which the remaining figures should be arranged to show the complete circuit.

The cord circuit of Fig. 1 located at the "A" operator's switchboard position has access over the answering plug shown at the left of the figure to jacks of incoming trunks, which trunks may, for example, be intercepting trunks from final selector or incoming selector multiples or special service trunks over which calling subscribers may obtain connection with the "A" switchboard operator's position for the purpose of obtaining the assistance of the operator in completing toll or other calls. The operator's telephone set and keyset of Fig. 2 are common to all cord circuits such as that shown in Fig. 1 of the operator's position. Through the cord circuit of Fig. 1 the operator has access to a group of trunk circuits terminating in local district selectors such as the trunk circuit shown in Fig. 3. The cord circuit may also have access to a plurality of groups of outgoing trunks of the character disclosed in the copending application of W. B. Strickler hereinbefore referred to, one group of these trunks terminating in incoming selector switches for terminating toll calls, the trunks of a second group terminating in office selectors of a distant office and the trunks of a third group terminating in district selectors of a distant tandem office.

The sender disclosed in Figs. 4 to 15, inclusive, is similar in general to the sender disclosed in the patent of Raymond and Scully, No. 1,862,549, granted June 14, 1932, and is identical with the sender disclosed in the application of W. B. Strickler hereinbefore referred to. This sender is arranged to operate in conjunction with the decoder and decoder connector disclosed in detail in the patent of Raymond and Scully, such decoder and decoder connector having been omitted from the present application for the purpose of simplifying the disclosure. The conductors extending to the left margins of Figs. 6 and 7 correspond with similar conductors shown in the Raymond and Scully patent for connection to the decoder connector.

It will be assumed that an incoming connection is extended in any well-known manner to the trunk jack 100 of Fig. 1 and that the desired connection may be completed over the trunk circuit of Fig. 3. The operator upon noting the illumination of the lamp (not shown) associated with jack 100, inserts the plug 101 of the cord circuit shown in Fig. 1 into jack 100. A circuit is then established from ground over the sleeves of jack 100 and plug 101 to battery through the winding of relay 102 and the winding of marginal relay 103 in series, and to battery in parallel therewith through the non-inductive winding 104 of relay 103. At the same time the trunk lamp is extinguished. Relays 102 and 103 both operate over a low resistance ground connected to the sleeves of trunks employed for special service and establish a circuit for the supervisory lamp 105 extending from battery over the inner contact of relay 102, resistance 106, back contact of relay 107, back contact of relay 108 to ground through lamp 105 and in parallel therewith from battery over the inner contact of relay 102, resistance 106, back contact of relay 107, back contact of relay 108, inner lower back contact of relay 109, inner normal contacts and winding of relay 110 to ground at the lower right normal contact

of key 111. Relay 110 locks in a circuit from battery at the inner contact of relay 102, inner upper alternate contacts and winding of relay 110 to ground at key 111.

As soon as plug 101 is fully inserted, relay 107 operates in a circuit from battery, ballast lamp 112, upper winding of relay 107, lower front contact of relay 103, lower left winding of repeating coil 113, lower normal contacts of key 114, rings of plug 101 and jack 100 and returning over the tips of jack 100 and plug 101, upon contacts of key 114, upper left winding of repeating coil 113, inner upper front contact of relay 103, lower winding of relay 107 to ground through ballast lamp 115. Relay 107 operates and a flashing shunt circuit is thereupon established for lamp 105 until the operator throws key 111 to the right to unlock relay 110 which circuit may be traced from ground through lamp 105, back contact of relay 108, front contact of relay 107, lower front contact of relay 110 to ground at the contacts of interrupter 116. In case, however, relay 107 operates before relay 110 can operate, lamp 105 does not light. The possible flashing of lamp 105 as above described is incidental and has no significance at this time.

When the operator throws her key 111 to the right or talking position, an obvious circuit is established from ground over the upper right contact of key 111 for relay 117 which establishes a circuit from ground at the upper front contact of relay 103, inner upper front contact of relay 117, conductor 118 to battery through the upper winding of relay 200. Relay 200 operates and a talking path is thereupon established from the upper right winding of repeating coil 113, inner upper right contact of key 111, conductor 119, upper contact of relay 200, right winding of repeating coil 201, condenser 202, lower contact of relay 200, conductor 120, inner lower right contact of key 111 to the lower right winding of coil 113. Assuming that the operator's telephone set 203 is plugged up, the talking path just traced is inductively associated therewith through the left winding of repeating coil 201 and the operator is thereupon enabled to converse with the calling subscriber to ascertain information concerning the desired connection.

It will be assumed that the desired connection is of a character which is to be completed over a district selector such as is shown in Fig. 3 and that therefore the operator first tests for an idle trunk of a group terminating in a district selector switch by testing the tip of calling plug 121 to the sleeve of the jack of a trunk of that group. If the trunk is busy there will be battery potential on the sleeve and this potential will be transmitted over the tip of plug 121, the upper normal contacts of relay 122, the inner upper back contact of relay 123, the upper normal contact of key 124, conductor 125, condenser 204, to ground through the lower right winding of repeating coil 205, which induces the busy potential through the left winding of coil 205 into the operator's telephone set, thus producing a click in her receiver. Assuming that she tests the trunk circuit of Fig. 3 and finds it idle and receives no click, she inserts the plug 121 into jack 302 thereby establishing a circuit extending from ground, winding of relay 300, the lower left and upper right contacts of cam 301, the sleeves of jack 302 and plug 121, windings of relay 126 and marginal relay 127 in series to battery and in parallel therewith through resistance 128 to battery. Due to the resistance of sleeve relay 300 of the trunk circuit, sufficient current flows through the winding of relay 126 to cause its operation, but marginal relay 127 does not operate. Relay 300 operates and locks over its upper front contact directly to the sleeve of jack 302 and prepares a circuit for lighting the group busy lamp 303 when all trunks of the group are busy. Relay 126 upon operating closes a circuit extending from battery over its lower contact, the lower normal contact of key 124 to ground through the winding of relay 123 which operates, opening the busy test circuit at its upper back contact and at its inner upper and inner lower front contacts connects the tip and ring contacts of plug 121 to the right windings of repeating coil 113. Relay 126 at its lower front contact also establishes a circuit for lamp 129, extending over the upper back contact of relay 130. Preparatory to keying the digits necessary to complete the connection, the operator now depresses the key 206 and, with the talking key 111 operated to the right, a circuit is established from ground at the lower back contact of relay 208, the right contacts of key 206, conductor 207, the lower and upper intermediate alternate contacts of key 111, the upper winding of relay 122 to battery at the lower contact of relay 123. Relay 122 thereupon operates and locks in a circuit from battery over the lower contact of relay 123, lower winding and inner front contact of relay 122, conductor 131, back contact of relay 209 and in parallel to ground through resistance 210 and the winding of relay 208. Relay 208 operates in this circuit opening the initial operating circuit of relay 122 and closing an obvious circuit for relay 211 which operates. Relay 122, at its upper and lower alternate contacts, disconnects the tip and ring contacts of plug 121 from the right windings of repeating coil 113, and connects these contacts over conductors 132 and 133 with the operator's keyset circuit.

Relay 211 upon operating closes an obvious circuit to light lamp 212, connects ground over conductor 213 for supplying operating

ground to the keys of the keyset 214 and establishes a circuit from ground at its upper contact through the winding and upper normal contacts of relay 215, conductor 132, upper alternate contacts of relay 122, tips of plug 121 and jack 302, upper contacts of cam 305, to battery through the winding of start relay 304. Relay 304 operates, but due to the high resistance of its winding, relay 215 at the keyset circuit does not receive sufficient current to operate. Relay 304, with relay 300 operated, closes a circuit from battery, upper winding of relay 306, contact of relay 304, conductor 363 to ground at the lower front contact of relay 300, relay 306 upon operating locking over its upper winding and inner upper front contact, lower left and upper right contacts of cam 307, upper right and lower left contacts of cam 308, inner upper back contact of relay 309, to ground on conductor 363 and closing a circuit extending from battery, winding of magnet 310, contact of cam 311, upper left contact of cam 312, to ground at the upper front contact of relay 306, thus advancing sequence switch 310 into position 2. Upon leaving position 1 the circuit of relay 304 and the locking circuit of relay 306 are opened and these relays release.

With sequence switch 310 in position 2, relay 313 operates in a circuit extending from battery through its winding, lower back contact of test relay 314, left contacts of cam 308, inner upper back contact of relay 309, to ground on conductor 363. At its lowermost contacts relay 313 connects the two lower windings of test relay 314 in a series circuit extending from battery through the middle winding of relay 314, lower contacts of relay 313, lower winding of relay 314, to ground at the left contacts of cam 315 thereby preparing the marginal test relay 314 for operation, and connects the test brush 366 of sender selector 350 over the upper contacts of cam 317, upper winding of relay 314, lower contacts of relay 313, lower winding of relay 314 and thence as traced to ground at cam 315.

It will first be assumed that the sender upon the terminals of which the brushes of selector 350 are at the time standing is busy and that no operating circuit is therefore closed for relay 314. A circuit is therefore closed from battery, winding of stepping relay 318, lower contacts of cam 369, back contact of stepping magnet 320, upper front contact of relay 313, upper back contact of test relay 314, upper right and lower left contacts of cam 308, upper back contact of relay 309 to ground on conductor 363. Relay 318 operates connecting the winding of stepping magnet 320 in a circuit extending over the upper contacts of cam 368, upper front contact of relay 318 to ground over the operating circuit of relay 318, whereupon magnet 320 energizes in turn opening the circuit of relay 318 which releases opening the circuit of magnet 320 which in turn releases and advances the brushes of switch 350 one step. In this manner through the alternate operation and release of relay 318 and magnet 320, the brushes of switch 350 are advanced step by step until test brush 366 engages the terminal of an idle sender, when the previously traced circuit through the upper and lower windings of test relay 314 to the test brush 366 will be completed, for example, over conductor 316, inner right back contact of relay 1000, left back contact of relay 1001 to battery through resistance 1002. Relay 314 now receives sufficient current to operate and at its lower back contact opens the circuit of relay 313 which releases and opens the circuit of stepping relay 318 to arrest further movement of switch 350. Relay 314 locks from battery on conductor 316 over brush 366, upper contacts of cam 317, upper winding and upper front contact of relay 314, upper right and lower left contacts of cam 308, upper back contact of relay 309, to ground on conductor 363. The increased potential on the sender test conductor 316 marks the sender as busy to other sender selectors. Relay 313 upon releasing also closes a circuit extending from battery, winding of magnet 310, contact of cam 311, lower right contact of cam 322, upper back contact of relay 313, lower front contact of relay 314, left contacts of cam 308, upper back contact of relay 309, to ground on conductor 363 for advancing the sequence switch 310 to position 3.

With the sequence switch in position 3, a circuit is closed from battery through the lower winding of marginal relay 309, to the lower left contact of cam 367 and from battery through the winding of sensitive relay 324 to the lower right contact of cam 367 and thence over the upper left contact of cam 367, inner lower front contact of relay 300, left contacts of cam 325, brush 326, conductor 321 and windings of relay 500 of the sender in series to ground. Relays 324 and 500 operate, but relay 309 being marginal does not because of the high resistance of the windings of relay 500. Relay 324 upon operating closes an obvious circuit for relay 327 which locks over its inner lower front contact and the right contacts of cam 328 to ground after sequence switch 310 reaches position 11 and until it leaves position 14.

Relay 500 upon operating closes an obvious circuit over conductor 501 for relay 700 which in turn causes the operation of relay 1302 over conductor 701 and connects battery to the off-normal battery conductor 702. Relay 1302 upon operating connects ground from its outer right front contact to the off-normal ground conductor 1303 thereby causing the operation of relay 1001 which in turn removes battery through resistance 1002 from conductor 316 to mark the sender

as busy and to release relay 314. Relay 314 upon releasing closes a circuit for advancing sequence switch 310 into position 4 extending from battery, winding of magnet 310, contact of cam 311, upper left contact of cam 322, upper back contact of relay 314, upper right and lower left contacts of cam 308, upper back contact of relay 309 to ground on conductor 363. At its next to the outer right front contact, relay 1302 closes an obvious circuit for relay 1300 which locks to ground on conductor 1303. With ground on conductor 1303 the operating circuit of relay 1100 extends over conductor 1101, the inner left back contact of relay 901, to conductor 1303 and the operating circuit of relay 1304 extends over the back contact of relay 1305, to conductor 1303, relays 1100 and 1304 both operating. A circuit is also closed from ground on conductor 1303, left contacts of cam 1202, conductor 1203, left back contact of relay 1306, conductor 1307 to battery through the left winding of relay 1400. The operation of relay 1400 at this time prevents the sender control switch 1200 from moving off normal if the call is abandoned before selections are started. Neither of the trunk class register relays 900 or 905 operates for this type of call and consequently relays 902, 903, 911, 1306, 1500 and 1501 do not operate upon the initial seizure of the sender.

With relay 1001 operated and relay 900 not operated a circuit is established from battery, windings of transfer relays 511 and 514, in series, back contact of relay 515, conductor 516, back contact of relay 900, conductor 906, inner right back contact of relay 505, conductor 506, inner left front contact of relay 1001 to ground. Relays 511 and 514 lock in series over the back contact of relay 515, conductor 516, back contact of relay 900, conductor 906, outer right front contact of relay 511, conductor 506 to ground. The operation of transfer relays 511 and 514 indicates that the first digit keyed by the operator will be registered on the first or A code register. With relay 511 operated, a circuit is established for relay 505 extending from battery, winding of relay 505, conductor 517, right front contact of relay 511, conductor 506, to ground at the front contact of relay 1001. At its right back contact, relay 505 opens the initial operating circuit of relays 511 and 514. When relay 1300 operates as previously described, the fundamental tip conductor 319 and the fundamental ring conductor 323 are disconnected from the windings of the trunk class register relays 900 and 905 and these conductors are thereby made free for fundamental selections.

With sequence switch 310 in position 4, a circuit is extended from battery through resistance 216, the upper normal contacts of relay 217, conductor 133, the lower alternate contacts of relay 122, the rings of plug 121, and jack 302, trunk conductor 334, the upper contacts of cam 335, brush 336, conductor 332, outer right back contact of relay 406, inner right normal contacts and winding of relay 407, left back contact of relay 408, outer left back contact of relay 406, conductor 409, to ground at the inner left front contact of relay 1302. Relay 407 in the sender operates locking to battery through resistance 410 independently of battery supplied through resistance 216 at the keyset and extending a circuit from ground at the upper contact of relay 211, upper normal contacts and winding of relay 215, conductor 132, upper alternate contacts of relay 122, tips of plug 121 and jack 302, trunk conductor 370, upper right and lower left contacts of cam 305, brush 333, conductor 329, inner left back contact of relay 406, the outer left front contact of relay 407, in series through the windings of impulse relays 411, 412 and 413, conductor 414 and the outer left front contact of relay 505 to 24-volt battery. Relay 407 also establishes a circuit from 24-volt battery in the sender over the inner left front contact of relay 505, conductor 424 through the windings of impulse relays 421, 422 and 423, the inner left front contact of relay 407, the right back contact of relay 406, conductor 332, brush 366, the upper contacts of cam 335, trunk conductor 334, rings of jack 302 and plug 121, lower alternate contacts of relay 122, to conductor 133 extending to the operator's keyset.

Relay 215 operates in the circuit previously traced locking over its upper alternate contacts to battery through resistance 216 under the control of relay 211 and closes a circuit from ground at the upper contact of relay 211, upper back contact of relay 218, lower contact of relay 215, to battery through the winding of relay 217. Relay 217 upon operating connects 48-volt battery through resistance 219 and the lower front contact of relay 217, to conductor 220 for supplying battery to key contacts of keyset 214 and connects the keyset over its inner lower front and upper alternate contacts and conductors 132 and 133 to the tip and ring impulsing conductors 329 and 332 as previously described. Relay 215 also closes a circuit extending from ground at the upper contact of relay 211, upper back contact of relay 218, lower front contact of relay 215, lower back contact of relay 218, to battery through lamp 221. Lamp 221 lights as an indication that the sender is in condition to receive the digits of a line designation.

Keying the office code

It will be assumed that to complete the desired connection to called line 390 having the designation CH3—1379 the operator first depresses the No. 2 key 237 for registering the code letter C on the registers of the A

code register. 48-volt battery is now connected through resistance 219, conductor 220, high resistance 229, the contacts of key 237, conductor 227, inner lower front contact of relay 217, conductor 132, thence as traced over the tip impulsing path previously traced including conductors 370 and 329, to 24-volt battery through the windings of impulse relays 411, 412 and 413. The current now flowing is of the proper strength and polarity to operate polarized relay 411 and sensitive relay 413, but due to the inclusion of the high resistance 229, relay 412 does not operate. With relay 413 operated a circuit is closed over the contact of relay 413, conductor 415, left front contact of transfer relay 511, to battery through the winding of transfer relay 512. Relay 512 operates and locks in series with the winding of relay 515, conductor 518, back contact of relay 619, conductor 519, right front contact of relay 512, conductor 520, back contact of relay 601, to ground on conductor 1303, but relay 515 being shunted as long as relay 413 remains operated does not operate at this time. Relay 411 upon operating closes a circuit from ground at its contact over conductor 417, next to inner contact of relay 514, to battery through the right winding of the A code register relay 522 and in parallel over the next to inner back contact of relay 526 to battery through the right winding of relay 527. Relays 522 and 527 operate and lock over their left windings and inner left front contacts, conductor 913 to ground at the outer left front contact of relay 1302.

When the operator releases the depressed key 237, relays 411 and 413 release, relay 413 opening the shunt around the winding of relay 515 whereupon relay 515 operates opening at its right back contact the locking circuit of relays 511 and 514 whereupon these relays release. Relay 514 upon releasing disconnects the operating circuits of the relays of the A code register and of relays 527, 528, 916 and 917 from the contacts of impulse relays 411, 412, 421 and 422 and relay 515 upon operating connects these contacts to the windings of the B code register relays.

When the operator depresses the No. 4 key 238 to register the code letter H, 48-volt battery is connected through resistance 219 over conductor 220, high resistance 229, right contacts of key 238, conductor 228, over the ring impulsing path including conductors 334 and 332 to 24-volt battery through the windings of impulse relays 421, 422 and 423. The current now flowing is of such polarity and strength that polarized relay 421 and sensitive relay 423 operate, but marginal relay 422 does not. With relay 423 operated a circuit is closed from ground at its contact over conductor 415, left back contact of transfer relay 511, left front contact of transfer relay 512, inner left back contact of relay 523, conductor 524 to battery through the winding of transfer relay 604. Relay 604 operates and locks through its winding and the winding of relay 619, right front contact of relay 604, back contact of relay 601 to ground on conductor 1303, but relay 619 being shunted as long as relay 423 remains operated, does not operate at this time. Relay 421 upon operating closes a circuit from ground over conductor 419, the next to outer left contact of relay 515, conductor 525, right back contact of relay 914 to battery through the right winding of relay 915 of the B code register. Relay 915 locks over its left winding and inner left front contact to ground on conductor 913.

At its left contacts key 238 connects ground from conductor 213 through low resistance 226, high resistance 231, conductor 227, thence over the tip impulsing path to 24-volt battery through the impulse relays 411, 412 and 413. The current flowing is not in the proper direction or of sufficient strength to operate polarized relay 411 or marginal relay 412, but sensitive relay 413 operates and performs the same function as described in connection with the operation of relay 423. As soon as the operator releases key 238, impulse relays 421, 423 and 413 release, relays 413 and 423 removing the shunt from the winding of relay 619, which now operates in the locking circuit of relay 604, opening at its back contact the locking circuits of relays 512 and 515 which now release. Relay 515 upon releasing, disconnects the operating circuits of the relays of the B code register from the contacts of impulse relays 411, 412, 421 and 422 and relay 619 upon operating connects the contacts of the impulse relays to the winding of the C code register relays.

When the operator depresses the key 223 to register the code digit 3 upon the relays of the C code register, 48-volt battery through low resistance 219 is connected over the contacts of key 223, conductor 227, thence over the tip impulsing path to 24-volt battery through the windings of impulse relays 411, 412 and 413. The direction of current now flowing is such as to operate polarized relay 411 and since a low resistance has been included in the operating circuit both relays 412 and 413 also operate. Relay 413 upon operating with transfer relays 511 and 512 released and transfer relay 604 operated, closes a circuit from ground over conductor 415, back contacts of relays 511 and 512, conductor 513, the left front contact of relay 604, to battery through the winding of relay 600. Relay 600 operates and locks in series with the winding of relay 601, back contact of relay 602, right front contact of relay 600, conductor 506 to ground, but relay 601 being shunted as long as relay 413 remains operated does not operate at this time. Relay

412 upon operating closes a circuit extending from ground at its contact over conductor 416, inner left contact of relay 619 to battery through the right winding of register relay 620. Relay 620 upon operating locks over its left winding and inner left front contact to ground on conductor 913. Relay 411 upon operating closes a circuit extending from ground over conductor 417, next to inner left contact of relay 619, right winding of register relay 621, to battery. Relay 621 locks over its left winding and inner left front contact to ground on conductor 913.

When the operator releases the depressed key 223, relays 411, 412 and 413 release, relay 413 opening the shunt around the winding of relay 601 whereupon relay 601 operates in the locking circuit of relay 600 opening at its right back contact the locking circuit of relays 604 and 619, whereupon relays 604 and 619 release, relay 619 disconnecting the operating circuits of the relays of the C code register from the contacts of the impulse relays and relay 601 upon operating connecting the contacts of the impulse relays to the windings of the thousands register relays.

Keying the numerical designation

When the operator depresses key 222 to register the thousands digit 1, ground on conductor 213 is connected through low resistance 226, the contacts of key 222, conductor 227, thence as traced over the tip impulsing path to 24-volt battery through the windings of impulse relays 411, 412 and 413. Due to the inclusion of the low resistance 226 sufficient current flows to operate both the sensitive relay 413 and the marginal relay 412, but polarized relay 411 does not receive current in the proper direction through its winding to cause its operation. Relay 413 upon operating with transfer relay 600 operated, establishes a circuit from ground at its contact over conductor 415, left back contacts of transfer relays 511 and 512, conductor 513, left back contact of transfer relay 604, left front contact of transfer relay 600 to battery through the winding of transfer relay 605. Relay 605 operates and locks in series with the winding of relay 602, back contacts of relay 606, left front contact of relay 605 to ground on conductor 1303, but relay 602 being shunted as long as relay 413 remains operated does not operate at this time. Relay 412 upon operating closes a circuit extending from ground at its contact over conductor 416, inner left contact of relay 601, to battery through the left winding of the thousands register relay 607. Relay 607 upon operating locks over its right winding and inner left front contact, conductor 1309 to ground at the inner right front contact of relay 1302.

When the operator releases depressed key 222, relays 411 and 413 release, relay 413 opening the shunt around the winding of relay 602, whereupon relay 602 operates in the locking circuit of relay 605, opening at its right contact the locking circuit of relays 600 and 601, whereupon these relays release, relay 601 disconnecting the operating circuits of the relays of the thousands register from the contacts of the impulse relays 411, 412, 421 and 422 and relay 602 upon operating connecting the contacts of these impulse relays to the windings of the hundreds register relays.

When the operator depresses key 223 to register the hundreds digit 3, 48-volt battery through low resistance 219 and conductor 220, is connected over the contacts of key 223, conductor 227, thence as traced over the tip impulsing path to 24-volt battery through the windings of impulse relays 411, 412 and 413. The direction of current now flowing through the windings of these relays is such as to operate the polarized relay 411 and since a low resistance has been included in the impulsing path, relays 412 and 413 also operate. Relay 413 upon operating with transfer relay 600 released and transfer relay 605 operated, closes a circuit from ground as traced to conductor 513, thence over the left back contacts of relays 604 and 600, right front contact of relay 605, to battery through the winding of transfer relay 607. Relay 607 operates and locks in series with the winding of relay 606 over conductor 608, right contact of relay 703, conductor 704, left front contact of relay 607, to ground on conductor 1303, but relay 606 being shunted as long as relay 413 remains operated does not operate at this time. Relay 412 upon operating closes a circuit extending from ground at its contact over conductor 416, inner left contact of relay 602, to battery through the right winding of hundreds register relay 609. Relay 609 upon operating locks over its left winding and inner left front contact, conductor 611, winding of relay 1003, to ground on conductor 1309. Relay 411 upon operating closes a circuit extending from ground at its contact over conductor 417, next to inner left contact of relay 602, right winding of register relay 610 to battery. Relay 610 upon operating locks over its left winding and inner left front contact, conductor 611, winding of relay 1003 to ground on conductor 1309.

When the operator releases depressed key 223, relays 411, 412 and 413 release, relay 413 opening the shunt around the winding of relay 606, whereupon relay 606 operates in the locking circuit of relay 607, opening at its back contact, the locking circuit of relays 605 and 602 whereupon these relays release. Relay 602 disconnects the operating circuits of the relays of the hundreds register from the contacts of impulse relays 411, 412, 421

and 422, and relay 606 upon operating connects the contacts of these impulse relays to the windings of the tens register relays.

When the operator depresses key 224, to register the tens digit 7 of the wanted line number, 48-volt battery on conductor 220, is connected through high resistance 229, left contacts of key 224, conductor 227, thence as traced over the tip impulsing path to 24-volt battery through the windings of impulse relays 411, 412 and 413. The direction of current now flowing through the windings of these relays is such as to operate the polarized relay 411 and, since high resistance 229 has been included in the impulsing path, marginal relay 412 does not operate, but relay 413 operates. Relay 413 upon operating with transfer relay 605 now released and transfer relay 607 operated, closes a circuit from ground as traced to conductor 513, left back contacts of relays 604 and 600, right back contact of relay 605, right front contact of relay 607, conductor 612, to battery through the winding of transfer relay 705. Relay 705 operates and locks in series with the winding of relay 703, right back contact of relay 706, outer left front contact of relay 705 to ground on conductor 1303, but relay 703 being shunted as long as relay 413 remains operated, does not operate at this time. Relay 411 upon operating closes a circuit extending from ground at its contact, over conductor 417, next to the inner left contact of relay 606 to battery through the right winding of relay 613 of the tens register. Relay 613 upon operating locks over its left winding and inner left front contact to ground on conductor 1309.

At its right contacts key 224 closes a circuit from ground on conductor 213, through low resistance 230, right contacts of key 224, conductor 228, thence as traced over the ring impulsing path to 24-volt battery through the windings of impulse relays 421, 422 and 423. The current now flowing is not in the proper direction to operate polarized relay 421, but since only low resistance 230 has been included in the impulsing path, both the sensitive relay 423 and marginal relay 422 operate. Relay 423 upon operating merely duplicates the function of relay 413 already described and relay 422 connects ground at its contact, over conductor 418, outer left contact of relay 606, conductor 614 to battery through the right winding of relay 1004 of the tens register. Relay 1004 upon operating locks over its left winding and inner left front contact to ground on conductor 1309.

When the operator releases depressed key 224, impulse relays 411, 413, 422 and 423 release, relays 413 and 423 opening the shunt around the winding of relay 703 whereupon relay 703 operates in the locking circuit of relay 705, opening at its right contact the locking circuit of relays 606 and 607 whereupon these latter relays release. Relay 606 upon releasing disconnects the operating circuits of the relays of the tens register from the contacts of the impulse relays and relay 703 upon operating connects the contacts of the impulse relays to the windings of the units register relays.

In response to the depression of key 225 for the units digit 9, 48-volt battery through low resistance 219 over conductor 220, the right contacts of key 225 and conductor 228 is applied over the ring impulsing path to 24-volt battery through the windings of impulse relays 421, 422 and 423. Due to the connection of 48-volt battery through a low resistance all three impulse relays respond. Relay 423 upon operating connects ground at its contact as previously traced to conductor 513, left back contacts of transfer relays 604 and 600, right back contacts of transfer relays 605 and 607, conductor 615, inner left front contact of transfer relay 705 to battery through the winding of transfer relay 707. Relay 707 operates and locks through the winding of relay 706, inner back contact of relay 708, outer front contact of relay 707, to ground on conductor 1303, but relay 706 being shunted as long as relay 423 remains operated, does not operate at this time. Relay 421 upon operating closes a circuit extending from ground at its contact, over conductor 419, next to outer left contact of relay 703, conductor 709, right winding of units register relay 1102 to battery. Relay 1102 upon operating locks over its left winding, inner left front contact, conductor 1310 to ground at the inner left front contact of relay 1302. Relay 422 upon operating closes a circuit extending from ground at its contact, over conductor 418, outer left contact of relay 703, conductor 710, to battery through the right winding of units register relay 1103. Relay 1103 operates and locks over its left winding and inner left front contact to ground on conductor 1310.

At its left contacts key 225 closes a circuit from ground through low resistance 226, high resistance 231, left contacts of key 225, conductor 228, thence over the tip impulsing path to 24-volt battery through the windings of impulse relays 411, 412 and 413, but due to the direction and strength of the current flowing, only relay 413 operates duplicating the function of impulse relay 423 already described. When the operator releases the depressed key 225, impulse relays 413, 421, 422 and 423 release, relays 413 and 423 opening the shunt around the winding of relay 706 whereupon relay 706 operates in the locking circuit of relay 707, opening at its back contact the locking circuit of relays 703 and 705, whereupon these latter relays release. Relay 703 upon releasing disconnects the operating circuits of the relays of the units register from

the contacts of the impulse relays, and relay 706 upon operating connects the contacts of the impulse relays to the windings of the stations register relays.

Following the keying of the numerical designation, the operator depresses the start key 232 which at its left contacts connects 48-volt battery through low resistance 219 and high resistance 229 over conductor 228, thence over the ring impulsing path to 24-volt battery through the windings of impulse relays 421, 422 and 423. The direction of current flowing is such as to operate polarized relay 421 and is of sufficient strength to operate sensitive relay 423, marginal relay 422 not operating. Relay 423 at its contact connects ground to conductor 615 as previously traced, thence over the inner left back contact of transfer relay 705, inner front contact of relay 707 to battery through the winding of transfer relay 711. Relay 711 operates and locks through the winding of relay 708, the left front contact of relay 711 to ground on conductor 1303, but relay 708 being shunted as long as relay 423 remains operated does not operate. Relay 421 closes an obvious circuit for relay 420 and closes a circuit from ground over conductor 419, the next to outer left contact of relay 706, conductor 712 to battery through the right winding of stations register relay 1104. Relay 1104 upon operating locks over its left winding and inner left front contact to ground on conductor 1310 and, at its outer contact closes an obvious circuit for register relay 1105. At its right contacts start key 232 closes a circuit from ground on conductor 213 over low resistance 230, conductor 227, thence over the tip impulsing path to 24-volt battery through the windings of impulse relays 411, 412 and 413. The direction of current flowing is not such as to permit polarized relay 411 to operate, but due to the current strength both sensitive relay 413 and marginal relay 412 operate. Relay 413 upon operating duplicates the function of relay 423. Relay 412 upon operating closes an obvious circuit for relay 425 over the front contact of relay 420, relay 425 locking to ground on conductor 1303. Relay 412 also closes a circuit from ground over conductor 416, inner left contact of relay 706, to battery through the left winding of relay 713. Relay 713 operates and locks over its right winding and inner left front contact to ground on conductor 1310 and extends its holding ground over conductor 714, middle front contact of register relay 1104, conductor 1106 to battery through the winding of relay 715, thereby operating relay 715.

Following the release of the start key 232, impulse relays 421, 423, 412 and 413 release, relay 421 in turn releasing relay 420, which at its back contact connects ground from conductor 1303, over the front contact of relay 425, back contact of relay 420, conductor 426, to battery through the winding of start relay 901. Relays 413 and 423 upon releasing remove the shunt from the winding of relay 708 which now operates in the holding circuit of relay 711 opening at its inner right back contact, the holding circuit of relays 706 and 707 which now release.

When the start relay 901 operates, with relay 1001 operated, a circuit is established from battery, winding of relay 406, inner right normal contacts of relay 408, conductor 428, outer left front contact of relay 901, conductor 908, to ground at the inner right front contact of relay 1001. Relay 406 operates releasing relay 407, connects 48-volt battery through resistance 429 over its outer right front contact to the ring impulsing path and 48-volt battery through the winding of marginal relay 408 over its inner left front contact to the tip impulsing path, these impulsing paths being connected respectively at the keyset circuit through the windings of polarized relays 233, and 234 to 24-volt battery. Relay 408 being marginal does not operate, but relays 233 and 234 both operate and close an obvious circuit for relay 235 which locks to ground at the upper contact of relay 211 and connects ground over its upper contacts to the tip impulsing path whereby marginal relay 408 in the sender operates and locks over its inner right front contact to ground on conductor 428 and opens the circuit of relay 406 which releases. Relay 406 upon releasing opens the operating circuits of relays 233 and 234, relay 233 now releasing, but relay 234 being held operated by relay 235. Relay 233 upon releasing closes a circuit from ground at its back contact, lower front contact of relay 235, winding of relay 209 to battery. Relay 209 operates and opens the circuit of relay 208, which upon releasing in turn releases relay 211. Relay 211 upon releasing in turn releases relays 235, 234, 209, 215 and 217 and extinguishes lamps 212 and 221. Relay 211 upon releasing also releases relay 122 in the cord circuit. The operator's keyset is now in normal condition.

If the operator disregards the pilot lamp 221 and starts keying a designation before the sender is attached and relay 217 has been operated from the sender, a circuit will be closed for relay 218 from battery through its winding, inner lower back contact of relay 217, conductor 227 to ground on conductor 213 through contacts of any operated keys of the keyset 214. Relay 218 upon operating locks over the left contacts of key 206, upper front contact of relay 218 to ground at the upper contact of relay 211 and at its lower front contact connects lamp 221 in a flashing circuit through interrupter contacts 236. To prepare the keyset for use, the operator must depress key 206 to release relay 218.

Provision for two or three digit office codes

Returning at this point to the operation of the code register relays, it will be recalled that relay 527 operated in parallel with the A code register relay 522. The group of relays 527, 528, 523, 526, 914, 916 and 917 is provided for enabling the sender to record either two or three digit office codes and to make the necessary changes in the sender circuits in either case. Had the first office code letter dialed had a numerical equivalent of three, then relays 522 and 529 of the A code register would have been operated in parallel with relays 527 and 528. Had the code letter had a numerical equivalent of four, then relays 912 and 916 would have been operated in parallel. Similarly for other code letters equivalent to digits 5 to 9, inclusive, code register relays 522, 529, 912 and 938 would have been selectively operated and relays 527, 528, 916 and 917 would have been operated similarly. In the case assumed the first code letter keyed was the equivalent of 2 signifying that the office code comprised three digits and therefore the operation of relay 527 was without effect. The value of the first code digit determines whether one or two more code digits will be received.

If it be assumed that the first code letter having the numerical value 3 indicates a two digit code, then the terminal 530 on the cross-connecting rack 533 is strapped to terminal 531. Then with relays 527 and 528 operated in response to keying such a code letter, a circuit is established from ground on conductor 913, inner left back contact of relay 917, conductor 918, inner right front contact of relay 527, right front contact of relay 528, terminals 530 and 531 to battery through the winding of relay 523 and in parallel over conductor 532 to battery through the winding of relay 914. Similarly, if any other first code letter is allocated for two digit codes, other terminals of the distributing rack 533 would be cross-connected to terminal 531 and when the relays of the group 527, 528, 916 and 917 corresponding to such code letters operate, relays 523 and 914 would be operated. With relays 523 and 914 operated, transfer relay 512 operated and transfer relay 511 released in response to keying the first code letter, then when the operator keys the second code letter thereby operating either one of impulse relays 413 or 423 and ground is connected to conductor 415, a circuit is established from conductor 415, left back contact of relay 511, right front contact of relay 512, inner left front contact of relay 523, conductor 534, winding of transfer relay 600 to battery instead of as previously traced through the winding of relay 604 to battery. Relay 600 locks in series with relay 601 over the back contact of relay 602, right front contact of relay 600 to ground on conductor 506, but as long as the operator holds the key depressed, relay 601 does not operate. With relays 523 and 914 operated, the conductors 416, 417, 418 and 419 extending from the contacts of the impulse relays now extend over front contacts of relay 515, front contacts of either relay 914 or relay 523 to the windings of relays of the C code register rather than as heretofore traced to windings of the B code register. Thus for two digit codes the second code digit is registered on the C code register. As soon as the depressed key is released, relay 601 operates in the locking circuit of relay 600 and opens the locking circuit of relays 512 and 515 which release, relay 515 opening the circuits extending from the contacts of the impulse relays to the C code register relays and relays 601 upon operating connecting the impulse relay contacts to the windings of the thousands register relays.

Connection of sender to decoder

Regardless of whether a two or three digit office code has been registered, as soon as the code digits have all been registered and relay 600 operates, a circuit is closed for relay 509, extending from battery through the winding of relay 509, conductor 510, right contacts of relay 600 to ground on conductor 506, relay 509 upon operating locking to conductor 506 and closing a holding circuit for relay 505 which has been previously operated. Relay 509 also connects battery from conductor 702, right contact of relay 509, outer right front contact of relay 505, conductor 535, right back contact of relay 903, conductor 919, inner right back contact of relay 1404, conductor 1427, right back contact of relay 920, left normal contacts of relay 921, conductor 922, inner left normal contacts of relay 1306, conductor 1334 to the decoder connector for causing the connection of a decoder with the sender. As described in the patent of Raymond and Scully hereinbefore referred to, as soon as an idle decoder connector and decoder becomes free to serve the sender, the sender is connected to the decoder by all of the conductors extending to the left margins of Figs. 6 and 7 with the exception of conductor 1334 and conductor 622 which is branched from off-normal battery conductor 702, and the code digit registrations are now transferred to the decoder, the A code digit being transferred over conductors of group 623 by ground placed thereon at contacts of the operated A code register relays, the B code digit being transferred over the conductors of group 624 by ground placed thereon at contacts of the operated B code register relays, and the C code digit being transferred over the conductors of group 625 by ground placed thereon at contacts of the operated C code register relays. Ground is also applied at the decoder over conductor 626, thence over the back contacts of all code register

relays of the sender which have not been operated, to conductors of the groups 623, 624 and 625 which were not grounded through the operation of code register relays so that all of the conductors of the three groups are now grounded. When all register relays of the decoder have operated, ground is removed at the decoder from conductor 626 and all decoder register relays release except those corresponding to operated register relays of the sender.

The decoder now translates the office code and determines therefrom the class of the desired call and in the manner fully described in the aforementioned patent of Raymond and Scully causes the setting of certain of the compensating resistance register relays 1413 to 1417, inclusive, over the group of conductors 627, the setting of certain of the class register relays 1405, 1411 and 1412 over the group of conductors 728, the setting of certain of the district brush register relays 1407, 1409 and 1410 over the group of conductors 727, the setting of certain of the district group register relays 1516, 1517, 1518 and 1519 over the group of conductors 729, the setting of certain of the office brush register relays 1509 to 1511, inclusive, over the group of conductors 725, and the setting of certain of the office group register relays 1512 to 1515 over the group of conductors 726. Since on the connection assumed, district selections are to be made, relay 502 is not operated from the decoder and since office selections are also to be made, relay 1440 is operated from the decoder over conductor 1441 and locks over its left winding and left front contact to ground on conductor 1254 as soon as relay 1306 operates and until sequence switch 1200 leaves position 7. After an interval to allow the register relays of the sender to be operated from the decoder, the decoder connects ground over conductors 628 and 1502 to battery through the right winding of relay 1501 which operates and locks over its left winding and inner left front contacts to ground on conductor 1303 and extends its locking ground over conductor 1308 to battery through the winding of relay 1306 thereby causing the operation of relay 1306. Relay 1306 upon operating causes the release of the decoder by removing battery from conductor 1334, prepares locking ground for operated relays of the compensating resistance, class, district brush and group and office brush and group register relays and opens the circuit of relay 1400 which now releases.

It will be assumed that compensating resistance register relays 1413, 1415 and 1417, no class register relays, office brush register relay 1509 and office group register relays 1512 and 1513 and no district brush or district group register relays have been operated from the decoder. The operated office brush and office group register relays lock over conductor 1503, the left contacts of cam 1206, conductor 1207, to ground at the right front contact of relay 1306 and the operated compensating resistance and class register relays lock over conductor 1254 and the upper contacts of cam 1206 to the right front contact of relay 1306. It will also be assumed that for office test and selection it is necessary to insert 600 ohms resistance into the fundamental circuit and for selections beyond the office selector, it is necessary to insert 300 ohms resistance and that therefore compensating register relays 1413, 1415 and 1417 have been operated from the decoder as previously stated, relay 1417 always being operated on this class of call if the trunk loop has 1300 ohms resistance or less.

With control switch 1200 in position 1 and sequence switch 310 of the district selector in position 4, the fundamental circuit is now completed from battery through the upper winding of control relay 306, upper left contact of cam 330, upper left contact of cam 307, inner upper contact of relay 327, left contacts of cam 328, brush 371, tip fundamental conductor 319, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, upper contacts of cam 1219, conductor 1231, winding of relay 1315, conductor 1316, back contact of counting relay 401, conductor 430, left winding of overflow relay 1317, conductor 1318, conductor 1348, resistance 941, outer left back contact of relay 911, inner left back contact of relay 902, conductor 932, right back contact of relay 502, conductor 507, back contact of relay 1400, conductor 1401, outer left front contact of relay 1306, conductor 1203, left contacts of cam 1202 to ground on conductor 1303. The left winding of relay 1317 is at this time shunted by resistance 1324 over the back contact of relay 1311. Relays 1315 and 306 operate over this circuit, relay 306 locking over its inner upper front contact and the left contacts of cam 307 to the fundamental tip conductor and closing a circuit for advancing sequence switch 310 into position 5. This circuit may be traced from battery, winding of magnet 310, contact of cam 311, upper left contact of cam 312 to ground at the upper front contact of relay 306. As switch 310 leaves position 4, relay 306 remains operated over its locking circuit and closes a circuit with switch 310 in position 5 extending from battery through the winding of up-drive magnet 337, right contacts of cam 338 to ground at the upper front contact of relay 306, for advancing the district selector brushes in a brush selection movement. As the brushes advance an intermittent shunting ground is connected to the tip fundamental over the lower contacts of cam 307, commutator segment 339, brush 340, upper right contact of cam 341 to ground at the lower left contact of cam 315 thereby holding relay 306

operated and intermittently shunting down the sender stepping relay 1315.

In the sender upon the operation of stepping relay 1315, no district brush register relays having been operated from the decoder, a circuit is established from ground at the lower left contact of cam 1204, lower right contact of cam 1217, conductor 1233, contact of relay 1315, conductor 1234, lower left and right contacts of cam 1235, conductor 1236, upper contacts of cam 1258, conductor 1238, left back contact of district brush register relay 1410, outer right back contact of register relay 1409, outer right back of register relay 1407, conductor 1423, left contacts of cam 1239, conductor 1240 to battery through the winding of the No. 0 counting relay 400. Relay 400 operates and locks through the windings of counting relays 401 and 402, conductor 405 to ground over the lower contacts of cam 1209. When the stepping relay 1315 deenergizes in response to the first shunting impulse from the district selector, relays 401 and 402 operate in the locking circuit of relay 400, relay 401 opening the fundamental circuit thereby releasing district selector control relay 306. Relay 306 upon releasing opens the circuit of up-drive magnet 337 to arrest the brush shaft in a position to trip the first set of brushes thereof and closes a circuit for advancing sequence switch 310 into position 6. This circuit extends from battery through the winding of magnet 310, contact of cam 311, lower left contact of cam 312 to ground at the upper back contact of relay 306. At the sender upon the operation of relay 402, a circuit is established from ground at its contact, conductor 404, outer left back contact of relay 1402, conductor 1403, upper contacts of cam 1208 to battery through the winding of sequence switch magnet 1200 for advancing switch 1200 out of position 1 into position 3. As switch 1200 leaves position 1¼ the locking circuit of counting relays 400, 401 and 402 is opened at the lower left contact of cam 1209 and the counting relays release.

Since it has been assumed that a distant office selector 375 is to be employed in the connection, relay 1440 has been operated as previously described. With sequence switch 310 in position 6 and sequence switch 1200 in position 3, the fundamental circuit is again established and relays 306 and 1315 both operate, relay 306 upon operating locking over the fundamental circuit and closing the previously traced circuit for moving sequence switch 310 out of position 6 into position 7. In position 7 the circuit of up-drive magnet 337 is again closed thereby advancing the selector brushes in a group selection movement. Since trip magnet 342 operated in a circuit extending over the upper left contact of cam 341, and the lower left contact of cam 315, as soon as switch 310 reached position 6, the first set of brushes is tripped during the initial portion of the group selection movement of the brush shaft. As the brush shaft advances the sender stepping relay 1315 is intermittenly shunted over a circuit extending from the upper left contact of cam 307, upper right contact of cam 330, commutator segment 343, brush 344, upper right contact of cam 341, to ground at cam 315.

In the sender upon the operation of relay 1315, a circuit is established from ground at the lower left contact of cam 1204, lower right contact of cam 1217, conductor 1233, contact of relay 1315, conductor 1234, lower left and right contacts of cam 1235, conductor 1236, right contacts of cam 1258, conductor 1263, back contacts of district group register relays 1516, 1517 and 1518, conductor 1423, upper left and lower right contacts of cam 1239, conductor 1264, back contact of district group register relay 1519, conductor 1240 to battery through the winding of No. 0 counting relay 400. Relay 400 operates and locks as previously described through the windings of relays 401 and 402 and, when stepping relay 1315 deenergizes in response to the first shunting impulse from the district selector, relays 401 and 402 operate. Relay 401 opens the fundamental circuit thereby releasing the district selector control relay 306. Relay 306 upon releasing opens the circuit of the up-drive magnet 337 to arrest the selected set of brushes in position to hunt over the first group of trunks to which it has access and closes the circuit previously traced for advancing sequence switch 310 into position 8.

In position 8 relay 306 operates in a circuit extending from battery through its lower winding, lower left contact of cam 330, upper right contact of cam 307, upper right and lower left contacts of cam 308, upper back contact of relay 309 to ground on conductor 363, closing the previously traced circuit for advancing sequence switch 310 into position 10. After leaving position 9, relay 306 is held operated over its upper winding and inner upper front contact, upper contacts of cam 345, brush 346, to ground on the sleeve terminal of the first trunk of the selected group if such trunk is busy. It will be assumed that it is busy and that when sequence switch 310 reaches position 10 relay 306 is locked operated thereby closing the previously traced circuit for up-drive magnet 337. Up-drive magnet 337 now causes the switch shaft to be advanced in a trunk selection movement. As soon as an idle trunk is encountered this locking circuit of relay 306 is opened and until the selector brushes are centered on the terminals of the idle trunk, relay 306 is maintained locked over its lower winding, lower contacts of cam 330, center-

ing commutator segment 347, brush 348, left and lower right contacts of cam 338, to ground at the upper from contact of relay 306. As soon as the brushes are centered, relay 306 releases opening the circuit of up-drive magnet 337 and closing the previously traced circuit for advancing sequence switch 310 into position 11. In position 11, relay 306 again operates over its lower winding and lower contacts of cam 315 and closes the previously traced circuit for advancing sequence switch 310 out of position 11 into position 12, relay 306 deenergizing as soon as the switch leaves position 11. With switch 310 in position 12, the tip fundamental conductor 319 is extended over brush 371, upper front contact of relay 327, right contacts of cam 349, to brush 351 and thence to battery through the control relay of the office selector 375 and the ring fundamental conductor 323 is extended over brush 331, lower front contact of relay 327, lower left and upper right contacts of cam 352, brush 353, to ground at the office selector. At the sender upon the operation of the relay 402 at the end of district group selection, a circuit is established from its contact over conductor 404, outer left back contact of relay 1402, conductor 1403, upper right and lower left contacts of cam 1208, conductor 508, to battery through the left winding of relay 1311, and in parallel over the left back contact of relay 502, conductor 1214, outer right back contact of relay 1500, conductor 1521, right normal contacts of relay 1108 to battery through the winding of slow-to-release relay 1109. Relay 1109 operates and closes an obvious circuit for slow-to-release relay 1108 which after an interval operates and locks over its right alternate contacts to ground on conductor 1521, opening at its right normal contacts the operating circuit of relay 1109. After an interval relay 1109 releases closing a circuit from ground at its back contact, left alternate contacts of relay 1108, conductor 1215, conductor 1212, upper right contact of cam 1211, contact of cam 1201 to battery through the winding of magnet 1200 for advancing switch 1200 into position 4. The delay introduced through the operation of relays 1108 and 1109 allows sufficient time to permit the district selector 360 to hunt for an idle trunk in the selected group before switch 1200 is advanced into position 4 for making a test of the selected trunk. Upon the advance of switch 1200 out of position 3¼ the locking circuit of the operated counting relays is opened at the lower contacts of cam 1209, relay 402 upon releasing in turn releasing relays 1108 and 1109 and relay 401 upon releasing again closing the fundamental circuit. Relay 1311 also operates and locks over its right winding and contacts, inner left back contact of relay 1312 to ground on conductor 1503, removing the shunt from the left winding of relay 1317.

Office trunk test

The fundamental circuit may now be traced from battery through the control relay of the office selector 375, thence as traced to conductor 319, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, upper right and lower left contacts of cam 1219, resistance 1218, lower left and upper right contacts of cam 1221, conductor 1222, front contact of relay 1417, conductor 1436, winding of trunk test relay 1336, conductor 1316, back contact of relay 401, conductor 430, left winding of overflow relay 1317, conductor 1318, left contacts of cam 1223, conductor 1256, right front contact of compensating resistance relay 1413, resistance 1428, back contact of relay 1414, conductor 1430, left and upper right contacts of cam 1225, conductor 1226, right back contact of relay 1313, conductor 323, thence as traced to ground at the office selector.

Relay 1336 operates in this circuit if the trunk is in operative condition, but relay 1317 does not operate. Relay 1336 causes the operation of relay 1320, which locks over conductor 1321, to ground over the lower right contact of cam 1227, at the lower left contact of cam 1204 until switch 1200 leaves position 5, and closes a circuit for relay 1312 over conductor 1322, upper right and lower left contacts of cam 1228, conductor 1229, outer right front contacts of relay 1320 to ground on conductor 1303. Relay 1312 upon operating releases relay 1311 to again shunt the left winding of relay 1317 and establishes a new fundamental circuit traceable as previously described from the tip fundamental conductor 319, left back contact of relay 1313, the outer left front contact of relay 1312, conductor 1323, right contacts of cam 1230, conductor 1231, winding of stepping relay 1315, conductor 1316, back contact of relay 401, conductor 430, left winding of overflow relay 1317, conductor 1318, left contacts of cam 1223, conductor 1256, right front contact of relay 1413, resistance 1428, back contact of relay 1414, conductor 1430, left and upper right contacts of cam 1225, conductor 1226, right back contact of relay 1313, to the ring fundamental conductor 323 to ground at the office selector. The operation of relay 1312 is effective at this time to remove the trunk test relay 1336 and resistance 1218 from the fundamental circuit thereby reducing the resistance of the circuit to such a degree as to cause the operation of the control relay of the office selector and the operation of stepping relay 1315 of the sender. Relay 1336 now releases. The sender is now in condition for controlling the office selector in its brush and group selection movements.

Office brush selection

It has been assumed that the decoder has

caused the operation of office brush register relay 1509. In response to the operation of the control relay of the office selector, the brush shaft thereof is driven upwardly in a brush selection movement causing the intermittent application of a shunting ground to the tip conductor of the fundamental circuit in the well-known manner for shunting the stepping relay 1315 of the sender. At the sender upon the operation of relay 1315 with register relay 1509 operated and control switch 1200 in position 4, a circuit is established from ground at cam 1204, lower right contact of cam 1217, conductor 1233, contact of relay 1315, conductor 1234 lower left and right contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, upper left contact of cam 1232, lower left contact of cam 1237, conductor 1257, right front contact of office brush register relay 1509, outer left back contact of register relay 1510, conductor 1520, back contact of the No. 1′ counting relay 433, winding of the No. 1 counting relay 434 to battery on conductor 702. Relay 434 operates and locks through the winding of relay 433, front contact of relay 434, conductor 436, lower left contact of cam 1217 to ground at cam 1204, but relay 433 being shunted does not operate until stepping relay 1315 deenergizes in response to the first shunting impulse from the office selector.

When relay 433 operates, it extends the previously traced circuit from conductor 1520 over its front contact, conductors 435 and 1423, left contacts of cam 1239, conductor 1240, to battery through the winding of counting relay 400. Relay 400 operates upon the next operation of stepping relay 1315 and locks through the windings of counting relays 401 and 402, front contact of relay 400, conductor 405, right front contact of relay 1312, conductor 1325, to ground over the upper right and lower left contacts of cam 1204. Relays 401 and 402 do not operate in this circuit until stepping relay 1315 again releases in response to the next shunting impulse. When relay 401 does operate, it opens the fundamental circuit thereby releasing the control relay of the office selector to arrest further movement of its brush shaft. Relay 402 upon operating closes a circuit from ground at its contact over conductor 404, outer left back contact of relay 1402, conductor 1403, right contacts of cam 1208, conductor 1326, inner left front contact of relay 1312, conductor 1213 to battery through the winding of magnet 1200 thereby advancing switch 1200 out of position 4 into position 6. As switch 1200 leaves positions 4 and 4½, the locking circuits of the operated counting relays are opened at the lower left contact of cam 1217 and the upper right contact of cam 1204 and the counting relays release. The office selector brush shaft has now been positioned preparatory to tripping the second set of brushes thereof. As sequence switch 1200 leaves position 5, the locking circuit of relay 1320 and the operating circuit of relay 1312 are opened at the lower right contact of cam 1227 and the upper right contact of cam 1228 respectively and these relays release. With relay 401 released the fundamental circuit through the control relay of the office selector and stepping relay 1315 of the sender may be traced from battery through the office selector control relay, thence to conductor 319, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, upper contacts of cam 1219, conductor 1231, winding of stepping relay 1315, conductor 1316, back contact of relay 401, conductor 430, left winding of relay 1317, conductor 1318, left contacts of cam 1223, conductor 1256, thence as previously traced to ground at the office selector.

Office group selection

With switch 1200 in position 6 and office group register relays 1512 and 1513 operated as assumed, a circuit is established from ground at cam 1204, lower right contact of cam 1217, conductor 1233, contact of relay 1315, conductor 1234, lower left and right contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, lower right contact of cam 1237, lower left contact of cam 1258, conductor 1259, right front contact of office group register relay 1512, outer left front contact of office group register relay 1513, conductor 617, back contact of the No. 3′ counting relay 437, winding of the No. 3 counting relay 438, to battery. Relay 438 operates and locks in series with relay 437, front contact of relay 438, conductor 436, lower left contact of cam 1217 to ground at cam 1204. At the office selector the control relay operating over the fundamental circuit causes the advance of the brush shaft in a group selection movement and the tripping of the selected second set of brushes. During the group selection movement, shunting impulses are transmitted over the tip fundamental conductor for intermittently shunting down stepping relay 1315 of the sender. Upon the first shunting down of relay 1315, counting relay 437 operates in the locking circuit of relay 438 and extends the counting relay control circuit over the front contact of relay 437, the back contact of relay 431 to battery through the winding of relay 432. On the next deenergization of relay 1315, relay 432 operates and locks in series with relay 431, front contact of relay 432, conductor 405 to ground over the lower contacts of cam 1209. Upon the next deenergization of stepping relay 1315, relay 431 operates and extends the control circuit over its front contact and the

back contact of relay 433 to battery through the winding of relay 434.

On the next energization of stepping relay 1315, relay 434 operates and locks through the winding of relay 433, its own front contact, to ground as previously traced on conductor 436. When relay 1315 again deenergizes relay 433 operates and extends the operating circuit over its front contact, conductors 435 and 1423, upper contacts of cam 1239, conductor 1260, back contact of office group register relay 1515, conductor 1240 to battery through the winding of counting relay 400. Upon the next energization of stepping relay 1315, relay 400 operates and locks in series with relays 401 and 402 over its own front contact and to ground on conductor 405. When stepping relay 1315 again deenergizes relays 401 and 402 operate, relay 401 opening the fundamental circuit to arrest further group selection movement of the office selector and relay 402 closing a circuit from ground over its contact, conductor 404, outer left back contact of relay 1402, conductor 1403, upper right and lower left contacts of cam 1208, conductor 508, back contact of relay 502, conductor 1214, outer right back contact of relay 1500, conductor 1521, right normal contacts of relay 1108 to battery through the winding of slow-to-release relay 1109. Relay 1109 operates and closes an obvious circuit for slow-to-operate relay 1108, which after an interval operates and locks over its right alternate contacts to ground on conductor 1521 opening at its right normal contacts the operating circuit of relay 1109. After an interval, relay 1109 releases, closing a circuit from ground at its back contact, left alternate contacts of relay 1108, conductor 1215, conductor 1212, upper right contact of cam 1211, contact of cam 1201 to battery through the winding of magnet 1200 for advancing switch 1200 into position 7. The delay introduced through the operation of relays 1108 and 1109 allows sufficient time to permit the office selector to hunt for an idle trunk in the selected group before switch 1200 is advanced into position 7 for making a test of the selected group of trunks.

Incoming trunk test

Upon the advance of sequence switch 1200 out of positions 6 and 6¼, the locking circuits of the operated counting relays are opened at the lower left contacts of cams 1217 and 1209, relay 402 upon releasing in turn releasing relays 1108 and 1109 and relay 401 upon releasing again closing the fundamental circuit for testing the selcted trunks outgoing from the office selector to an incoming selector. With compensating resistance register relays 1413, 1415 and 1417 operated as previously assumed, the fundamental circuit may now be traced from battery through the winding of the control relay (not shown) of the incoming selector thence to conductor 319 as previously traced, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, right contacts of cam 1219, conductor 1220, outer left back contact of relay 1006, conductor 1012, resitance 1218, lower left and upper right contacts of cam 1221, conductor 1222, right front contact of compensating resistance register relay 1417, conductor 1436, winding of trunk test relay 1336 conductor 1316, back contact of relay 401, conductor 430, left winding of relay 1317, conductor 1318, upper contacts of cam 1223, conductor 1224, right front contact of compensating resistance register relay 1415, resistance 1429, back contact of register relay 1416, conductor 1419, right contacts of cam 1225, conductor 1226, right back contact of relay 1313, thence as traced to ground at the incoming selector. If the incoming selector is in normal condition, relay 1336 operates closing an obvious circuit for relay 1320 which now locks over the locking circuit previously described closing the previously traced circuit for relay 1312. Relay 1312 upon operating establishes a new fundamental circuit traceable as previously described to the left back contact of relay 1313, thence over the outer left front contact of relay 1312, conductor 1323, right contacts of cam 1230, conductor 1231, winding of stepping relay 1315, conductor 1316, back contact of relay 401, conductor 430, left winding of relay 1317, conductor 1318, upper contacts of cam 1223, conductor 1224, right front contact of relay 1415, resistance 1429, back contact of relay 1416, conductor 1419, thence as traced to ground at the incoming selector. With relay 1312 operated trunk test relay 1336 releases. The sender is now in condition for controlling the incoming selector in its brush selection movement.

With selection control switch 1200 in position 7, a circuit is closed for operating relay 1005, extending from battery, winding of relay 1005, inner left back contact of class relay 1006, conductor 1007, upper left contact of cam 1217, to ground at cam 1204. It will be recalled that in response to the keying of the designation 1379 and the start combination, relay 607 of the thousands register, relays 609 and 610 of the hundreds register, relays 613 and 1004 of the tens register, relays 1102 and 1103 of the units register and a start relay 901 were operated. When, therefore, relay 1005 operates, with thousands register relay 607 operated, a circuit is closed for transferring the thousands digit registration to relay 1506. This circuit extends from battery through the winding of relay 1506, conductor 1507, outer left front contact of relay 1005, conductor 1008, inner left front contact of thousands register relay 607 to ground on conductor 1309. If the thousands digit were 2 with register relay 616 operated, relay 1407 of the district brush register which also serves as an

incoming brush register would be operated over a circuit through its right winding, conductor 1408, inner left front contact of relay 1005, conductor 1009, inner left front contact of register relay 616 to ground on conductor 1309. If the thousands digit were 3 with register relays 607 and 616 operated, relays 1506 and 1407 would both be operated over the circuits traced and in a similar manner relays of the district brush register and relay 1506 would be operated as follows to register the thousands digits 4 to 9, inclusive; thousands register relay 1010 being operated for digit 4 would operate relay 1409; thousands register relay 1011 being operated for digit 5 would operate relay 1410; thousands register relays 607 and 1011 being operated for digit 6 would operate relays 1506 and 1410; thousands registers relays 616 and 1011 being operated for digit 7 would operate relays 1407 and 1410, thousands register relays 607; 616 and 1011 being operated for digit 8 would operate relays 1506, 1407 and 1410 and thousands register relays 1010 and 1011 being operated for digit 9 would operate relays 1409 and 1410. If the thousands digit were zero none of the relays 1506, 1407, 1409 and 1410 would be operated. The remaining registrations on the hundreds, tens and units register relays are not transferred.

Incoming brush selection

In response to the operation of the control relay of the incoming selector 380, the brush shaft of the incoming selector is driven upwardly in a brush selection movement causing the intermittent application of a shunting ground to the tip conductor of the fundamental circuit in the well-known manner for intermittently shunting down the stepping relay 1315 of the sender. At the sender upon the initial operation of relay 1315 with none of the district brush register relays 1407, 1409 and 1410 operated, but with relay 1506 operated, to register the fact that an incoming selector brush set should be selected in accordance with the registered thousands digit 1, a circuit is established from ground at cam 1204, lower right contact of cam 1217, conductor 1233, contact of pulsing relay 1315, conductor 1234, lower left and right contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, right contacts of cam 1237, conductor 1238, left back conductor of register relay 1410, outer right back contact of relay 1409, left back contact of relay 1407, conductor 1423, left contacts of cam 1239, conductor 1240, winding of the No. 0 counting relay 400 to battery. Relay 400 operates and locks through the winding of counting relays 401 and 402 in parallel over conductor 405, outer right front contact of relay 1312, conductor 1325, upper right and lower left contacts of cam 1204, to ground, but relays 401 and 402 do not operate in this locking circuit being shunted by ground over the circuit previously traced through the contact of pulsing relay 1315. When relay 1315 releases due to the connection of ground to the tip fundamental conductor as the incoming brush shaft reaches a position to select the first brush set thereof, relays 401 and 402 operate, relay 401 opening the fundamental circuit to release the incoming selector control relay to arrest further brush selection movement and relay 402 advancing the selection control switch 1200 out of position 7 into position 9. This circuit may be traced from battery, winding of magnet 1200, conductor 1213, inner left front contact of relay 1312, conductor 1326, right contacts of cam 1208, conductor 1403, left back contact of relay 1402, conductor 404 to ground at the contact of relay 402. When the sequence switch 1200 leaves position 7½, the locking circuit of counting relays 400, 401 and 402 is opened at the upper right contact of cam 1204 and the counting relays release. As sequence switch 1200 leaves position 8, the circuit of relay 1312 is opened at the upper left contact of cam 1228, and relay 1312 releases.

Incoming group selection

With counting relay 401 and relay 1312 released, the fundamental circuit extends from the tip fundamental conductor 319, over the outer left back contact of relay 1312, conductor 1314, right contacts of cam 1219, conductor 1220, outer left back contact of relay 1006, conductor 1012, lower left and upper right contacts of cam 1230, conductor 1231, winding of stepping relay 1315, thence as traced through the left winding of overflow relay 1317 to the ring fundamental conductor 323. The control relay of the incoming selector 380 and stepping relay 1315 of the sender operate, but overflow relay 1317 does not receive current in the proper direction to operate at this time. The control relay of the incoming selector is now instrumental in driving the selector brush shaft upwardly in a group selection movement, the first set of brushes being tripped in the well-known manner during the initial portion of this movement and shunting ground being connected to the fundamental tip conductor, from the group commutator segment, to intermittently release the sender stepping relay 1315.

Stepping relay 1315 upon operating with relay 1506 and hundreds register relays 609 and 610 operated in accordance with the thousands digit 1 and hundreds digit 3, a circuit is established from ground at cam 1204, upper right contact of cam 1217, conductor 1234, contact of stepping relay 1315, conductor 1233, upper contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, lower right con-

tact of cam 1237, upper right contact of cam 1232, conductor 1241, outer right front contact of relay 1506, conductor 1508, inner right back contact of relay 1410, conductor 1424, outer left back contact of hundreds register relay 1014, conductor 1015, lower back contact of the No. 2′ counting relay 431, winding of the No. 2 counting relay 432 to battery on conductor 702, counting relay 432 operates closing a locking circuit for itself through its winding, the winding of the No. 2′ counting relay 431, front contact of relay 432, conductor 405, to ground over the lower contacts of cam 1209, but relay 431 being shunted does not operate until stepping relay 1315 deenergizes as the incoming brush shaft approaches the first group selection position. When relay 431 operates it extends conductor 1015 over its front contact, the back contact of the No. 1′ counting relay 433 to battery through the winding of the No. 1 counting relay 434. Relay 434 operates upon the next energization of stepping relay 1315 and locks through the winding of counting relay 433, the front contact of relay 434, conductor 436, lower left contact of cam 1217, to ground at cam 1204. On the next deenergization of stepping relay 1315, counting relay 433 operates extending conductor 1015 over the front contacts of relays 431 and 433, conductors 435 and 1423, left contacts of cam 1239, conductor 1240 to battery through the winding of the No. 0 sending relay 400. On the next energization of relay 1315, relay 400 operates locking through the windings of relays 401 and 402 which latter relays operate upon the next deenergization of relay 1315, relay 401 opening the fundamental control circuit to arrest the incoming selector in position for hunting in the third group of trunks accessible to the selected first set of brushes and relay 402 closing a circuit to advance sequence switch 1200 out of position 9 into position 11.

The circuit for advancing sequence switch 1200 may be traced from ground at the contact of relay 402 over conductor 404, left back contact of relay 1402, conductor 1403, upper contacts of cam 1208 to battery through the winding of magnet 1200. As sequence switch 1200 leaves positions 9 and 9¼, the locking circuits of the operating counting relays are opened at the lower left contacts of cams 1217 and 1209. Relay 401 upon releasing again closes the fundamental circuit. As sequence switch 1200 passes through position 10, the fundamental loop in the sender is closed as previously traced from conductor 319, left back contact of relay 1313, outer left back contact of relay 1312, conductor 1314, right contacts of cam 1219, conductor 1220, outer left back contact of relay 1006, conductor 1012, resistance 1218, lower contacts of cam 1221, resistance 1242, conductor 1226, right back contact of relay 1313, to conductor 323, thereby establishing a high resistance discharge path for the cable extending to the incoming selector. When sequence switch 1200 reaches position 11, the high resistance discharge path is opened at the sender and the same fundamental loop as employed for incoming group selection is established at the sender through the windings of the sender stepping relay 1315 and overflow relay 1317. Following the completion of group selection, the incoming selector hunts for ande connects with an idle final selector in the well-known manner.

Final brush selection

The sender stepping relay 1315, now operates preparatory to controlling final selector brush selection. In the well-known manner the brush shaft of the final selector 385 is now advanced in a brush selection movement transmitting impulses for intermittently shunting the sender stepping relay 1315. Upon the first energization of relay 1315 over the fundamental circuit, with hundreds register relays 609 and 610 operated, as described, to register the hundreds digit 3, a circuit is established from ground at cam 1204, upper right contact of cam 1217, conductor 1234, contact of relay 1315, conductor 1233, upper contact of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, lower right and upper left contacts of cam 1237, conductor 1243, left back contact of hundreds register relay 1016, conductor 1017, outer left front contact of register relay 610, outer left front contact of register relay 609, conductor 617, back contact of the No. 3′ counting relay 437, winding of the No. 3 counting relay 438 to battery on conductor 702. Relay 438 operates and locks in series with relay 437, over the front contact of relay 438, conductor 436, lower left contact of cam 1217, to ground at cam 1204, but relay 437 being shunted does not operate. Upon the first deenergization of stepping relay 1315 in response to the first shunting impulse applied from the final selector, counting relay 437 energizes and transfers conductor 617 over the front contact of relay 437, the back contact of the No. 2′ counting relay 431 to battery through the winding of the No. 2 counting relay 432. Uuon the next energization of relay 1315, relay 432 operates and locks in series with relay 431. Upon the next deenergization of relay 1315, relay 431 operates in a similar manner. The counting relays 433 and 434 operate in response to the next energization and release of stepping relay 1315. When relay 433 operates it extends control conductor 617 over its front contact, conductors 435 and 1423, left contacts of cam 1239, conductor 1240, winding of the No. 0 counting relay 400, to battery. Relays 400, 401 and 402 now operate in the manner previously described. When relay 401

operates the fundamental circuit is opened to arrest the further brush selection movement of the final selector and when relay 402 operates a circuit is established for advancing sequence switch 1200 out of position 11 into position 13. The final selector has now been positioned preparatory to tripping the fourth set of its brushes.

Final tens selection

The circuit for advancing sequence switch 1200 into position 13 may be traced from ground at the contact of relay 402, over conductor 404, left back contacts of relay 1402, conductor 1403, upper contacts of cam 1208 to battery through the winding of magnet 1200. As sequence switch 1200 leaves positions 11 and 11¼, the locking circuits of the operated counting relays are opened at the lower left contacts of cams 1217 and 1209. When sequence switch 1200 reaches position 13, the fundamental circuit employed for final brush selection is again established. Relay 1315 again operates and the final selector is in the well-known manner advanced in a group or tens selection movement, the selected fourth set of brushes being tripped during the initial portion of this movement. As the final selector brush shaft advances from group to group shunting impulses are transmitted for intermittently operating the sender stepping relay 1315.

Upon the first energization of relay 1315, with tens register relays 613 and 1004 operated as described, to register the tens digit 7, a circuit is established from ground at cam 1204, upper right contact of cam 1217, conductor 1234, contact of stepping relay 1315, conductor 1233, upper contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, lower right contact of cam 1237, lower left contact of cam 1232, conductor 1244, left back contact of tens register relay 1018, conductor 1019, left front contact of register relay 613, outer left back contact of register relay 618, conductor 1015, back contact of the No. 2′ counting relay 431, winding of the No. 2 counting relay 432 to battery on conductor 702. In response to the intermittent operation of relay 1315, counting relays 432, 431, 434 and 433 operate successively, relay 433 upon operating extending the counting relay control conductor 1015 over the front contacts of relays 431, and 433, conductors 435 and 1423, upper left contact of cam 1239, upper right contact of cam 1245, conductor 1246, outer left front contact of tens register relay 1004 conductor 1020, back contact of the No. 9′ counting relay 439 to battery through the winding of the No. 9 counting relay 440. In response to the further intermittent operation of stepping relay 1315, counting relays 440, 439, 442, 441, 444, 443, 446, 445, 448, 447, 400, 401 and 402, operate in succession. When relay 401 operates, the fundamental circuit is opened to arrest the final selector brush shaft with its fourth set of brushes in position to advance over terminals of the eight group of the brush bank in which subscriber's line 390 terminates and relay 402 closes a circuit for advancing sequence switch 1200 out of position 13 into position 15.

Final units selection

The circuit for advancing sequence switch 1200 into position 15 may be traced from ground at the contact of relay 402, conductor 404, left back contact of relay 1402, conductor 1403, upper contacts of cam 1208 to battery through the winding of magnet 1200. As sequence switch 1200 leaves positions 13 and 13¼, the locking circuits of the operating counting relays are opened at the lower left contacts of cam 1217 and 1209. When sequence switch 1200 reaches position 15, the fundamental circuit is again established. Relay 1315 again operates and the final selector is in the well-known manner advanced in a terminal or units selection movement. As the brush shaft advances from terminal position to terminal position, shunting impulses are transmitted for intermittently operating the sender stepping relay 1315.

Upon the first energization of relay 1315, with the units register relays 1102 and 1103 operated as described to register the units digit 9, a circuit is established from ground at cam 1204, upper right contact of cam 1217, conductor 1234, contact of relay 1315, conductor 1233, upper contacts of cam 1235, conductor 1236, outer right back contact of relay 1404, conductor 1422, lower right contact of cam 1237, lower right contact of cam 1232, conductor 1247, outer left front contact of units register relay 1102, conductor 1107, back contact of the No. 4′ counting relay 449, winding of the No. 4 counting relay 450 to battery on conductor 702. In response to the intermittent operation of stepping relay 1315, counting relays 450, 449, 438, 437, 432, 431, 434 and 433 operate in succession, relay 433 upon operating extending the counting relay control conductor 1107, over the front contacts of relays 449, 437, 431 and 433, conductors 435 and 1423, upper left contact of cam 1239, lower left contact of cam 1245, conductor 1248, outer left front contact of units register relay 1103, conductor 1020, back contact of the No. 9′ counting relay 439, to battery through the winding of the No. 9 counting relay 440. In response to the further intermittent operation of stepping relay 1315, counting relays 440, 439, 442, 441, 444, 443, 446 and 445, 448, 447, 400, 401 and 402, operate in succession. When relay 401 operates the fundamental circuit is opened to arrest the final selector brush shaft with the brushes of its fourth brush set in engagement with terminal 1379 of the desired line 390,

and relay 402 closes the previously traced circuit for advancing sequence switch 1200 out of position 15 into position 17. As switch 1200 leaves positions 15 and 15¼, the locking circuits of the operating counting relays are opened at the lower left contacts of cam 1217 and 1209. In position 17 the fundamental circuit is again closed through the winding of the sender stepping relay 1315 and the left winding of overflow relay 1317.

Following the completion of final units selection, the sequence switch of the incoming selector advances in the well-known manner, reversing the connection of battery and ground to the conductors 319 and 323 of the fundamental circuit, and upon finding the fundamental circuit closed at the sender through the back contact of counting relay 401, further advances cutting off the reversed battery. At the sender, the momentary reversal of battery causes the operation of stepping relay 1315 and the operation of polarized overflow relay 1317 which locks to battery through its right winding, conductor 1327, upper left and lower right contacts of cam 1249, conductor 1250 to ground at the front contact of relay 1317. At its front contact, relay 1317 also establishes a circuit extending over conductor 1250, right contacts of cam 1249, conductor 1251, to battery through the winding of relay 1402. Relay 1402 at its back contact opens the circuit over which operating ground was supplied to contacts of the register relays for operating the counting relays and with stepping relay 1315 operated, closes a circuit for operating the No. 0 counting relay 400. The circuit of relay 400 may be traced from battery, winding of relay 400, conductor 1240, middle front contacts of relay 1402, conductor 1236, upper contacts of cam 1235, conductor 1233, contact of stepping relay 1315, conductor 1234, upper right contact of cam 1217 to ground at cam 1204. As soon as the reversed battery is disconnected at the incoming selector, relay 1315 releases and counting relays 401 and 402 operate in series with the winding of relay 400 over the front contact of relay 400, conductor 405, to ground at the lower contacts of cam 1209. In the event that relay 1315 does not remain operated long enough to permit counting relay 400 to operate, an alternative operating circuit for relays 400, 401 and 402 in series is established over conductor 403, inner front contact of relay 1402, conductor 1425, right contacts of cam 1252, conductor 1253, to ground at the inner right front contact of relay 1302. Relay 401 upon operating opens the fundamental circuit and relay 402 upon operating closes a circuit for operating relay 1313.

The circuit of relay 1313 may be traced from ground at the front contact of relay 402, conductor 404, outer left front contact of relay 1402, conductor 1426, to battery through the winding of relay 1313. Relay 1313 upon operating closes a circuit for relay 1328 over the alternate contacts of relay 1304, conductor 1329, upper left and lower right contacts of cam 1245, conductor 1403, to ground at the inner left front contact of relay 1313. With relay 1328 operated the fundamental tip conductor 319 is connected through resistance 1330, the front contact of relay 1328 to the ring conductor 323 of the fundamental circuit, thus simulating the trunk closure which is usually made when a regular district selector is employed in an established connection. This circuit is maintained until the fundamental circuit is opened at the trunk circuit of Fig. 3. Relay 1328 upon operating also extends its operating ground to battery through the winding of relay 1305, which locks over its left front contact to ground on conductor 1303 locking relay 1328 operated and opening the circuit of relay 1304 which releases. With relay 1305 operated and relay 1304 released, ground on conductor 1303 extended over the left front contacts of relays 1305 and 1328, normal contacts of relay 1304, right front contact of relay 1305, right back contact of relay 1331, conductor 1332, to battery through the winding of relay 910. Relay 910 upon operating locks over its right contact to ground on conductor 1303 and at its left back contact opens the shunt around the high resistance left winding of relay 500. The current now flowing from ground through the windings of relay 500, conductor 321, brush 326, and thence as previously traced to battery in parallel through the windings of relays 324 and 309 is not of sufficient strength to maintain relay 324 operated and it releases.

Relay 324 upon releasing closes a circuit from battery, upper winding of relay 306, upper back contact of relay 324, to ground over the upper right and lower left contacts of cam 315, relay 306 upon operating closing a circuit from ground at its upper front contact, upper left contact of cam 312, to battery through the winding of magnet 310 for advancing sequence switch 310 out of position 12 into position 15. As sequence switch 310 leaves position 14, the conductors extending to the sender are opened and the sender is released by the opening of the circuit previously traced through the windings of relay 500.

When the circuit through the windings of relay 500 is opened, relay 500 releases in turn releasing relays 700 and 1302. Relay 1302 upon releasing disconnects ground from conductor 1303, and relay 700 disconnects offnormal battery from conductor 702, whereupon all operated relays of the sender release. At its back contact, relay 700 closes a circuit from ground over conductor 724, upper left contact of cam 1211, contact of cam 1201 to

battery through the winding of magnet 1200, thus advancing sequence switch 1200 into normal position. All operated apparatus of the sender is now in normal condition.

With sequence switch 310 in position 15, the talking circuit from the operator's position to the incoming selector 380 may be traced over the tip brushes of office selector 375 and district selector 360, the upper contacts of cam 349, conductor 370, tips of jack 302 and plug 121, upper normal contacts of relay 122, which released when the operator's keyset was released following completion of keying, inner upper front contact of relay 123, upper right winding of repeating coil 113, upper back contact of relay 127, upper front contact of relay 123, winding of polarized supervisory relay 134, lower back contact of relay 127, lower right winding of repeating coil 113, inner lower front contact of relay 123, lower normal contacts of relay 122, rings of plug 121 and jack 302, conductor 334, upper contacts of cam 352, ring brushes of district selector 360 and office selector 375, to the incoming selector. From the incoming selector 380, the talking circuit is established over brushes of the incoming selector and brushes of the final selector 385 to the subscriber's line 390 in the well-known manner. When the called subscriber answers, current flowing over the talking path extending from the incoming selector to the operator's cord circuit is reversed in the well-known manner, thereby causing the operation of polarized relay 134. Relay 134 causes the operation of relay 130 over an obvious circuit which in turn at its upper back contact opens the circuit of calling supervisory lamp 129.

Upon the termination of the conversation, the calling and called subscribers restore their receivers to the switchhooks thereby releasing the answering supervisory relay 107 and the calling supervisory relay 134 whereupon the lamps 105 and 129 light as disconnect signals. The operator upon noting the lighted lamps withdraws the plugs 101 and 121, releasing the operated relays of the cord circuit, extinguishing lamps 105 and 129 and opening the talking circuit to the incoming selector 360. The withdrawal of plug 121 from jack 302 releases relay 300 which closes a circuit from ground at its lower back contact, upper left and lower right contacts of cam 354, lower back contact of relay 324, upper right contact of cam 322, to battery through the winding of magnet 310 for advancing switch 310 into position 18. As switch 310 leaves position 16¼, ground is removed from district test brush 346 at the lower left contact of cam 345. In position 18 the circuit of down-drive magnet 355 is established over the upper contacts of cam 356 to ground at the back contact of relay 300 and the district selector shaft is driven into normal position. Upon reaching normal position a circuit is established from battery, winding of magnet 310, lower left contact of cam 322, normal commutator segment 357, brush 348, upper right contact of cam 341 to ground at cam 315 for advancing sequence switch 310 into normal position. The circuits of the district selector are now in normal position. Other selectors which have been used in the establishment of the connection are restored to normal in the well-known manner.

Overflow and tell-tale conditions—district selector goes to tell-tale

The operation of the sender in successfully completing a connection having been described, consideration will now be given to connections which are not completed on account of some irregularity, and first, those which failed because a selector shaft runs to an overflow terminal on account of an all-trunks-busy condition or to a tell-tale position because some trouble arises in the operation of the apparatus or circuits. These conditions will be considered in the order of their occurrence in the advance of selection control switch 1200 of the sender.

If the shaft of district selector 360 goes to tell-tale in making brush or group selection, that is, with sequence switch 310 in either positions 5 or 7, a circuit is established from battery through the winding of magnet 310, lower right contact of cam 312, tell-tale commutator segment 358, brush 340, upper right contact of cam 341, to ground at cam 315 for advancing switch 310 into position 8. In position 8 a circuit is closed from battery lower winding of relay 306, lower left contact of cam 330, upper right contact of cam 307, upper right and lower left contacts of cam 308, back contact of relay 309, to ground on conductor 363. Relay 306 operates and advances sequence switch 310 to position 9, sequence switch 310 being then advanced to position 17 over a circuit extending from battery through the winding of magnet 310, lower right contact of cam 312, segment 358, brush 340, upper right contact of cam 341 to ground at cam 315. When sequence switch 310 leaves position 14, the conductors extending to the sender are opened and the sender restores as previously described.

With sequence switch 310 in position 17, interrupted ground is applied over the lower contacts of cam 317 through the winding of stepping relay 318, to battery thereby intermittently operating relay 318. On the first operation of relay 318, 48-volt battery is connected over the lower contacts of cam 368, resistance 360, inner front contact of relay 318, right contacts of cam 335, to trunk conductor 334 and, over the lower contacts of cam 368, upper contact of relay 318, resistance 359, right contacts of cam 305, to

trunk conductor 370. If the keyset is still connected with the cord circuit, and relay 122 of the cord circuit is still operated, trunk conductors 370 and 334 are extended over alternate contacts of relay 122 to 24-volt battery through the windings of polarized relays 234 and 233 respectively at the keyset. These relays then operate in turn operating relay 235 which locks to ground at the contacts of relay 211 and locks relay 234. When relay 318 releases, relay 233 releases and with relay 235 operated, the keyset is released and in turn releases relay 122 as previously described. Relay 318 upon releasing also connects 24-volt battery through resistance 361, back contact of relay 318, right contacts of cam 335, to the ring trunk conductor 334 and ground from cam 315 over the lower right contact of cam 341, upper contacts of cam 369, resistance 362, resistance 359, right contacts of cam 305 to the tip trunk conductor 370, the trunk conductors 370 and 334 then extending at the cord circuit with relay 122 released through the winding of polarized supervisory relay 134. Relay 134 is thus operated and closes the previously traced circuit for relay 130 which operates in turn opening the circuit of supervisory lamp 129. When relay 318 again operates, relay 134 releases in turn releasing relay 130 to relight lamp 129. Thus due to the intermittent operation of relay 318, the cord supervisory lamp 129 is flashed as a reorder signal that the operator should pull down the connection and try again to establish the connection with another district selector trunk. When the cord circuit plug 121 is removed from jack 302, relay 300 releases and the district selector circuit is returned to normal as previously described.

District selector goes to an overflow position

If the district selector shaft goes to an overflow terminal in hunting for an office selector in position 10 of sequence switch 310 relay 306 releases as ground is not connected to the overflow sleeve terminal with which brush 346 engages and sequence switch 310 is thereby advanced into position 11. From position 11 switch 310 is now advanced into position 17 over the circuit extending from battery, winding of magnet 310, upper right contact of cam 312, segment 339, brush 340, upper right contact of cam 341, to ground at cam 315. With sequence switch 310 in position 17, the keyset is dismissed if it is still connected and the cord supervisory lamp 129 is flashed as a reorder signal through the intermittent operation of relay 318 as previously described in connection with the establishment of the tell-tale condition. As switch 310 leaves position 14 the sender is released as previously described.

Office selector goes to tell-tale position

If the office selector 375 goes to the tell-tale position in making brush selection, with control switch 1200 of the sender in position 4, or in making group selection with switch 1200 in position 6 and is of the type which does not return reversed battery over the fundamental circuit in that condition, the sender times out as hereinafter described, advances the district circuit to the reorder position and releases. If the office selector is of the type which sends reversed current, stepping relay 1315 and overflows relay 1317 of the sender function in the same manner as will be described in connection with the advance of an office selector to an overflow terminal in hunting for an idle trunk.

Office selector goes to overflow position

If the office selector goes to an overflow terminal while hunting for an idle trunk, it transmits reversed current over the fundamental circuit to the sender and with sender control switch 1200 in position 7, the trunk test relay 1336 operates in turn operating relays 1320 and 1312 as previously described. Relay 1312 upon operating removes the high resistance 1218 and the winding of trunk test relay 1336 from the fundamental circuit and connects the winding of stepping relay 1315 into the fundamental circuit as previously described. The resistance of the fundamental circuit is now reduced to such an extent that stepping relay 1315 and overflow relay 1317 operate on the reversed current. Relay 1317 upon operating locks over its right winding, conductor 1327, upper left and lower right contacts of cam 1249, conductor 1250, to ground at the front contact of relay 1317 and extends its locking ground over the right contacts of cam 1249 and conductor 1251, thereby operating relay 1402, and over the lower left contact of cam 1249, conductor 1268, winding of relay 1331, to battery on conductor 702. Relay 1331, upon operating, locks to ground at its inner left front contact and establishes a circuit from battery, winding of relay 1113, conductor 1114, outer left front contact of relay 1331, conductor 1115, left normal contacts of relay 1108 to ground at the back contact of relay 1109. Relay 1113 operates, connects locking ground to conductor 1115, and establishes a circuit for relay 1109 extending from ground at its right contacts, over the right normal contacts of relay 1108. Relay 1109 operates closing an obvious circuit for relay 1108 which after an interval operates, locking to ground at the front contacts of relay 1113 and opening the circuit of relay 1109 which after an interval releases. With relay 1113 operated and relay 1109 released, a circuit is closed from ground at the back contact of relay 1109, left alternate contacts of relay 1108, left contacts of relay 1113, conductor 1116, lower right contact of cam 1211, winding of magnet 1200 to battery for ad-

vancing the control switch 1200 into position 9.

If the office selector has been used to establish a connection to another operator's position in response to the keying of an operator's code, or in response to the keying of a code indicating a call indicator connection, then when the trunk test relay 1344 operates, with control switch 1200 in position 7 and relay 1320 operated, relay 1312 is not operated. In this case the fundamental circuit does not include resistance 1218 and therefore relay 1317 operates in series with relay 1344 in response to reversed battery over the fundamental circuit and following the operation of relay 1317, relays 1331, 1113. 1109 and 1108 operate to advance switch 1200 into position 9 as just described.

Relay 1331 upon operating maintains the fundamental circuit closed over the upper contacts of cam 1230 at its right front contact, while control switch 1200 advances from position 4 to position 7¾. After switch 1200 leaves position 7¾, the fundamental circuit is opened, releasing stepping relay 1315. The operation of relay 1315 with relay 1402 operated causes the operation of counting relay 400 over a circuit extending from ground at cam 1204, lower right contact of cam 1217, conductor 1233, contact of relay 1315, conductor 1234, contacts of cam 1235, conductor 1236, front contact of relay 1402, conductor 1240 to battery through the winding of relay 400. Relay 400 operates and locks through the windings of relays 401 and 402, relays 400 and 402 operating as soon as relay 1315 releases, relay 402 upon operating closing a circuit from ground at its contact over conductor 404, outer front contact of relay 1402, conductor 1426 to battery through the winding of relay 1313, which operates locking to ground on conductor 1303, permanently opening the fundamental circuit and closing a circuit extending from ground at its left front contact over conductor 1403, upper contacts of cam 1208 to battery through the winding of magnet 1200 for advancing switch 1200 into position 17. With switch 1200 in position 17 and relay 1313 operated, a circuit is closed for relay 1328 over the alternate contacts of relay 1304, conductor 1329, upper left and lower right contacts of cam 1245, conductor 1403, to ground at the inner left front contact of relay 1313. Relay 1328 extends its operating ground to battery through the winding of relay 1305 which locks itself and relay 1328 to ground on conductor 1303 and opens the circuit of relay 1304 which releases.

Relay 1331 also closes a circuit extending from ground at its inner left front contact, conductor 1350, right front contact of relay 901, conductor 933, outer right front contact of relay 408, inner right back contact of relay 406, conductor 467 to battery through the winding of relay 934. Relay 934 operates closing a shunt from ground at its left contact over conductor 935 to ground through the right winding of relay 500 and since the high resistance left winding of relay 500 is at the time shunted by the left back contact of relay 910, the resistance of relay 500 is reduced to 5 ohms whereby the current flowing over conductor 321 to battery through the windings of relays 309 and 324 is increased to such an extent as to cause the operation of marginal relay 309 of the district selector. Relay 309 upon operating locks over its upper winding and inner upper front contact to ground on conductor 363 and closes a circuit from ground at its upper front contact, left contacts of cam 356, upper left and lower right contacts of cam 354, lower front contact of relay 324, upper winding of relay 314, upper contacts of cam 317, brush 366, conductor 316, back contact of relay 1000, outer left front contact of relay 1001, conductor 1025, inner right front contact of relay 505, conductor 536 to battery through the left winding of relay 1444. Relay 1444 operates in turn operating relays 1404 and 1437. Relay 1404 also closes a circuit extending from battery, winding of relay 910, conductor 1332, right front contact of relay 1404, conductor 1445, right front contact of relay 1305, normal contacts of relay 1304, thence to ground over the locking circuit of relay 1305. Relay 910 upon operating locks over its right front contact and its left back contact opens the shunt around the left high resistance winding of relay 500.

The current now flowing from ground through the windings of relay 500 and winding of relay 324 is not sufficient to hold relay 324 operated and it releases. With relay 309 operated and relay 324 released a circuit is established for advancing sequence switch 310 into position 17, extending from battery, winding of magnet 310, upper right contact of cam 32, lower back contact of relay 324, lower right and upper left contacts of cam 354, left contacts of cam 356, to ground at the upper contact of relay 309. When relay 324 releases and switch 310 passes beyond position 13, the sender is released, and when switch 310 reaches position 17, the cord supervisory lamp 129 is flashed as previously described as a reorder signal. In passing beyond position 16¼ the district selector brushes are disconnected and any switches beyond the district selector are released in the well-known manner. District selector 360 releases as previously described as soon as the operator removes plug 121 from jack 302.

Incoming selector goes to tell-tale or overflow

If an incoming selector is employed in the establishment of a connection and goes to the tell-tale position during brush selection with

selection control switch 1200 of the sender in position 7, or during group selection with control switch 1200 in position 9, reversed current is sent over the fundamental circuit operating relays 1315 and 1317 followed by the operation of relays 1402 and 1331 as previously described in connection with office overflow. Relays 1113, 1109 and 1108 also operate, but perform no useful function at this time, since when relays 1315 and 1402 operate, relay 400 operates over a circuit from battery through its winding, conductor 1240, middle front contacts of relay 1402, conductor 1236, right and lower left contacts of cam 1235, conductor 1234, contact of relay 1315, conductor 1233, lower right contact of cam 1217 to ground at cam 1204, locking through the windings of relays 401 and 402. As the incoming selector advances out of the reserved battery position, relay 1315 releases permitting relays 401 and 402 to operate. A circuit is now established from ground at the contact of relay 402, over conductor 404, front contact of relay 1402, conductor 1426, to battery through the winding of relay 1313. Relay 1313 then advances control switch 1200 to position 17 as previously described. From this point the sender functions as previously described to advance the district selector 360 to the reorder position for flashing the cord supervisory lamp 129 and for releasing the sender.

If the incoming selector goes to overflow during trunk hunting for a final selector with control switch 1200 in position 11, reversed current is transmitted from the incoming selector over the fundamental circuit and the sender functions in the same manner as described in connection with the advance of the incoming to tell-tale and the district selector 360 is advanced to the reorder position dismissing the sender. If the final selector goes to tell-tale in making any selection, the incoming selector is advanced in the well-known manner to momentarily send reversed current over the fundamental circuit just as previously described for a successful final units selection and the district selector of Fig. 3 is then advanced to the reorder position dismissing the sender.

Trouble conditions in the sender

Conditions in the sender will now be discussed which may arise when the sender operations do not progress fast enough to satisfy the sender time measure circuit due to failure of the operator to key at all, failure to complete keying, failure to depress the start key after all digits have been keyed, or due to an apparatus or circuit trouble which prevents the sender from completing its work and clearing out after keying has been completed. The sender is provided for this purpose with two sets of timing circuits, one for measuring the allowable interval from the time the sender is seized until all the digits have been registered and the other for measuring the allowable interval for making selections starting from the time all digits have been keyed. The first timing circuit consists of relays 1026, 1027, 1028 and interrupter 1029 and is started from relay 1001, when the sender is seized. The second timing circuit consists of relays 1123, 1030, 1031, 1032 and 1033, and interrupter 1034, and is started from the start relay 901, or from relay 1027 when operated.

As soon as relay 1001 operates following the seizure of the sender and interrupter 1029 closes its contacts, relay 1026 operates in a circuit extending over the back contact of relay 1027, contacts of interrupter 1029, outer left back contact of start relay 901, conductor 908, to ground at the inner right contact of relay 1001, locking through the winding of relay 1027, front contact of relay 1026, thence to ground at the front contact of relay 1001. Relay 1027 does not operate in this locking circuit until interrupter 1029 opens its contacts. Upon the operation of relay 1027 and the next closure of the interrupter contacts, relay 1028 operates in a circuit extending over the front contact of relay 1027, contacts of interrupter 1029, back contact of relay 901 to ground on conductor 908 locking over its outer right front contact to ground on conductor 908 independent of the interrupter contacts. If all digits have been registered and start relay 901 is operated before the above described operations are completed, relay 1028 does not operate and relays 1027 and 1026 release. If, however, the keying is not completed before relay 1028 operates and locks, relay 1028 closes a circuit for relay 406 extending over the right normal contacts of relay 408, conductor 428 to ground at the inner left front contact of relay 1028. Relay 406 upon operating releases relay 407 which disconnects the impulse relays 411, 412, 413, 421, 422 and 423 from the tip and ring impulsing conductors 329 and 332 extending to the operator's keyset, connects conductor 329 through the inner left front contact of relay 406 to 48-volt battery through the winding of relay 408 and connects conductor 332 over the right front contact of relay 406 to 48-volt battery through resistance 429. As previously described, both polarized relays 233 and 234 in the keyset now respond to release the keyset, direct ground being then connected at the key set to conductor 329 thereby causing the operation of marginal relay 408. Relay 408 upon operating locks to ground applied to conductor 428 by relay 1028, opens the operating circuit of relay 407 to prevent its reoperation, releases relay 406 and closes a circuit extending from ground at the middle right front contact of relay 1028, conductor 933, outer right front contact of relay 408,

inner right back contact of relay 406, conductor 467, winding of relay 934 to battery. Relay 934 upon operating stunts the right winding of relay 500 as previously described and since the left winding of relay 500 is at this time also shunted at the back contact of relay 910, the resistance of relay 500 is reduced to such an extent that marginal relay 309 of the district selector 360 operates. The operator is thereupon given a reorder signal as previously described and the sender is dismissed.

When the start combination has been keyed and relay 901 is operated indicating that all digits have been keyed, a circuit is established for operating the relays of the second timing circuit. On the first closure of the contacts of interrupter 1034, a circuit is established from battery, resistance 1122, winding of relay 1123, right back contact of relay 1032, right back contact of relay 1030, contacts of interrupter 1034, conductor 1035 to ground at the inner left front contact of relay 901. Relay 1123 locks through the right winding of relay 1030, front contacts of relay 1123 to ground on conductor 1035, but relay 1030 does not operate until the interrupter contacts open. On the next closure of the interrupter contacts, ground on conductor 1035 is extended through the interrupter contacts, right front contact of relay 1030, left back contact of relay 1032 to battery through the winding of relay 1031, relay 1031 then operating and locking through the winding of relay 1032, front contact of relay 1031 to ground on conductor 1035. On the next opening of the interrupter contacts, relay 1032 operates in this locking circuit. If neither relay 1440 or 1339 is operated at this time indicating that the call does not involve a distant office selector or the transmission of call indicator code impulses, a circuit is now established for relay 1033 which may be traced from battery, winding of relay 1033, left front contact of relay 1030, conductor 1036, right back contact of relay 1440, conductor 1446, outer left back contact of relay 1339, conductor 1351, outer left front contact of relay 1032, outer back contact of relay 1000 to ground at the inner left front contact of relay 1001. If either relay 1440 or relay 1339 is operated, the circuit of relay 1033 is not established directly following the operation of relay 1032 as just described, but is delayed until after the contacts of interrupter 1034 close and again open. This is brought about as follows: When the interrupter contacts close following the operation of relay 1032, a circuit is closed from ground, on conductor 1035, the interrupter contacts, right front contact of relay 1030, right front contact of relay 1032, to battery through the left winding of relay 1030 for holding relay 1030 operated and over the inner left front contact of relay 1032, conductor 1037, to battery through resistance 1122 thus shunting relay 1123 and the right winding of relay 1030, and relay 1123 then releases. As soon as the interrupter contacts open again the holding circuit of relay 1030 is opened and relay 1030 releases. A circuit is now closed for relay 1033 over the left back contact of relay 1030, outer left front contact of relay 1032, outer back contact of relay 1000 to ground at the inner left front contact of relay 1001 and relay 1033 operates. Thus for calls involving a distant office selector or full mechanical tandem equipment, a longer time interval is measured before relay 1033 operates.

When relay 1033 operates it closes a circuit for relay 934 extending over conductor 1038 to ground at the outer right front contacts of relay 1033. Relay 934 in turn shunts the right winding of relay 500 to cause the advance of the district selector 360 to the reorder position and the release of the sender in the manner previously described. At its inner right front contact relay 1033 connects ground to contacts of interrupter 1029 thereby starting the operation of timing relays 1026, 1027 and 1028 which, after a period of 30 to 60 seconds, lights the stuck sender lamp 1039 over a circuit extending from battery, lamp 1039, outer left front contact of relay 1028 to ground at the outer right contact of relay 1033 if the sender does not restore in the meantime.

Operating errors

If the operator plugs into the district selector trunk circuit of Fig. 3 and keys a number that requires a trunk terminating directly in an incoming selector, the first three digits of the number corresponding to an operator's code, class register relay 1405 is operated from the decoder in turn operating relay 1442 and a circuit is established for relay 1447 extending over the outer contacts of relay 1442, conductor 1448, inner right back contact of relay 523, conductor 538, left front contacts of transfer relay 607 to ground on conductor 1303. With relay 1447 operated, a circuit is closed for relay 934 extending over conductor 467, inner right back contact of relay 406, outer right front contact of relay 408, which operated releasing relay 406 following the operation of start relay 901, conductor 933, right back contact of relay 1028, conductor 736, right front contact of relay 1447, conductor 1254, upper contacts of cam 1207, to ground at the outer right front contact of relay 1306. Relay 934 in the manner previously described causes the advance of the district selector circuit of Fig. 3 to the reorder position dismissing the sender.

What is claimed is:

1. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminat-

ing in a selector switch, a register sender accessible from said trunk circuit for controlling said selector switch, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, operator-controlled means for associating said calling device with said cord circuit, and means controlled from said trunk circuit for disassociating said calling device from said cord circuit.

2. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminating in a selector switch, a register sender accessible from said trunk circuit for controlling said selector switch, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, a relay for connecting said calling device to said cord circuit, operator-controlled means for operating said relay, and means controlled from said trunk circuit for releasing said relay to disassociate said calling device from said cord circuit.

3. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminating in a selector switch, a register sender accessible from said trunk circuit for controlling said selector switch, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, a relay for connecting said calling device to said cord circuit, operator-controlled means for operating said relay, and relay means controlled from said trunk circuit for releasing said relay to disassociate said calling device from said cord circuit.

4. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminating in a selector switch, a register sender accessible from said trunk circuit for controlling said selector switch, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, a supervisory relay and a supervisory signal in said cord circuit, a second relay for connecting said calling device to the calling end of said cord circuit and for disconnecting said supervisory relay therefrom, operator-controlled means for operating said second relay, and means controlled from said trunk circuit for first releasing said second relay to disassociate said calling device and to render said supervisory relay effective and for then intermittently operating said supervisory relay to flash said signal.

5. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminating in a selector switch, a register sender accessible from said trunk circuit for controlling said selector switch to select an idle outgoing trunk in a desired group, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, a supervisory relay and a supervisory signal in said cord circuit, a second relay for connecting said calling device to the calling end of said cord circuit and for disconnecting said supervisory relay therefrom, operator-controlled means for operating said second relay, and means in said trunk circuit operable if said selector fails to find an idle outgoing trunk circuit for first causing the release of said second relay to disassociate said calling device and to render said supervisory relay effective, and for then intermittently operating said supervisory relay to flash said signal.

6. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminating in a selector switch, a register sender accessible from said trunk circuit for controlling said selector switch in a plurality of selective movements, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, a supervisory relay and a supervisory signal in said cord circuit, a second relay for connecting said calling device to the calling end of said cord circuit and for disconnecting said supervisory relay therefrom, operator-controlled means for operating said second relay, and means in said trunk circuit if said selector overruns in any of its selective movements for first causing the release of said second relay to disassociate said calling device and to render said supervisory relay effective and for then intermittently operating said supervisory relay to flash said signal.

7. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminating in a selector switch, other selector switches, a register sender accessible from said trunk circuit for controlling said selector switches to extend a desired connection, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, a supervisory relay and a supervisory signal in said cord circuit, a second relay for connecting said calling device to the calling end of said cord circuit and for disconnecting said supervisory relay therefrom, operator-controlled means for operating said second relay, and means in said trunk circuit operable if any of said selectors fails to find an idle trunk outgoing therefrom for first causing the release of said second relay to disassociate said calling device and to render said supervisory relay effective, and for then intermittently operating said supervisory relay to flash said signal.

8. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminating

in a selector switch, other selector switches, a register sender accessible from said trunk circuit for controlling said selector switches to extend a desired connection, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, a supervisory relay and a supervisory signal in said cord circuit, a second relay for connecting said calling device to the calling end of said cord circuit and for disconnecting said supervisory relay therefrom, operator-controlled means for operating said second relay, and means in said trunk circuit operable if any of said selectors over-run in any of their selective movements for first causing the release of said calling device and to render said supervisory relay effective and for then intermittently operating said supervisory relay to flash said signal.

9. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminating in a selector switch, a register sender accessible from said trunk circuit for controlling said selector switch to extend desired connections, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, a supervisory relay and a supervisory signal in said cord circuit, a second relay for connecting said calling device to the calling end of said cord circuit and for disconnecting said supervisory relay therefrom, operator-controlled means for operatitng said second relay, and means in said trunk circuit operable if said calling device is operated to register an incomplete or erroneous line designation in said sender for first causing the release of said relay to disassociate said calling device and to render said supervisory relay effective and for then intermittently operating said supervisory relay to flash said signal.

10. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminating in a selector switch, a register sender accessible from said trunk circuit for controlling said selector switch to extend desired connections, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, a supervisory relay and a supervisory signal in said cord circuit, a second relay for connecting said calling device to the calling end of said cord circuit and for disconnecting said supervisory relay therefrom, operator-controlled means for operating said second relay, and means in said trunk circuit operable if said sender fails to perform its functions within a predetermined period for first causing the release of said relay to disassociate said calling device and to render said supervisory relay effective and for then intermittently operating said supervisory relay to flash said signal.

11. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminating in a selector switch, a register sender accessible from said trunk circuit for controlling said selector switch to extend desired connections, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, a supervisory relay and a supervisory signal in said cord circuit, a second relay for connecting said calling device to the calling end of said cord circuit and for disconnecting said supervisory relay therefrom, operator-controlled means for operating said second relay, polarized relays at said operator's position for releasing said second relay to disassociate said calling device and to render said supervisory relay effective, and a relay in said trunk circuit intermittently operative for first operating said polarized relays and for then intermittently operating said supervisory relay to flash said signal.

12. In a telephone system, an operator's position having a cord circuit, a trunk circuit accessible to said cord circuit and terminating in a selector switch, a register sender accessible from said trunk circuit for controlling said selector switch to extend desired connections, a calling device at said operator's position for controlling the registration of desired line numbers in said sender, a polarized supervisory relay and a supervisory signal in said cord circuit, a second relay for connecting said calling device to the calling end of said cord circuit and for disconnecting said supervisory relay therefrom, operator-controlled means for operating said second relay, two polarized relays at said operator's position controllable respectively over the tip and ring conductors of said cord circuit and trunk circuit for releasing said second relay to disassociate said calling device and to render said supervisory relay effective, a relay in said trunk circuit, and means to intermittently operate said trunk relay, whereby upon the first operation of said trunk relay, battery current of one polarity is connected to both of said trunk conductors for operating said two polarized relays and upon each subsequent release of said trunk relay, battery of the opposite polarity and ground are connected to said trunk conductors for intermittently operating said supervisory relay to flash said signal.

In witness whereof, I hereunto subscribe my name this 7th day of March, 1932.

JAMES B. NEWSOM.