Feb. 23, 1932. L. E. KITTREDGE 1,846,261

TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 1

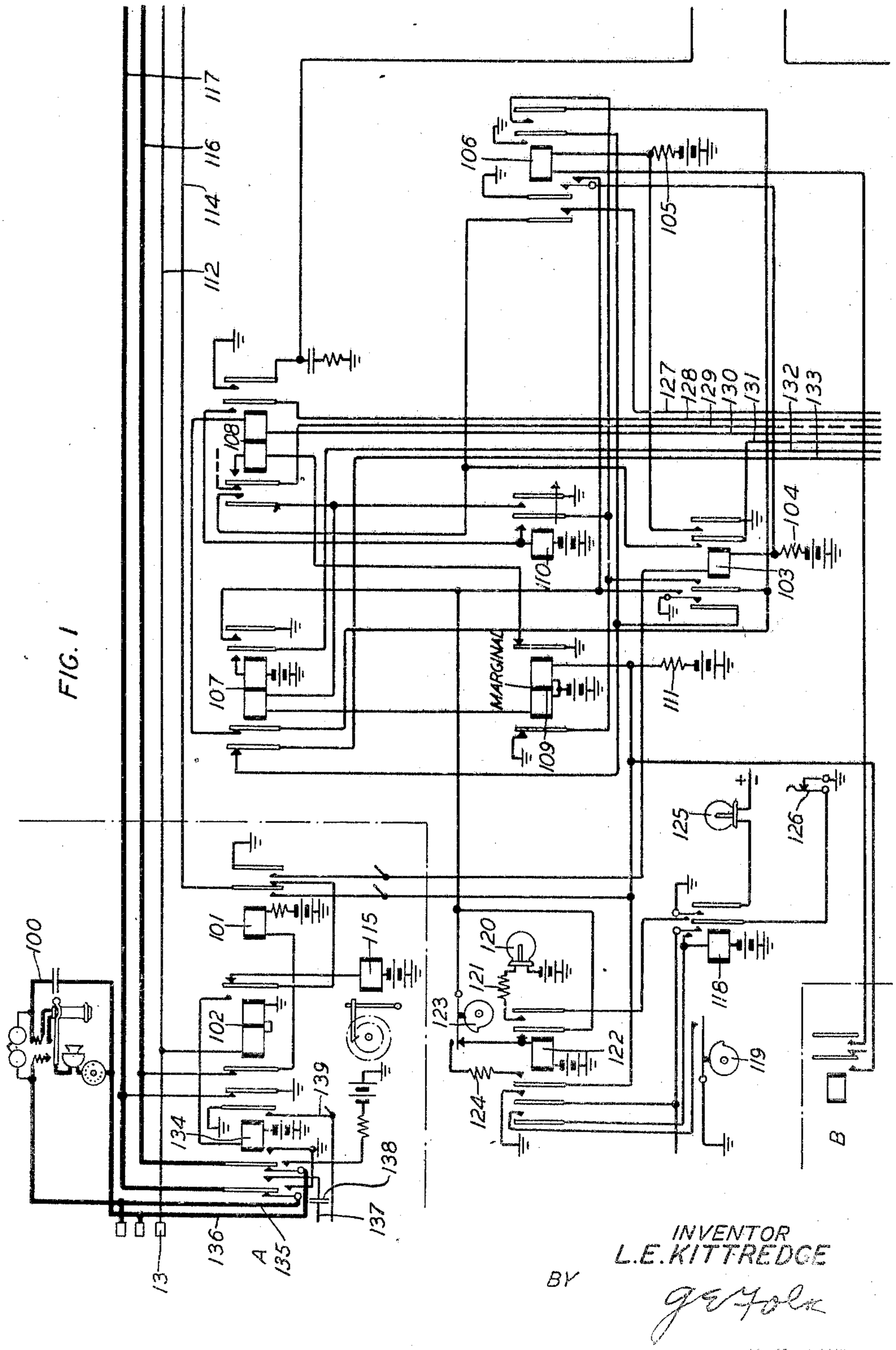

FIG. 1

INVENTOR
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BY

Feb. 23, 1932. L. E. KITTREDGE 1,846,261

TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 2

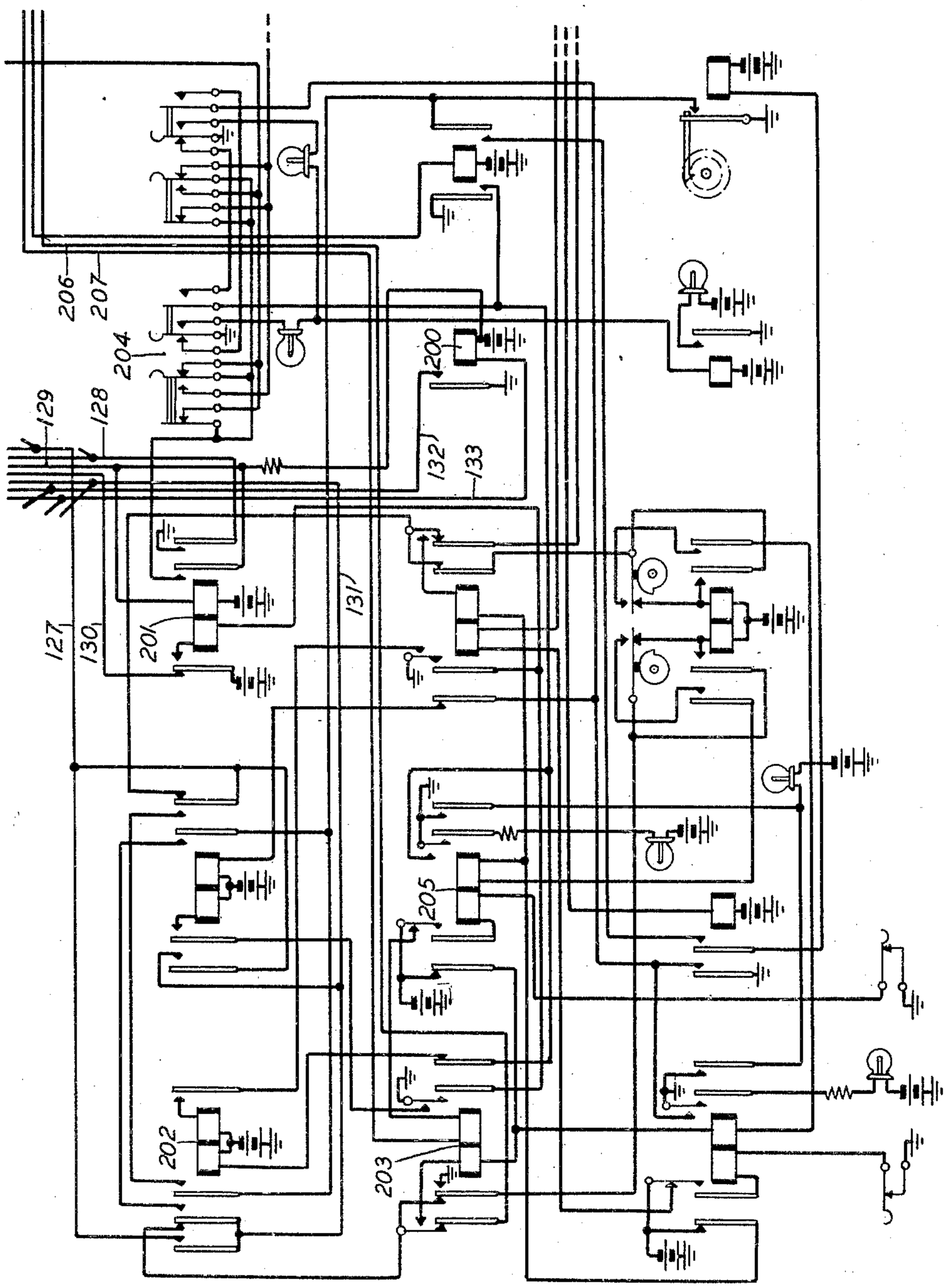

FIG. 2

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TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 3

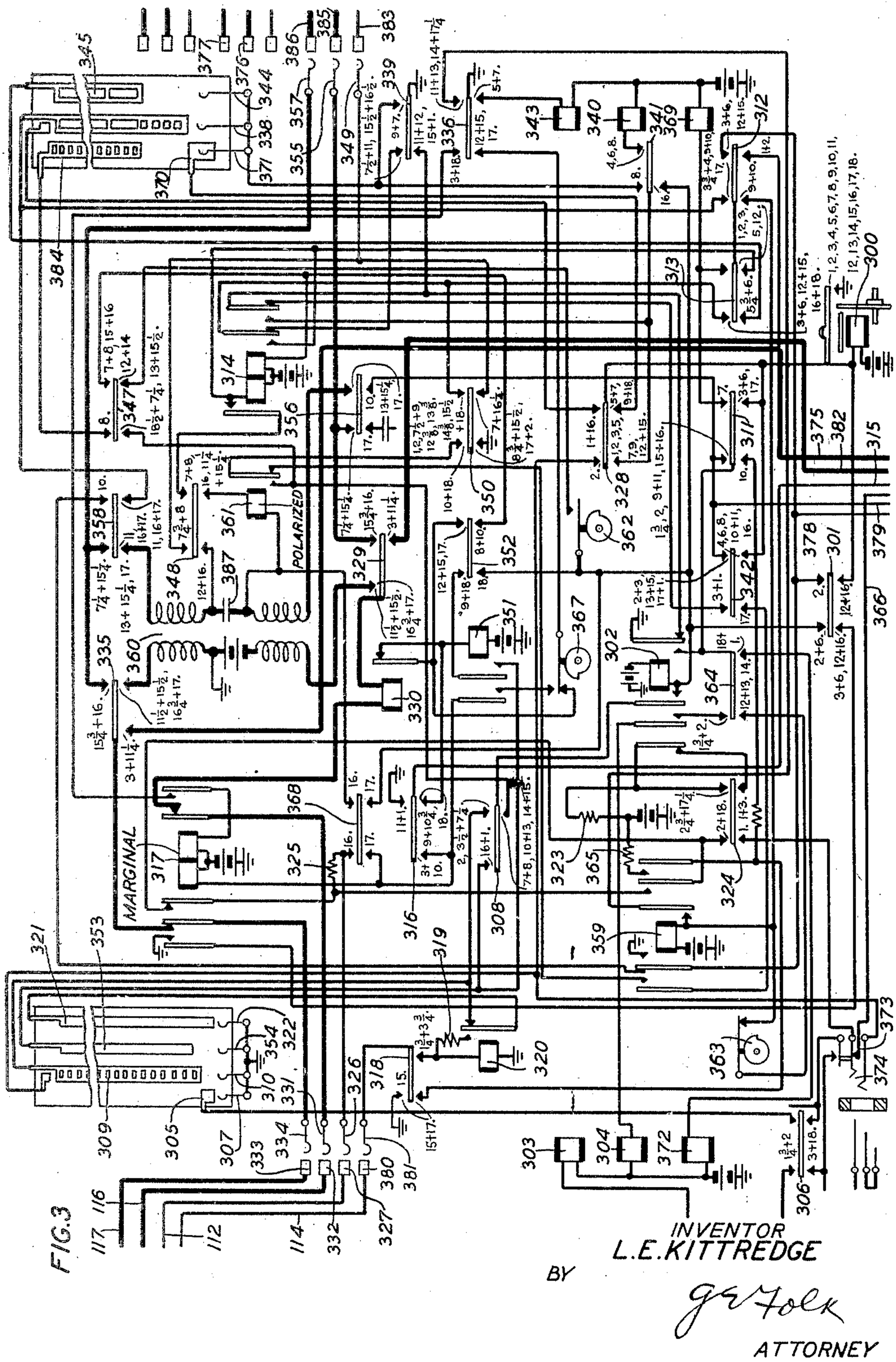

FIG.3

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TELEPHONE SYSTEM

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FIG. 4

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TELEPHONE SYSTEM

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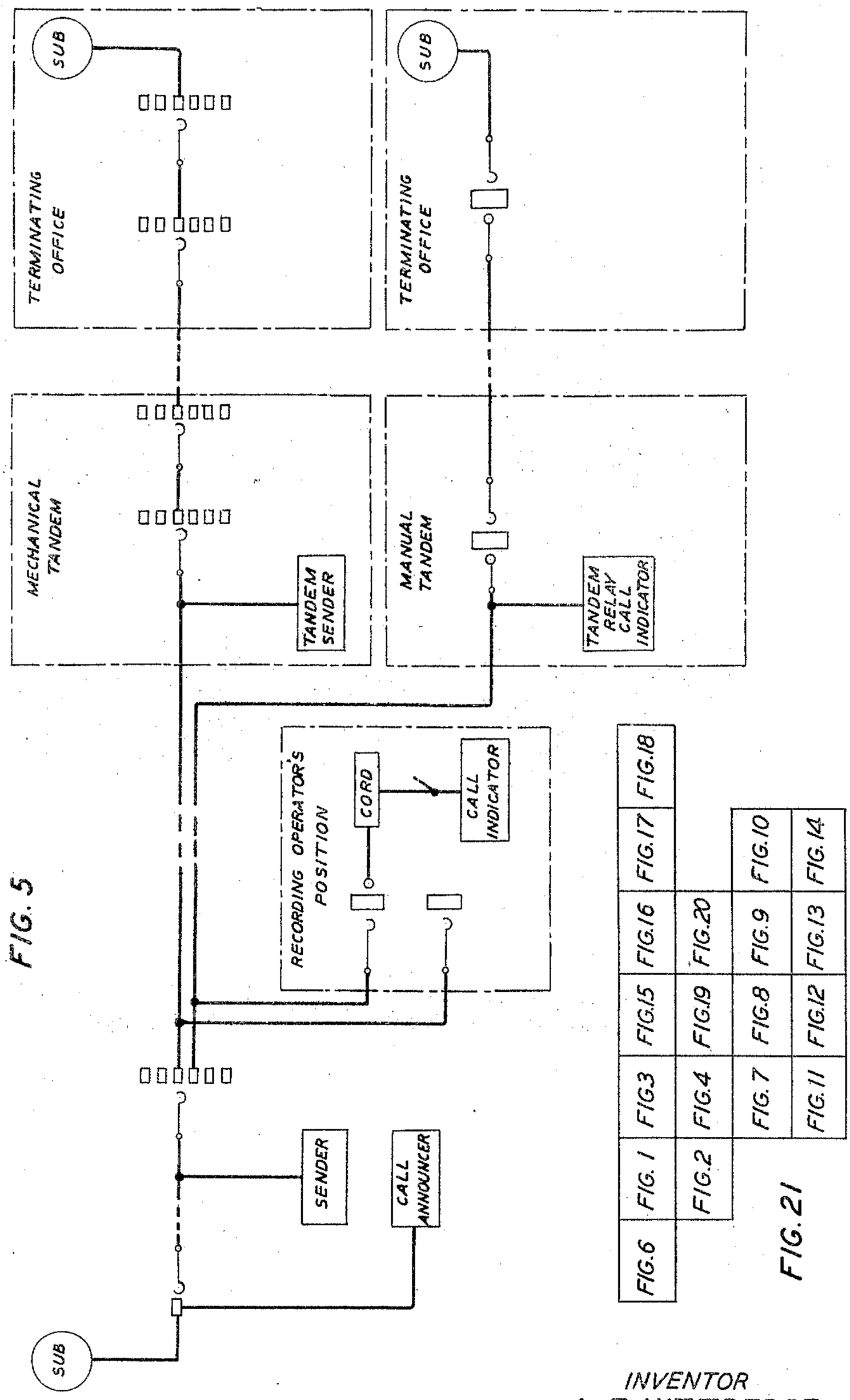

FIG. 5

FIG. 21

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TELEPHONE SYSTEM

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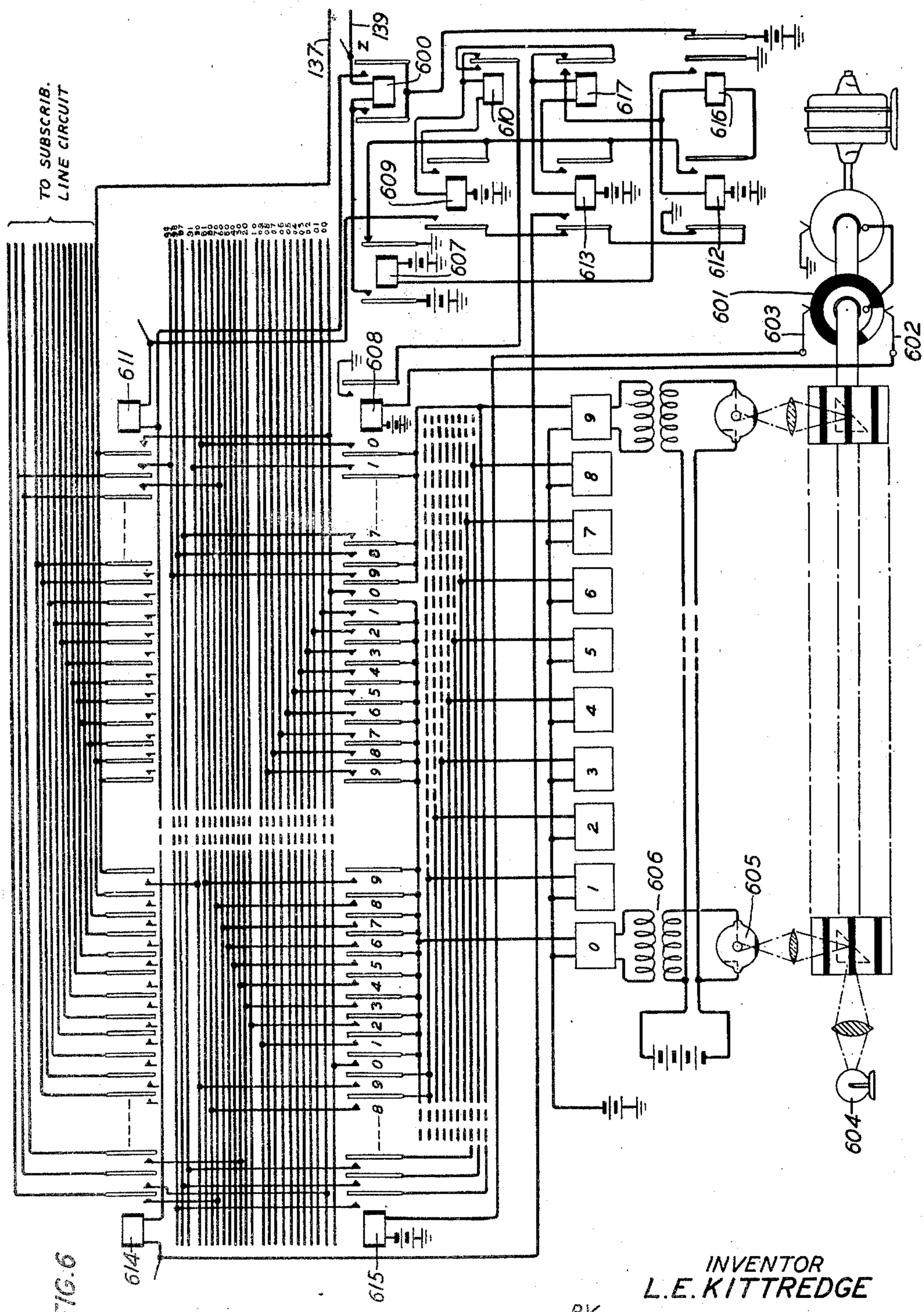

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TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 7

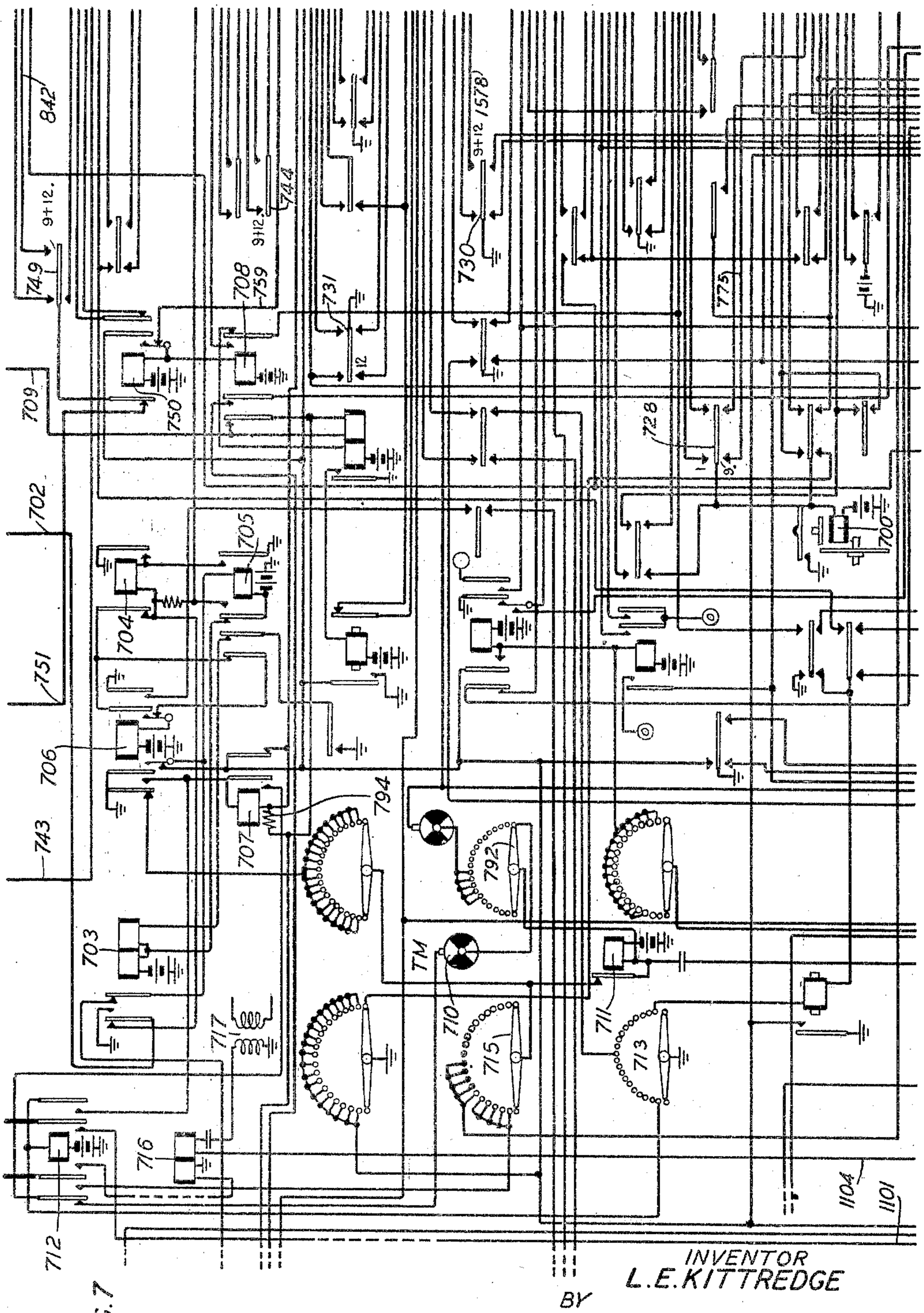

FIG. 7

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TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 8

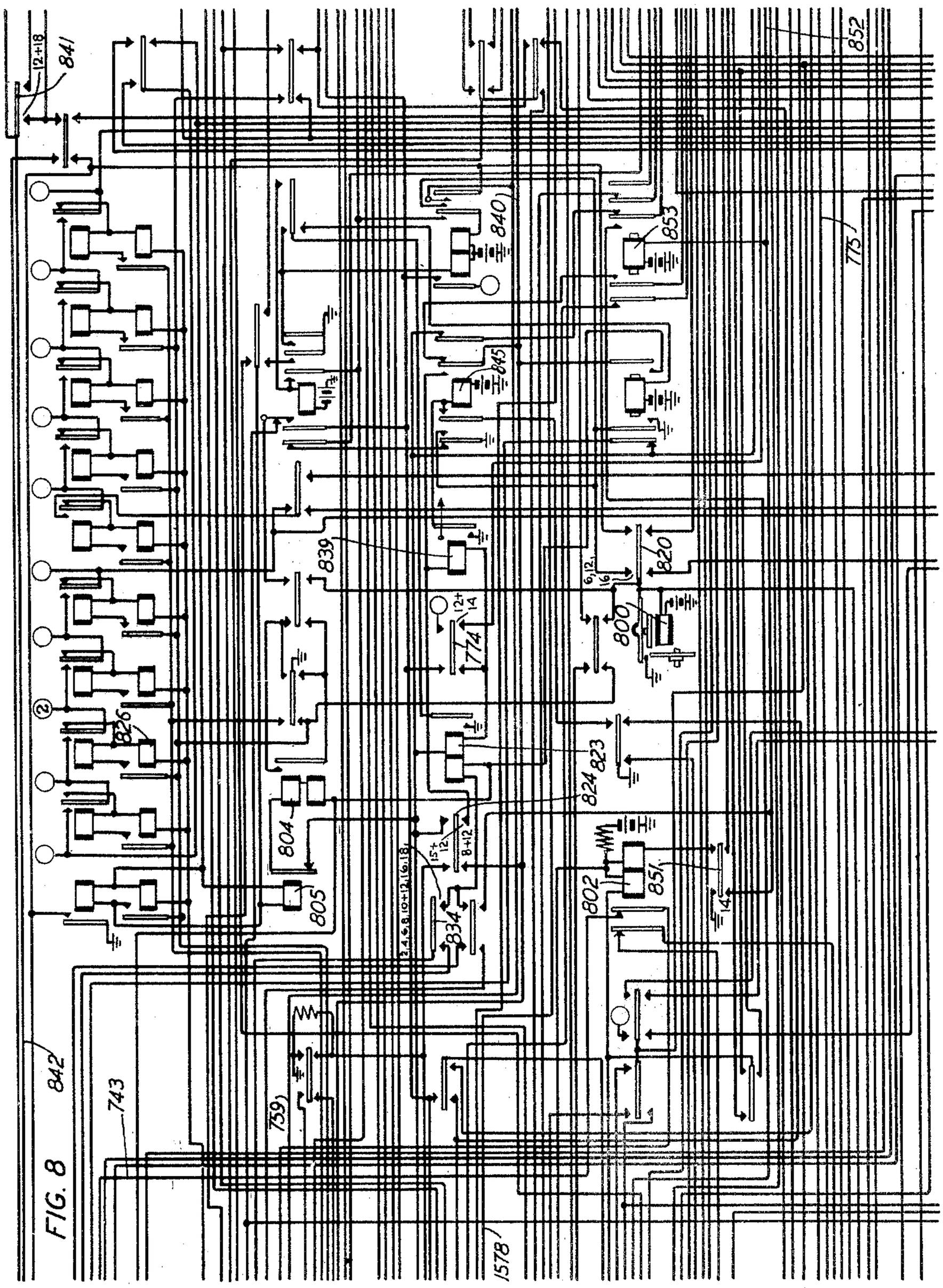

FIG. 8

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TELEPHONE SYSTEM

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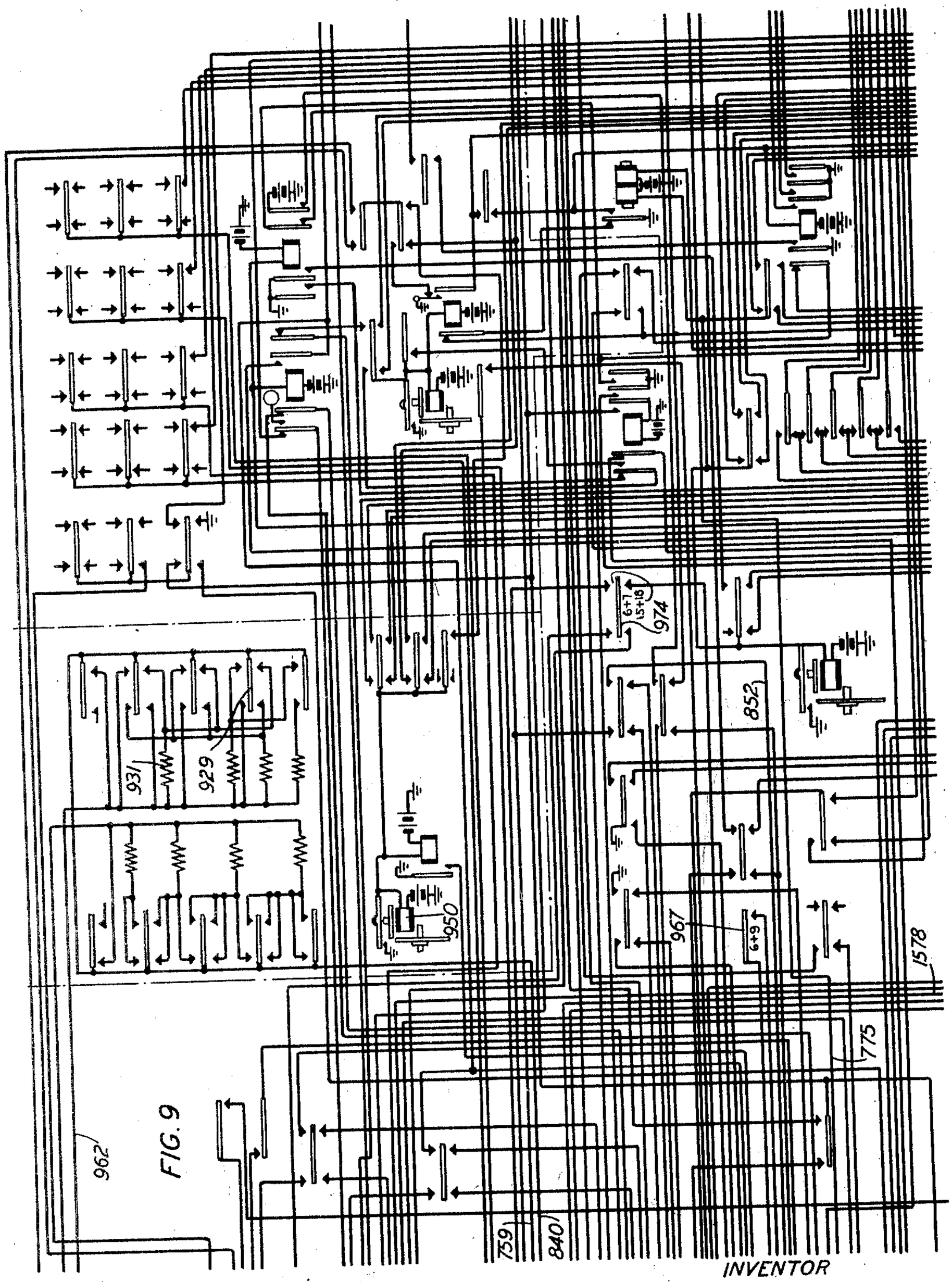

FIG. 9

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TELEPHONE SYSTEM

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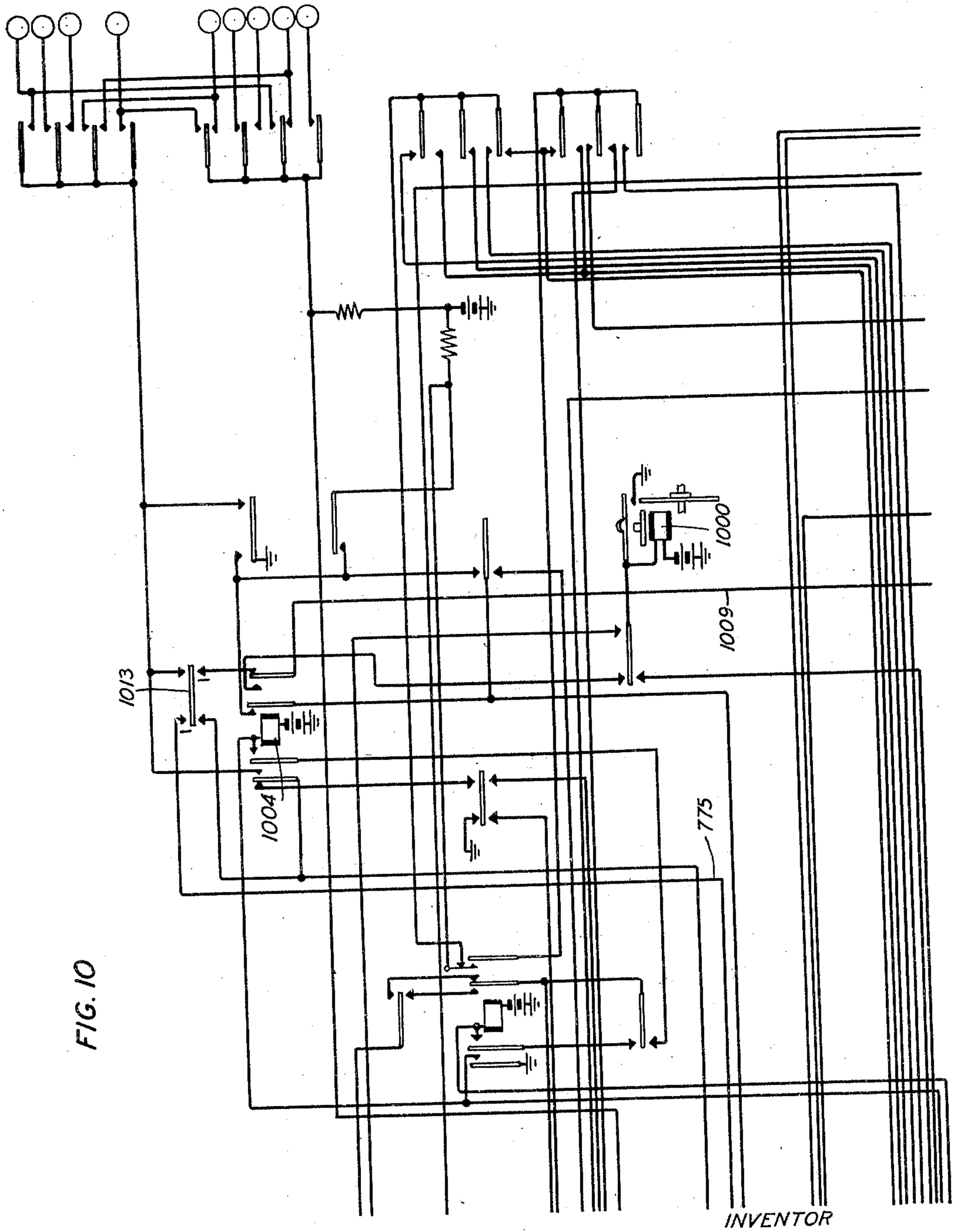

FIG. 10

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TELEPHONE SYSTEM

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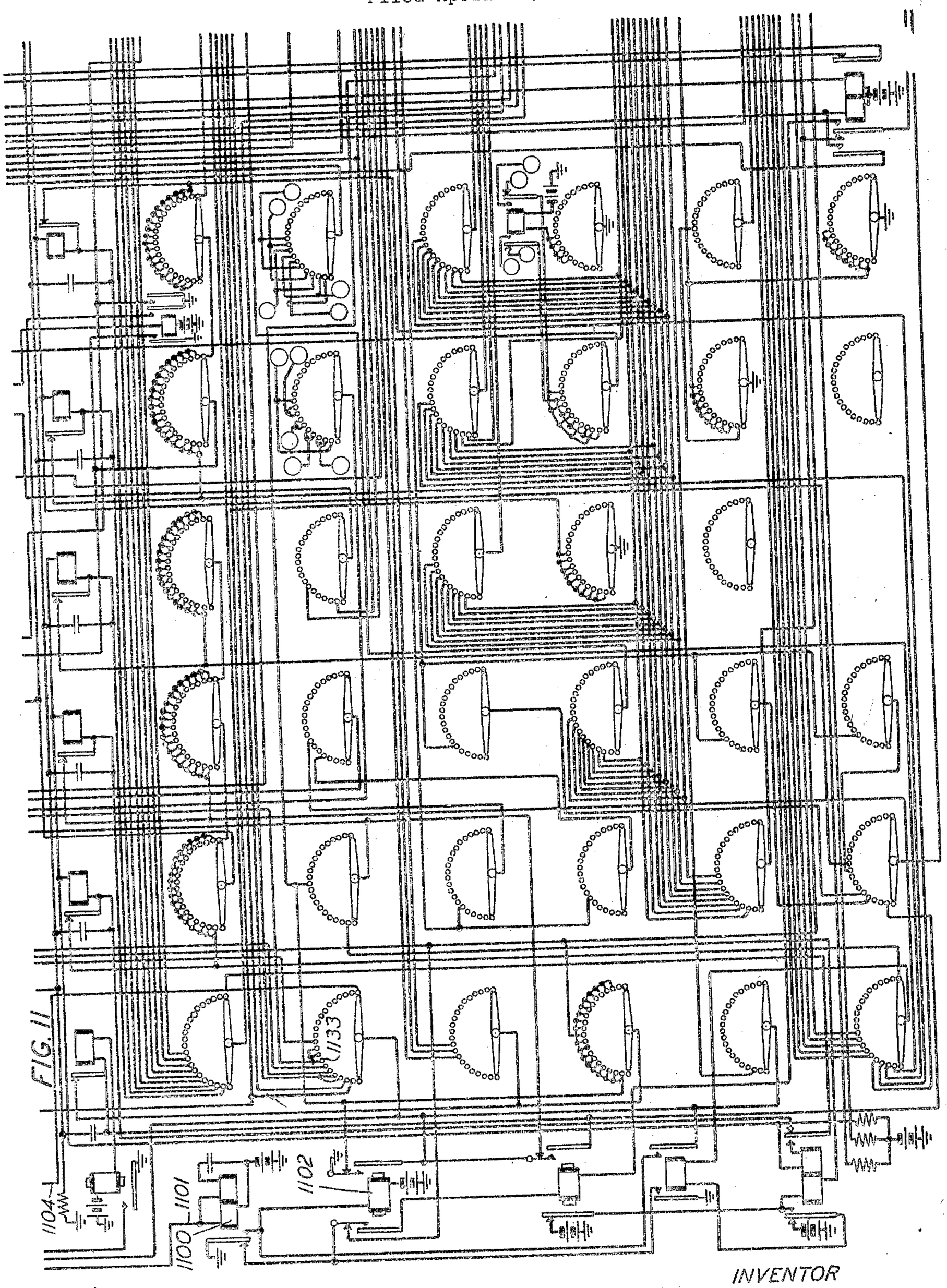

FIG. 11

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TELEPHONE SYSTEM

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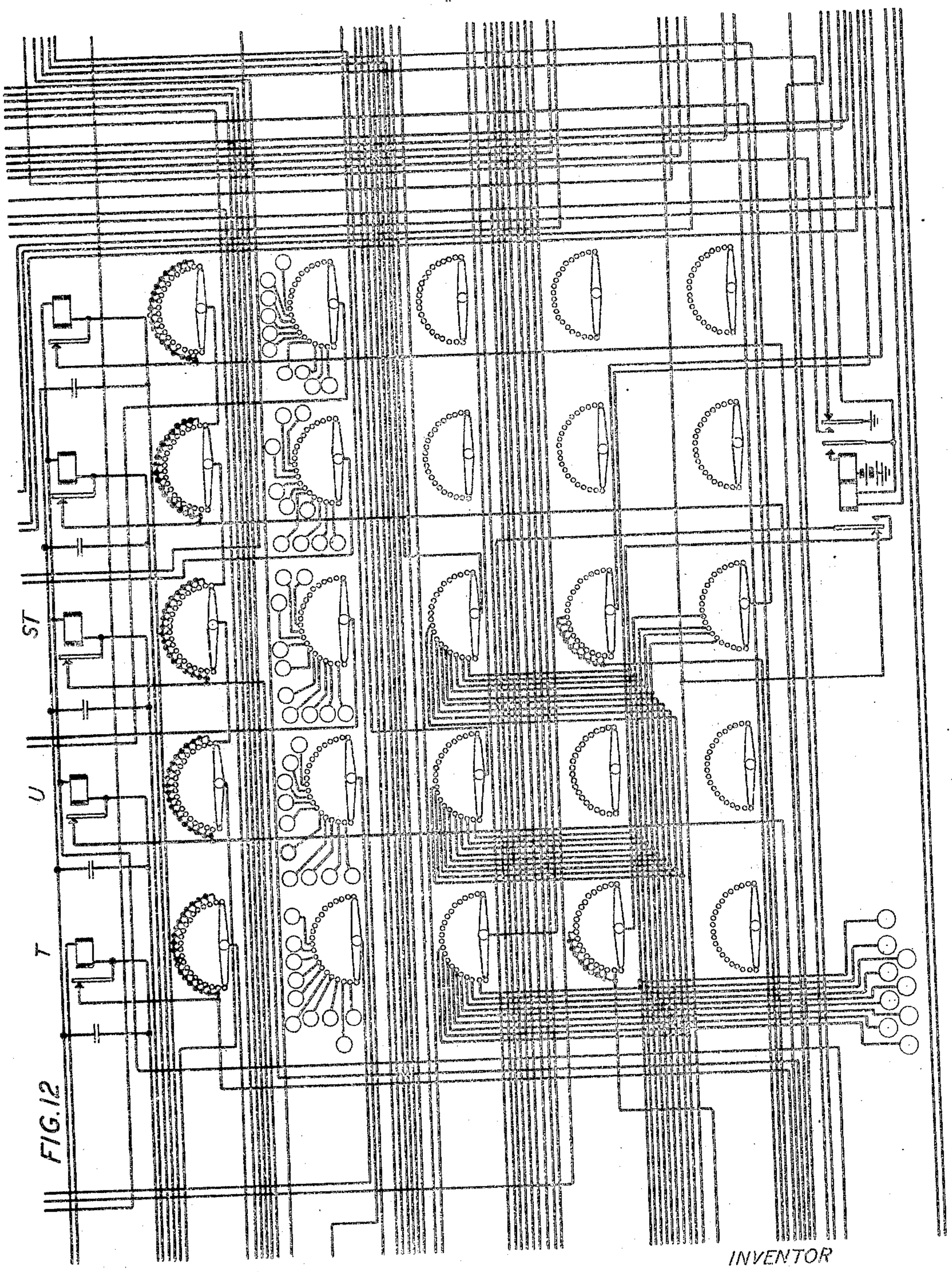

FIG. 12

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TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 13

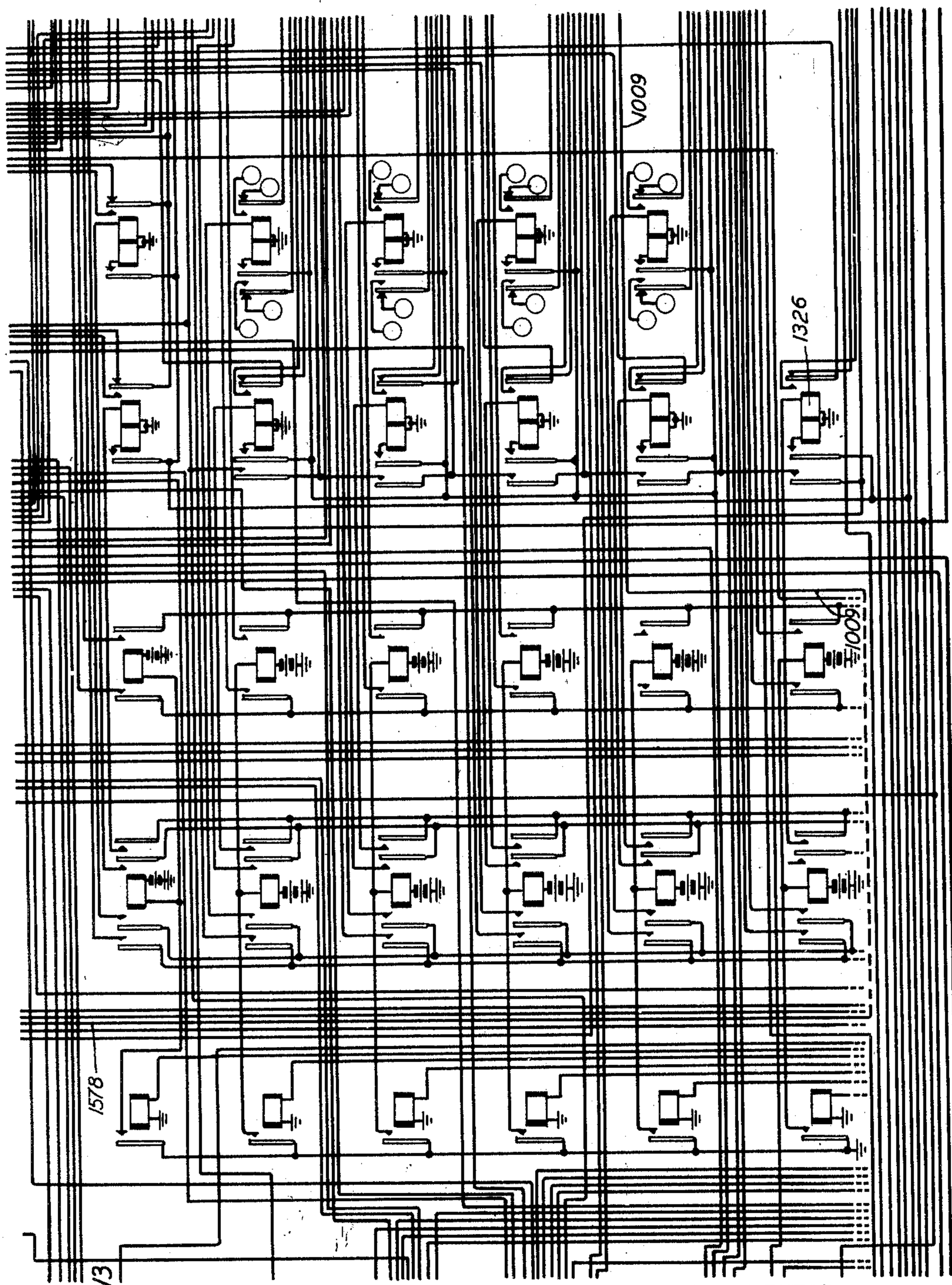

FIG. 13

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TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 14

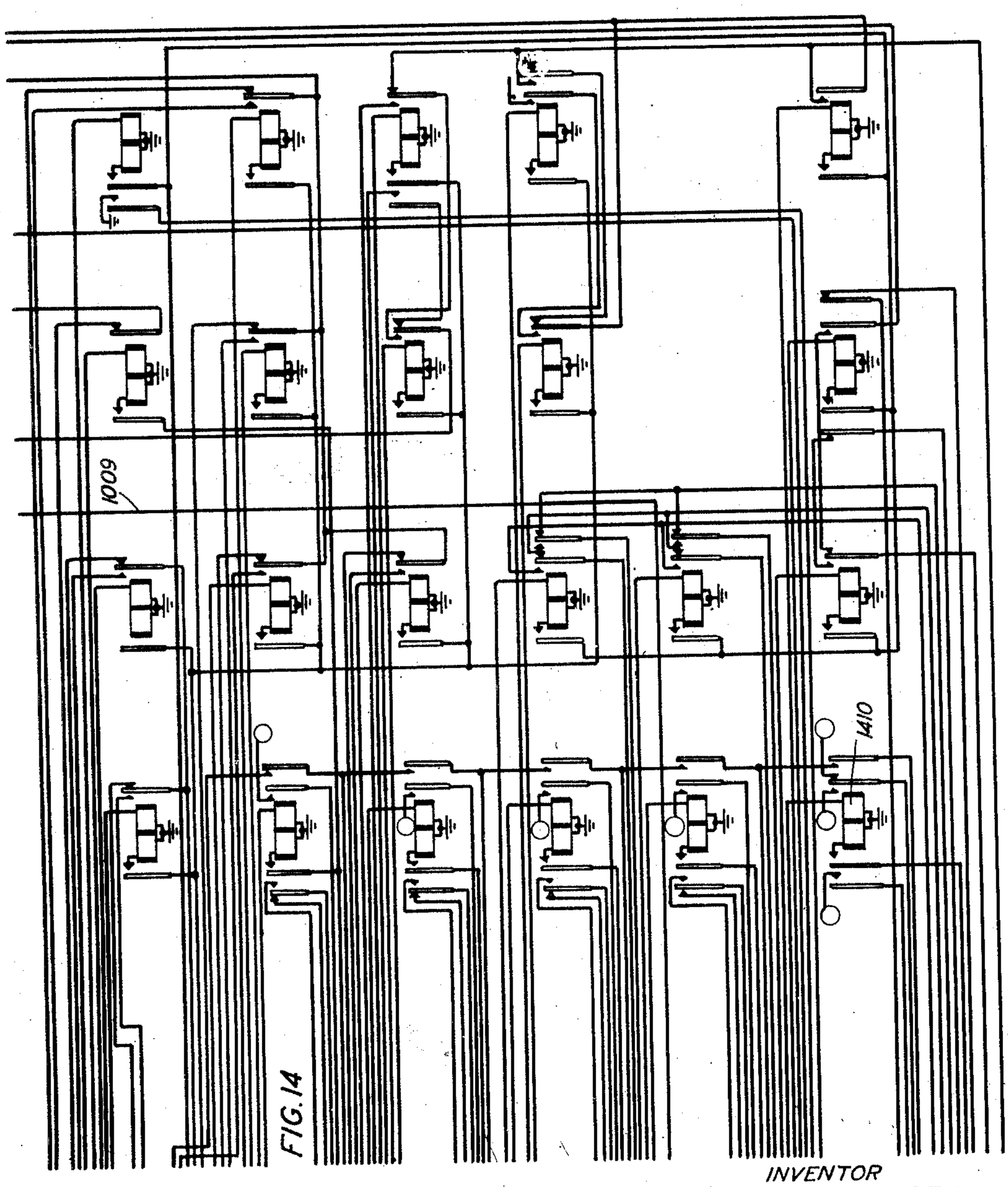

FIG. 14

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TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 15

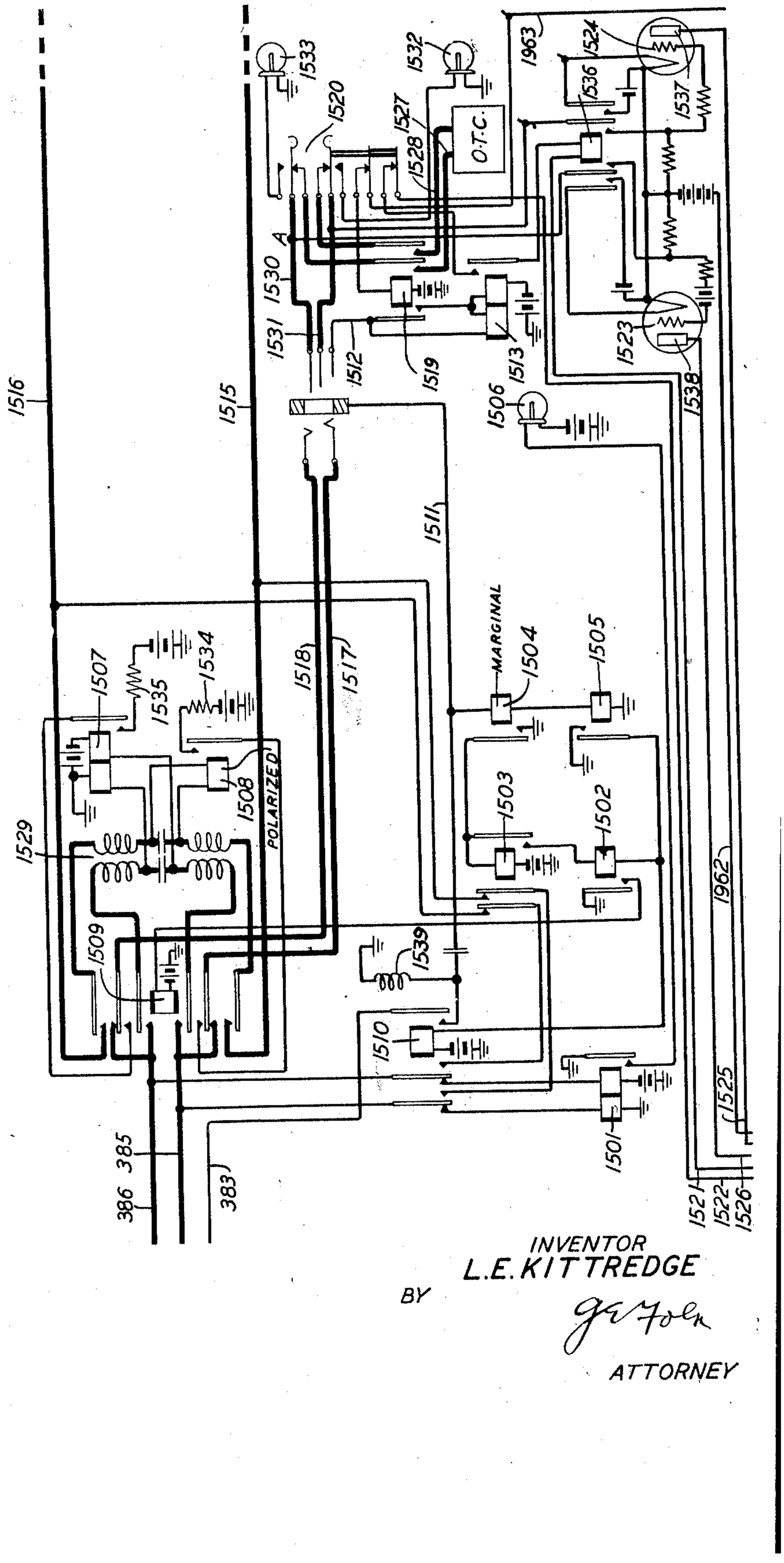

FIG. 15

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TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 16

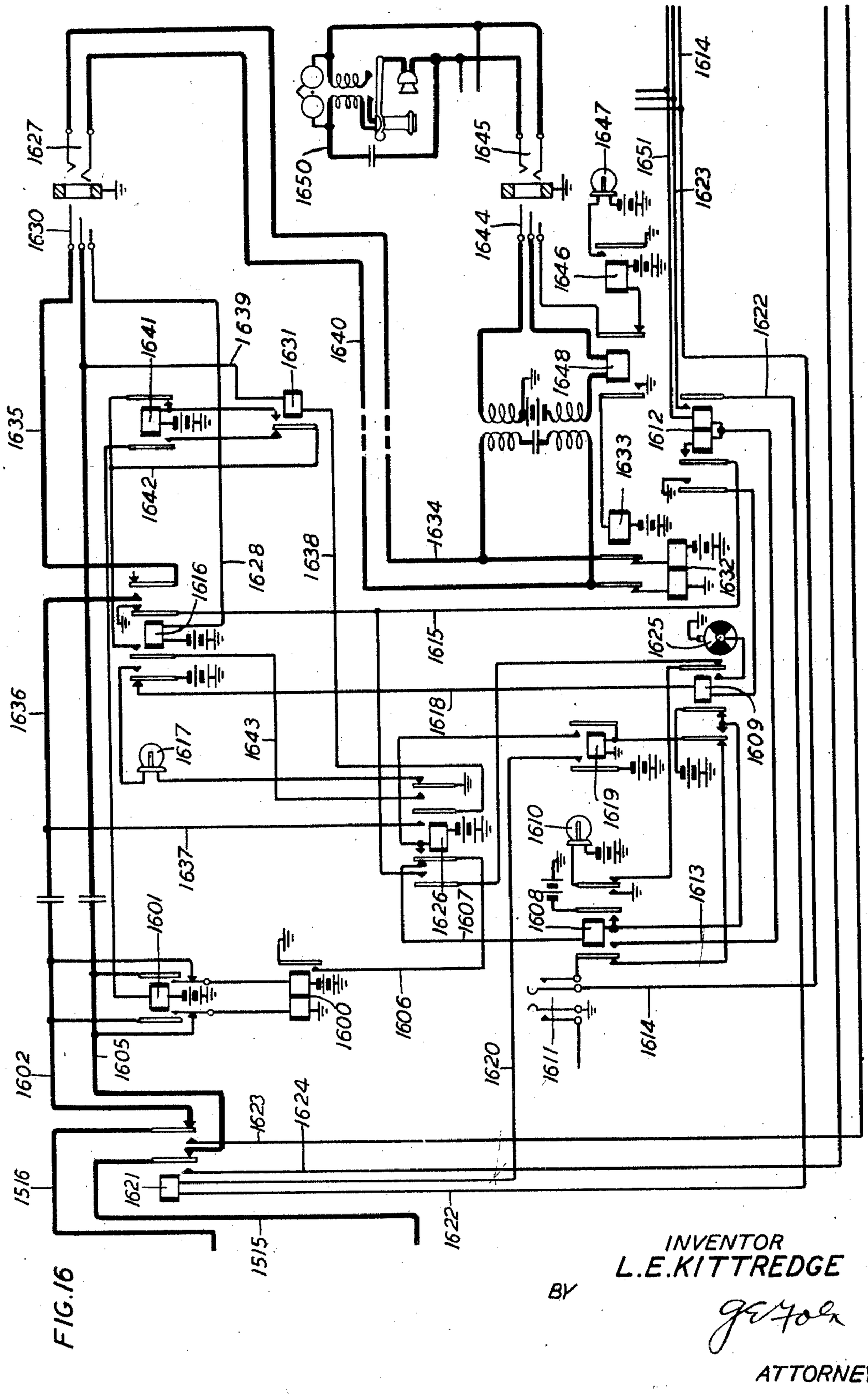

FIG. 16

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TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 17

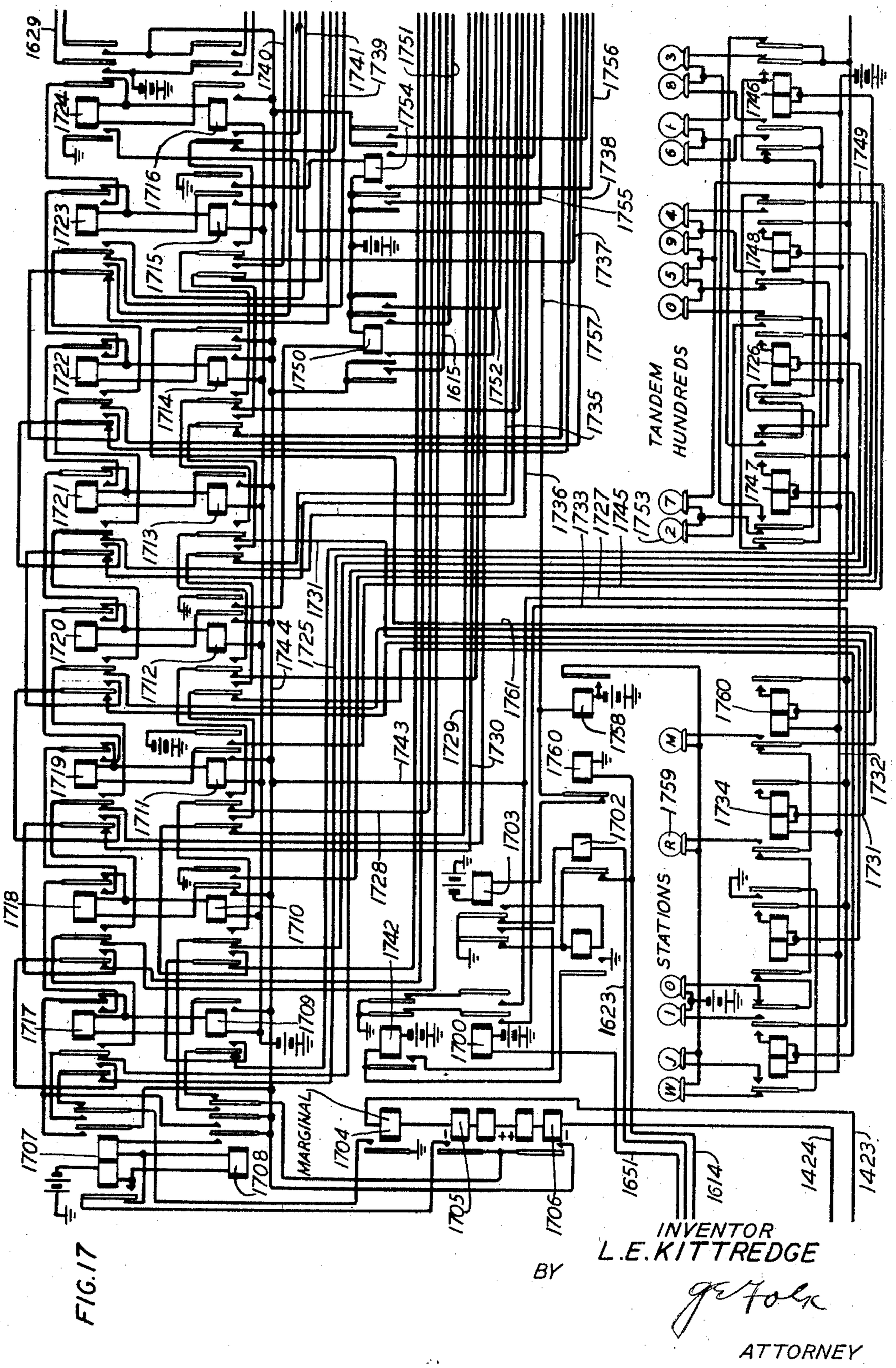

FIG. 17

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TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 18

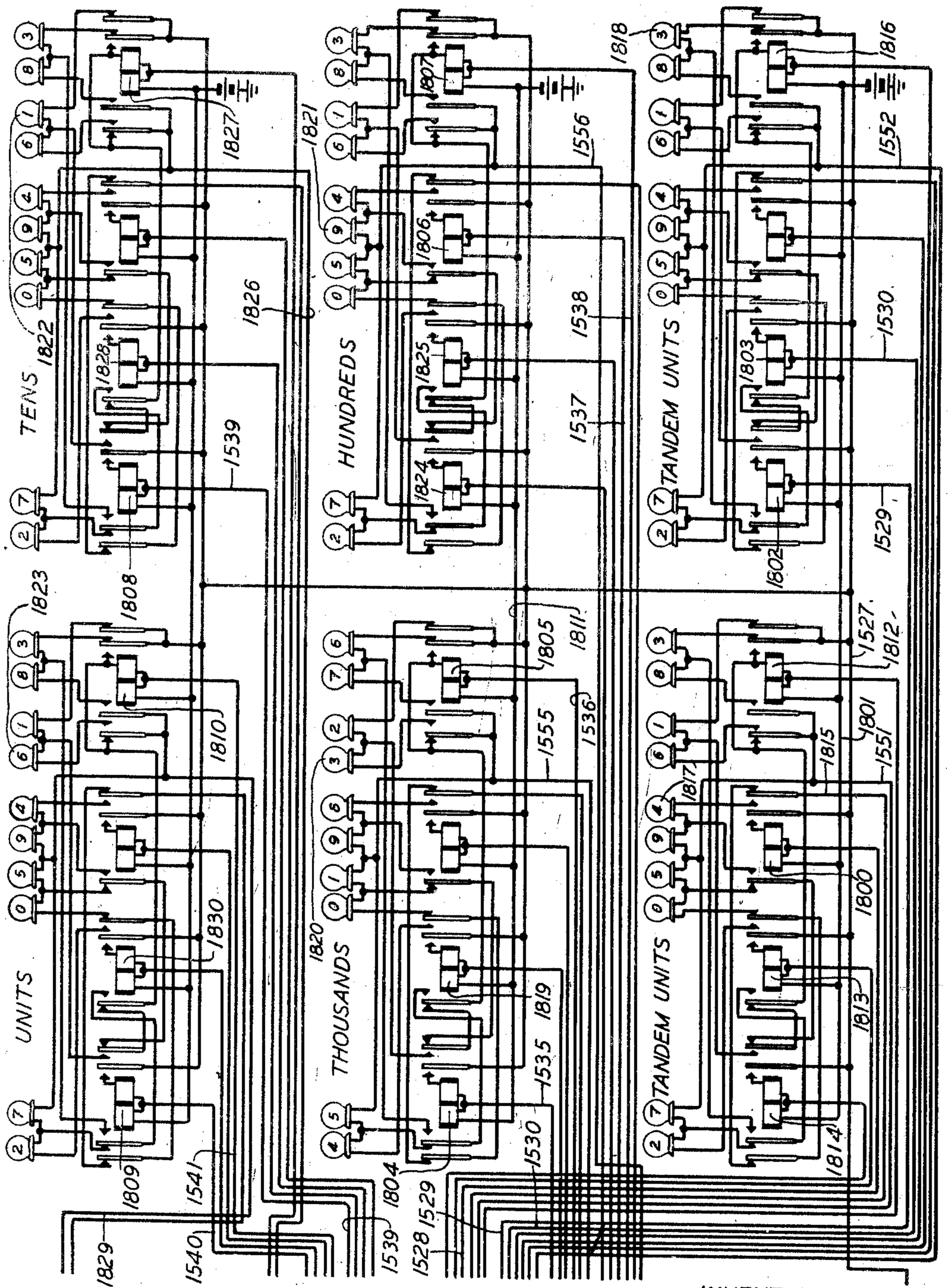

FIG. 18

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TELEPHONE SYSTEM

Filed April 11, 1931 20 Sheets-Sheet 19

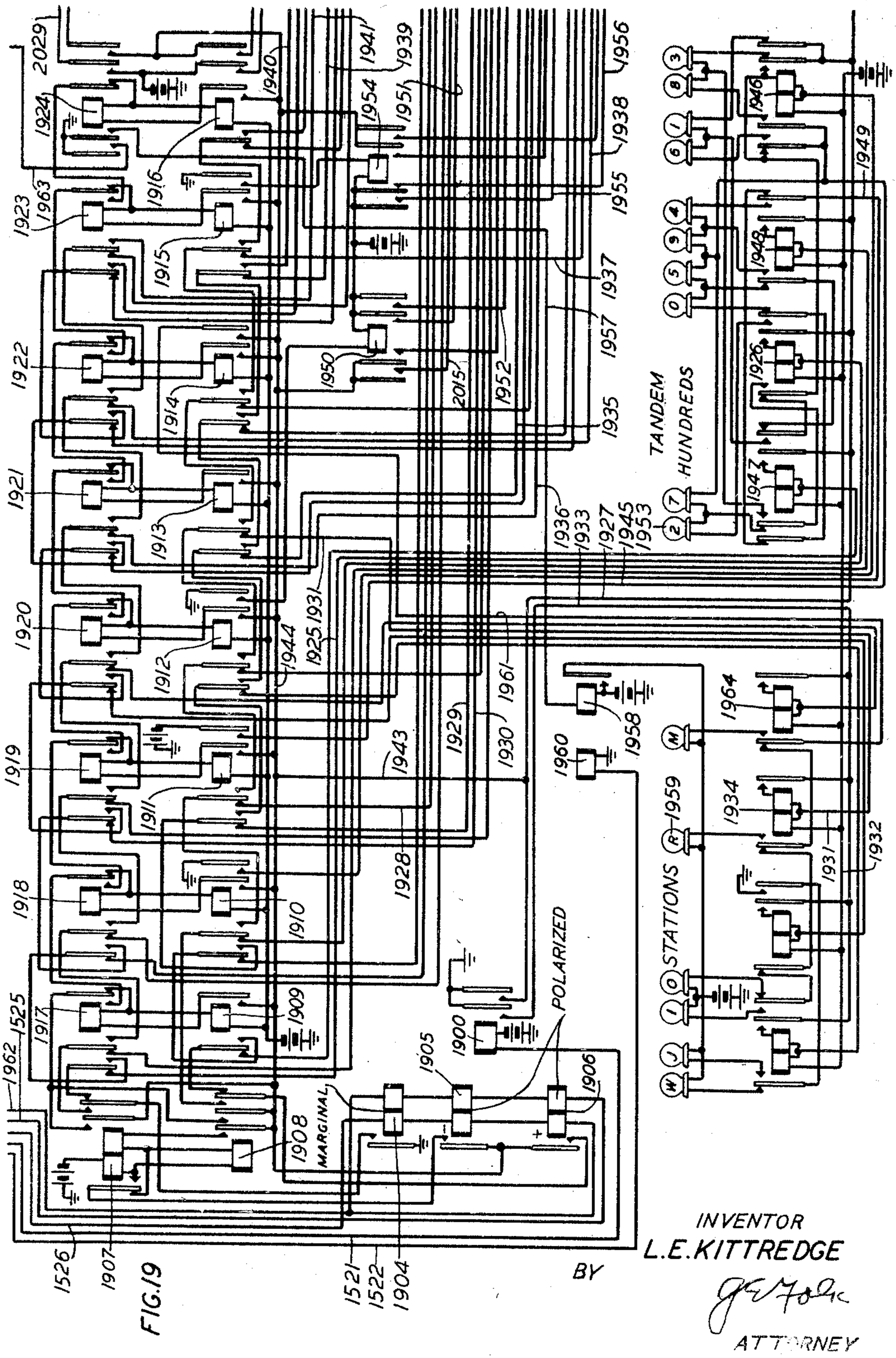

FIG. 19

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TELEPHONE SYSTEM

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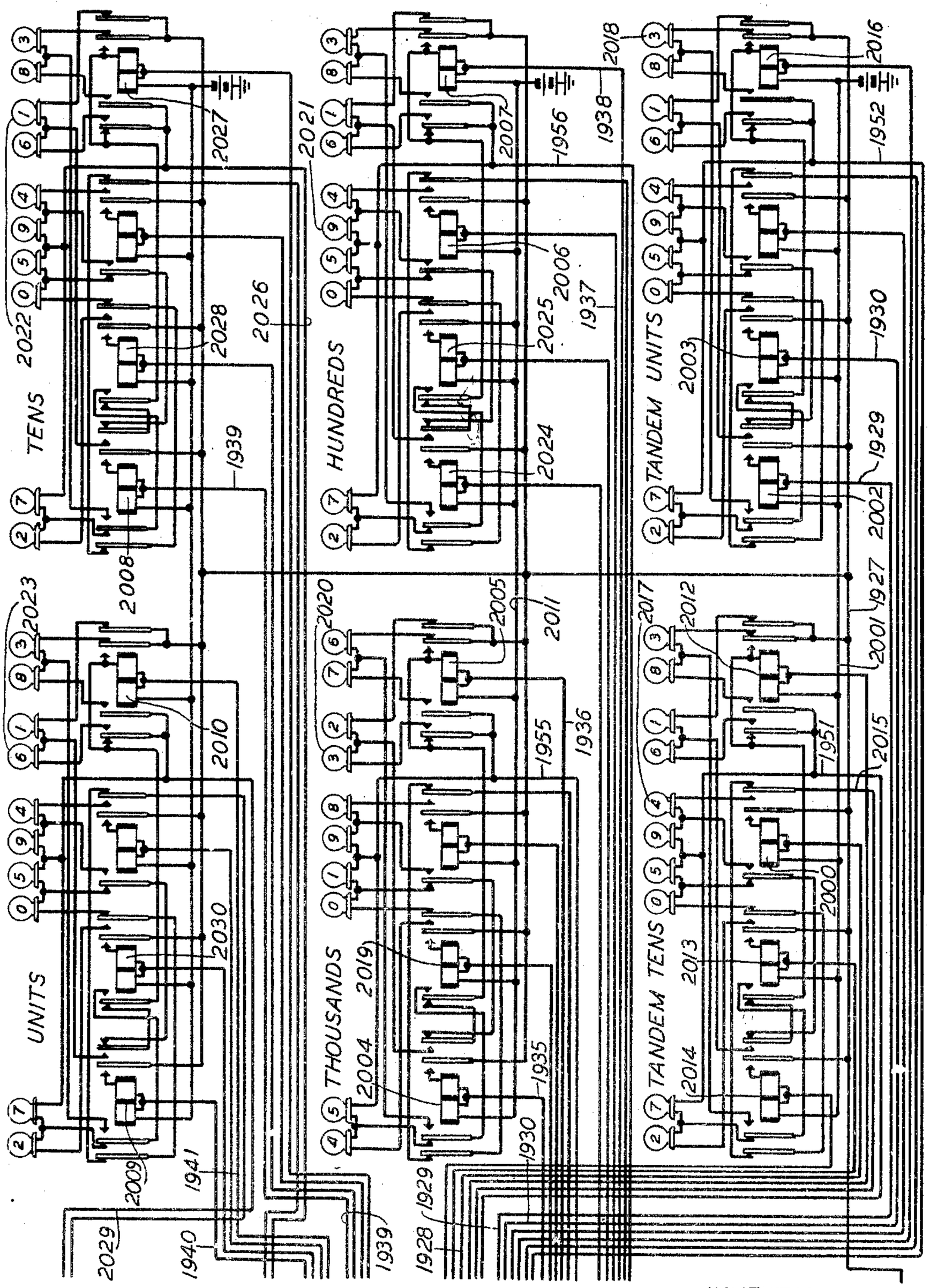

FIG. 20

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Patented Feb. 23, 1932 1,846,261

UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Application filed April 11, 1931. Serial No. 529,528.

This invention relates to a telephone exchange system and more particularly to an automatic means for apprising the operator of the calling and called line numbers; the former by mechanical voice reproduction, commonly known as a call announcer, and the latter by a lamp display. It has for its general object an organization of circuits whereby, on toll calls, the recording operator is relieved of the necessity of requesting of the calling subscriber the information necessary to make out a toll ticket, such as the station number from which the call is being made and the office and number of the called subscriber, which information, according to my invention, is supplied automatically. It includes, as well, visual means for apprising the recording operator of the duration of the call in order that the said toll ticket may also contain the total time of conversation.

In the handling of toll traffic, it is well understood that the attention of an operator is required in order to insure a ticket record from which toll charges may be entered and collections made, relative to the use of the telephone plant. In such a class of connections, the calling line is first extended to an operator who requests of the calling subscriber the number of the calling station as well as the office and number of the called station. In order to verify the accuracy of the information received relative to the calling station so that toll charges may be correctly assessed to the station from which the call is made, various means, well known in the art, have hitherto been employed with comparative degrees of success. The operating methods, however, which have been evolved by the use of these means are subject to some limitations, chief among which may be mentioned the undesirability of questioning the veracity of the subscriber and the incident delays in completing the extension of the calling line to its ultimate destination. The latter objection is especially serious with respect to attempted extensions of dial operation to A—B toll areas, that is, in areas which involve, at the present time, the extension of calling lines to suburban districts and requiring the assistance of the A and B operators in the well known manner, but for which special charges and a ticket record have to be made as in all other classes of toll connections. The difficulty arises from the fact that no advantage is derived by having the subscriber dial the entire number if the automatic switches are powerless to extend the call beyond the recording operator's position where mechanical trunking must end to permit the operator thereat to obtain the necessary ticket information. In such cases the use of mechanical switching means for selecting a trunk from the operator's position to the distant area, while the extension of the calling line to the operator's position remains under the control of the subscriber's dial, would be uneconomical since the manual selection of an outgoing trunk to the outgoing area from the operator's position would, under such circumstances, be cheaper and more expeditious.

By means of my invention these difficulties are eliminated. The ticketing and verifying information is obtained by the operator without making any inquiries of subscriber, thereby allowing the extension of dialing facilities to the A—B toll areas while still retaining facilities for ticketing calls extending to these areas.

While the present invention is disclosed herein with respect to a telephone system adapted to automatically extend a call to a tandem center exclusively by mechanical switching under the subscriber's dial control and involving the use of well known panel apparatus, it is to be understood that the invention is not so limited and may be easily adapted for use in any other system and with any other type of apparatus well known in the telephone art. In accordance with the invention, therefore, one specific embodiment of which is disclosed herein by way of illustration, this is accomplished in the following improved manner:

A recording operator's position is provided and the trunks outgoing from the switch multiple banks to the various tandem offices are paralleled to the said position through suitable switching devices and extend to jacks

with each of which a lamp is associated. The trunks terminate either at the operator's position in the tandem office in the usual way, if said tandem office is manual, or in suitable switches associated with an impulse receiving sender if the tandem office is automatic. Call indicator devices are likewise provided at the manual tandem office to receive from the register sender the impulses which represent the terminating office and the called subscriber's number in that office. These impulses are likewise received in the sender cooperating with incoming switches in the case of a mechanical tandem office. The recording operator's position is likewise provided with a call indicator device similar in structure to that used at the manual tandem position, and is adapted to be operatively associated with a position cord which is used to connect the call indicator circuit with any of the tandem trunks paralleled to the recording operator's position.

An organization of circuits comprising a group of multi-contact relays and various other relays which control the operation of a continuously revolving drum carrying ten separate voice records of the ten digits is also provided and is called herein the line announcer circuit. The tip conductor of each subscriber's line circuit in the office is extended to one of the contacts of a multi-contact relay. At the proper time, as explained hereinafter, the line announcer circuit operates to identify the tip conductor of the calling line, and when found, the line announcer is automatically connected to the recording operator's telephone circuit to transmit thereto the audible announcement of the line number corresponding to the identified tip conductor.

In general, the invention operates in the following way: Referring to Fig. 5 which diagrammatically represents the component parts of the invention, the calling subscriber dials the office code and number of the called subscriber in the usual way and the automatic switches select an outgoing trunk which, in the present embodiment of the invention, is a manual tandem trunk extending to an operator's position therein and paralleled to the recording operator's position. When the connection is extended thus far and the register sender is ready to transmit the impulses to the tandem office representing the called office and subscriber's number, the lamp associated with the selected trunk at the recording operator's position is lighted as an indication to the operator that the call is to be ticketed before it is completed. The operator inserts the position cord into the trunk jack and a circuit is then closed over the trunk to light the trunk lamp at the distant tandem operator's position as a signal thereat to take up the connection. The tandem operator depresses an assignment key associated with the trunk and causes thereby the operation of the register sender at the originating office to release and transmit over the trunk line the call indicator impulses above mentioned. Since the trunk is, at this time, also extended to the recording operator's call indicator circuit through the medium of the connecting cord, these impulses are received and registered at this position, as well as at the tandem position. A thermionic amplifying circuit is associated with each cord conductor and permits these impulses to be sufficiently amplified to be recorded in the call indicator circuit of the recording position without materially affecting the characteristics of the impulses which, at the same time, are being recorded in the call indicator device at the tandem operator's position. The record of the called office and line number therein is therefore recorded and then displayed both at the recording operator's position and at the tandem position; the former display to be used for ticketing purposes and the latter for extending the trunk to the proper called office.

If the call is being routed to a terminating automatic office via a mechanical tandem, then the relay call indicator impulses would be received in a tandem sender associated with the connecting trunk. The registration of the impulses therein will operate the tandem sender to control the line extending switches to the terminating office.

When the call indicator impulses have been transmitted a relay is operated at the recording operator's position to delay transmission of the ringing signal.

In the meanwhile the district selector, under the control of the register sender, is advanced to a position whereby a circuit is completed to operate a relay in the subscriber's line circuit which, on operating, splits the calling line circuit conductors, establishes an artificial holding circuit for the subscriber's line, connects the tip conductor to the extension thereof in the line announcer circuit and closes another circuit for starting the operation of the line announcer. The multi-contact relays of the line announcer circuit then operate to identify the tip conductor thus extended and, when found, causes the connection of the particular records on the revolving drum containing the digits representing the identified line to be operated. Circuits are closed to transmit to the operator's telephone circuit an announcement of the identified line number. The announcement is repeated thereafter at predetermined intervals until it is cut off at the recording position by the operation of a key associated with the cord. The ringing signal is then transmitted and, when the called subscriber answers, a supervisory lamp associated with the cord is lighted. There is also another supervisory lamp associated with the cord which is used for

supervising the calling line and which is also lighted so long as the calling subscriber is on the line.

The recording operator is thus automatically provided with the usual information for ticketing the call without any inquiries of the calling subscriber.

A clearer conception of the scope and purpose of the invention will be obtained from a consideration of the following description taken in connection with the attached drawings in which,

Fig. 1 shows one of a group of subscribers' lines together with the line and the trip circuit common to a group of lines which serves to control a start circuit;

Fig. 2 shows the start circuit serving a plurality of groups of lines;

Fig. 3 shows a line finder-district selector circuit for extending the line to terminating points;

Fig. 4 shows one of a plurality of link circuits serving the start circuit of Fig. 2 and having access to a plurality of line finder-district selector circuits such as shown in Fig. 3; a portion of two other links are also shown;

Fig. 5 shows a schematic layout of two possible types of connections for which the present invention is adapted;

Fig. 6 shows the line announcer mechanism;

Figs. 7, 8, 9, 10, 11, 12, 13 and 14 show such parts of the circuits of a sender adapted to be selected by the link, to control and perform such operations as will more clearly render a complete understanding of the invention;

Fig. 15 shows an incoming tandem trunk to the recording operator's position, together with a controlling cord and thermionic amplifier;

Fig. 16 shows the incoming tandem trunk and completing trunk from the tandem operator's position to the teminating office and completing cord and calling subscriber's line thereat.

Figs. 17 and 18 show the relay call indicator circuit associated with the tandem operator's position;

Figs. 19 and 20 show the relay call indicator circuit associated with the recording operator's position; and

Fig. 21 shows the manner in which the above numbered drawings, except Fig. 5, are to be placed with respect to each other in order to disclose the invention completely.

It is to be noted that such parts of the sender as are here used for describing the invention form a part of the sender shown in Patent 1,505,171, granted to F. A. Stearn dated August 19, 1924 wherein the same figure numbers and the same numerical designation of apparatus are used and reference is made to that patent for a complete description of such operations as are herein indicated. Only such designations are shown as refer to apparatus used in the following description, it being thought proper to omit such others as would have no reference to the present invention.

When the subscriber at substation 100 removes his receiver from the switchhook a circuit is closed for line relay 101 extending from battery through that relay, inner contacts of relay 102, left inner back contacts of relay 134, over the subscriber's loop, left outer back contacts of relay 134, to ground at the outer left contact of relay 102. Relay 101 operates and closes a circuit from battery, resistance 104, through the winding of relay 103 to ground at the outer contacts of relay 101.

The operation of relay 103 closes a circuit from battery, resistance 105 to ground at the right outer contacts of relay 103. This circuit is in shunt of the winding of relay 106, which relay serves the second subgroup of the group to which line 100 belongs, thus preventing the extension of a call from that subgroup, while the trip circuit is in use with line 100. The operation of relay 103 also closes a circuit from battery, through the winding of relay 200, conductor 133, outer left contacts of relay 107, left outer contacts of relay 103 to ground. In addition, relay 103 closes a circuit from battery, over the back contact of relay 201, conductor 130, right winding of trip relay 108, inner left contacts of relay 107, left inner contacts of relay 103, left contacts of relay 109 to ground.

Relay 108 operates in this circuit and closes a locking circuit for itself from ground, right contacts of relay 109, left winding and inner left contacts of relay 108, over the inner left back contacts of the trip relays of the other groups of lines, conductor 129, right winding of start relay 201 to battery. Relay 201 operates in this circuit. A circuit is now closed for relay 110 extending from battery through the winding of relay 110, right inner contacts of relay 108, conductor 128, to ground at the outer right contacts of relay 201. Relay 110 locks in an obvious circuit to ground at the left back contact of relay 109. Relay 108, together with relay 103, prepares a circuit from the outer contacts of relay 110, left outer front contacts of relay 108, right inner contact of relay 103, conductor 131, left back contact of relay 202, outer left back contact of relay 203, conductor 206, upper contact of cam 401, upper contact of cam 402, brush 461, and its associated terminal, conductor 378, upper contacts of cam 301, winding of relay 302, to battery, assuming that the line finder of Fig. 3 had been allotted for use by the switch 460 and the sequence switch 300 is therefore standing in position 2.

The operation of relay 108 also closes a circuit from ground over its outer right contact, through the winding of the trip magnet

303, serving the group of lines in which line 100 appears on the line finder frame, to battery. Relay 110, upon energizing closes a circuit from battery, through the left winding of relay 109, left winding of relay 107, outer contact of relay 110 to ground. Relay 107 operates and locks through its right winding conductor 132 and inner right contact to the contact of relay 200.

The operation of relay 302 closes a circuit from battery, through the winding of updrive magnet 304, middle left contact of relay 302, upper left contact of cam 364, right front contact of relay 302 to ground.

Under the control of the updrive magnet 304 the line finder shaft is moved upwardly. Due to the operation of the trip magnet 303 the set of brushes serving the group of lines to which line 100 belongs is tripped. When the shaft leaves the tripping zone a circuit is closed from ground over brush 307, through commutator segment 305, upper contacts of cam 306, outer left normal contact of key 304, inner right contact and right winding of relay 201 to battery. Relay 201 is held operated in this circuit but the circuit through the locking winding of relay 108 is shunted and that relay releases, in turn releasing the trip magnet 303. As soon as brush 307 leaves segment 305 the circuit of relay 201 is opened and that relay releases again connecting battery to the operating windings of relay 108 and the corresponding relays in other trip circuits, so that subsequent calls may be served.

Relay 302 closes a locking circuit for itself over its inner left contact, right upper contact of cam 308, back contact of relay 320, commutator segment 321, brush 322, to ground, which is closed as soon as the line finder shaft moves upward. Relay 302 also closes a circuit from battery, over the inner left contact of relay 205, right winding of relay 203, conductor 207, left contacts of cam 403, brush 462 and its associated terminal, conductor 379, upper left contact of cam 311, right front contact of relay 302 to ground. The operation of relay 203 removes ground from conductor 206 thus preventing the start of another line finder for some subsequent call until the brushes are tripped. Relay 203 locks in a circuit from battery, over the outer left contact of relay 205, left winding and outer left front contact of relay 203, left back contact of relay 202, conductor 131, inner right contact of relay 103, outer left contact of relay 108, outer contact of relay 110 to ground. The operation of relay 203 also closes a locking circuit for relay 201 from battery, left contact and left winding of relay 201, inner right contact of relay 203 to ground. The circuits just traced are established before relay 108 is released by the shunting action of commutator segment 305. As soon, however, as relay 108 deenergizes it opens the locking circuit of relay 203, restoring the start circuit to condition to serve subsequent calls.

When relay 302 operates it also closes a circuit from ground through its right front contact, upper left contact of cam 311, conductor 379, brush 462, and its associated contact, right contacts of cam 404, upper left contact of cam 405, right winding of relay 406, winding of relay 407, upper left contact of cam 408, upper right contact of cam 409, resistance 410 to battery. Relays 406 and 407 operate, relay 406 closing a locking circuit for itself and relay 407 from battery, through resistance 410, upper right contact of cam 409, upper left contact of cam 408, winding of relay 407, right winding of relay 406, contact of cam 411, contact of relay 406 to ground. Relay 407 operates in this locking circuit and closes a circuit from battery, through the winding of sequence switch magnet 400, upper contacts of cam 412, contact of relay 407 to ground. Magnet 400 operates advancing the link circuit sequence switch to position 2.

In position 2 ground is connected from the right contact of cam 415 to brush 466 and its associated contact, conductor 375, lower right contact of cam 312, lower right contact of cam 313, left winding of relay 314 to battery. Relay 314 operates, but performs no function until the calling line has been found. Ground from the front contact of relay 406 is also extended over the contact of cam 411, upper left contact of cam 405, upper right contact of cam 404, left contacts of cam 403, conductor 207, right winding of relay 203, inner left contact of relay 205 to battery, holding relay 203 operated until the link circuit is moved out of position 1. When the link circuit arrives in position 2 relays 406 and 407 release. The release of relay 407 completes a circuit from ground at its back contact, upper right and lower left contact of cam 405, winding of magnet 487 to battery. Magnet 487 operates and closes an obvious circuit for magnet 488. Magnet 488 is the rotary magnet for sender selector switch 480 and causes the switch to rotate in search of an idle sender.

An idle sender is characterized by the connection of battery, through the winding of relay 706 and its right inner normally made contact, left outer contact of relay 705, back contact of relay 704, outer back contact of relay 703, conductor 702 and its corresponding terminal in the set engaged by brush 483. With the link circuit sequence switch in position 2 ground is connected over the upper right contact of cam 421, through the left winding of relay 406, lower contact of cam 413, right winding of relay 406, winding of relay 407, lower contact of cam 401, lower right contact of cam 402 to brush 483 and thence over the circuit above traced to relay 706.

When brush 483 encounters a terminal corresponding to an idle sender, to which battery is connected as above described, relays 406 and 706 operate. Relay 406 short circuits its left hand winding over its contact and the contact of cam 411, permitting relay 407 to operate in series with the right hand winding of relay 406. The operation of relay 407 opens the circuit of magnet 487 and closes a circuit from battery through the winding of sequence switch magnet 400, upper contact of cam 412, front contact of relay 407 to ground advancing the link sequence switch to position 3.

Relay 706 operates in the above mentioned circuit and at its inner right hand armature and front contact closes a locking circuit for itself independent of the armature contact of relay 705 and at its inner left hand front contacts closes a circuit for relay 705. Relay 705 operates and connects ground to conductor 702 for marking the seized sender as busy to all other links over a circuit which may be traced from ground on the right contacts of relay 705, winding of relay 704, thence to conductor 702 through the outer left back contacts of relay 703. At its inner front contacts, relay 705 connects battery to one side of relay 704 and ground on the other side from its right contacts but since relay 704 is shunted at this time this relay does not energize.

Relay 706, upon energizing, also establishes a circuit for relay 707 which may be traced from ground on the left outer front contacts of relay 706, winding of relay 707, resistance 794, left outer contacts of relay 708, conductor 709, brush 484 of sender selector 480, lower left and right upper contacts of cam 408, brush 464 of district finder 460, conductor 315, left contact of cam 316, left winding of relay 317 to battery, which circuit is not completed until the district sequence switch reaches position 3.

In the meantime the line finder shaft continues to move upwards until it reaches the terminals corresponding to the calling subscriber's line. When these terminals are encountered a circuit is completed from battery, through the right winding of relay 109 and resistance 111, inner front contact of line relay 101, conductor 114, terminal 380, brush 381, right contact of cam 318, winding of relay 320 to ground. Relay 320 operates and closes a circuit in shunt of its winding through resistance 319, right front contact of relay 320, commutator segment 321, brush 322 is ground. Relay 109, which is marginal, is so adjusted as not to operate in the circuit previously traced in series with relay 107 or in the circuit traced for the winding of relay 320. With resistance 319 in parallel with relay 320 relay 109 operates. The operation of relay 109 opens the locking circuit of relay 110 and relay 110 releases after an interval due to the fact that relay 110 is slow to release.

Relay 320 opens the locking circuit of relay 302 and that relay releases as soon as brush 310 encounters an insulating segment of centering commutator 309. The release of relay 302 opens the circuit of updrive magnet 304 and stops the line finder on the calling subscriber's line. It also connects battery through resistance 323 and its left back contact, lower right and upper left contacts of cam 324, inner back contact of relay 317, resistance 325, brush 326, and terminal 327, over conductor 112, windings of cut-off relay 102 to ground. Relay 102 operates and releases line relay 101 removing the calling condition from terminal 380. The release of relay 101 opens the energizing circuit of relay 109 permitting its release as soon as relay 110 releases. The release of relay 101 permits relay 103 to release and also opens the circuit of relay 320. The connection of battery with terminal 327 marks terminal 113 and the other multiple terminals of calling line 100 in the terminal banks of final selectors with reduced battery potential to render the line busy at such final selectors. The release of relay 302 closes a circuit from battery through the winding of sequence switch magnet 300, lower left contact of cam 328, outer right front contact of relay 314, right back contact of relay 302 to ground. Sequence switch 300 is advanced in this circuit to position 3.

When sequence switch 300 leaves position 2 the circuit of relay 314 is opened and that relay releases. When the sequence switch 300 reaches position 3, the previously traced circuit for relays 707 and 317 is completed. Relay 317, being marginal, does not operate at this time. Relay 707, however, operates and closes a circuit for advancing the time measure switch TM into position 1 under the influence of interrupter 710 over a circuit which may be traced from battery, through the winding of stepping magnet 711, wiper 792 and the normal terminal of the bank with which it is associated, interrupter 710, the outer left hand armature and back contact of relay 712, the inner contacts of relay 707 and thence to ground at the outer left hand front contact of relay 706.

As soon as the time measure switch reaches position 1 a circuit is established for relay 712 which may be traced from battery through the winding of relay 712, terminal on bank cooperating with wiper 713 to ground. Relay 712, upon energizing, closes a locking circuit for itself independent of wiper 713, through its winding, its outer right front contacts and thence to ground at the outer left front contact of relay 706. A new circuit for magnet 711 may now be traced from wiper 715, outer left front contact of relay 712, the inner front contact of relay 707, to

ground at the outer left contacts of relay 706. Stepping magnet 711, under the influence of its own self interrupter contacts advances the wipers of the time measure switch to position 6 in which position the circuit of magnet 711 is opened at wiper 715.

The placing of ground on conductor 702 as previously described short circuits relays 406 and 407 and these relays release. The release of relay 407 closes a circuit from battery, through the winding of sequence switch magnet 400, lower right contact of cam 412, back contact of relay 407 to ground. Sequence switch 400 is advanced to position 4, from which position it is moved to position 5 by means of ground over the lower left contact of cam 412.

In position 5 of the link sequence switch 400, the dialing leads and the fundamental circuit leads are cut through directly from the district circuit to the sender circuit and the operation of relay 712 closes the subscriber's dialing circuit. The dialing circuit may be traced from battery, through the left winding of stepping relay 1100, conductor 1101, through various controlling circuits shown in that part of the sender which is shown in Fig. 6 of the above mentioned patent to Stearn and indicated herein by broken conductor 1101, right inner contacts of relay 712, brush 485 and cooperating terminal, lower contacts of cam 414, district finder brush 465 and its cooperating terminal, conductor 382, lower contact of cam 329, winding of relay 330, right back contact of relay 317, line finder brush 331, terminal 332, conductor 116, left inner back contacts of relay 134, through the subscriber's substation, left outer contacts of relay 134, conductor 117, terminal 333, brush 334, middle left back contacts of relay 317, left contact of cam 335, conductor 375, brush 466 and its associated terminal, lower left contact of cam 415, brush 486 and its cooperating terminal, left inner contacts of relay 712, through the contacts of controlling relays in Fig. 6 of the above identified patent and indicated in Fig. 7 by a broken conductor, left winding retardation coil 716 to ground. The stepping relay 1100 energizes in this circuit and, at its front contacts, closes a circuit for the slow-releasing relay 1102, this circuit extending from battery through the winding of relay 1102 and thence to ground through the front contacts of relay 1100. A circuit is now closed for sending a dialing tone to the calling subscriber's line, which circuit may be traced from ground through the right front contacts of relay 1102, wiper 1133 and normal terminal of the bank upon which it is resting, conductor 1104, the right winding of retardation coil 716 and thence to ground through the secondary winding of the tone coil 717. The tone current flowing in this circuit is inductively transmitted to the substation of the calling subscriber through the left-hand winding of coil 716 and over the circuit previously traced.

Assuming that the subscriber desires a connection with a called subscriber's line 1650 and that the said called line is to be reached through the district selector shown in Fig. 3 and the manual tandem and final offices schematically shown in Fig. 5, the subscriber proceeds to dial three digits corresponding to the office designation of the desired line and then dials four digits representing the number of the line in such office. The three digits which represent the called office code will cause the setting of the district selector switch to choose a trunk line to the desired tandem office and when connection to that office is accomplished, cause the transmission thereto of impulses representing the code letters and numerical digits dialed by the subscriber, which impulses cause the setting of registers for displaying the wanted code and number both at the recording operator's position and at the tandem operator's position.

The manner in which the impulses representing the office code and number dialed by the subscriber are registered in the sender and the subsequent operations of the sender in controlling the movement of the district selector to select an idle trunk line in the wanted tandem direction, forms no part of this invention and reference is made to the above identified patent for a complete description of such operations. It is sufficient for the purpose of this disclosure to state that when the district selector has been successfully connected to an outgoing trunk extending to the tandem office and which trunk is herein shown in Figs. 15 and 16, the district selector sequence switch is in position 10 and when the well known truck test is to be made the switches of the various parts of the sender and relays therein have been operated in accordance with the detailed disclosure of the above mentioned patent to close the trunk test circuit path. In this case, however, the trunk test is not made until a preliminary test is made at the recording position before the said trunk is finally closed through to the tandem position. Accordingly, the following circuit is closed: battery through the right winding of relay 1501, left inner back contacts of relay 1510, conductor 386 and cooperating terminal, brush 357, upper contacts of cam 358, back contacts of relay 359, conductor 378, brush 461 and cooperating terminal, upper and left lower contacts of cam 402, brush 481 and cooperating terminal, conductor 743, left outer back contacts of relay 802, the left contact of cam 744 (9 to 12), the right contact of cam 834, the left winding of relay 823, the windings of sender stepping relay 804, the armature and back contact of relay 805, the contact of class switch 967 (6 to 9), the lower contacts of cam 774, (12 to 14), the winding of relay

839, the lower contacts of cam 824, conductor 840, the lower right contact of cam 929, it being assumed that the compensating resistance switch 950 had been set in position 4, resistance element 931, conductor 962, the left-hand contact of cam 841 (12 to 18), conductor 842, the right contact of cam 749 (9 to 12), the left back contact of relay 750, conductor 751, brush 482 and its corresponding terminal, left lower and right upper contacts of cam 404, brush 462 and its corresponding terminal, conductor 379, right lower and left upper contacts of cam 356, brush 355, conductor 385 and corresponding terminal, left outer back contacts of relay 1510, left winding of relay 1501 to ground. Relays 839 and 1501 energize over this circuit. Relay 1501 closes an obvious circuit for lamp 1506 thereby indicating to the recording operator that a call is being established over the trunk line associated with the said lamp and for which verifying and recording information is necessary. Relay 839 closes an obvious circuit for relay 845 which, in operating, closes a circuit from ground on its left outer front contacts, left upper contact and cam 820 to the winding of magnet 800 thereby advancing the sender sequence switch 800 into position 14.

As soon as sequence switch 800 reaches position 14 a circuit is established for relay 853 which may be traced from battery through the winding of this relay, conductor 852 to ground through the left contacts of cam 851 (14). Relay 853 operates and performs functions to be noted hereinafter.

The operator at the recording position answers by inserting the plug of a cord circuit, such as A, into the jack of the trunk associated with the lighted lamp 1506. A circuit is now closed from ground, winding of relay 1505, winding of relay 1504, conductors 1511 and 1512, both windings of relay 1513 in series to battery. Relay 1505 operates in this circuit but relay 1504, being marginal, does not. Relay 1505 operates relay 1510 over an obvious circuit and this relay, in operating, disconnects relay 1501 from the incoming trunk conductors 385 and 386 and connects them over the left front contacts of relay 1510 and the left contacts of relay 1503 to the outgoing trunk conductors 1515 and 1516, respectively, connecting with the outgoing trunk to the tandem office shown in Fig. 16. The operation of the left hand transfer contacts of relay 1510 causes a momentary opening of the above described circuit loop extending into the sender and including relay 839 but the opening is of such short duration that relay 839 does not release. Relay 1510, over its right contacts, connects ground through resistance 1539 to conductor 383 to establish a busy test for the trunk. The release of relay 1501 extinguishes lamp 1506 thereby indicating to the recording operator that the trunk was successfully cut through to the tandem office.

With the connection of the incoming trunk conductors 385 and 386 to the outgoing trunk conductors 1515 and 1516, the circuit previously established through relay 1501 is now established through relay 1600 of the incoming trunk in the tandem office, the circuit path being established as follows: ground through the left winding of relay 1600, left normally made contacts of relay 1601, conductor 1605, inner back contacts of relay 1621, conductor 1515, left inner contacts of relay 1503, left outer front contacts of relay 1510, conductor 385, over the previously described loop through the district, link and sender and including relay 839 therein, conductor 386, left inner front contacts of relay 1510, left outer contacts of relay 1503, conductor 1516, outer back contacts of relay 1621, conductor 1602, right normally made contacts of relay 1601, right winding of relay 1600 to battery. This circuit causes the operation of relay 1600.

It will be noted that the operator's cord at the recording position is also bridged across the trunk through conductors 1517 and 1518 over the bottom and top middle back contacts, respectively, of relay 1509 and relay 1536 is closed in circuit from ground through the winding of coil 1960, conductor 1522, bottom outer contacts of key 1520, contacts of relay 1513, winding of relay 1536, conductor 1521, winding of relay 1900 to battery. Relays 1900 and 1536 operate in the above circuit. Relay 1900 closes locking ground to the register relays of the associated call indicator circuit. Relay 1536, through its left and right outer contacts closes the filament battery circuits of the thermionic tubes 1523 and 1524. Through its right inner contacts it connects ring conductor of the cord circuit A to the grid element 1524 and through its left inner contacts it connects tip conductor 1530 of the cord circuit to the grid element 1523.

In the meanwhile the operation of relay 1600 closes a circuit for relay 1608 from ground on the contacts of relay 1600, left inner back contacts of relay 1626, winding of relay 1608, left inner back contacts of relay 1609 to battery. Relay 1608 closes an obvious circuit for assignment lamp 1610 to indicate to the operator that a call is awaiting on the trunk associated with the lighted lamp. Relay 1608 locks to battery over its right inner contacts and, through its left front contacts, partially prepares a circuit for relay 1612 which will be effective when key 1611 is depressed.

The operator at the manual tandem office, noting the lighted assignment lamp, depressed key 1611 associated with the trunk. The depression of the key closes a circuit from ground through the winding of relay

1760, conductor 1614, right contacts of key 1611, left front contacts of relay 1608, right winding of relay 1612, conductor 1651, winding of relay 1700 to battery. Relays 1612, 1700 and 1760 operate in the above circuit.

Relay 1612 upon energizing in this circuit closes a locking circuit for itself extending from battery on conductor 1651, through both of its windings in series, its left inner contacts, conductor 1615 and thence to ground at the right inner contacts of relay 1616. Relay 1612 also closes a circuit for relay 1609 from battery through the left outer back contacts of relay 1616, conductor 1618, winding of relay 1609 and thence to ground on the left outer contacts of relay 1612. Relay 1609 upon energizing opens the initial energizing circuit of relay 1608 and establishes a circuit for relay 1619 from battery through the right inner contacts of relay 1608, left outer front contacts of relay 1609, winding of relay 1619 to ground. Relay 1609 prepares, at its right front contacts, a flashing circuit for assignment lamp 1610. With relays 1612 and 1619 now energized, a circuit is established for lamp indicator connecting relay 1621 from battery on the left contacts of relay 1619, conductor 1620, winding of relay 1621, conductor 1622, right contacts of relay 1612, conductor 1623, winding of relay 1702 to ground on the inner back contacts of relay 1703. Relays 1621 and 1702 energize in this circuit, relay 1621 disconnecting the winding of trunk relay 1600 from trunk conductors 1515 and 1516 and extending these conductors over conductors 1624 and 1623 to the windings of control relays 1704, 1705 and 1706 of the call indicator.

Upon the deenergization of relay 1600 following the operation of relay 1621, the locking circuit of relay 1608 is opened and relay 1608 thereupon releases, thereby opening the previously traced circuit for lamp 1610 and connecting the lamp 1610 in a circuit extending through the right front contacts of relay 1609 to ground through interrupter 1625 for flashing lamp 1610 until the line designation has been transferred from the local sender to the lamps of the call indicator. Upon the deenergization of relay 1608 the initial energizing circuit of relay 1619 is opened at the right front contacts of relay 1608, and relay 1619 is now maintained energized in a locking circuit through its winding, right contacts, to battery through the winding of relay 1626. Relay 1626 upon energizing in this locking circuit opens the initial energizing circuit of relay 1608 and prepares a locking circuit for itself which is effective upon the reenergization of relay 1600 as more particularly described hereinafter.

At the local sender, upon the opening of the fundamental circuit by the operation of the indicator connecting relay 1621 and the connection thereto of the closed loop comprising relays 1704, 1705 and 1706 of the call indicator circuit, relay 839 releases opening the circuit of relay 845. With relay 845 deenergized and relay 853 energized, various circuits are closed for operating relay call indicator impulse switch 1000 which, during its rotation, transmits groups of impulses over the trunk line which are indicative of the office code and number of the wanted line therein. These impulses are of the type which are known as light negative, heavy negative, light positive and blank, depending upon the polarity of the battery which is applied to tip and ring conductors of the trunk and the resistance introduced in the pulsing loop. The circuits by which these impulses are generated and the manner in which they are transmitted forms no part of this invention and reference is made to the above identified patent for a complete description of the operation of the sender, a part of which is shown herein, for the manner in which the relay call indicator impulses are generated and transmitted.

It was noted that the trunk line connecting with the tandem office is extended to the recording operator's position through conductors 1518 and 1517 and these, in turn, through cord conductors 1530 and 1531 and the contacts of relay 1536 are connected with grid elements 1523 and 1524 of the thermionic amplifying circuit. The plate 1538 of one of the amplifying tubes connects over conductors 1526 through left windings of relays 1904, 1905 and 1906 and conductor 1962 with plate battery. The plate 1537 of the other tube connects over conductor 1525 through the right windings of relays 1904, 1905 and 1906 and conductor 1962 to the plate battery. The electrical constants of the thermionic detectors are such that, as the relay call indicator impulses are transmitted from the sender through the circuit loop of the tandem trunk including relay call indicator pulsing relays 1704, 1705 and 1706 as already described, they are impressed in parallel upon the grid elements 1524 and 1523. The impulses, therefore, not only effect the response of relays 1704, 1705 and 1706 but also in addition, effect the above mentioned grid elements of the detectors to cause space currents to flow through the plate circuits extending from plates 1537 and 1538, conductors 1525 and 1526, windings of relays 1904, 1905, 1906, to the plate battery thereby amplifying the currents so that these relays are affected in a similar manner by the relay call indicator impulses as are the pulsing relays 1704, 1705 and 1706 at the tandem position.

It is evident from what has already gone before that the possibility of connecting impulse responsive devices to a trunk line is not limited to one thermionic detector and one relay detector as is illustrated in the present embodiment of the invention. As

many thermionic detectors can be added as is necessary for facilitating the setting up of a connection, or for supervision, or for monitoring, as the case may be, and the tandem call indicator itself could likewise be made to operate through a thermionic detector connected to the trunk line without departing from the spirit of the invention. Under such circumstances, when the impulses are transmitted by the sender, all thermionic and relay responsive devices would operate during the transmission of each of the impulses and be recorded in the impulse registers at the respective positions in the manner described below.

The manner in which these impulses effect the operation of the relay call indicator register circuit shown in Figs. 19 and 20 at the recording position will now be described and since this circuit is similar to that at the tandem position and shown in Figs. 17 and 18, the operation of the latter will be omitted in order not to unduly burden this specification with repetition. Both registers operate simultaneously and the difference in the two circuits lies only in the fact that the electrical properties of pulsing relays 1904, 1905 and 1906 differ from those of the corresponding relays 1704, 1705 and 1706 in order to cause them to respond accurately to thermionic impulses resulting from the call indicator impulse response of the two grid elements 1523 and 1524. Otherwise the two circuits are the same and identical relays operate simultaneously. In order that the operations may be followed in both circuits at once, the last two numbers of the numerical designations of identical apparatus and conductors has been made the same in both circuits so that while in the following description the apparatus of Figs. 19 and 20 will be mentioned, it is understood that reference to the identical apparatus of Figs. 17 and 18 can be made with the same result.

It will be assumed that the calling subscriber has dialed 243—3916—R wherein the first three digits represent the called office code and the last four digits and party letter the called subscriber's number in that office. The group of impulses for each digit as well as the party letter may be obtained by reference to the above identified patent and only the effect of the impulses as they are received will be described. In response to the first heavy negative pulse of current, relays 1904 and 1905 operate. Relay 1905 upon energizing closes a circuit extending from ground on the right outer front contacts of relay 1900, conductor 1943, contacts of relay 1905, the left back contacts of relay 1907, the winding of relay 1908, and thence to battery through the low resistance left winding of relay 1907. Relay 1908 energizes in this circuit but owing to the high resistance winding of relay 1908, relay 1907 does not receive sufficient current to become energized. Upon the energization of relay 1908 a circuit is established for relay 1909 which may be traced from battery through the winding of relay 1909, the right back contacts of relay 1917, the middle front contacts of relay 1908, and thence to ground on conductor 1943. Relay 1909 energizes in this circuit and establishes a locking circuit for itself extending through its own winding, the winding of relay 1917, through its own right contacts to ground on conductor 1944 but relay 1917 does not energize in this locking circuit since, at this time, its winding is shunted by ground connected through the armature contact of relay 1908.

Marginal relay 1904 upon energizing closes a circuit for lamp relay 1926 which may be traced from ground through the contacts of relay 1904, the right outer back contacts of relay 1907, the left outer back contacts of relay 1917, conductor 1925, left winding of relay 1926, and thence to battery on conductor 1932. Relay 1926 upon energizing locks in a circuit from battery through both of its windings, its inner right contacts, and to ground on conductor 1927.

Relay 1908 upon energizing also establishes a circuit which may be traced from ground on conductor 1944 through the inner contacts of relay 1908, the right high resistance winding of relay 1907, the winding of relay 1908, thence to battery through the left winding of relay 1907, but this circuit is ineffective to energize relay 1907 since the right-hand winding of relay 1907 is shunted by a connection to ground through the contacts of relay 1905. Upon the deenergization of relay 1905 following the completion of the first negative impulse, the shunt around the winding of relay 1907 is removed at the contact of relay 1905 and relay 1907 thereupon energizes and both relays are now locked in series through the inner contacts of relay 1908 to ground on conductor 1944.

The next impulse which is transmitted is a light negative impulse, and only the negatively polarized relay 1905 responds, closing a circuit from ground on conductor 1944, the contacts of relay 1905, the left front contacts of relay 1907, to one terminal of the winding of relay 1908, and since the other terminal of this winding is at the time connected to ground through the right-hand winding of relay 1907 and the inner contacts of relay 1908, relay 1908 is shunted down and deenergizes. Relay 1907 is now maintained energized through its low resistance left winding and its left front contacts through the contacts of relay 1905, and deenergizes upon the cessation of the second negative impulse and the consequent deenergization of relay 1905. With the release of relay 1907, relay 1917 is operated and locked over a previously traced circuit in series with relay 1909, right contacts of relay 1909 to ground

on conductor 1944. The tandem hundreds code has not been transmitted and in response thereto the lamp relay 1926 has been energized and locked. The tandem tens digit impulse code is next transmitted and this code, for the tens digit is a light negative impulse, a light positive impulse and a light negative impulse.

In response to the first light negative impulse of current, the negatively polarized relay 1905 responds establishing a circuit for relay 1908 as previously traced, which in turn closes a circuit for relay 1910 which may be traced from battery through the winding of relay 1910, the right back contacts of relay 1918, the right front contacts of relay 1917, the middle contacts of relay 1908, and thence to ground on conductor 1944. Relay 1910 upon energizing closes a locking circuit for itself extending through its winding, the winding of relay 1918, the right inner contacts of relay 1910, and thence to ground on conductor 1944. Relay 1918 does not energize in this circuit since its winding is shunted by ground connected through the contacts of relay 1908. Upon the cessation of the first negative impulse and the deenergization of relay 1905, relay 1907 becomes energized in the manner previously described. In response to the next impulse which is of positive polarity, the positively polarized relay 1906 energizes establishing a circuit for lamp relay 2000 which may be traced from ground on conductor 1944 through the contacts of relay 1906, the outer front contacts of relay 1908, the left inner front contacts of relay 1910, the left inner back contacts of relay 1911, conductor 1928, the left winding of relay 2000, and thence to battery on conductor 2001. Relay 2000 upon energizing locks to ground on conductor 1927 through both of its windings and its right inner contacts. In response to the last negative impulse, relay 1905 again energizes and causes the release of relay 1908 as previously described. Upon the cessation of the last negative impulse, relay 1907 deenergizes, and since at this time both relays 1907 and 1908 are deenergized, the shunt around the winding of relay 1918 is opened and relay 1918 energizes in the locking circuit of relay 1910. The tandem tens code impulses have now resulted in the energization of the tandem tens lamp relay 2000.

The tandem units digit was assumed to be 3 and the impulse code for this digit is a positive, a heavy negative and a light negative impulse. When the sender relay call indicator impulse switch 1000 has rotated to the position for sending this series of impulses and the first or positive impulse is sent, positively polarized relay 1906 energizes and establishes a circuit from ground on conductor 1944 through its contacts, the outer back contacts of relay 1908, the left front contacts of relay 1909, the left outer front contacts of relay 1910, the left outer back contacts of relay 1911, conductor 1929, and thence to battery on conductor 2001 through the left winding of lamp relay 2002. Relay 2002 upon energizing locks to ground on conductor 1927 through both of its windings and right inner front contacts. In response to the second impulse of heavy negative current, the negatively polarized relay 1905 and marginal relay 1904 energize. Relay 1905, upon energizing, closes the previously traced circuit for relay 1908, which upon energizing establishes a circuit for relay 1911 which may be traced from battery through the winding of relay 1911, the right back contacts of relay 1919, the right front contacts of relays 1918 and 1917, the middle contacts of relay 1908 to ground on conductor 1944. Relay 1911 upon energizing locks in a circuit extending through the winding of relay 1919, but relay 1919 being shunted at this time by the ground extending through contacts of relay 1908 does not energize in this locking circuit. Relay 1904 upon energizing establishes a circuit which may be traced from ground through the contacts of this relay over the right outer back contacts of relay 1907, the left outer front contacts of relays 1917 and 1918 and the left outer back contacts of relay 1919, conductor 1930, and thence to battery through the left winding of lamp relay 2003. Relay 2003 upon energizing locks to ground on conductor 1927 through both of its windings and its right inner contacts.

Upon the cessation of this impulse of current through the windings of relay 1904 and 1905, these relays deenergize whereupon relay 1907 energizes in the manner previously described. In response to the last light negative impulse, relay 1905 again energizes and establishes a circuit from ground on conductor 1944 for shunting down relay 1908. Upon the cessation of this impulse and the deenergization of relay 1905, relay 1907 deenergizes. Relays 1907 and 1908 being both deenergized, the shunt circuit around the winding of relay 1919 is opened and this relay energizes in the locking circuit of relay 1911 preparatory to controlling the registration of the stations digit which is next transmitted.

It has been assumed that the numerical designation of the desired line is 3916—R and that this designation has been registered upon the numerical and stations registers of the local sender. Therefore, after the code impulses are transmitted the impulse switch 1000 in the sender rotates into position for transmitting a code of impulses representing the stations designation R. This code of impulses comprises a light negative followed by a positive and a second light negative impulse. In response to the first negative impulse, the negatively polarized relay 1905 responds and in the manner previously described establishes a circuit for relay 1908,

which in turn establishes a circuit for relay 1912 which may be traced from battery through the winding of relay 1912, the right back contacts of relay 1920, the right front contacts of relays 1919, 1918 and 1917 to ground on conductor 1944 through the middle contacts of relay 1908. Relay 1912 upon energizing locks up through the winding of relay 1920, but since the winding of relay 1920 is shunted by the contacts of relay 1908, relay 1920 does not energize at this time. Upon the cessation of the first negative impulse, relay 1907 becomes energized in the manner previously described.

In response to the second impulse of positive polarity, the positively polarized relay 1906 energizes and establishes a circuit for the station's lamp relay 1934 which may be traced from ground on conductor 1944, contacts of relay 1906, outer front contacts of relay 1908, the left inner front contacts of relays 1910, 1911 and 1912, the left inner back contacts of relay 1913, conductor 1931, and thence through the left-hand winding of lamp relay 1934 to battery on conductor 1932. Relay 1934 upon energizing locks up over a circuit extending from battery through both of its windings, its right contacts, conductor 1933, the right inner front contacts of relay 1900 to ground. In response to the last impulse of negative current, the negatively polarized relay 1905 again energizes causing the deenergization of relay 1908 in the manner previously described. Upon the cessation of this impulse, relay 1907 deenergizes and since at this time both relays 1907 and 1908 are deenergized, the shunt around the winding of relay 1920 is opened and relay 1920 energizes in the locking circuit of relay 1912 preparatory to controlling the operation of the thousands lamp relays.

It having been assumed that the thousands digit is 3, a code comprising a positive, a light negative and a heavy negative impulse is, therefore, transmitted for controlling the registration of the thousands digit upon the lamp relays of the relay call indicator. In response to the first positive impulse, therefore, the positively polarized relay 1906 energizes and establishes a circuit for lamp relay 2004 which may be traced from ground on conductor 1944, contacts of relay 1906, the outer back contacts of relay 1908, the outer left front contacts of relays 1909, 1910, 1911 and 1912, the outer left back contacts of relay 1913, conductor 1935, the left winding of lamp relay 2004 and thence to battery on conductor 2011. Relay 2004 upon energizing locks over both of its windings and its inner right contacts to ground on conductor 1927. In response to the second impulse of negative current, the negatively polarized relay 1905 responds and in the manner previously described establishes a circuit for relay 1908, and relay 1908 in turn establishes a circuit for relay 1913 which may be traced from battery through the winding of relay 1913, the right back contacts of relay 1921, the right front contacts of relays 1920, 1919, 1918 and 1917, the middle contacts of relay 1908 to ground on conductor 1944. Relay 1913 thereupon establishes a locking circuit through its own winding, the winding of relay 1921, the right contacts of relay 1913, and to ground on conductor 1944. Relay 1921 being shunted at this time through the armature and contact of relay 1908, does not energize in this locking circuit. Upon the cessation of this negative impulse, relay 1907 energizes in the manner previously described.

In response to the last impulse of heavy negative current, the negatively polarized relay 1905 and marginal relay 1904 both energize, relay 1905 causing the deenergization of relay 1908 in the manner previously described, and marginal relay 1904 establishing a circuit for lamp relay 2005 which may be traced from ground at the armature contact of relay 1904, the right outer front contacts of relay 1907, the left front contacts of relays 1917, 1918, 1919 and 1920, the left inner back contacts of relay 1921, conductor 1936, and thence to battery on conductor 2001 through the left-hand winding of relay 2005. Relay 2005 upon energizing locks through both of its windings and its right inner front contacts to ground on conductor 1927. Upon the cessation of this last negative impulse relay 1907 deenergizes, and since at this time both relays 1907 and 1908 are deenergized, the shunt around the winding of relay 1921 is removed and this relay energizes in the locking circuit of relay 1913 preparatory to controlling the registration of the hundreds digit upon the lamp relays of the indicator.

It having been assumed that the hundreds digit of the desired number is 9, a code comprising a light negative, a positive and a heavy negative impulse is transmitted for setting the hundreds lamp relays. In response to the first impulse of negative current, therefore, the negatively polarized relay 1905, energizes and establishes the previously traced circuit for energizing relay 1908, and relay 1908 upon energizing establishes a circuit for relay 1914 which may be traced from battery through the winding of relay 1914, the right back contacts of relay 1922, and thence through the right front contacts of relays 1921, 1920, 1919, 1918 and 1917, and the middle contacts of relay 1908 to ground on conductor 1944. Relay 1914 upon energizing locks through the winding of relay 1922 and its own right front contacts to ground on conductor 1944, but relay 1922 does not energize at this time since its winding is shunted at the contacts of relay 1908. Upon the cessation of the first negative impulse, relay 1907 energizes in the manner previously described.

In response to the second positive impulse of current, the positively polarized relay 1906 responds and establishes a circuit for the hundreds lamp relay 2006 which may be traced from ground on conductor 1944 through the contacts of relay 1906, the outer front contacts of relay 1908, the left inner front contacts of relays 1910, 1911, 1912, 1913 and 1914, the left inner back contacts of relay 1915, conductor 1937, the left winding of relay 2006, and thence to battery on conductor 2011. Relay 2006 upon energizing in this circuit locks through both of its windings and its inner right contacts to ground on conductor 1927. In response to the last impulse of heavy negative current, the negatively polarized relay 1905 and the marginal relay 1904 energize, relay 1905 shunting down relay 1908 as previously described, and relay 1904 establishing a circuit for lamp relay 2007 which may be traced from ground through the contacts of relay 1904, the right outer front contacts of relay 1907, the left inner front contacts of relays 1917, 1918, 1919, 1920 and 1921, the left inner back contacts of relay 1922, conductor 1938, and thence to battery through the left winding of relay 2007. Relay 2007 upon energizing locks through both of its windings and its right inner front contacts to ground on condenser 1927. Upon the cessation of this last negative impulse relay 1907 deenergizes, and since at this time both relays 1907 and 1908 are deenergized, the shunting circuit around the winding of relay 1922 is opened and this relay energizes in the locking circuit of relay 1914.

It having been assumed that the tens digit of the desired number is 1 a code comprising a positive and two light negative impulses is transmitted over the fundamental circuit to register the tens digit 1 on the tens lamp relays of the indicator. In response to the first impulse of positive polarity, therefore, the positively polarized relay 1906 responds and establishes a circuit for the tens lamp relay 2008 which may be traced from ground on conductor 1944 through the contacts of relay 1906, the outer back contacts of relay 1908, the left outer front contacts of relay 1909, 1910, 1911, 1912, 1913 and 1914, the left outer back contacts of relay 1915, conductor 1939, and thence to battery through the left winding of relay 2008. Relay 2008 upon energizing locks through both of its windings and its right inner contacts to ground on conductor 1927. In response to the second impulse of negative polarity, the negatively polarized relay 1905 energizes and in the manner previously described establishes a circuit for relay 1908, which latter relay upon energizing establishes a circuit for relay 1915 which may be traced from battery through the winding of relay 1915, the right back contact of relay 1923, the right front contacts of relay 1917 to 1922 inclusive, the middle contacts of relay 1908 to ground on conductor 1944. Relay 1915 upon energizing establishes a locking circuit for itself extending through the winding of relay 1923 and its own right inner front contacts, but relay 1923 being shunted at this time through the contacts of relay 1908 does not energize in this locking circuit. Upon the cessation of this negative impulse, relay 1907 energizes in the manner previously described. In response to the last negative impulse, the negatively polarized relay 1905 again energizes and in the manner described shunts down relay 1908. Upon the termination of this impulse relay 1907 deenergizes, and since at this time both relays 1907 and 1908 are deenergized, the shunt around the winding of relay 1923 is open and relay 1923 energizes in the locking circuit of relay 1915 preparatory to controlling the registration of the units digit.

It having been assumed that the units digit is 6, a code comprising a positive, a negative and a heavy negative impulse is transmitted over the fundamental circuit to control the registration of the units digit upon the units lamp relays of the indicator. In response to the first impulse of positive polarity, therefore, the positively polarized relay 1906 responds and establishes a circuit extending from ground on conductor 1944, contacts of relay 1906, the outer back contacts of relay 1908, the left outer front contacts of relays 1909 through 1915, inclusive conductor 1940, and thence to battery through the left winding of relay 2009. Relay 2009 upon energizing in this circuit closes a locking circuit for itself extending through both of its windings and its inner right contacts to ground conductor 1927. In response to the second impulse of negative polarity, the negatively polarized relay 1905 responds and in the manner previously described establishes a circuit for relay 1908, which in turn establishes a circuit for relay 1916, which may be traced from battery through the winding of relay 1916, the right inner back contacts of relay 1924, and thence through the right front contacts of relays 1917 to 1923 inclusive, through the middle contacts of relay 1908 to ground on conductor 1944. Relay 1916 upon energizing establishes a locking circuit for itself extending through the winding of relay 1924 to ground on conductor 1944 through its right inner front contacts. Relay 1924, however, does not energize in this locking circuit since its winding is shunted by ground through the contacts of relay 1908.

Upon the cessation of the negative impulse of current, relay 1907 becomes energized in the manner previously described. In response to the last heavy negative impulse of current, the negatively polarized relay 1905 and marginal relay 1904 both energize, the

energization of relay 1905 causing the deenergization of relay 1908, and the energization of marginal relay 1904, establishing a circuit for lamp relay 2010 which may be traced from ground through the contacts of relay 1904, the right outer front contacts of relay 1907, the left inner front contacts of relays 1917 to 1923 inclusive, conductor 1941, the left winding of relay 2010 to battery. Relay 2010 upon energizing locks through both of its windings and its right inner front contacts to ground on conductor 1927. Upon the cessation of the last negative impulse relay 1907 deenergizes, and since at this time both relays 1907 and 1908 are deenergized, the shunt around the winding of relay 1924 is removed and this relay energizes in the locking circuit of relay 1916. The complete office and numerical designation of the desired line has now been transferred to the lamp relays of the relay call indicator both at the recording position and at the tandem position.

Upon the completion of the tandem tens registration on the lamp relays of Fig. 20 and the energization of relay 1911, a circuit is completed for the No. 2 tandem hundreds lamp 1953 which may be traced from battery through the right outer contacts of relay 1911, conductor 1945, the left outer back contacts of relay 1946, the left front contacts of relay 1926, the left inner back contacts of relay 1947, lamp 1953, the right outer front contacts of relay 1926, the left outer back contacts of relay 1947, the right outer and back contacts of relay 1948, conductor 1949, and thence to ground at the right outer front contacts of relay 1910. Upon the completion of the tandem units registration and the energization of relay 1912, a circuit is established for relay 1950 which may be traced from battery through the winding of relay 1950 to ground at the right outer front contacts of relay 1912. Relay 1950 upon energizing establishes circuits for the No. 4 tandem tens lamps 2017 and the No. 3 tandem units lamp 2018. The circuit for lamp 2017 may be traced from battery through the right inner contacts of relay 1950, conductor 1951, the left outer back contacts of relay 2012, the left back contacts of relay 2013, the right outer back contacts of relay 2014, the left front contacts of relay 2000, lamp 2017, the right outer front contacts of relay 2000, conductor 2015, the left outer contacts of relay 1950 to ground on conductor 1944. The circuit for lamp 2018 may be traced from battery through the right outer contacts of relay 1950, conductor 1952, the left outer back contacts of relay 2016, the left front contacts of relay 2003, the left inner front contacts of relay 2002, lamp 2018, the right inner back contacts of relay 2016, and thence to ground on conductor 1927.

Tandem lamps 1953, 2017 and 2018 now being illuminated indicate the No. 243 corresponding to the office code. The operator at the tandem position, noting these lamps, may proceed at this time to order up the trunk over the order wire, not shown, extending to the indicated office which will be assumed to be the terminating office shown in Fig. 16 and receive from the terminating operator the assignment of a trunk. The recording operator before whom the same lamps are illuminated does nothing other than wait for the display of the rest of the number.

Upon the completion of the hundreds registration and the energization of relay 1915, a circuit is established for relay 1954, which latter relay upon energizing establishes circuits for lighting the selected No. 3 thousands lamp 2020 and the No. 9 hundreds lamp 1921. The circuit for lamp 2020 may be traced from battery through the left outer contacts of relay 1954, conductor 1955, the left outer front contacts of relay 2005, lamp 2020, the right outer front contacts of relay 2004, the left back contacts of relay 2019, and thence to ground on conductor 1927 through the right inner front contacts of relay 2005. The circuit for lamp 2021 may be traced from battery through the left inner contacts of relay 1954, conductor 1956, lamp 2021, the left front contacts of relay 2006, the right outer back contacts of relay 2024, the left back contacts of relay 2025, the right inner front contacts of relay 2007 to ground on conductor 1927.

Upon completion of the units registration and the energization of relays 1916 and 1924, circuits are established for the No. 1 tens lamp 2022 and the No. 6 units lamp 2023. The circuit of lamp 2022 may be traced from battery through the right middle contacts of relay 1916, conductor 2026, the left outer back contacts of relay 2027, the left back contacts of relay 2028, the right outer front contacts of relay 2008, lamp 2022, the right outer back contacts of relay 2027, thence to ground on conductor 1927. The circuit of lamp 2023 may be traced from battery through the right middle front contacts of relay 1924, conductor 2029, the left outer front contacts of relay 2010, lamp 2023, the right outer front contacts of relay 2009, the left back contacts of relay 2030, and thence to ground on conductor 1927 through the right inner front contacts of relay 2010.

Upon the energization of relay 1924, a circuit is also established extending from ground at the left inner contacts of relay 1924 over conductor 1957, and to battery through the winding of relay 1958. Relay 1958 upon energizing establishes a circuit for the R stations lamp 1959 which may be traced from battery through the contacts of relay 1958, lamp 1959, the left front contacts of relay 1934, the left back contacts of relay

1964, conductor 1961, the right outer front contacts of relay 1914, and thence to ground on conductor 1944. The line designation 3916—R of the desired line terminating in the terminating office whose code is 243 is now indicated by the lamps of the relay call indicator at the recording position and at that of the tandem position simultaneously.

Relay 1924, when operated, also closes ground to conductor 1963 which causes the operation of relay 1519 in the cord circuit by way the bottom middle make contacts of key 1520. Relay 1519, through its left contacts short circuits the left winding of relay 1513 and the quantity of current now flowing over the previously traced circuit including relays 1505 and 1504 is increased and causes the operation of relay 1504. Relay 1504 closes an obvious circuit for relay 1503 which, in operating, opens the trunk conductors to the tandem office so as to prevent the immediate operation of the ringing circuit since, after the sender is dismissed and talking selection has taken place as briefly described below and more completely described in the above mentioned patent to Stearn, the district selector is advanced into talking and ringing position 14 and which operation would thereafter take place if the trunk were closed through to the battery and ground circuit through relay 1600 after the transmission of the impulses. However, it is necessary to delay ringing in this case since the recording operator, having received a lamp display of the called office and number must still, in addition, receive the number of the calling line for the toll call ticket record.

In the meanwhile when the relay call indicator impulser 1000 reaches normal position 1, it closes a circuit for advancing the translator control switch 700 from position 9 into position 12. The circuit may be traced from battery through the magnet of switch 700, the lower left contact of cam 728, conductor 775, the upper left and lower right contacts of cam 1013 (1), the right outer back contacts of relay 1004, conductor 1009, through the contacts of a controlling relay in the translator circuit, not shown, conductor 1578 and thence to ground at the upper right contact of cam 730 (9 to 12).

With the translator control sequence switch in position 12 a circuit is now established through the windings of advance relays 708 and 750 in parallel over conductor 759, the upper right and lower left contacts of class switch cam 974 and thence to ground at the lower left contact of cam 731 (12). According to the manner of operation described in the above mentioned patent, relays 708 and 750 cause the advance of the sequence switch 300 of the district selector out of position 10 and into position 11 and cause the establishment of a fundamental circuit as therein described extending from relay 314 of the district selector shown in Fig. 3 of the present specification through the windings of the sender stepping relay 804. Talking selection is now controlled in substantially the same manner as therein described, the counting relays being under the control of the talking selection register relays 1326 and 1410. Since the call is extended to a manual tandem office the code dialed by the calling subscriber would, in this instance, cause the energization of talking selection relay 1326 for establishing a control path for relay 826, called the No. 2 counting relay of Fig. 8 to set the sequence switch 300 of the district selector into position 15. Following talking selection, the sender is dissociated from the district selector and restores in the manner described in the above mentioned patent.

In position 15 a circuit is closed in the district selector from ground on the upper contact and cam 318, brush 381, terminal 380, conductor 114, inner back contacts of relay 101, right front contacts of relay 102, winding of relay 134 to battery. Relay 134 operates, connects ground over its left outer front contacts to conductor 135 which connects with one side of the subscriber's loop and battery through a resistance over the left inner front contacts to conductor 136 which connects with the other side of the subscriber's loop. The left innermost front contact of relay 134 connects ground to conductor 116 to hold relay 330 energized, while conductor 117 is connected by way of the outer front contact to conductor 137 through condenser 138. At the same time conductor 139 is grounded through the right inner contacts of relay 134. Conductor 139 is multipled to similar contacts of all relays 134, one of each of which relays is associated with a subscriber's line and the multipled conductor connects with the winding of relay 600, Fig. 6.

The line announcer mechanism shown in Fig. 6 illustrates one form which such a mechanism may take. It comprises a series of drums having opaque and partially transparent sections, the partial transparent sections being photographic records of the sounds corresponding to digits from 0 to 9. The light from a source, such as lamp 604, may be directed by any suitable means through the speech records to photoelectric cells, such as 605, each connected to one side of a transformer, such as 606. The output currents are amplified by suitable vacuum tube amplifiers and transmitted to the trunk repeating coil 360 in the manner hereinafter described, and inductively transmitted over the trunk circuit which has been established to the recording operator's position. The call announcer mechanism such as disclosed in Patent No. 1,645,573, patented October

18, 1927 in the name of H. M. Bascom may also be employed.

The line announcer connecting circuit, also shown in Fig. 6, illustrates one form by which the connection between the line announcer mechanism and the recording operator's position may be made. It comprises a plurality of multi-contact relays of a structure well known to the art, arranged in two separate groups. To a contact on one of the multi-contact relays of each of the two separate groups, a conductor, such as conductor 137, from each subscriber's line is connected. In Fig. 6 the two groups of multi-contact relays are represented by multi-contact relays 611 and 614, respectively, and conductor 137 is shown connected to the appropriate contact of each of these relays. Since, in a large telephone office, the line capacity may be 10,000 subscribers' lines, a sufficient number of other relays are connected in parallel with relay 611 and another number in parallel with relay 614 to provide connection with the conductors from all the subscribers' lines.

Two other multi-contact relays, namely, relays 608 and 615 are also provided; each of these relays having 100 contact pairs for a 10,000 line office. The contacts of relay 608 are divided into ten groups of ten pairs of contacts each. The armatures of each group are strapped together and connected to one side of a particular amplifier while the contacts of the armatures of all of the ten groups are connected to a group of common conductors, designated from 00 to 99, of which a number only are shown in Fig. 6. The order in which these contacts are wired to the said common conductors depends upon the particular amplifier to which each associated group of armatures is connected and each contact in a group of ten is wired to a conductor whose first digit of its numerical designation is the same as the numerical designation of the amplifier to which the armatures of the group is connected. For example, in Fig. 6 one side of the amplifier 0 is connected, so far as multi-contact relay 608 is concerned, to the left group of armatures designated 0 to 9. The contact making with armature 0 of this group is cross connected to conductor 00, the contact making with armature 1 is cross connected to conductor 01 and so on; the contact making with the last armature 9 being cross connected to conductor 09.

In the same way one side of the amplifier 1 is connected to the second group of armatures of relay 608 and their corresponding contacts are connected in numerical order to conductors 10 to 19. In a like manner the remaining amplifiers are each connected to a group of ten armatures of relay 608 and their corresponding contacts connected to the common conductors 20—99 so that the first digit of the numerical designation of the common conductor is the same as the number of the amplifier to which the armatures of the group are connected while the second corresponds to the numerical designation of the armature in the group with which the contact makes. That is, the 100 common conductors designated from 00 to 99 are wired in such a manner to the contacts of relay 608 that each amplifier is multipled to ten common conductors the first digit of whose numerical designation is the same as the number of the amplifier to which the particular group of armatures is connected.

The contacts of multi-contact relay 615 are likewise divided into ten groups of ten pairs of contacts each and one side of each amplifier is likewise connected to a separate group of ten armatures. The contacts making with these armatures, however, are now connected to those common conductors the second digit of whose numerical designation is the same as the number of the amplifier to which the cooperating armature group is connected. That is, the contact making with armature 0 to the group of armatures connected to amplifier 0 is connected to conductor 00; the contact making with armature 1 of the same group is connected to conductor 10; the contact making with the armature 2 is connected to conductor 20 and so on; the contact making with armature 9 being connected to conductor 90. In the same way the contacts making with the group of armatures connected to one side of amplifier 1 are connected to conductors 01, 11, 21, 31, 41, 51, 61, 71, 81 and 91 and likewise all contacts making with the armatures of the remaining groups are connected to those conductors whose last digit of their numerical designation is identical with the number of the amplifier to which its cooperating group of armatures is connected and whose first digit is identical with the number of the armature of the particular group to which the contact wired to the said conductor belongs.

The subscriber's numerical designation in the office where his line terminates is divided, for line announcing purposes, into two parts; the first consisting of the thousands and hundreds and the second of the tens and units. Conductor 137 of any line is multipled to that armature of relay 611 whose contact is connected to the one conductor of the 100 conductors whose numerical designation corresponds to the thousands and hundreds of the subscriber's number, while the said conductor is again multipled to that armature of relay 614 whose contact is connected to the one conductor of the 100 conductors whose numerical designation corresponds to the tens and units. The same thing is true of each conductor 137 from every subscriber's line in the office.

The manner in which the line announcer mechanism as well as the cooperating connecting circuit operates to give an oral pronouncement of the calling subscriber's line, will now

be described. Now the time at which announcements are made corresponds with the period in which the unshaded segment of the timing drum 601 is in contact with either brush 602 or 603. As will be evident from the operations described below, the circuit of relay 600 is not completed until relay 607 is operated, which event occurs only during periods of no announcement. Assuming, therefore, that relay 607 is operated the above traced circuit of relay 600 is completed to the winding of relay 600 by battery on the left contacts of relay 607, allowing the said relay to operate. Starting from the instant when the unshaded or conducting segment of the timing drum 601 makes contact with brush 602, an obvious circuit is closed for multi-contact relay 608 causing it to operate. Relay 608, at its right contacts, closes a circuit for relay 609 from ground on the right contacts of relay 608, back contacts of relay 610, winding of relay 609 to battery. Relay 609 operates and completes a circuit for relay 611 from ground on the back contacts of relay 612, back contacts of relay 613, left contacts of relay 609, winding of multi-contact relay 611, right contacts of relay 600, to battery on the outer contacts of relay 616. Relay 611 and those operated in parallel with it, close their respective contacts to the subscribers' lines test conductors. For the purposes of illustration it will be assumed that the exchange number of the subscriber 100 in Fig. 1 is 0091. Conductor 137 of subscriber 100, therefore, is extended to an armature of multi-contact relay 611 whose contact is cross connected to the common conductor designated 00 and to an armature of multi-contact relay 614 whose cooperating contact is cross connected to common conductor designated 91. When, therefore, multi-contact relays 611 and 608 operate as above described, a pronouncement circuit is closed from ground through the upper left hand winding of repeating coil 360 in the district selector, right lower contact of cam 335, left middle contacts of relay 317, brush 334 and cooperating terminal 333, conductor 117, left outer front contacts of relay 134, condenser 138, conductor 137, armature and cooperating contact of relay 611 to conductor 00, armature 0 and cooperating contact of relay 608 of the group of armatures connected to amplifier 0, through the amplifier 0 to battery. Conductor 116 of the line to the district selector is closed to ground on the left inner front contacts of relay 134, conductor 116, terminal 332, brush 331, right inner contacts of relay 317, winding of relay 330, cam 329 and left upper contact thereof, left lower winding of repeating coil 360 to battery. The announcement "0" is thus made over the circuit above described and repeated over the secondary of repeating coil 360 to the operator's telephone circuit at the recording position over the following path: Conductor 1527 connecting with one side of the operator's telephone circuit OTC, right inner contacts of relay 1519, upper normal contacts of key 1520, cord conductor 1530, conductor 1518, upper middle back contacts of relay 1509, conductor 386 and cooperating terminal, brush 357, left contacts of cam 358, right upper winding of repeating coil 360, condenser 387, right lower winding of repeating coil 360, upper contacts of cam 356, brush 355, conductor 385 and cooperating terminal, bottom middle back contacts of relay 1509, conductor 1517, cord conductor 1531, bottom inner normal contacts of key 1520, right middle contacts of relay 1519, conductor 1528 connecting with the other side of the operator's telephone circuit OTC. The operator hears the pronouncement "0" which, in the case under illustration, is the thousands digit of the calling subscriber's number.

The pronouncement is completed at the time brush 602 of the timing drum engages an insulating segment, at which time relay 608 releases. Relay 610 which up to this time was held in a released condition by the shunting ground from the right contacts of relay 608 to one side of its winding, now operates in series with relay 609 and locks in series therewith over the right contacts of relay 609 to ground on the front contacts of relay 607. When the timing drum has rotated to the position in which the conducting segment engages brush 603, an obvious circuit is closed to operate multi-contact relay 615. With the operation of this relay a circuit is again closed over the previously traced path on conductor 137, conductor 00, the 0 armature and cooperating contact of relay 615, through the amplifier to battery. The operator now hears the pronouncement of the second digit of the subscriber's number which, in the illustration assumed, is zero. The pronouncement is completed when the timing drum is rotated so that the commutator segment no longer engages brush 603, at which time relay 615 releases and disconnects the announcing drums from the common conductors. When the timing drum advances to where its conducting segment again engages brush 602, a previously described circuit is closed for operating relay 608 and the closure of the right contacts of this relay closes a circuit for relay 613 from ground on the right contacts of relay 608, front contacts of relay 610, back contacts of relay 617, winding of relay 613 to battery. Relay 613 operates in this circuit, opens the circuit of relay 611, causing this relay to release, and closes, over its left front contacts, the following circuit for operating multi-contact relay 614: ground on the contacts of relay 612, left front contacts of relay 613, winding of multi-contact relay 614, right contacts of relay 600, right outer contacts of relay 616, to battery. Relay 608 connects the amplifiers to the com-

mon conductors and relay 614, in operating, likewise connects all of the test conductors of subscriber's lines to the common conductors. Remembering that the tens numerical designation of the calling subscriber's line is 9, circuits are closed over previously traced paths from the operator's telephone circuit OTC to conductor 137, armature and cooperating contact of relay 614 connected to conductor 91, armature 1 and cooperating contact of relay 608 in that group of ten armatures which are connected to amplifier 9, through the amplifier to battery. The operator now hears the pronouncement 9 which is the tens digit of the calling subscriber's number.

When the conducting segment of the timing drum is disengaged from brush 602, relay 608 releases and disconnects the amplifier 9 from the common conductors. The release of relay 608 also removes the short circuit from around the winding of relay 617, so that this relay now operates and locks in series with the relay 613 to ground on the right contacts of relay 607. Relay 614, however, remains operated.

When the timing drum conducting segment again engages brush 603, multi-contact relay 615 again operates as already described and the amplifiers are again connected to the common conductors and to the subscribers' lines test conductors through multi-contact relay 614 and those in parallel with it. A circuit is now closed to conductor 137 over the armature and cooperating contacts of relay 614, above described, armature No. 9 and cooperating contact in that group of armatures of relay 615 which is connected to amplifier 1, through the amplifier 1 to battery. The operator hears the oral pronouncement 1 of the units digit of the calling subscriber's number.

When brush 603 is disengaged from the conducting segment of the timing drum, relay 615 releases, thereby disconnecting the amplifiers from the common conductors and hence from the test conductors of the subscriber's lines. When the conducting segment of the timing drum again makes with brush 602, relay 608 operates which, over its right contacts closes a circuit for relay 612 from battery through the winding of relay 612, front contacts of relay 617, front contacts of relay 610 to ground on the right front contacts of relay 608. Relay 612 operates and the consequent breaking of its back contacts causes the release of multi-contact relay 614, thereby disconnecting the test conductors of the subscriber's lines from the common conductors. During this period, therefore, due to the released condition of both multi-contact relays 614 and 611 and those in multiple with them, no announcement is transmitted to the recording operator. When the commutator segment disengages brush 602, relay 608 releases. The shunt around relay 616 is thereby removed and relay 616 operates and locks in series with the winding of relay 612 to ground on the right contacts of relay 607 by way of the front contacts of relay 612. Relay 616 closes an obvious circuit for relay 607 which, in operating, unlocks relays 612, 616, 613, 617, 609 and 610. Relay 616 likewise unlocks relay 600 which releases when relay 607 releases.

It is during this period of no announcement that relay 607 is operated and consequently furnishes operating battery for relay 600. This is done in order to prevent a connection being set up to the operator's telephone circuit from the call announcer mechanism in the midst of a pronouncement. When relay 616 releases, relay 607 likewise releases as will, also, relay 600 and if, prior to its release, ground is still connected to conductor 137, relay 600 will reoperate and the above cycle of operations is repeated thereby giving the operator another pronouncement cycle of the calling subscriber's number. This pronouncement is repeated for every cycle of operation as described above, there being two pulsing intervals of the timing drum between each pronouncement.

From the foregoing description of the line announcer operation, it is evident that simultaneous pronouncements of different numbers can be given over different subscriber's line-test conductors 137 and hence over associated established trunking connections to cooperating independent operators' positions. When either relay 611, or its multipled relays, and relay 608 are operated, the test conductors of the subscriber's lines are connected to the line announcer mechanism and since each armature and cooperating contact thereof is connected to one of the common conductors 00 to 99, a separate circuit to each amplifier and associated announcing drum will be simultaneously closed to test conductors associated with a calling line to which a connection has been established at a recording operator's position and to which ground has been connected by the operation of relay 134 of the subscriber's line circuit.

It will be observed also that the operation of relay 134 cuts off the calling subscriber's telephone set from the line and it follows that the pronouncement of the number over the established connection will not be heard by him. Should it become desirable, however, to permit the subscriber to listen to a pronouncement of his own line number, relay 134 can be dispensed with, conductor 137 connected permanently to conductor 117, while conductor 139 can be made to connect directly to conductor 114 by connecting conductor 139 to the right front contacts of relay 132.

The operator, as soon as she has understood the announcement, is satisfied with the visual

designation of the number of the desired connection and has made appropriate ticket records of both, operates key 1520. Relays 1519, 1536 and 1900 release. Relay 1519 disconnects the operator's telephone circuit from the trunk and removes the short circuit around the left winding of relay 1513. The release of relay 1900 removes locking ground from conductors 1933, 1927, and 1943 and 1944 thereby releasing all the relays of the call indicator circuit and extinguishing the lamp indication of the called office and subscriber's number therein. The increase in resistance in the circuit previously traced and including relays 1513, 1504 and 1505, causes relay 1504 to release. The opening of the ground at the contacts of relay 1504 causes relay 1502 to operate from ground on the contacts of relay 1505, winding of relay 1502, right contacts and winding of relay 1503 to battery. Relay 1502 operates relay 1509. Relay 1509 connects the trunk conductors 385 and 386 to the left windings of the repeating coil 1529.

A circuit is now closed from ground through the left winding of relay 1507, left upper winding of repeating coil 1529, top inner contacts of relay 1509, conductor 386 and thence over a previously described path in the district selector including the right upper winding of repeating coil 360, bottom contacts of cam 348, winding of relay 361, right lower winding of repeating coil 360, upper contacts of cam 356, the previously described path including conductor 385, bottom inner contacts of relay 1509, left lower winding of repeating coil 1529, right winding of relay 1507, to battery. Relay 1507 operates and the direction of current in the above circuit is such as to operate polarized relay 361 in the district selector. Relay 1507 closes a circuit from battery through resistance 1535, contacts of relay 1507, top middle front contacts of relay 1509, conductor 1518, cord conductor 1530, top front contacts of key 1520, lamp 1533 to ground. Lamp 1533 lights and indicates to the recording operator that the calling subscriber is still on the line. Relay 361, in operating closes a circuit for relay 314 from ground through the left contacts of cam 350, front contacts of relay 361, left lower and right upper contacts of cam 347, right winding of relay 314 to battery. Relay 314 operates and closes a circuit to the winding of sequence switch magnet 300 from battery through the winding of the said magnet, cam 328 and left lower contact thereof, right outer front contacts of relay 314, lower contacts and cam 339 to ground. Sequence switch 300 is advanced to position 16 and, as it leaves position 15, ground to conductor 114 over the upper contact of cam 318 and brush 381 is broken at the upper contact of cam 318. As the switch leaves position 15¼ the circuit of relay 361 is opened at the right lower contact of cam 348, causing it to release but relay 314 is now locked under the control of the tandem trunk over a circuit from ground through resistance 1539, right contacts of relay 1510, conductor 383 and associated terminal 383, brush 349, right contacts of cam 350, right inner front contacts of relay 314, left winding of relay 314 to battery. Relay 134 releases, opens the circuit of relay 600 which releases if there are no other calls waiting, and reconnects the calling subscriber to the trunk conductors 116 and 117. Relay 1507 now holds over the loop to the subscriber's line formed by connecting the trunk loop and subscriber's loop at cam 335 and right upper contact thereof and at cam 329 and right upper contact.

Meanwhile, at the tandem position, the tandem operator, upon noting the display of the terminating office code and number therein of the called subscriber on the lamps of the indicator, picks up the plug 1630 and tests the sleeve of the trunk jack 1627 of the assigned trunk and then inserts the plug in the jack. Upon the insertion of the plug in the jack, sleeve relay 1616 is energized over conductor 1628 and the sleeve contact of the plug and jack and, at its right outer back contacts, disconnects the tip of the plug 1630 from the test winding of her head set, not shown, and connects the tip of the plug over conductor 1635 to conductor 1636. Relay 1616, at its right inner contacts opens the holding circuit extending through the winding of relay 1612 and 1700 whereupon these relays deenergize, relay 1700 disconnecting ground potential from the holding conductors 1733, 1727, 1743 and 1744 for releasing all energized relays of the relay call indicator. At its left outer contacts relay 1616 opens the circuit of relay 1609 for disconnecting lamp 1610 from the circuit extending through the interrupter 1625, the signal on lamp 1610 thereupon being changed from a flashing signal, indicating registration upon the relay call indicator, to a dark signal indicating completion of such registration.

With the plug 1630 in jack 1627 of the assigned trunk 1634–1640 and sleeve relay 1616 energized, a circuit is now established for relay 1631 which may be traced from battery through the right winding of relay 1632, inner contacts of relay 1633, trunk conductor 1634, tip contacts of jack 1627 and plug 1630, conductors 1635, 1636, 1637 and 1638, winding of relay 1631, conductor 1639, ring contacts of plug 1630 and jack 1627, conductor 1640, outer contacts of relay 1633 to ground through the left winding of relay 1632. Relay 1631 operates and establishes a circuit for relay 1641 extending from battery through the winding of relay 1641, front contacts of relay 1631, conductor 1642, left inner contacts of relay 1616, conductor 1643 to ground on the right outer contacts of relay 1626. Relay

1641, upon energizing, locks through its right contacts to ground on conductor 1643 independently of the armature contacts of relay 1631. The operator at the terminating office responds to the seizure of the assigned trunk and in response to the transmission of the line number, indicated over a call wire or by any other suitable means by the tandem operator, inserts plug 1644 in which the trunk 1634–1640 terminates, in the jack 1645 of the indicated line and proceeds to call the party in the well known manner. In response to the insertion of the plug in the jack, sleeve relay 1646 is energized over the sleeve conductor of the cord and establishes an obvious circuit for the calling supervisory lamp 1647. Upon the response of the called subscriber 1650, supervisory relay 1648 is energized in the well known manner over the called subscriber's line loop, opening at its right contacts the circuit of sleeve relay 1646 to extinguish lamp 1647 and closing at its left contacts the circuit of relay 1633. Relay 1633 operates and disconnects bridged battery from conductors 1634 and 1640 of the trunk circuit whereupon relay 1631 at the tandem operator's trunk circuit releases. With relay 1641 operated and relay 1631 released, a circuit is now established for reversing relay 1601 which may be traced from battery through the winding of relay 1601, left contacts of relay 1641, left back contacts of relay 1631, left inner contacts of relay 1616, to ground on the right front contacts of relay 1626. The energization of reversing relay 1601 reverses the connection of the terminals of the battery to the trunk conductors 1515 and 1516, thereby causing the current flowing over the trunk circuit through the right-hand windings of repeating coil 1529 and including the winding of relay 1508, to operate relay 1508. Relay 1508, on operating closes a circuit from battery through resistance 1534, contacts of relay 1508, bottom middle front contacts of relay 1509, conductor 1517, cord conductor 1531, bottom inner make contacts of key 1520, lamp 1532 to ground. Lamp 1532 lights as an indication that the called subscriber has answered and due to the fact that lamp 1533 is likewise lighted over the circuit controlled by the contacts of relay 1507 operating over the district bridge, the operator is apprised that the two subscribers are in direct communication and may time the call from the instant lamp 1532 is lighted.

Upon the termination of the conversation, the subscribers restore their receivers to their switch hooks. At the terminating operator's position relay 1648 deenergizes, reestablishing the circuit of sleeve relay 1646 to establish the circuit of lamp 1647 and to reconnect battery and ground through the windings of relay 1632 to conductors 1634 and 1640 of the trunk circuit extending to the tandem office. Relay 1631 thereupon reoperates and relay 1601 releases, causing a reversal of current through the established trunk, the release of relay 1508 and the consequent extinguishment of lamp 1532. The recording operator notes the extinguished lamp and completes the timing of the call. The operator at the terminating office noting the illumination of lamp 1647 withdraws the plug 1644 from the jack 1645 thereby restoring the apparatus at her position to normal condition.

When the calling subscriber restores his receiver lamp 1533 is extinguished due to the release of relay 1507. The recording operator now disconnects the cord from the trunk and restores key 1520. Relay 1505 releases in consequence thereby releasing relays 1510, 1503, 1502 and 1509. The release of relay 1510 removes ground from holding conductor 383 to the sleeve of the district. Relay 314 releases in consequence and restores the district selector in the well known manner.

What is claimed is:

1. In a telephone system, a plurality of telephone lines each having an arbitrary designation, an operator's position, means for extending a calling telephone line to said operator's position, means responsive to said extension for indicating the designation of a desired connection, and means also responsive to said extension for indicating the arbitrary designation of said calling telephone line.

2. In a telephone system, a plurality of telephone lines each having an arbitrary designation, an operator's position, means for extending a calling telephone line to said operator's position, means responsive to said extension for visibly indicating the designation of a desired connection, and means also responsive to said connection for audibly indicating the arbitrary designation of said calling telephone line.

3. In a telephone system, a plurality of telephone lines each having an arbitrary designation, an operator's position, means for extending a calling telephone line to said operator's position, means for recording and transmitting the designation of a desired connection, means in said operator's position responsive to said extension for receiving and displaying the designation of said desired connection, and means also responsive to said extension for audibly indicating the arbitrary designation of said calling telephone line.

4. In a telephone exchange system, a plurality of telephone lines each having an arbitrary designation, line extending switches, means for extending said calling line through said line extending switches to said operator's position, a register sender, means for connecting said register sender to said calling line, the said register sender being capable of recording and transmitting over said line extending switches the designation of a desired connection, a line indicating device at said

operator's position capable of receiving and displaying the designation of said desired connection, a line announcer capable of operable association with said calling line, and means controlled by said line announcer and responsive to the reception of the designation of said desired connection at said operator's position for audibly indicating the arbitrary designation of said calling telephone line at said operator's position.

5. In a telephone system, a plurality of lines each having an arbitrary designation, line extending switches, a register sender capable of receiving and transmitting designations of desired connections, an operator's position, an operator's telephone circuit at said position, means for extending said calling line over said line extending switches to said operator's position, means for connecting said register sender to said calling line, a line announcer capable of operable association with said calling line, means at said operator's position for receiving and displaying the designation of said desired connection, and means controlled by said line announcer and responsive to the reception of the designation of said desired connection at said operator's position for audibly transmitting to said operator's telephone circuit an announcement of the arbitrary designation of said calling line.

6. In a telephone exchange system, a calling office, a tandem office, a calling line in said calling office having an arbitrary designation, an operator's position in said calling office, a call indicator circuit in said operator's position, an operator's position at said tandem office, a call indicator circuit at said tandem operator's position, a trunk line connecting said calling line with said tandem office and extending to said operator's position at said calling office, said trunk line terminating at said tandem operator's position and having a call signal thereat, a register sender at said calling office capable of receiving the designation of a desired connection and transmitting said designation over said trunk line by coded impulses, means for connecting said register sender to said calling line, a line announcer at said calling office, means responsive to a connection of said trunk line with the said operator's position at said calling office for operating said call signal of said trunk line at said tandem position, means responsive to an operation at said tandem position for operating said register sender to transmit the coded impulses of the designation of said desired connection over said trunk line and for registering said impulses in said call indicator circuit at said operator's position at said calling office and at said operator's position at said tandem office respectively, means in said operator's position at said calling office responsive to the termination of the transmission of said impulses of said desired connection designation for operatively connecting said call announcer to said calling line and means responsive to the operation of said line announcer for audibly announcing said arbitrary designation of said calling line at said operator's position at said calling office.

7. In a telephone system, a calling line having an arbitrary designation, an operator's position, means whereby said line is operably associated with said position, a register sender capable of recording the designation of a wanted connection and of transmitting said designation in the form of coded impulses over said means, an indicating device at said operator's position arranged to be operated in response to said impulses, a line announcer adapted to reproduce verbal announcements at repeated intervals, means for operably associating said line announcer with said calling line, and means responsive to the operation of the said indicating device for operating said line announcer for audibly announcing the arbitrary designation of said calling line at stated intervals.

8. In a telephone exchange system, line finder and line extending switches, an operator's position, a line announcer circuit, a calling subscriber's line circuit having a conductor of the said line circuit extending to said line announcer, means for extending said calling subscriber's line over said line finder and line extending switches to said operator's position, a register sender capable of recording the designation of a wanted connection and of transmitting said designation in the form of coded impulses over said line extending switches, an indicating device at said operator's position arranged to be operated in response to said impulses, means responsive to the termination of the transmission of said impulses for starting the operation of said line announcer and means for operating said line announcer to audibly announce the arbitrary designation of said calling line over said conductor.

9. In a telephone system, a plurality of telephone lines each having an arbitrary designation, a plurality of operators' positions, means for extending a calling telephone line to each of said operator's positions, means responsive to each of said extensions for indicating at each of said operators' positions the designation of a desired connection and means common to all of said telephone lines and responsive to each of said extensions for indicating the arbitrary designation of each of said calling lines extended to each of said operators' positions.

10. In a telephone system, a first office, a plurality of telephone lines in said first office, each of said lines having an arbitrary designation, an operator's position at said first office, a second office, an operator's position at said second office, a called subscriber's line

having an arbitrary designation, a trunk line connecting said first office, said operator's position in said first office, and said operator's position in said second office, means including said trunk line for extending a calling telephone line to said operator's position at said first office and to said operator's position at said second office, means responsive to said extension for indicating at both of said operator's positions the designation of said called subscriber's line, means at said operator's position at said first office responsive to said indication for indicating the arbitrary designation of said calling line, means including the said trunk line at said operator's position at said second office for extending the said trunk connection to said called subscriber's line and means at said operator's position at said first office responsive to the answering of the said called subscriber for supervising the conversation period over said established connection.

11. In a telephone system, a first office, a plurality of telephone lines in said first office, each of said lines having an arbitrary designation, an operator's position at said first office, a second office, automatic switches in said second office, a trunk line connecting said first office with said operator's position at said first office and with said automatic switches in said second office, a called subscriber's line having an arbitrary designation, means including the said trunk line for extending a calling telephone line to said operator's position at said first office and to said automatic switches at said second office, means responsive to said extension for transmitting a series of impulses for indicating at said operator's position the designation of said called subscriber's line, means at said operator's position at said first office responsive to said indication for indicating the arbitrary designation of said calling line, means responsive to said series of impulses transmitted from said first office for operating said automatic switches in said second office for extending said calling subscriber's line to said called subscriber's line, and means at said operator's position at said first office responsive to the answering of the said called subscriber for supervising the conversation period over the said established connection.

12. In a telephone system, a first office, a plurality of telephone lines in said first office, each of said telephone lines having an arbitrary designation, a second office, an operator's position in said second office, means for extending a calling line in said first office to said operator's position in said second office, means responsive to said extension for indicating the designation of a desired connection at said operator's positions, and means responsive to said extension for indicating the arbitrary designation of said calling line which has been extended to the operator's position of said first office.

13. In a telephone system, a plurality of telephone lines each having an arbitrary designation, an operator's position, a calling and called line, means for extending said calling line to said operator's position, means responsive to said extension for indicating the designation of a desired connection at said operator's position, means responsive to the indication of said designation for extending said calling line to said called line, means also responsive to said indication for indicating the arbitrary designation of said calling line at said operator's position, and means at said operator's position responsive to said called line for checking the conversation time of the established connection.

14. In a telephone system, a calling telephone line having an arbitrary designation, an identifying conductor for said calling line, a receiving station, means for connecting said telephone line with said receiving station, a line announcing mechanism and a line announcing control circuit comprising a plurality of switching device for operatively associating said identifying conductor with said line announcing mechanism, whereby an oral pronouncement of said arbitrary designation is transmitted by said line announcing mechanism over said identifying conductor to said receiving station.

15. In a telephone system, a plurality of calling telephone lines each having an arbitrary designation, an identifying conductor for each line, a plurality of receiving stations, means for connecting said telephone lines individually to said receiving stations, a line announcing mechanism and a line announcing control circuit, said control circuit comprising a plurality of switching devices for operatively associating said identifying conductors with said line announcing mechanism whereby oral pronouncements of the arbitrary designations of the calling line are transmitted over the identifying conductors of calling lines to the particular receiving stations connected to such lines.

16. In a telephone system, a calling telephone line having an arbitrary designation, an identifying conductor for said calling line, a line announcing mechanism, a line announcing control circuit comprising a first plurality of switching devices and a second plurality of switching devices, the said identifying conductor being connected to said first plurality of switching devices, a common group of conductors connected to the said first and to said second switching devices whereby, upon the connection of said line announcing control circuit to said calling line, successive pronouncement circuits are established from said line announcing mechanism to said identifying conductor over said

first and second plurality of switching devices and over one of said common conductors.

17. In a telephone system, a plurality of calling telephone lines each having an arbitrary designation, an identifying conductor for each of said calling lines, a line announcing mechanism, a line announcing control circuit comprising a first plurality of switching devices and a second plurality of switching devices, said identifying conductors being connected to said first plurality of switching devices, a common group of conductors connected to the said first and to said second switching devices whereby upon the connection of said line announcing control circuit to said plurality of calling lines successive pronouncement circuits are established from said line announcing mechanism to each of said identifying conductors over said first and second plurality of switching devices and over various ones of said common conductors.

18. In a telephone system, a plurality of telephone lines each having an arbitrary designation, an operator's position, means for extending a calling telephone line to said operator's position, means responsive to said extension for indicating the designation of a desired connection, means also responsive to said extension for audibly indicating the arbitrary designation of said calling line at said operator's position, and cooperative means also responsive to said extension for audibly indicating the arbitrary designation of said calling line to said calling subscriber.

19. In a telephone exchange system, a register sender capable of generating a series of coded impulses, a plurality of receiving stations, means for connecting said register sender with each of said plurality of receiving stations, means in said sender for transmitting said coded impulses over said connecting means, and means at each one of said plurality of receiving stations responsive to said impulses.

20. In a telephone exchange system, a register sender capable of generating a series of coded impulses, a receiving station, means for connecting said register sender with said receiving station, means in said register sender for transmitting said coded impulses over said connecting means, thermionic means at said receiving station responsive to said impulses and means at said receiving station responsive to said last mentioned means for registering said impulses.

21. In a telephone exchange system, a register sender capable of generating a series of coded impulses, a plurality of receiving stations, means for connecting said register sender to each of said plurality of receiving stations, means in said register for transmitting said coded impulses over said connecting means, thermionic devices at each of said plurality of receiving stations responsive to said impulses and means at each of said plurality of receiving stations responsive to the thermionic devices thereat for registering said impulses.

22. In a telephone exchange system, a register sender capable of generating a series of coded impulses, a plurality of receiving stations, means for connecting said register sender to each of said plurality of receiving stations, means in said register sender for transmitting said coded impulses over said connecting means, thermionic devices at one or more of said plurality of receiving stations responsive to said impulses, relay responsive devices at other of said plurality of receiving stations responsive to said impulses, and means at each of said plurality of receiving stations responsive respectively to said thermionic devices or said relay devices for registering said impulses.

In testimony whereof, I have signed my name to this specification this 10th day of April, 1931.

LINUS E. KITTREDGE.