July 28, 1931. W. W. CARPENTER ET AL 1,816,634

TELEPHONE EXCHANGE SYSTEM

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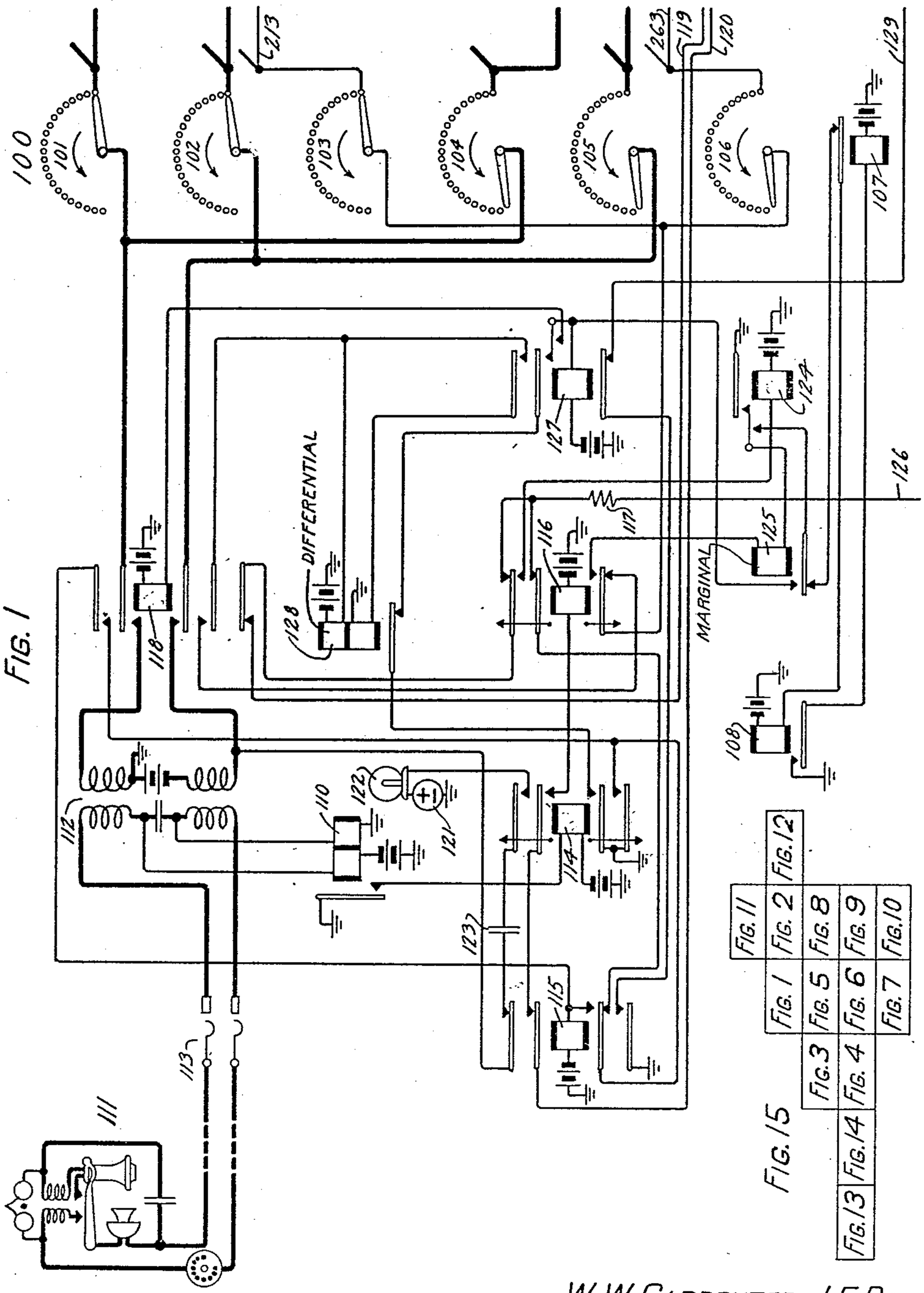

FIG. 1

FIG. 15

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TELEPHONE EXCHANGE SYSTEM

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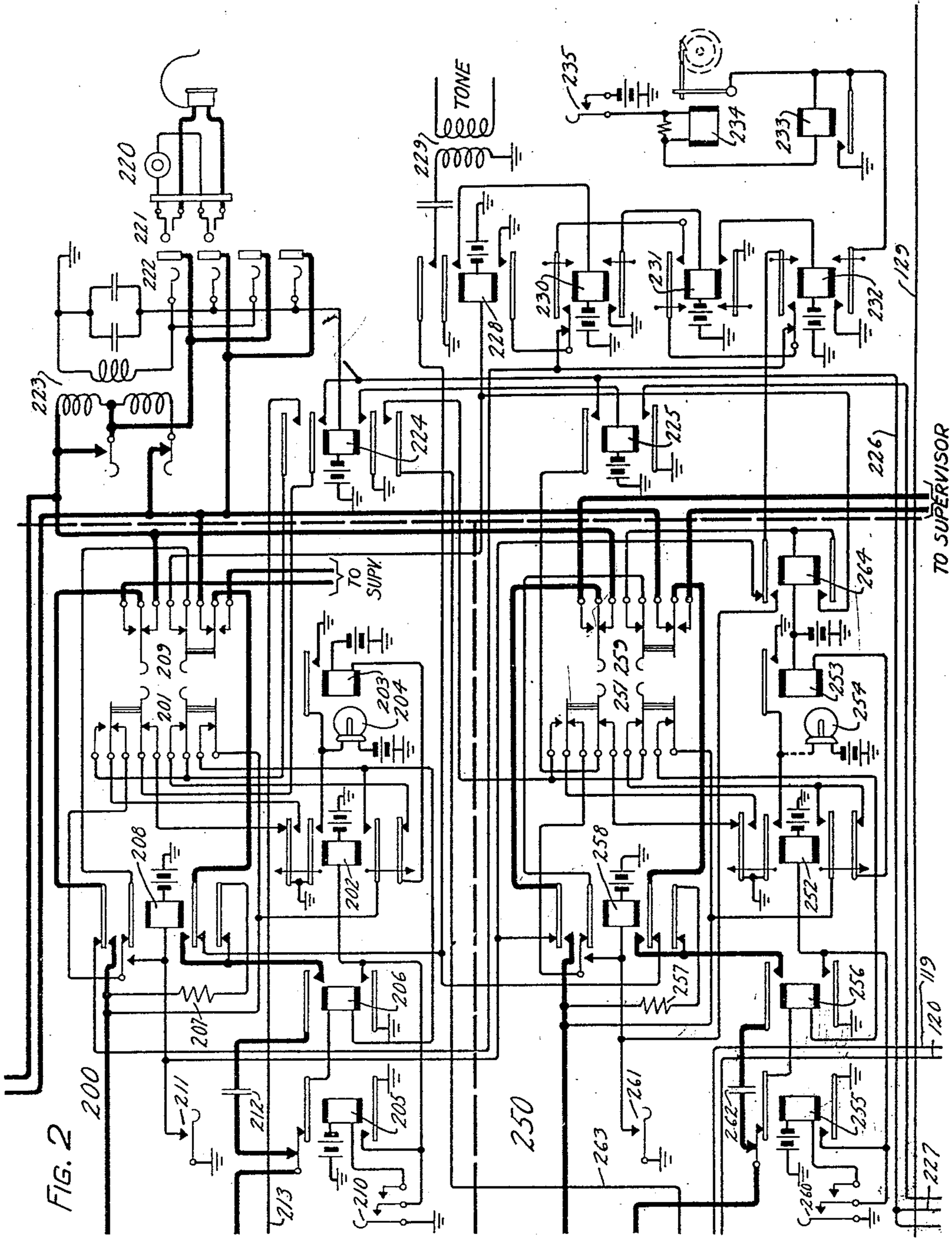

FIG. 2

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TELEPHONE EXCHANGE SYSTEM

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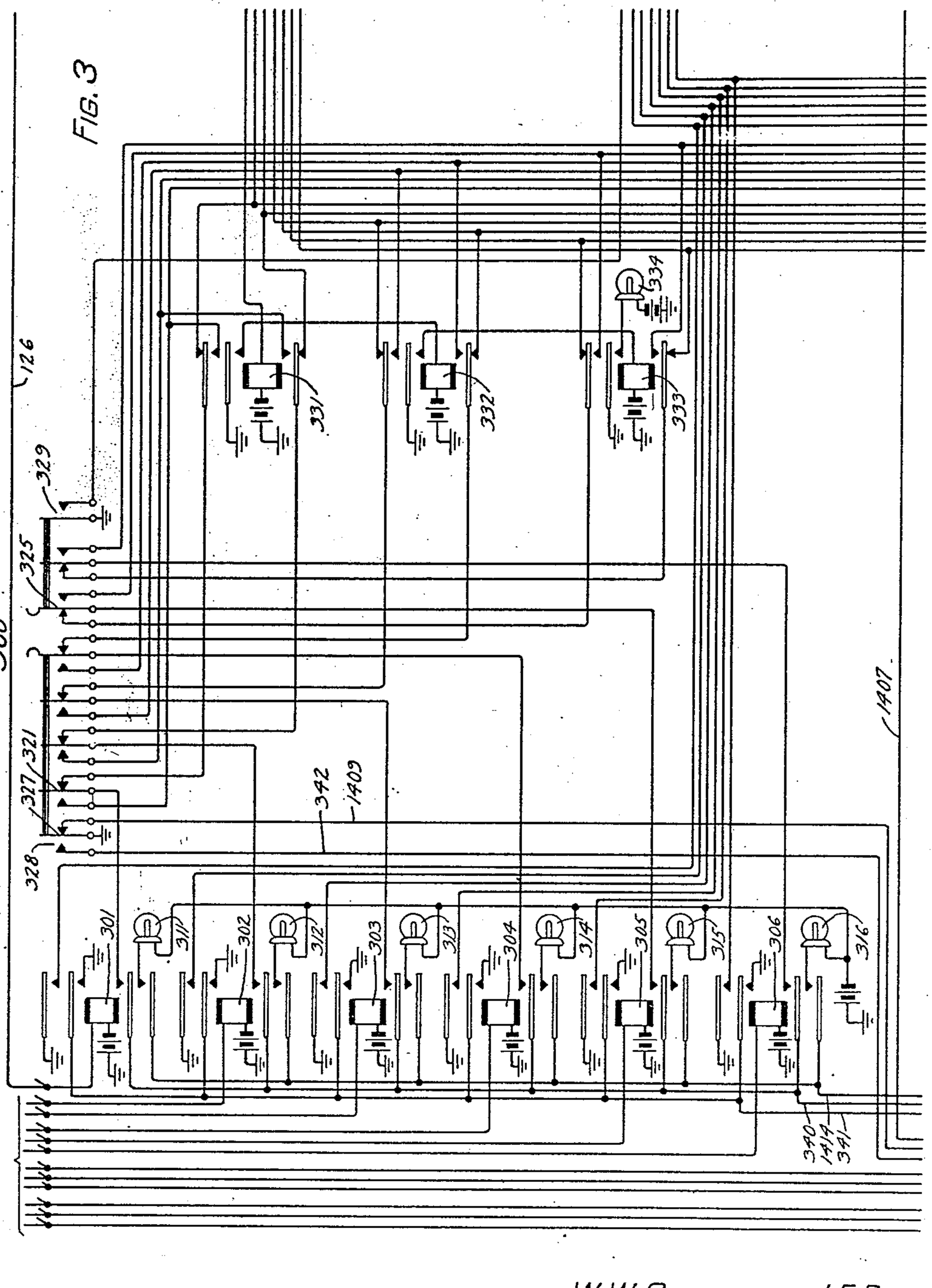

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TELEPHONE EXCHANGE SYSTEM

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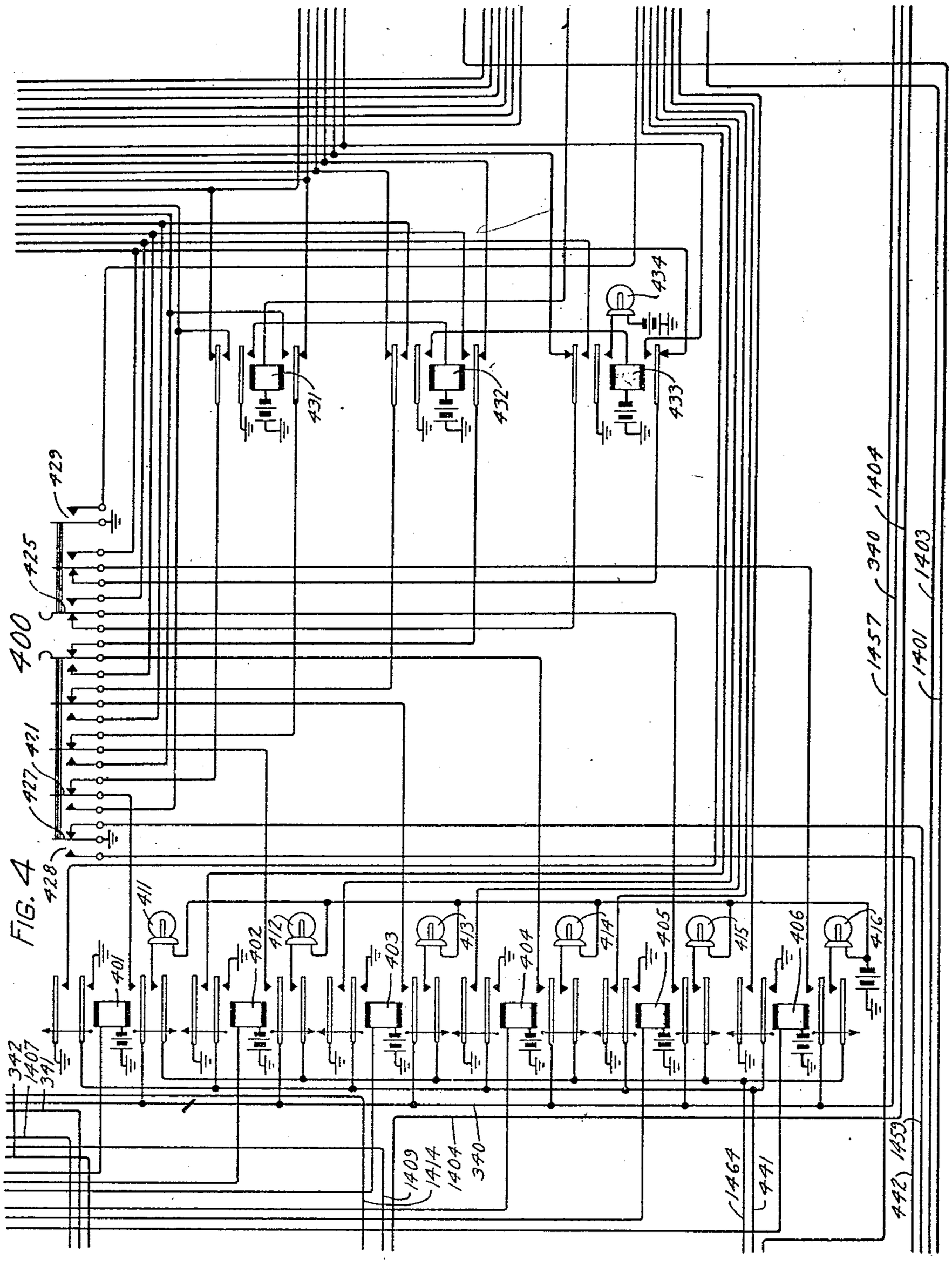

FIG. 4

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TELEPHONE EXCHANGE SYSTEM

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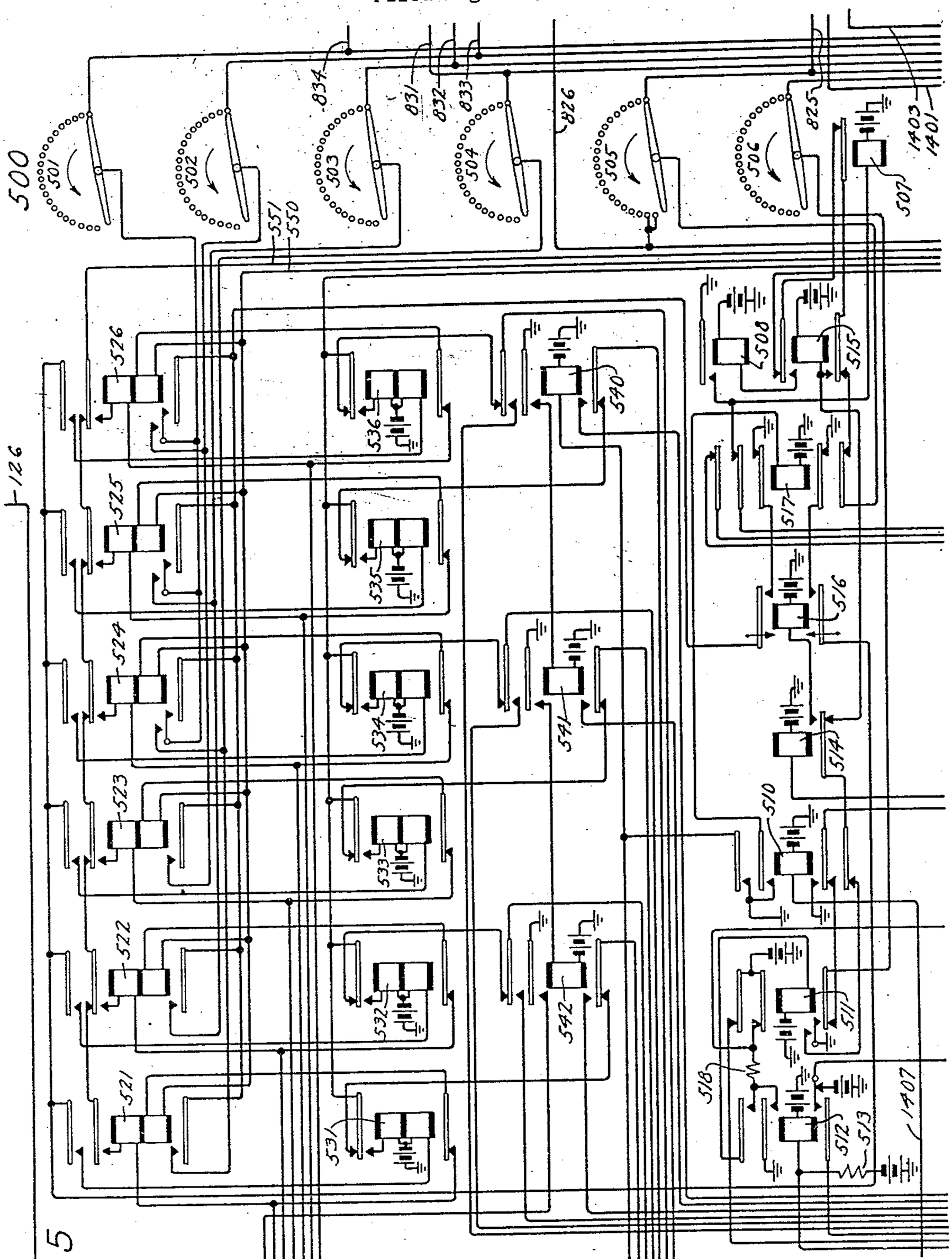

FIG. 5

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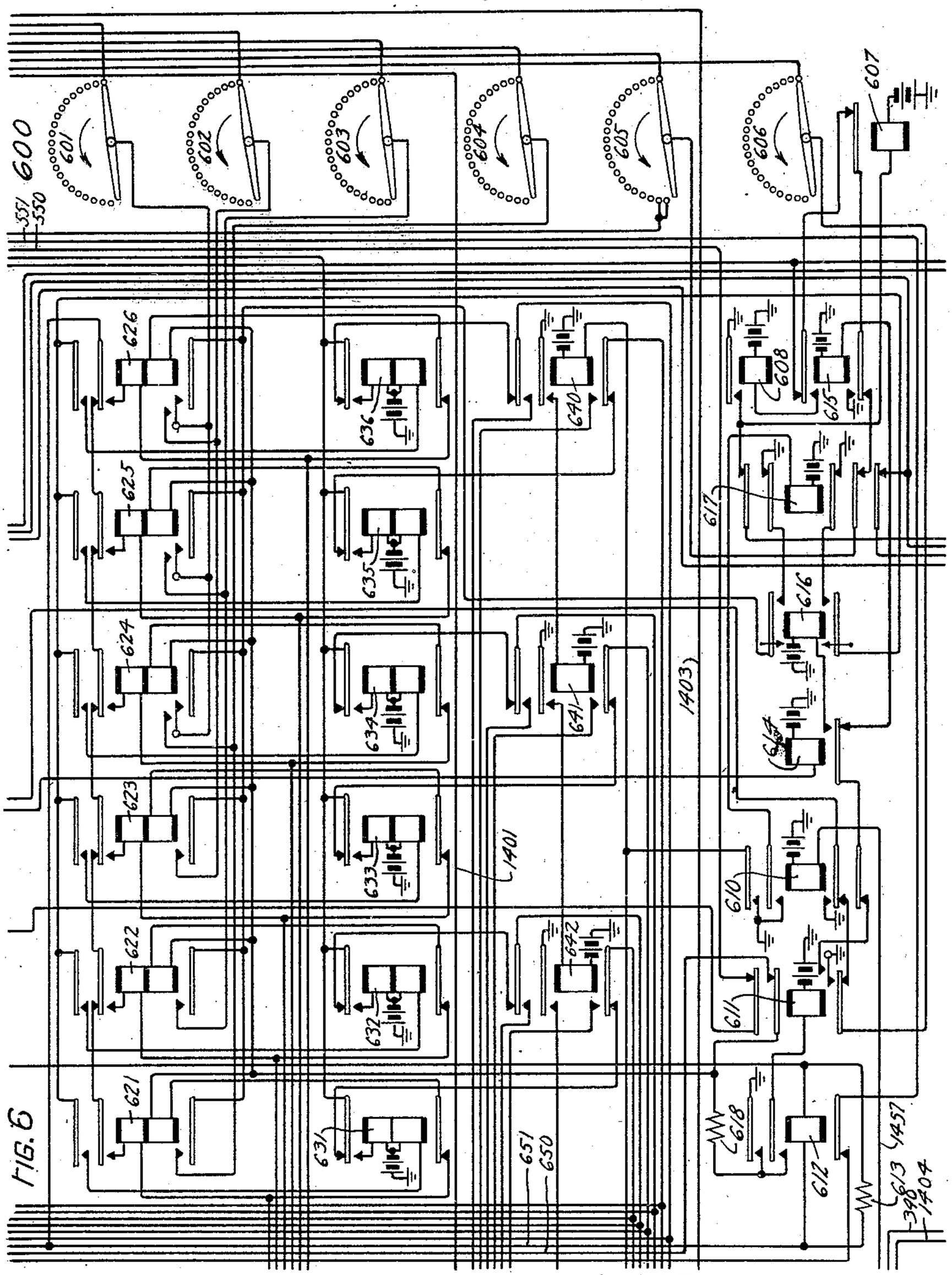

FIG. 6

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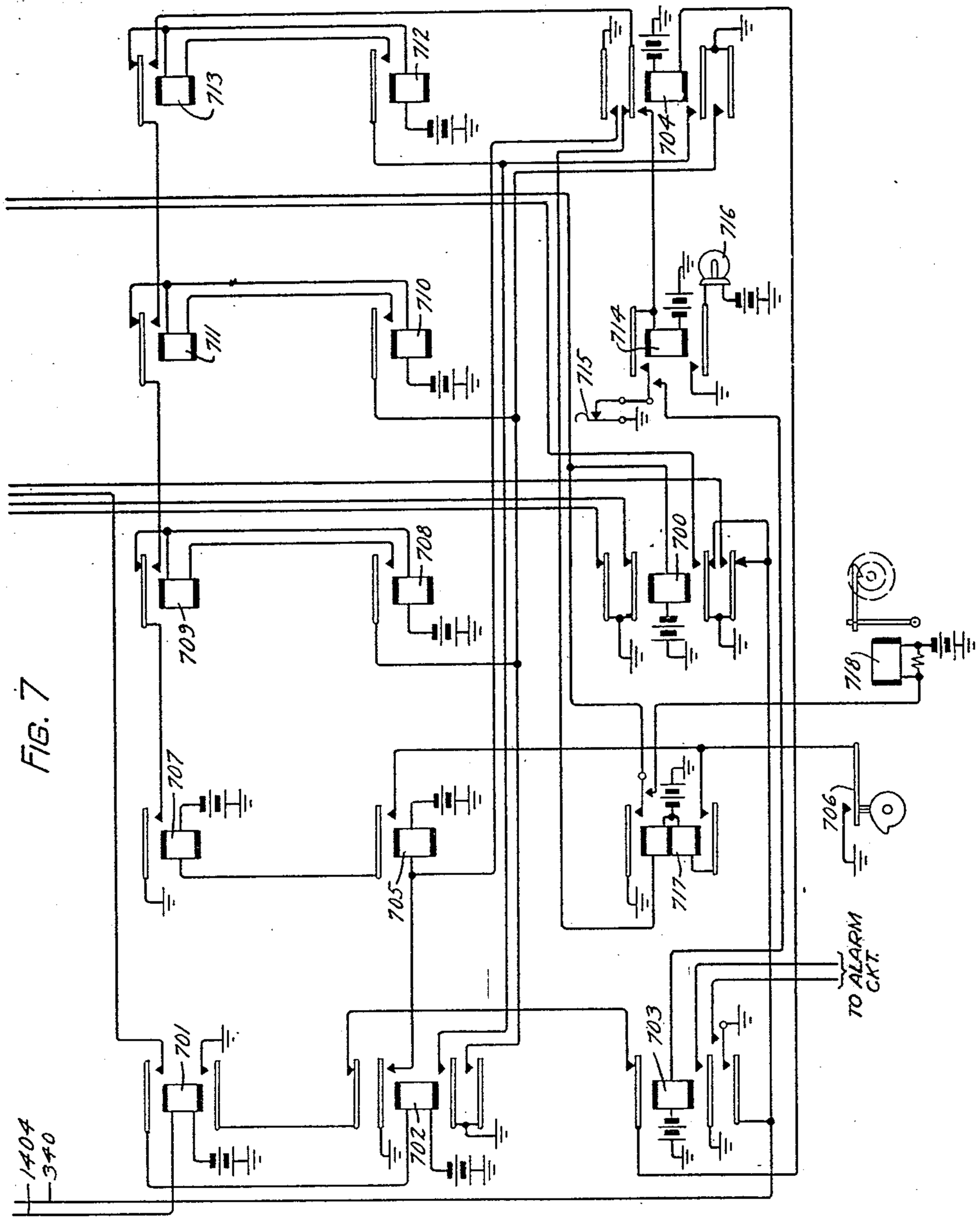

FIG. 7

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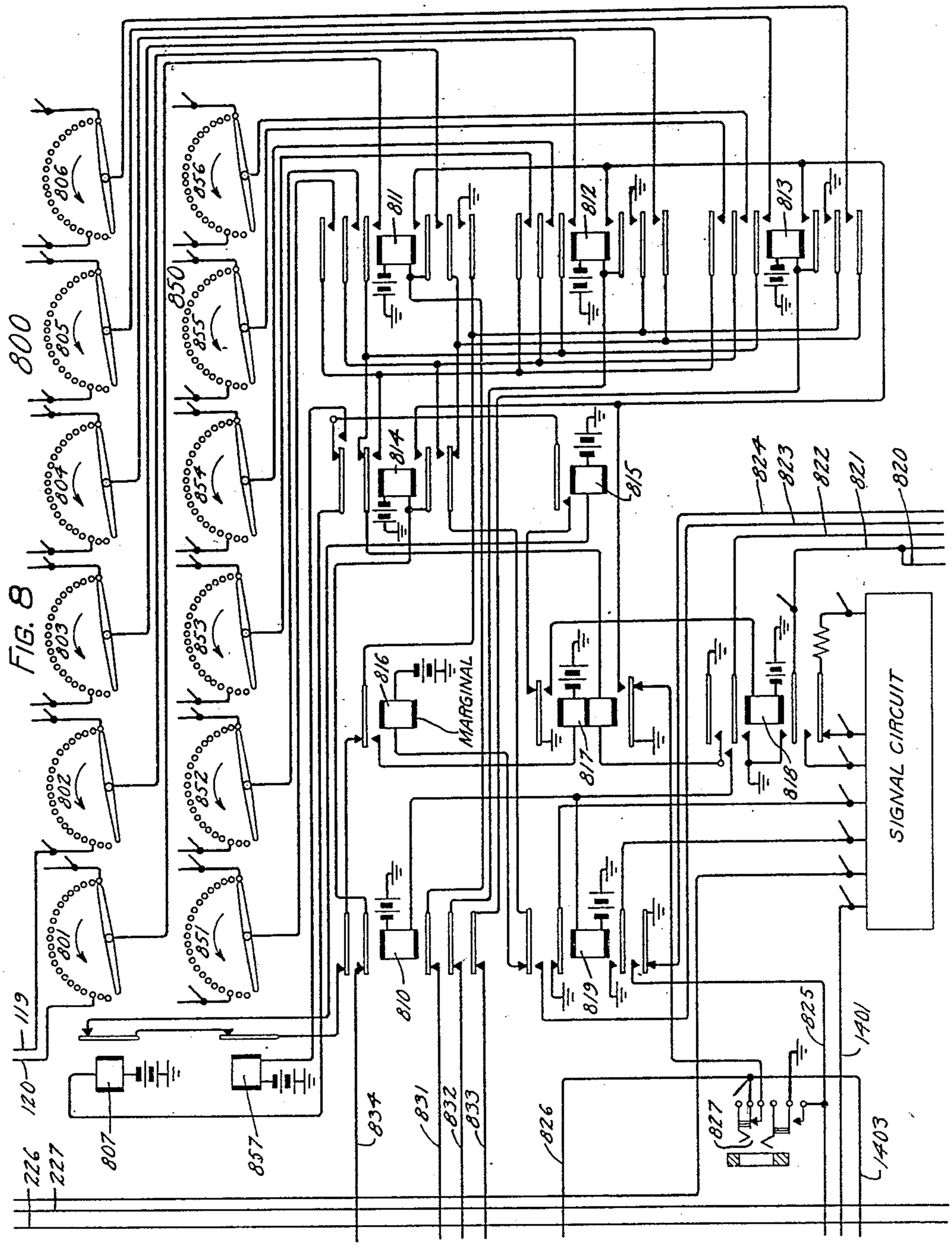

FIG. 8

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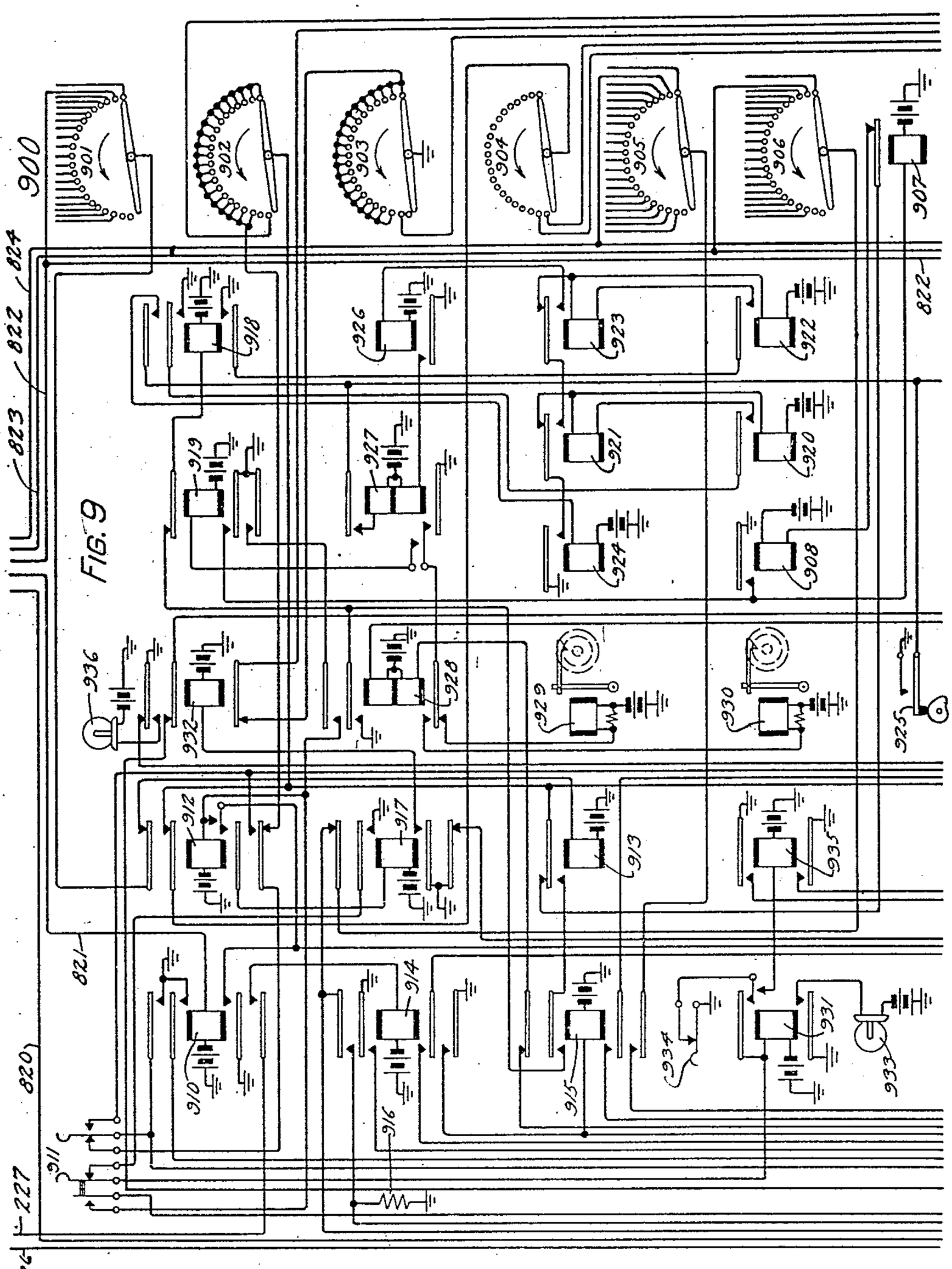

FIG. 9

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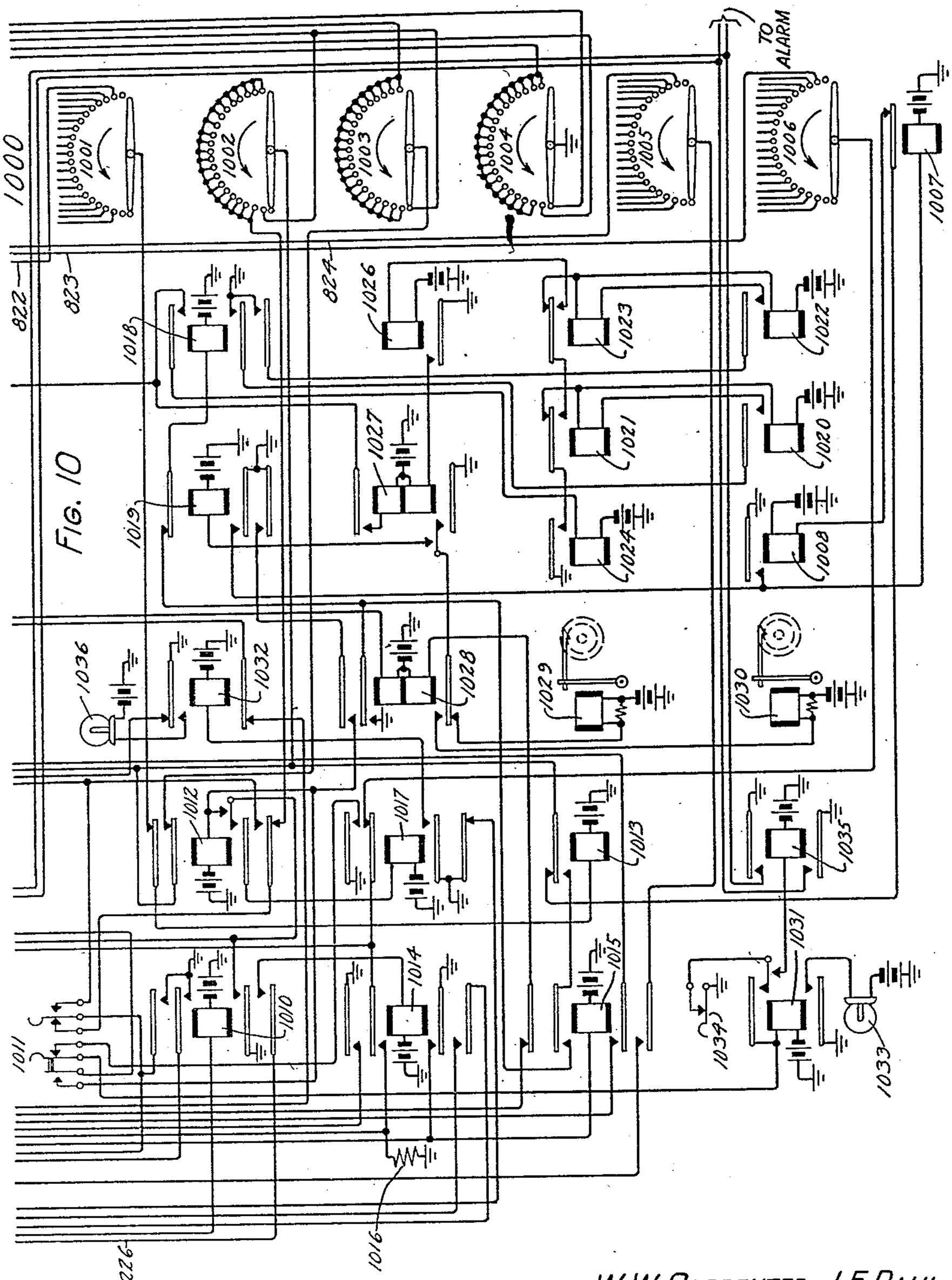

FIG. 10

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TELEPHONE EXCHANGE SYSTEM

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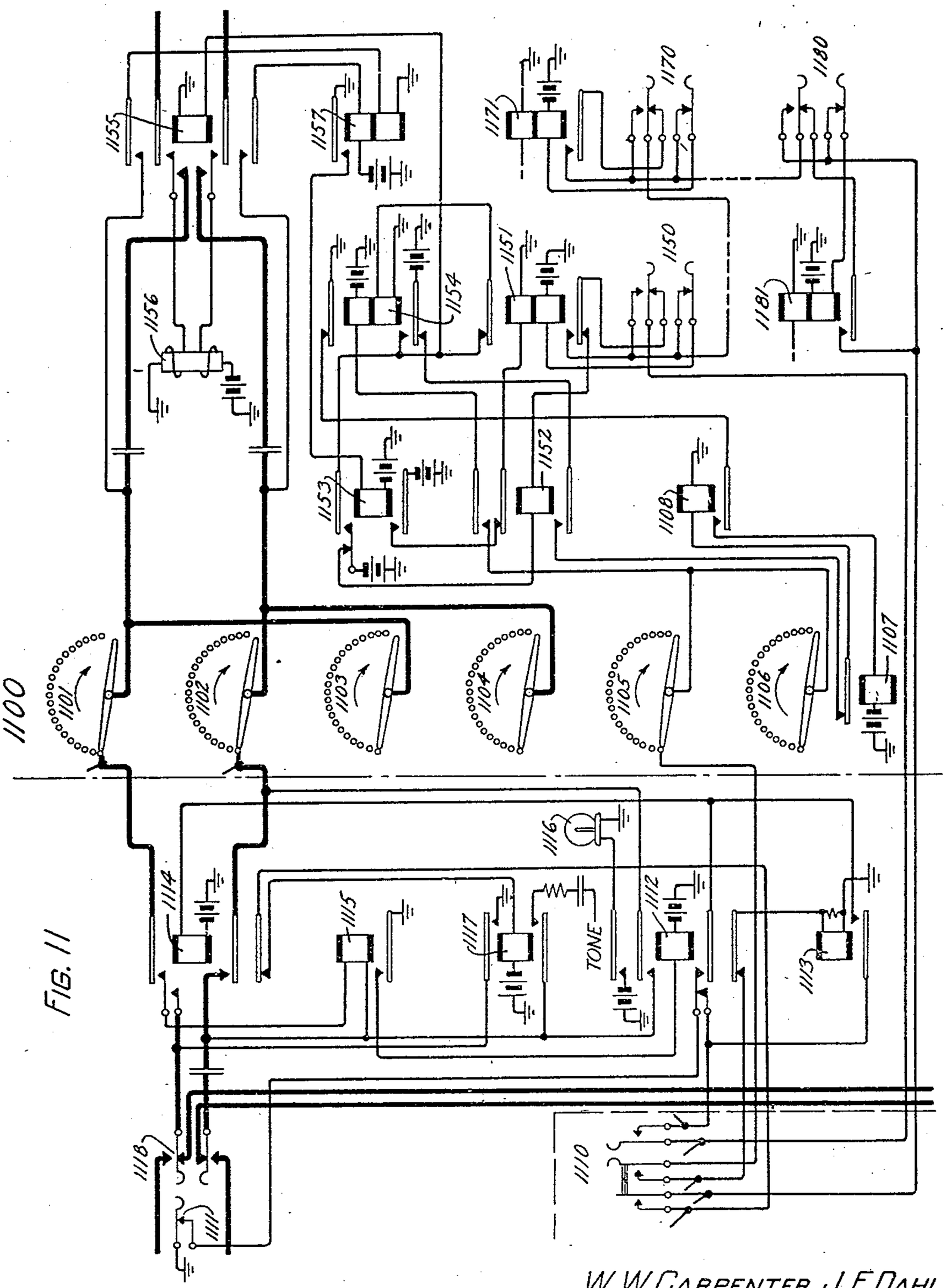

FIG. 11

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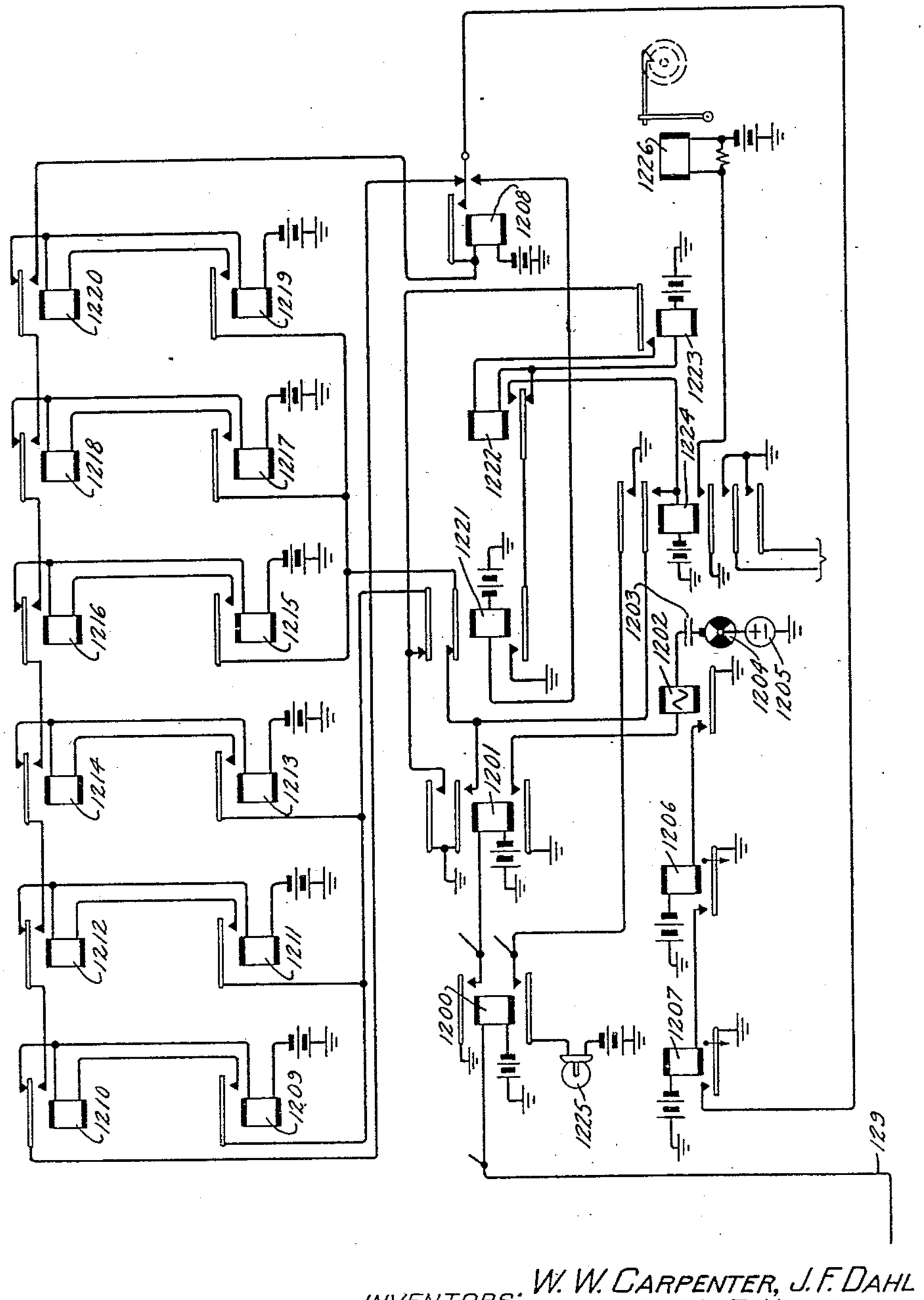
FIG. 12



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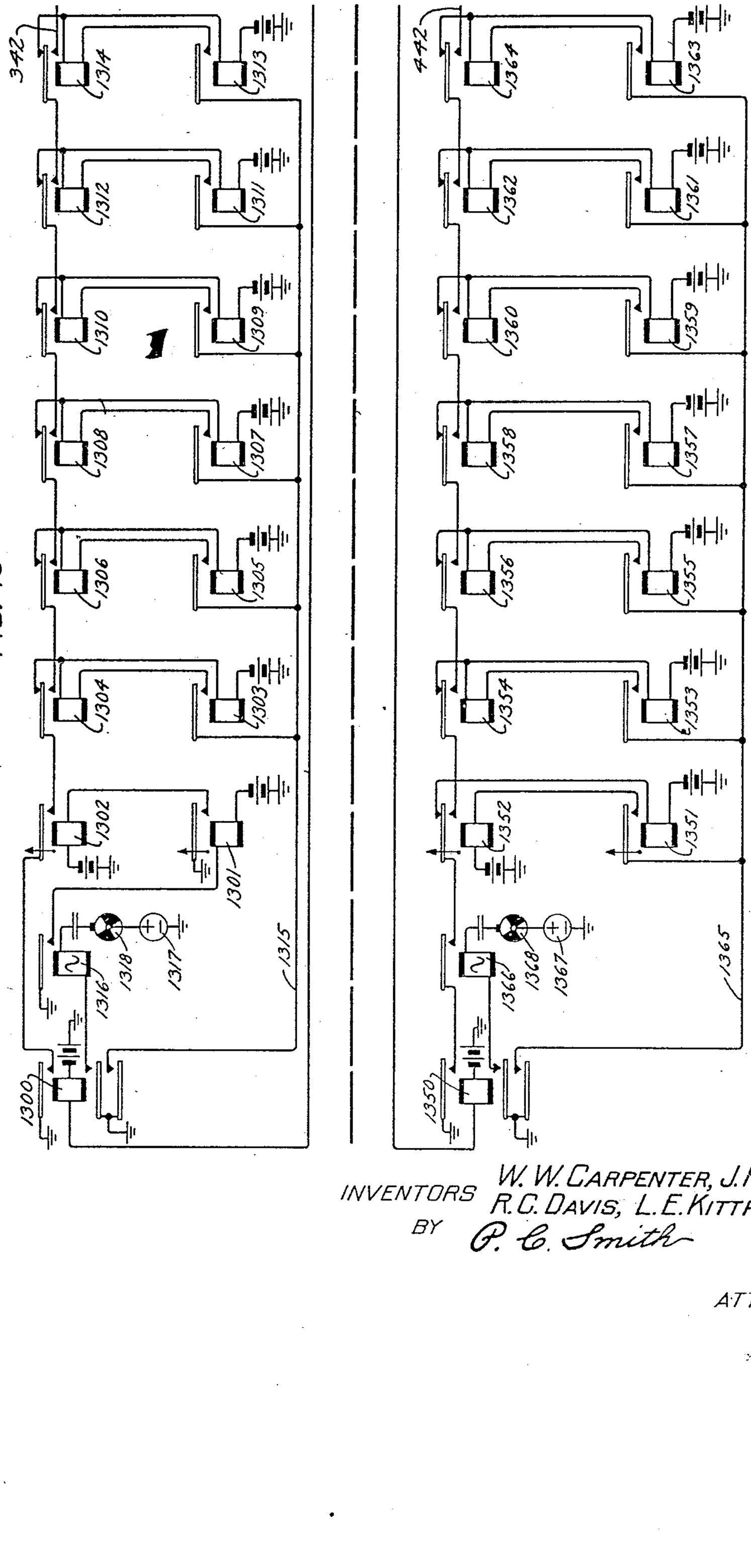

FIG. 13

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July 28, 1931. W. W. CARPENTER ET AL 1,816,634

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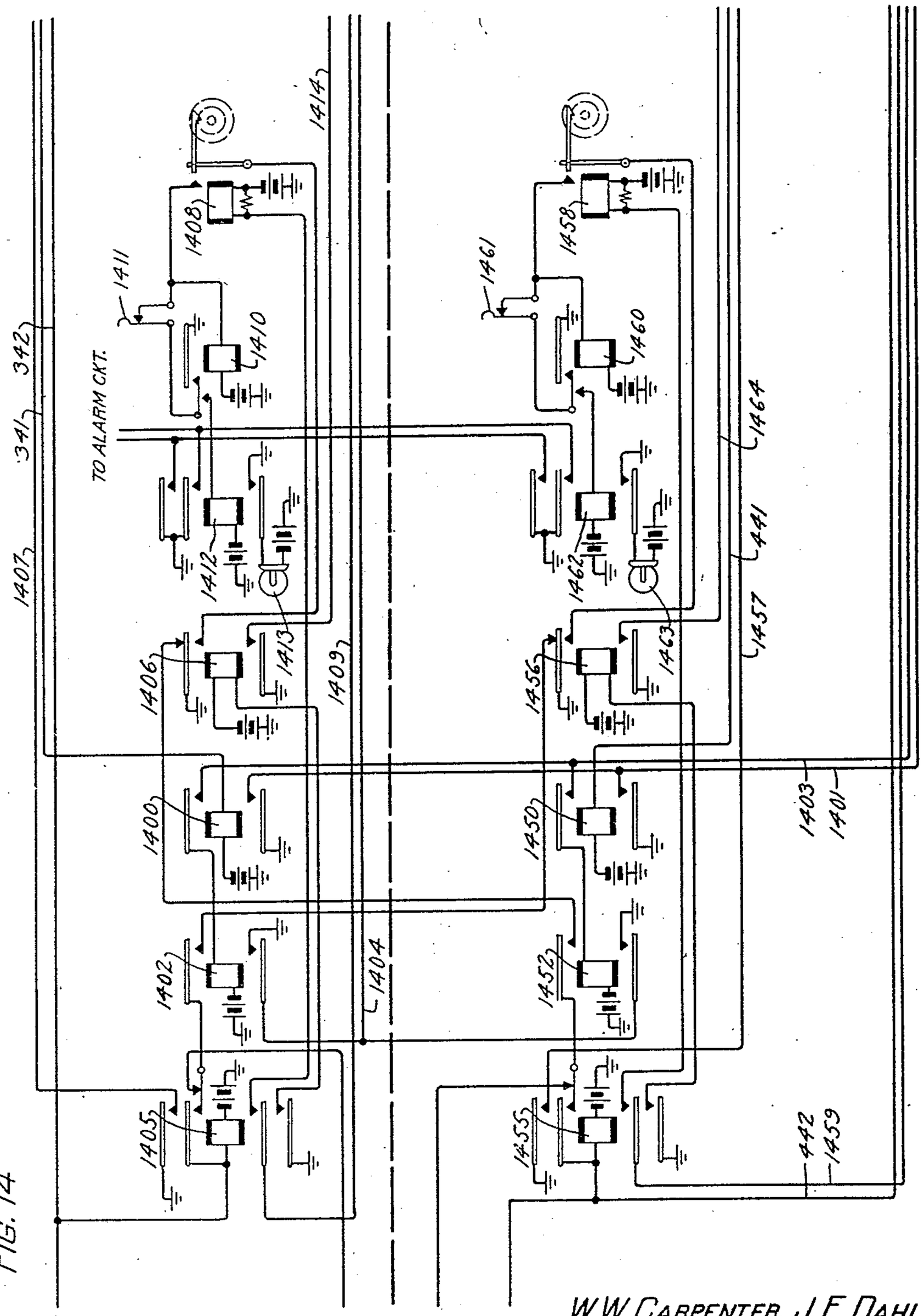

FIG. 14

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Patented July 28, 1931 1,816,634

UNITED STATES PATENT OFFICE

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TELEPHONE EXCHANGE SYSTEM

Application filed August 27, 1929. Serial No. 388,705.

This invention relates to telephone systems and more particularly to systems employing operators' positions and has for its object to increase the rapidity and efficiency with which calls may be directed to the attention of operators.

Specifically stated the present embodiment of the invention lies in an improved arrangement for directing calls to an information bureau or office. This office is centrally located and connected with other offices by means of interoffice trunks. As calls reach the information office over these trunks they are stored and the calls are directed to the individual operators as the operators become idle and in the order in which the calls are stored. For this purpose a plurality of storing circuits are provided together with an allotter and a start circuit before which the storing circuits appear in the same order. The allotter causes the association of a storing circuit with each incoming trunk over which a call is extended and thereupon if an operator is idle the start circuit causes the association of the trunk with an idle operator's position. If all of the operators are busy, a predeterimined number of calls may be stored and these calls directed to the operators as the operators become idle. In order to provide as far as possible for uninterrupted service, the allotter and start circuits are provided with duplicate apparatus, both portions of the apparatus functioning under normal conditions but either portion capable of functioning alone if the other portion is disabled. This is brought about by means of timing devices which measure off a time interval great enough to permit the proper completion of the particular stage of the operation and then disable the faulty portion of the equipment. Other timing devices advance the allotter or the start circuit if the operation of either is delayed but if all of the storing circuits or operators are busy these timing devices are rendered ineffective. The circuits also embody certain novel features which will be described hereinafter.

The invention will be more clearly understood from the consideration of the following description in connection with the accompanying drawings in which Fig. 1 shows a trunk circuit incoming to the information office, Fig. 2 shows the receiving circuits of the operator's desk, Figs. 3 to 7 show the allotter circuit, Fig. 8 shows one call storing circuit, Figs. 9 and 10 show the start circuit, Fig. 11 shows an outgoing trunk circuit by which the operator may reach other desks, Fig. 12 shows the trunk alarm circuit, Figs. 13 and 14 show an alarm circuit for timing the operation of the entire allotting arrangement and Fig. 15 shows the manner in which the drawings should be arranged.

The trunk circuit shown in Fig. 1 is one suitable for receiving calls from a panel type machine switching office. Calls incoming from a step-by-step office, or from a manual office receive battery from the distant end and therefore substitute a bridging relay for relay 110. In the case of calls from a manual office, a supervisory relay is provided in the outgoing end of the trunk to indicate to the calling operator that the information operator has answered. The switch 100 has access to the receiving circuits at the operators' positions and since only three conductors are necessary, the tip, ring and test conductors have been connected in multiple to two brushes in each case. One set of three brushes has access to one receiving circuit at each operator's position while the other set may either have access to the second receiving circuit at such positions, or to other operators' positions according to the number of positions. In the system shown 40 operators' positions are provided, which may be reached over 20 of the 22 paired brush sets. The second receiving circuits are therefore restricted to the remaining 2 pair of brush sets, to which they are connected in multiple.

The allotter circuit shown in Figs. 3 to 7 serves to direct incoming calls to storing circuits one at a time in a predetermined order. To insure continuity of service the allotter has been divided into two sections, an A section shown in Figs. 3 and 5, and a B section shown in Figs. 4 and 6, each of which normally serves half of the incoming trunks, but is capable of serving all. The relays shown in Fig. 7 are chiefly timing relays.

For simplicity the two sections may be referred to simply as the A allotter and the B allotter although the two in combination really form one allotter. Switches 500 and 600 have access in multiple to the storing circuits and normally stand in engagement with the same idle storing circuit so that the same idle storing circuit is preallotted by both allotters. Relays 301 to 306 and 401 to 406 are group relays each one common to a group of ten trunks. The groups served by relays 301 to 306 may conveniently be identified as groups 1 to 6 while those served by relays 401 to 406 may be known as groups 7 to 12. Whenever a call is received on a trunk in one of the groups the corresponding group relay is operated. Keys 300 and 400 are transfer keys by means of which all calls from one section may be transferred to the other section. Relays 521 to 526 are the cut-in relays and operate in response to the operation of the corresponding group relay to give an indication to the storing circuit of the group within which the call originated. Relays 531 to 536 are lock-out relays and are used to prevent the handling of a second call in a particular group of trunks while calls are waiting in other groups. Relays 621 to 626 and 631 to 636 perform similar functions for the B allotter. The timing circuit of Fig. 7 serves to advance the switches 500 and 600 provided they are not advanced by the storing circuit within a predetermined leng h of time. They also operate an alarm if the advancing mechanism fails.

Fig. 8 represents one of twenty storing circuits by means of which calls incoming in rapid succession may be received and stored and subsequently directed to the attention of an operator in the order in which they were stored. Two 22 position switches are employed to reach the 120 trunks since only two conductors interconnect the trunk and the storing circuit whereby the 12 brushes may be arranged in six groups of two brushes each, each having access to twenty trunks. The spare terminals are left disconnected. Relays 811, 812 and 813 in combination with relay 814 serve to identify the particular switch and brush set having access to the twenty trunks within which the calling trunk lies. The twenty trunks to which a pair of brushes has access includes two corresponding groups of ten trunks. For example brushes 801 and 802 connect with the trunks of groups 1 and 7.

The start circuit of Figs. 9 and 10 is also a duplicate arrangement for the purpose of insuring continuous service. However, in this case the switches 900 and 1000, instead of operating simultaneously, operate alternately, the arrival of one switch at its 21st position serving to advance the other switch to its first position and the switches remaining on their 22nd terminals when not in use. As in the case of the allotter circuit, a plurality of timing relays are provided which serve to transfer all calls to one half of the start circuit when the other half fails for some reason. Each of the switches 900 and 1000 has access to the twenty storing circuits in the same order and in the same order as the switches of the allotter. The allotter advances following the allotment of a call and may get well in advance of the start circuit, since the start circuit can only advance when operators' positions are free. However, since the allotter and start circuit advance over the storing circuits in the same order, the stored calls are directed to idle operators' positions in the same order as that in which they were stored.

Each operator is provided as shown in Fig. 2 with two receiving circuits 200 and 250. When the operator is at her position she attaches her headset 220 to the position circuits by means of plug 221 and jack 222 in the usual manner and the position is thereby marked available by the operation of relay 224 not only to incoming trunks, but to the start circuit over conductors 226 and 227. Normally the operator holds only the receiving circuit 200 in readiness for use, the second receiving circuit 250 being held out of service by the operation of release key 251.

The outgoing trunk circuit of Fig. 11 serves to connect the operator with other offices or other desks in the same office. As many of these trunks as the traffic demands are supplied for each destination and the starting circuit controlled by the operator is extended from trunk to trunk as they become busy. The equipment between the dotted lines in Fig. 11 is individual to the operator's position and common to all trunk groups while the equipment at the right is individual to the trunk circuit with the exception of relays 1171 and 1181 and keys 1170 and 1180 which represent schematically other trunk circuits. Key 1110 is common to all the trunks of the corresponding group. Access to the forty operators' positions is obtained in the same manner as in the incoming trunks, that is by multipling the tip, ring and sleve conductors each to two brushes.

The alarm circuits of Fig. 12 and Figs. 13 and 14 are essentially timing circuits being series of timing relays operated under the control of ringing current and a ringing interrupter. The circuit of Fig. 12 is operated when the information operator disconnects before the calling subscriber, and sounds an alarm if there is an undue delay in disconnection at the calling office. The alarm circuit of Figs. 13 and 14 is provided in duplicate, there being an alarm for each section of the allotter. An alarm is sounded if too great a time elapses between the reception of a call and the complete release of the allotter. This alarm circuit also initiates

the transfer of all calls to the other half of the allotter circuit.

Without attempting to trace circuits in detail, an outline of the operation of a successful call will first be given. The selection of an incoming trunk at a distant office causes the operation of relay 110 in turn operating relay 114. Relay 114 operates relay 301 and also marks the trunk to the storing circuits. Relay 301 operates cut-in relay 521 which locks through the winding of relay 512 in turn operating relays 511, 514 and 516. With relays 516 and 521 operated, relay 811 in the associated storing circuit is operated. This relay causes switch 800 to hunt for the trunk and closes the test circuit by way of brush 802 to the winding of relay 816. Relay 816 in turn operates relays 817, 818, 810 and 819 thus indicating to the start circuit that a call is waiting by grounding conductors 820 and 821. Ground connected to conductors 820 and 821 causes the operation of relays 910 and 1010. With an operator at her position and idle, so that ground is connected to conductors 226 and 227, relays 914 and 1014 are operated, in turn operating relays 915 and 1015. The operation of these relays advances switch 900 or 1000, depending on which is in service, and relay 913 or 1013 tests whether the next storing circuit still has a call stored on it. If so, relay 913 or 1013 operates stopping the switch and ground is connected through resistance 916, or 1016 to conductor 823 and thence to conductor 119 and winding of relay 124 as an indication to the trunk that it may hunt for an idle operator's position. Such a position is indicated by battery connected to the terminal of brush 103 and brings the switch 100 to rest, extending the talking conductors to the operator's telephone after she has been warned by two short tones that a call is incoming. It is apparent from the foregoing that the direct operations involved in allotting a call to an idle operator are comparatively simple although the apparatus involved is somewhat intricate. A detailed discussion of the circuits will now be given.

The subscriber at substation 111 desiring information will dial the code number as given in the telephone directory. In response thereto his line would be extended to a trunk line outgoing to the centralized information desk which is the subject of the present invention. The equipment for extending the connection to this trunk may be any standard panel type equipment, for example, that disclosed in U. S. Patent 1,598,402 to O. H. Kopp, granted June 22, 1926. When the talking circuit is established a circuit is completed from battery, through the left winding of relay 110, upper left winding of repeating coil 112, through the switching apparatus indicated by switch 113, over the loop at the district selector, back to the lower left winding of coil 112 and the right winding of relay 110 to ground. Relay 110 operates, closing an obvious circuit for relay 114 which is somewhat slow to release, to prevent its release in case of short interruptions of the line current. As will be apparent as the circuits are traced, the release of this relay 114 at any point in the establishment of the connection releases the entire connection. Relay 114 closes a circuit from ringing current source 121 through ballast lamp 122, outer upper contact of relay 114, condenser 123, outer upper contact of relay 115 to the lower right winding of repeating coil 112 and battery thus inducing a tone similar to the ringing induction tone in the line circuit indicating to the subscriber that the call has reached the information office and is being extended to an operator. Relay 114 also closes a circuit from ground at its outer lower contact, lower back contact of relay 115, inner upper contact of relay 116, through resistance 117 to conductor 126 and the winding of relay 301 in the allotter circuit. It also closes a circuit from ground over its outer lower contact, lower back contact of relay 115, upper back contacts of relay 116, lower back contact of 118 to conductor 119 and the terminals corresponding to this trunk circuit in the storing circuit switches such as switch 800. It likewise prepares a circuit from battery, through the winding of relay 116, inner upper contact of relays 114 and 115 to conductor 120 and corresponding terminals in the storing circuit switches. Conductor 119 terminates in the bank of brush 802 of the storing circuit shown and conductor 110 in the bank of brush 801.

Relay 301 in operating closes a circuit from ground at the lower back contacts of relay 700, conductor 340, inner lower contact of relay 301, contact 321 of transfer key 300, upper back contact of relay 331, lower back contact of relay 531, lower winding of relay 521, conductor 550, outer upper contact of relay 611, inner upper contact of relay 511 to battery. Relay 521 operates in this circuit and locks in a circuit which extends from ground to the contact of relay 331 as above traced and thence through the upper winding and inner upper contact of relay 521, upper back contacts of relays 522, 523, 524, 525 and 526, conductor 551, lower contact of relay 612, to battery through the winding of relay 512 and resistance 513 in parallel. Relay 512 operates, connecting ground through resistance 518 to the inner upper contact of relay 511, shunting the operating winding of relay 521 and any other cut-in relays which may be operated at this time. It also closes a circuit over its two upper contacts for relay 511 and at its lowest contact shunts the winding of relay 612 and removes battery from the locking circuit of relays 621 to 626.

Relay 511 in operating opens the operating circuits for the cut-in relays of both allotters A and B. It also prepares two circuits one of which tests to determine whether the allotter switches 500 and 600 are in synchronism, i. e., are engaging the same storing circuit, and the other of which serves to bring switch 500 into synchronism with switch 600. The first circuit may be traced from battery, through the winding of relay 514, inner lower contact of relay 610, lower back contact of relay 611, brush 606 and the terminal on which it is standing which is cross connected to the corresponding terminal of brush 506 and thence over brush 506, lower front contact of relay 511 to ground. If brushes 506 and 606 are standing on corresponding terminals, relay 514 operates and the second circuit is ineffective. If this is not the case, the circuit closed by relay 511, over its innermost lower contact, outer back contact of relay 510, back contact of relay 514, winding of relay 515 to battery, is completed. Relay 515 in operating extends its operating ground over the back contact of stepping magnet 507, upper front contact of relay 515, winding of relay 508 to battery. Relay 508 closes a circuit for magnet 507 which operates, opening the circuit of relay 508. Relay 508 releases in turn releasing magnet 507 and stepping the brushes of allotter switch 500 to the next storing circuit. This reciprocal action continues until brush 506 engages the terminal corresponding to that engaged by brush 606, or until the timing relays function.

Assuming that the switches are in synchronism and that relay 514 operates, it closes a circuit from ground over the innermost lower contact of relay 511, outer lower contact of relay 510, front contact of relay 514, winding of relay 516 to battery. Relay 516 in operating closes a circuit from ground over the inner lower contact of relay 517, lower contact of relay 516, outer upper contact of relay 521, lower winding of relay 531 to battery. Relay 531 operates, but is ineffective unless a call is waiting in another group. If a call were waiting in group 2, indicated by the operation of relay 302, relay 531 would lock over its upper front contact, upper back contact of relay 532, upper back contact of relay 542, outer upper contact of relay 302 to ground. Relay 531 in operating would open the operating circuit of relay 521 and prevent its reoperation until the call in group 2 had been handled. If no other call is waiting relay 531 releases at the same time that relay 521 releases. Relay 516 also closes a circuit from ground, over the inner upper contact of relay 517, upper contact of relay 516 to the lower armatures of the cut-in relays. With relay 521 operated this ground extends over the lower front contact of that relay, brush 504, conductor 831, inner lower contact of relay 810, winding of relay 811 and battery thus initiating the operation of the storing circuit.

It may be noted that each of the groups of trunks served by the two allotters has a definite position of priority according to the position in the chain of cut-in relays. Since the locking circuits of the cut-in relays extend over the back contacts of the relays following them in the chain, it is apparent that group 6, corresponding to group relay 306 and cut-in relay 526, has the preferred position in allotter A while group 12 corresponding to group relay 406 and cut-in relay 626 has the preferred position in allotter B. However, all of the groups 1 to 6 have a preferred position to groups 7 to 12 since, as described above, a call incoming to allotter A causes the operation of relay 512 and the disconnection of battery from relay 612 of allotter B. However, the lock-out relays 531 to 536 not only lock to group relays of allotter A, but to group relays of allotter B and therefore when one call has been served in each group of allotter A in which a call exists, the calls waiting in allotter B will be served before any more calls can be served in allotter A. When one call has been allotted in each group, wherein calls are waiting, the operation of the last lock-out relay, releases all of the lock-out relays and permits other calls to be allotted. The manner in which the timing circuits function and in which calls may be transferred from one allotter to the other will be described hereinafter.

The operation of relay 811 as described above, initiates the operation of switch 800 to hunt for the trunk marked by ground over conductor 119. The operation of relay 811 also determines that brushes 801 and 802 will be used to connect the storing circuit with the trunk circuit. Brushes 851 and 852 of switch 850 also extend over contacts of relay 811, but the circuits controlled by these brushes are open at the contacts of relay 814. Relay 814 operates in a circuit over the inner upper contact of relay 810, conductor 834, brush 501 to the contact of relays 524, 525 or 526, or similar contacts in the B allotter. It may be noted that relay 811 is operated over brush 504 and contacts of relays 521 and 524, relay 812 over brush 503 and relays 522 and 525, while relay 813 is operated over brush 502 and relays 523 and 526. Relays 521 to 526 identify the group, to which the incoming trunk belongs, to the storing circuit by operating one of relays 811 to 813 and operating or non-operating relay 814. Similar circuits are closed in the B allotter, but since each brush set has access to 20 trunks it has access to one group of trunks from each allotter.

The circuit for operating switch 800 may be traced from battery, through the winding of relay 815, over the back contacts of magnets 807 and 857, outer upper contact of relay

810, back contact of relay 816 to ground at the outer lower contact of relay 811. Relay 815 closes a circuit from ground over the back contact of relay 817, contact of relay 815, upper normal contact of relay 814 winding of magnet 807 to battery. Relay 815 and magnet 807 cooperate to advance switch 800 in search of the trunk marked. When this trunk is found the ground connected to conductor 119 is extended over brush 802, middle lower contact of relay 811, lower back contact of relay 814, outer upper back contact of relay 819, winding of relay 816 to battery. Relay 816 in operating disconnects ground from relay 815 and connects it to the upper winding of relay 817 and battery. Relay 817 in operating closes a circuit from ground over its upper front contact to the winding of relay 818. It also closes a circuit over its lower front contact to lock relay 811. Relay 818 in operating closes an obvious circuit for relays 810 and 819. Relays 818 and 819 control circuits for indicating to the signal circuit that a call has been stored. Relay 818 also closes a circuit for interlocking the trunk and storing circuit from ground over its outer upper contact, lower winding of relay 817, inner upper back contact of relay 814, innermost upper contact of relay 811 to brush 801 and over conductor 120 to the winding of relay 116 as previously traced. Relay 116 operates in this circuit disconnecting ground from the winding of relay 301 permitting that relay to release. It also disconnects ground from conductor 119, but relay 817 is already held operated and is therefore unaffected by the release of relay 816. Relay 116 also prepares two circuits, one from battery through the winding of relay 124, upper front contact of relay 116, lower back contact of relay 118 to conductor 119. It also prepares a circuit from brushes 103 and 106, lower front contact of relay 116, winding of relay 125 to the contact of relay 124. The trunk circuit now awaits the action of the start circuit.

Relay 810 in operating opens the circuit of relay 815 to prevent switch 800 moving out of engagement with the trunk of Fig. 1. It disconnects the control conductors 831 to 834 from relays 811 to 814. Relay 819 connects ground over its outer lower contact to conductor 825, brush 505, lower back contacts of relays 517 and 515, back contact of magnet 507, upper back contact of relay 515 to the winding of relay 700. This circuit also extends in parallel from conductor 825 through brush 605, middle lower back contact of relay 617, lower back contact of relay 615, back contact of magnet 607, upper back contact of relay 615 to the winding of relay 700. Relay 700 in operating disconnects ground from conductor 340 thus releasing cut-in relay 521 and in turn the lock-out relay 531 unless another call is waiting. Relay 700 also closes a circuit over its inner lower front contact, middle upper contact of relay 517 to the winding of magnet 507, and battery and a second circuit over its outer lower front contact, upper back contact of relay 617, to the winding of magnet 607 and battery. These two magnets operate and when both are operated, open the circuit of relay 700 which releases, in turn releasing the magnets and advancing the allotter switches to preallot the next storing circuit. If the next storing circuit should be busy, for example by the insertion of a make-busy plug in jack 827, ground would be connected over a conductor corresponding to conductor 825 to the next terminal and the allotter would advance to a subsequent storing circuit. When all the call storing circuits have been associated with incoming trunks, as might occur when only a few operators are on duty, ground is connected to the first twenty terminals of brushes 505 and 605 from the corresponding storing circuits. The allotter switches 500 and 600 advance over these terminals. The circuit for advancing the allotter switches over the 21st and 22nd terminals is closed over conductor 826, in parallel to the normal contacts of jacks such as jack 827 to ground at the lower back contact of relays such as relay 817 in the storing circuits which are idle. Therefore, if all storing circuits are busy, the allotter switches remain in engagement with their 21st terminals until a storing circuit becomes idle. When one becomes idle the switches advance over terminals 21 and 22 by the idle ground of that storing circuit and over intermediate storing circuits by means of their busy ground and come to rest on the idle storing circuit.

Relay 818 in addition to the functions above described connects ground over its inner contacts to conductors 820, 821 and 822 leading to the start circuit. The connection of ground to conductors 820 and 821 completes circuits for relays 910 and 1010 which both operate.

As soon as relay 910 operates it closes a circuit from battery through the winding of relay 908, back contact of magnet 907, back contact of relay 913, brush 902 and its strapped off-normal terminals, lower back contact of relay 912, right normal contact of key 911 to ground at the outer upper contact of relay 910. Relay 1010 attempts to prepare a similar circuit for relay 1008 but it will be remembered that only one of the switches 900 and 1000 function at the time and it is assumed that switch 900 is the one now in use. The circuit closed by relay 910 is therefore effective while the attempted closure by relay 1010 is ineffective, since brush 1002 is engaging its 22nd terminal which is disconnected. Relay 908 in operating closes a circuit for magnet 907 which opens the circuit of relay 908 and thereby the circuit of magnet 907, advancing the start

circuit to the next storing circuit. A circuit is then closed from battery though the winding of relay 913, upper back contact of relay 912, brush 901 to conductor 822 which is grounded by the operation of relay 818. Relay 913 operates, opening the circuit of relay 908 and preventing the further advance of switch 900. The apparatus is arranged so that abandonment of the call by the subscriber before its extension to the information operator will release all apparatus. Therefore it is possible that the start circuit in advancing may encounter a storing circuit, the call on which has been abandoned. In that case relay 913 would not be operated until the start circuit reached a storing circuit on which a call was actually waiting. Since relays 910 and 1010 are not operated unless a call is actually waiting, the switches are not advanced idly.

Relay 910 also prepares a circuit from battery through the winding of relay 914, outer lower contact of relay 910 to conductor 227 which terminates in ground at an operator's position if that operator is idle. Referring for the moment to the operators' circuits of Fig. 2 it will be seen that the connection of headset 220 to the telephone circuit completes a circuit from ground through the right winding of repeating coil 223, contacts of jack 222 and plug 221 through the operator's transmitter to battery through the winding of relay 224. Relay 224 closes a circuit from ground at the upper back contact of relay 202, inner upper normal contact of key 201, inner upper contact of relay 224 to conductor 226 and conductor 227. Relay 224 in operating closes an obvious circuit for relay 225 which also supplies ground to conductor 226 over the back contact of relay 252, inner upper normal contact of key 251 and the upper contact of relay 225. However, this circuit is normally open since the operator employs the receiving circuit 200 for all calls unless she is holding a call on that circuit. Therefore key 251 will be operated and the circuit closed by relay 225 opened at the contact of that key. The circuit of relay 914 extends in multiple to all operators' positions so that, as long as one operator is idle, the circuit will be completed whenever relay 910 operates. Relay 914 also closes an obvious circuit for relay 915. Relay 1010 closes a similar circuit for relay 1014 to conductor 226 which also operates if an operator is available and closes an obvious circuit for relay 1015. Relay 914 also closes a parallel circuit for relay 1015 and relay 1014 closes a parallel circuit for relay 1015 thus insuring the operation of these two relays even though one of the relays 910, 914, 1010 or 1014 fails to operate.

The operation of relay 913 as above described closes a circuit from battery through the winding of relay 918, back contact of relay 919, upper front contact of relay 915, front contact of relay 913, brush 902, back contact of relay 912, right normal contact of key 911, to ground at the uppermost contact of relay 910. Relay 918 initiates a timing operation for the purpose of determining whether the start circuit functions properly.

At the time relay 914 operates, it closes a circuit from ground through resistance 916, outer upper contact of relay 914, upper back contact of relay 917, brush 906, conductor 823, upper front contact of relay 819, lower back contact of relay 814, middle lower contact of relay 811, brush 802, conductor 119, lower back contact of relay 118, upper front contact of relay 116, winding of relay 124 to battery as an indication to the trunk that it may hunt for an idle operator's position. This same circuit is also closed at the lower contact of relay 1014 and a similar circuit is prepared by both relays 1014 and 914 to brush 1006 which is ineffective because of the position of switch 1000. The presence of resistance 916 in this circuit reduces the potential on the terminal of brush 802 through which it passes so that it will not interfere with the operation of storing circuit switches hunting over terminals multipled thereto in search of other trunks. Relay 124 in operating extends the test circuit through relay 125 to ground at its outer front contact and closes a circuit at its inner front contact over the back contact of relay 125, back contact of magnet 107, winding of relay 108 to ground. Relay 108 closes an operating circuit for magnet 107 and the relay and magnet cooperate to advance the trunk switch 100 in search of an idle operator's position. It will be remembered that an idle operator's position is indicated by battery through the winding of relay 203, lower back contact of relay 202, inner contact of key 201, outer upper contact of relay 224, conductor 213 to the terminal of brush 103.

When the operator's position is found, this circuit is completed through the winding of relay 125 to ground as above traced. Relay 125 in operating closes a circuit from ground over the inner front contact of relay 124, front contact of relay 125, winding of relay 127 to battery. It also opens the circuit of relay 108 and brings switch 100 to rest. Relay 127 locks over its middle upper contact, back contact of relay 128 to ground at the inner lower contact of relay 114. In addition, it connects the two windings of relay 128 in series, but this relay is wound differentially so that it remains unoperated. Relay 127 also closes a circuit from its operating or locking ground to the winding of relay 118 and battery. Relay 118 connects the right winding of the repeating coil to the tip and ring conductors of the operator's receiving circuit. It also closes a circuit from battery through the winding of relay 115, outer upper contact of relay 118 to ground

at the outer lower contact of relay 114. Relay 118 also opens the circuit of relay 124 in turn releasing relay 125. Relay 115 in operating locks directly to the outer lower contact of relay 114; disconnects the ringing tone to inform the subscriber that his line has been extended to an operator's position; and opens the circuit of relay 116.

The disconnection of relay 116 from conductor 120 opens the circuit of relay 817 in the storing circuit. Relay 116 in releasing prepares a circuit from the upper winding of relay 128, middle lower contact of relay 118, lower back contact of relay 116 to brush 103 to prepare the release circuit. Relay 817 in releasing opens the circuit of relay 818 in turn releasing relays 810 and 819. Relay 817 also opens the locking circuit of relay 811 and the storing circuit is restored to normal. The release of relays 817 and 818 open the circuits of relays 913, 910 and 1010 which in turn release the remaining relays of the start circuit, the switch 900 remaining in this position until the reception of a call causes it to advance to start another trunk.

If other calls are stored and waiting, relays 910 and 1010 remain operated but the release of relay 913 permits the advance of switch 900 to the next storing circuit. When an operator becomes idle relay 914 operates and passes the starting signal to the trunk.

Switch 900 continues to advance until it reaches position 21. In this position a circuit is closed from ground, brush 903 in position 21, cross connected to brush 1003 in position 22, inner upper contact of relay 1012 back contact of relay 1013, back contact of magnet 1007, winding of relay 1008 to battery. Relay 1008 operates magnet 1007 which, in operating, releases relay 1008 and in turn magnet 1007, advancing switch 1000 to position 1. A circuit is now closed from ground over brush 1004 in position 1 and subsequent operative positions, brush 904 in position 21, inner upper contact of relay 912, back contact of relay 913, back contact magnet 907 winding of relay 908 to battery. Relay 908 and magnet 907 cooperate to advance switch 900 to position 22 where it remains while switch 1000 functions.

At the operator's position the completion of the test circuit to relay 125 operates relay 203 which lights lamp 204 indicating to the operator that a call is being directed to her receiving circuit. The operation of relay 118 connecting the tip and ring conductors to the receiving circuit completes a circuit from the ring conductor, over the upper normal contact of relay 205 to the winding of relay 206, lower normal contact of key 201 to the tip conductor which is supplied by battery through the repeating coil 112. Relay 206 operates, in turn operating relay 202 and extends the ring conductor through condenser 212 to contacts of relay 208. It also connects resistance 207 across the trunk to absorb clicks caused by connecting the operator's telephone to the trunk circuit. Relay 202 opens the circuit of relay 203 thus removing the idle indication from this receiving circuit. It also supplies a substitute circuit for lamp 204. In addition it closes a circuit from ground over its upper front contact, outer upper normal contact of key 201, inner upper back contact of relay 208, inner lower contact of key 209 to the winding of relay 228. Relay 228 closes a circuit through the secondary winding of tone coil 229 over its outer upper contact, inner lower back contact of relay 208, outer lower normal contact of key 209, through the operator's receiver and repeating coil, upper normal contact of key 209, outer upper back contact of relay 208, normal contact of relay 230 to ground at the lower contact of relay 228. A tone is therefore transmitted to the operator. Relay 228 also closes an obvious circuit for relay 230 which is slow to operate and after an interval opens its normal contact disconnecting the tone from the operator's receiver. Relay 230 also closes a circuit for relay 231 which is also slow to operate and after an interval recompletes the secondary circuit of the tone coil over the normal contact of relay 232, upper contact of relay 231, alternate contact of relay 230 to ground at the lower contact of relay 228. Relay 231 also operates relay 232 which, after an interval measured by its slow to operate character, again opens the tone circuit completing the second of the so-called zip tones. It also extends the circuit closed from ground at the lower contact of relay 228 over the alternate contact of relay 232, back contact of relay 264 to the winding of relay 208. If key 235 is operated it likewise operates the peg count meter 234 and relay 233. Relay 208 disconnects resistance 207, opens the circuit of relay 228 and closes a locking circuit for itself over its alternate contact and outer upper normal contact of key 201 to ground at the outer upper contact of relay 202. It likewise extends the talking conductors to the operator's headset. The operator may now talk with the subscriber and supply him with such information as he desires.

Having completed the conversation the operator then closes release key 201 to release the receiving circuit from the trunk. In so doing a circuit is completed from battery, through the upper winding of relay 128, outer lower front contact of relay 118, lower back contact of relay 116, brush 103, conductor 213, outer upper contact of relay 224, upper alternate contact of key 201 to ground at the outer upper contact of relay 202. Since relay 128 is differentially wound this circuit now shunts the lower winding of relay 128 and permits the relay to operate. The operation of relay 128 releases relay 127 and in

turn relay 118 whereupon relay 128 itself releases. However, relays 110, 114 and 115 remain operated under the control of the calling subscriber. The operation of key 201 also opens the circuit of relay 208 which relay releases, further disconnecting the operator's headset from the trunk. Relay 202 at its lower front contact holds relay 206 connected to the tip and ring conductors until relay 118 releases, when these two relays release. The release of relay 202 extinguishes lamp 204 and restores the circuits for marking the position idle to both trunks and start circuits.

If the operator does not have the information available, or for any other reason she cannot handle the call herself, the operation of key 209 extends the talking conductors to the supervisor's position where the supervisor may take the call by operating a key at her position, not shown, or the call may merely be held while a search is being made. If the supervisor handles the call, the operator may render trunk 250 selectable by restoring key 251. The operation is essentially the same as for trunk 200 except that relay 264 is operated by relay 252 to start the zip tones and transfer the circuit controlled by relay 232 from relay 208 to relay 258. The circuit of lamp 254 extends through apparatus not shown to take care of the multipling of the auxiliary trunks.

If the subscriber gets tired of waiting and disconnects, the equipment at the trunk circuit is released followed by the release of relays 211 and 205 and the restoration of the idle indication. Under these circumstances the receiving circuit may be reselected and lamp 204 lighted, but due to the operation of key 209 relay 228 cannot be operated and no tone will be received nor will the talking conductors be cut through. However, the restoration of key 209 permits the call to be extended in the manner above described without previously operating the release key 201. If lamp 204 lights, indicating an incoming call and no zip tones are heard, even after the restoration of key 209, the operator may connect her headset with the incoming trunk by closing key 211 which operates relay 208 directly and extends the trunk to her telephone.

If the information desired must be obtained from some other office, or the operator needs to communicate with another office for any reason she may operate key 1110 individual to that office at her position. The closure of key 1110 completes a circuit from battery over the normal contact of relay 1153 through the winding of relay 1152, lower back contact of relay 1151, upper normal contact of key 1150, right contact of key 1110, normal contact of relay 1112 to ground at the contact of key 1111. Relay 1152 closes a circuit from ground through the winding of relay 1108, back contact of magnet 1107, lower contact of relay 1152 to battery at the lower back contact of relay 1154. Relay 1108 closes a circuit from battery through the winding of magnet 1107, contact of relay 1108 to ground at the upper contact of relay 1154. Relay 1152 closes a test circuit from battery through the upper winding of relay 1154, upper front contact of relay 1152 to brushes 1105 and 1106. This circuit is extended when switch 1100 finds the position at which key 1110 is operated over the inner left contact of key 1110, back contact of relay 1112, through the winding of relay 1113 to ground. Relays 1154 and 1113 operate in this circuit.

Relay 1154 opens the circuits of relay 1108 and magnet 1107, bringing switch 1100 to rest. It also closes a holding circuit for itself from battery over its lower front contact, back contact of relay 1151 to ground through its lower winding. A circuit extends in parallel with this from battery over the lower front contact of relay 1154 to ground through the winding of relay 1155. Relay 1155 connects battery and ground through retard coil 1156 to the outgoing trunk as a signal to the distant office. It also connects the talking conductors to the outgoing end of the trunk and connects battery and ground through the windings of relay 1157 to the incoming end of the trunk. Relay 1113 closes a circuit from ground over the normal contact of relay 1112, front contact of relay 1113, winding of relay 1114 to battery. Relay 1114 extends the talking conductors to the operator's telephone circuit and also connects the winding of relay 1115 in series with the windings of relay 1157. Relay 1115 closes a circuit for relay 1112 which lights lamp 1116 and opens the circuit of relays 1154 and 1113. However, relay 1112 closes a substitute circuit for relay 1114 over its lower alternate contact to ground at key 1111. The lighting of lamp 1116 indicates to the operator that an outgoing trunk has been connected to her telephone set and that she may now release key 1110. The operation of relay 1157 closes a circuit for relay 1153 which further opens the circuit of relay 1152 and closes a circuit from battery over the lower contact of relay 1153, back contact of relay 1152, upper winding of relay 1151 to ground. Relay 1153 also closes a holding circuit for relay 1155 to battery at the upper alternate contact of relay 1153. Relay 1151 extends the starting circuit over the upper normal contact of the key 1150, lower front contact of relay 1151 to the next trunk circuit. Relay 1151 also prepares a holding circuit for itself over the lower normal contact of key 1150, front contact of relay 1151, upper normal contact of key 1150 to the starting circuit, so that the release of a trunk during the time that another trunk is hunting will not interfere

with the hunting trunk. The operator may now proceed with her conversation and when it is finished she will operate key 1111 to release the trunk. The operation of key 1111 opens the circuit of relay 1114 which in turn releases relays 1115 and 1157. Relay 1115 releases relay 1112 and extinguishes lamp 1116. Relay 1157 releases relays 1153, 1155 and 1151 whereupon the trunk is completely restored to normal. Key 1118 permits the supervisor to use the trunk by transferring the talking leads to her circuit.

If all of the outgoing trunks of a group are busy, the operation of key 1110 closes a circuit from battery, winding of relay 1117, back contact of relay 1114, contact of key 1110 over the front contact of the transfer relays and the normal contacts of the make busy keys of all trunks, such as relay 1181 and key 1180, relay 1171 and key 1170, relay 1151 and key 1150, right contact of key 1110, normal contact of relay 1112, to ground at key 1111. Relay 1117 connects a busy tone to the ring conductor informing the operator that all trunks of the group are busy. The operator need only release key 1110 since no other relays are operated.

When the information operator disconnects, it will be remembered, relay 127 releases, but relay 115 is held operated under the control of the calling subscriber. If the subscriber fails to disconnect immediately, a circuit is closed from ground over the lower front contact of relay 115, lower back contact of relay 127, conductor 129, winding of relay 1200 to battery. Relay 1200 closes a circuit from ground at its upper front contact through the winding of relay 1201 to battery. Relay 1201 completes a circuit from ground through ringing current source 1205, interrupter 1204, condenser 1203, alternating current relay 1202 to ground at the lower contact of relay 1201. It also supplies locking ground for various relays of Fig. 12. Relay 1202 operates under the control of the ringing interrupter once every six seconds, closing a circuit for relay 1206 which is slow to release and independent of slight fluctuations in the operation of relay 1202. Relay 1206 in turn operates relay 1207 and relay 1207 controls the timing relays. The first operation of relay 1207 closes a circuit from ground at its front contact, over the normal contact of relay 1208, back contact of relay 1210, winding of relay 1209 to battery. Relay 1209 locks through the winding of relay 1210, upper back contact of relay 1221 to ground at the outer upper contact of relay 1201, but relay 1209 does not operate until the operating circuit of relay 1210 is opened by the release of relay 1207 during the silent period of the ringing machine. In a similar manner relays 1211 to 1220 are successively operated and locked. With relay 1220 operated, the next operation of relay 1207 closes a circuit from ground over its front contact, normal contact of relay 1208, front contacts of relays 1210, 1212, 1214, 1216, 1218 and 1220 to the winding of relay 1208. Relay 1208 opens the operating circuit for relays 1209 to 1220 and locks to the front contact of relay 1207 as long as that relay remains operated. It also extends ground from the front contact of relay 1207 over the inner front contact of relay 1208 to the winding of relay 1221. Relay 1221 opens the locking circuits of relays 1209 to 1220 and closes a circuit over its lower contact, back contact of relay 1222 to the winding of relay 1223 and battery. Relay 1223 locks through the winding of relay 1222 to the ground at the outer upper contact of relay 1201, but relay 1222 does not operate until relay 1207 releases in turn releasing relays 1208 and 1221. Relays 1209 to 1220 are now reoperated as above described, followed by the operation of relays 1208 and 1221. Since relay 1222 is now operated the operation of relay 1221 closes a circuit from ground over its front contact, front contact of relay 1222 to the winding of relay 1224. Relay 1224 locks over its inner upper contact to ground at the inner upper contact of relay 1201. A circuit is closed over the outer upper contact of relay 1224 and the lower front contact of relay 1200 for lamp 1225. Relay 1224 also operates meter 1226 and connects ground to the office alarm board to operate visual and audible alarms at that point. Relay 1200 and lamp 1225 are common to a group of ten trunks and therefore lamp 1225 identifies the group of trunks in which the trunk which failed to release is located. The complete operation of this circuit requires in the neighborhood of a minute and a quarter to complete and therefore is ample time for disconnection under ordinary circumstances. Whenever the called subscriber releases, relays 1200 and 1201 release, restoring the timing circuit, extinguishing lamp 1225 and retiring the alarms.

If for any reason a storing circuit does not advance the allotter the timing relays of Fig. 7 are provided to advance the allotter automatically after the expiration of approximately two seconds. When relay 301 operated it closed a circuit from ground over its inner upper contact, to conductor 341 operating relay 1400 in the allotter alarm circuit. Relay 1400 operates and closes a circuit from battery through the winding of relay 1402, upper contact of relay 1400, conductor 1403, contact of jack 827 to ground at the lower back contact of relay 817 at such storing circuits as are idle, this circuit extending in multiple to all of the call storing circuits. With relay 1402 operated a circuit is closed from ground over the lower contact of relay 1402, conductor 1404 to the winding of relay 701 and battery. Relay 701 closes a circuit from battery through the

winding of relay 702, upper contact of relay 701, over the outer lower contact of relay 617 to ground at the inner upper contact of relay 700 and over the outer upper contact of relay 517 to ground at the outer upper contact of relay 700. Relay 702 closes an obvious circuit for relay 705 and locking circuits for certain other relays of Fig. 7 and opens the circuit for relay 704. Relay 705 closes a circuit from battery through the winding of relay 707, contact of relay 705 to ground over interrupter 706. Relay 707 therefore operates intermittently to control the operation of relays 708 to 713. The first operation of relay 707 closes a circuit from ground over its contact, back contact of relay 709 to the winding of relay 708 and battery. Relay 708 locks through the winding of relay 709 to ground at the outer lower contact of relay 702, but relay 708 does not operate until relay 707 releases at the next opening of the interrupter contact. Subsequently relays 710 to 713 are similarly operated, relay 713 extending the circuit controlled by relay 707 over the upper back contact of relay 704 to the upper winding of relay 717. Relay 717 locks through its lower winding and lower contact during the closed period of interrupter 706. It closes a circuit for meter 718 to indicate the number of times that the allotter switches have been advanced by the timing relays. It also closes a circuit for relay 700 which closes the circuits previously traced for advancing switches 500 and 600 to the next storing circuit. The operation of relay 700 opens the circuits of relay 702 and restores the timing relays.

If the failure of relay 700 to operate is due to a break in the synchronizing conductors, so that the advance of one allotter switch cannot produce a position of synchronism, the timed operation of relay 700 advances both switches, while the one switch continues to hunt. This operation continues until a position is found where the synchronizing conductors are unbroken or until the alarm circuit of Figs. 13 and 14 operates.

If relay 700 operates in response to the action of the storing circuit, but fails to release, relay 702 is released and a circuit is closed from ground over the lower contact of relay 701, back contact of relay 702, back contact of relay 703 to the winding of relay 704. Relay 704 operates relay 705 to initiate the operation of the timing relays. However, with relay 704 operated the operation of relay 713 extends the ground from the front contact of relay 707 over the inner upper front contact of relay 704 to the winding of relay 714 which locks through key 715 to ground. Relay 714 lights lamp 716 and operates relay 703. Relay 703 opens the circuit of relay 704, connects ground to the general alarm board to operate visual and audible alarms and connects ground to conductor 340 to permit the functioning of the cut-in relays to direct calls successively to the same storing circuit.

If relay 700 should fail to operate altogether, either in response to the storing circuit, or to the timing relays, the allotter switches cannot be advanced to another storing circuit and the calls will be directed to the same storing circuit one after the other. The storing circuit reconnects itself to the allotter only after it has been released by the trunk so that it cannot be affected by a calling condition in the allotter. When the storing circuit is again attached to the trunk the group relay in the allotter is released if that is the only call in that group. If more than one call exists in that group, the group relay will be held operated and the corresponding cut-in relay will be operated. When the storing circuit reestablishes the circuits which connect it with the allotter, the group identifying relay is again operated in the storing circuit and the second call in the group is handled. When the group relay releases the cut-in relay can be released and calls in other groups taken care of. If calls arrive so rapidly that the allotter cannot handle them in this manner, the allotter alarm circuit will function to bring in an additional alarm.

This alarm circuit is shown in Figs. 13 and 14. It will be remembered that the operation of relay 301, or any group relay in the A allotter causes the operation of relay 1400. Similarly the operation of any group relay in the B allotter causes the operation of relay 1450. As above stated relay 1402 is only operated when idle call storing circuits are available. Therefore, this alarm circuit as well as the timing circuit of the allotter itself can only function if idle storing circuits are available. The operation of relay 1402 closes a circuit from battery through the winding of relay 1300, normal contact of relay 1405, upper contact of relay 1402, back contact of relay 1456 to ground. As will be shown hereinafter, relays 1406 and 1456 operate when the timing function is completed in the corresponding alarm circuit. Therefore, if one alarm circuit has "timed out", the other circuit can neither start timing, nor complete a timing operation already started unless the two circuits complete their operations simultaneously. Relay 1300 in operating closes a circuit from ground through ringing source 1317, ringing interrupter 1318, winding of alternating current relay 1316 to ground over the inner lower contact of relay 1300. Relay 1316 operates with each closure of the ringing interrupter in turn operating relays 1301 and 1302 which are slow to release and are thus independent of small fluctuations in the ringing current. Relay 1300 also connects ground to the armature of relay 1302 and provides ground for locking

relays 1303 to 1314. The first operation of relay 1302 connects ground over its armature, back contact of relay 1304 to the winding of relay 1303 and battery. Relay 1303 locks through the winding of relay 1304, contact of relay 1303, conductor 1315 to ground at the outer lower contact of relay 1300, but relay 1304 does not operate until relay 1302 releases during the open period of the interrupter. At subsequent closures of the interrupter contact relays 1305 to 1314 are operated, consuming approximately 36 seconds. The operation of relay 1314 extends the operating ground for the timing relays to the winding of relay 1405. Relay 1405 locks over its upper alternate contact, upper contact of relay 1402 to ground at the upper contact of relay 1456 and opens the circuit of relay 1300 to release the timing relays. Relay 1405 also operates relay 1406, opening the circuit of relay 1350 to stop any timing operations in connection with the B allotter. Relay 1405 connects ground to conductor 1407 and the winding of relay 510 to initiate the transfer of all calls from the A allotter to the B allotter. Relay 1405 also closes a circuit from battery through the winding of meter 1408, inner lower contact of relay 1405, conductor 1409 to ground at contact 327 of transfer key 300 to record the number of times that it is necessary to transfer calls from the A allotter to the B allotter. The message register in operating closes a circuit from ground over the upper contact of relay 1406, contact of meter 1408, winding of relay 1410 to battery. Relay 1410 locks over key 1411 to ground at its outer upper contact and closes a circuit for relay 1412 over its inner upper contact. Relay 1412 in operating lights lamp 1413 as an indication of the nature and location of the trouble and connects ground to the general alarm circuit to bring in visual and audible alarms. Key 1411 permits the attendant to silence the alarm while he is locating the trouble. Relay 1406 also closes a circuit from ground over its lower contact, conductor 1414 to lamp 311 and battery to indicate the group of trunks with which the allotter was working at the time that the alarm circuit transferred the calls. The operation of the B alarm circuit is substantially the same as that of the A alarm circuit.

It may be noted that relay 1400 remains operated as long as any one of the relays 301 to 306 are operated. The release of all these group relays releases relay 1400 and restores the timing circuit to normal unless relay 1410 has operated and locked. It is possible therefore, that this alarm may merely indicate an unusually heavy load, instead of a relay circuit failure.

The operation of relay 510 as above described, closes circuits for relays 540, 517 and 614. Relay 510 also opens the circuits which test the switches for synchronism and advance them to synchronism. The operation of relay 614 simulates the successful completion of the test for synchronism by the B allotter. Relay 517 opens that part of the circuit of relay 702 closed at its contact, opens the circuit of magnet 507 controlled by relay 700, opens the circuit for operating the group relays of the storing circuits, the circuit for operating the lock-out relays and the circuit for operating relay 700 over brush 505. In other words, relay 517 completely disables the A allotter. Relay 540 causes the successive operation of relays 541, 542, 331, 332 and 333. Relays 540, 541 and 542 transfer the locking circuits controlled by the group relays of the A allotter from lock-out relays 531 to 536 to the lock-out relays 631 to 636. Relays 331, 332 and 333 transfer the operating and locking circuits for the cut-in relays controlled by the group relays of the A allotter from cut-in relays 521 to 526 to cut-in relays 621 to 626. The operation of any one of the group relays 301 to 306 now controls the cut-in relays and lock-out relays of the B allotter so that each cut-in and lock-out relay corresponds to two groups, one from each allotter. Only one call from each two groups can now be allotted while calls wait in other groups. Relay 333 also lights lamp 334 to indicate that calls have been transferred from allotter A to allotter B. Relays 610, 617, 640, 641, 642, 431, 432 and 433 perform similar functions for the B allotter.

Transfer key 300 permits calls to be transferred from the A allotter to the B allotter at the desire of the attendant to permit adjustments, or for any other reason. The operation of key 300 transfers the circuits controlled by group relays 301 to 306 from cut-in relays 521 to 526 to cut-in relays 621 to 626 directly. It also closes a circuit from ground over contact 328, conductor 342 to the winding of relay 1405. Relay 1405 performs the same functions as when operated by the timing relays except that, since the circuit of meter 1408 is opened at contact 327, this meter does not operate and the alarm relays 1410 and 1412 cannot operate. However, relay 510 is operated as before and completes the transfer. Key 300 also closes a local circuit for relay 540.

Timing circuits are also provided to control the operation of the start circuit. It will be remembered that when relay 913 operated a circuit was closed for relay 918. This relay prepares certain locking circuits, and completes a circuit from battery through the winding of relay 924, outer upper contact of relay 918 to ground through the contact of interrupter 925. Relay 924 operates at each closure of the interrupter contact, completing at its first closure a circuit from ground over its upper contact, back contact of relay 921, winding of relay 920 to battery. Relay 920

locks through the winding of relay 921 to ground at the inner upper contact of relay 918, but relay 921 does not operate until relay 924 releases. At the next operation and release of relay 924, relays 922 and 923 operate and lock to the lower contact of relay 918. At the next operation of relay 924 a circuit is extended from ground over the front contacts of relays 924, 921 and 923 to the winding of relay 926 and ground. Relay 926 closes a circuit for relay 927 which locks to the contact of interrupter 925. Relay 927 closes a circuit from ground over its inner lower contact to the winding of relay 919 and over its outer lower contact and the back contact of relay 928 to the winding of meter 929. Relay 919 opens the circuit of relay 918 and connects ground over its inner lower contact to the winding of magnet 907. As soon as interrupter 925 opens its contact, relay 927 releases in turn releasing relay 919 and magnet 907, advancing switch 900 to the next storing circuit. This arrangement permits advancing the start circuit where the storing circuit is not released to do so.

When the storing circuit releases ground is connected over the lower back contact of relay 819 to conductor 824 and the corresponding terminal of brush 905. If now another call is received causing the operation of relay 910 and an operator is idle so that relays 914 and 915 operate, but the start circuit switch fails to advance, the ground thus connected to brush 905 is extended over the outer lower contact of relay 915, lower contact of relay 1032 to the upper winding of relay 928 and battery. The immediate advance of the start circuit switch to the next storing circuit following the operation of relays 910 and 1010 opens the circuit of relay 928 and renders that relay normally ineffective. If the start switch 900 fails to advance, the closure of this circuit operates relay 928 which closes a circuit from ground over its inner upper contact, back contact of relay 919 to battery through the winding of relay 918 initiating the timing operation. When the operation is completed, causing the operation of relay 927 and relay 919, meter 930 is operated over the front contacts of relays 928 and 927 in place of meter 929. The operation of relay 919 also closes a circuit from ground over its lower front contact, outer upper contact of relay 928 to the winding of relay 912 and battery. Relay 912 locks over its middle lower contact to ground at the inner lower contact of relay 910 and extends this ground to the winding of relay 917. Relay 912 opens the circuit of relay 913 and the circuit of relay 908 thus preventing the advance of switch 900. It also extends ground from the contact of relay 910 to the winding of relay 1008 so that the operation of relay 910 will advance switch 1000. Relay 917 in operating opens the start circuit to the trunk and closes a circuit for relay 931. It also operates relay 932. Relay 932 lights lamp 936 to indicate that the A start circuit has been disabled as well as opening other circuits by which the start circuit controls, or is controlled by the storing circuit. Relay 931 lights lamp 933 and locks over key 934 in turn operating relay 935. Relay 935 connects ground to the alarm circuit for operating the general visual and audible alarms. Key 934 permits the silencing of the alarm while the trouble is being located.

Relay 928 or 1028 is also operated if both relays 915 and 1015 fail to operate, relay 928 operating over the back contact of relay 915 and the front contact of relay 1015, while relay 1028 operates over the back contact of relay 1015 and the front contact of relay 915. Otherwise their function is the same as above described. It should be noted that neither of the above timing operations can take place unless relays 914 and 1014 have operated, indicating the presence of an idle operator.

Either one of the start switches may be disabled by the operation of corresponding key 911 or 1011. The operation of key 911 closes a circuit from battery through the winding of relay 912, left contact of key 911 to ground at the lower back contact of relay 1017. Relay 912 performs the functions above described except that the opening of the inner left contact of key 911 prevents the operation of relay 931 and the sounding of an alarm. The right contact of key 911 closes ground over the outer upper contact of relay 910 to the armature of relay 1013 to function switch 1000 under the control of relay 910.

In order to prevent both start switches remaining in an operative position, for example, after a failure has been remedied, a self restoring circuit is provided for switch 1000 whenever both brushes 903 and 1003 engage terminals from 1 to 20. Similarly to prevent both switches becoming inoperative, circuits are provided for operating relay 908 should switches 900 and 1000 simultaneously stand in positions 21 or 22.

What is claimed is:

1. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, means to extend calls to said trunk circuits, means responsive to the extension of calls to said trunk circuits for storing said calls and means to extend said calls to idle operators' positions in the order in which they are stored.

2. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, a plurality of storing circuits common to said operators' positions, means to extend calls to said trunk circuits, means responsive to the extension of each call to one of said trunk circuits for associating one of said storing circuits with said trunk circuit and

means for extending said trunk circuits to said operators' positions in the order in which they are connected with storing circuits.

3. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, a plurality of storing circuits, an allotter, means in said allotter responsive to the extension of calls to said trunk circuits for causing said storing circuits to be associated with said trunk circuits in a predetermined order, a start circuit and means controlled by said start circuit to cause the connection of said trunk circuits with said operators' positions in the same order as said storing circuits were allotted.

4. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, a plurality of storing circuits, an allotter, means in said allotter responsive to the extension of calls to said trunk circuits for causing said storing circuits to be associated with said trunk circuits in a predetermined order, a start circuit and means controlled by said start circuit effective as long as one of said operators' positions is idle to cause the connection of said trunk circuits with said operators' positions in the same order as said storing circuits were allotted.

5. In a telephone system, a plurality of offices, another office, a plurality of operators' positions at said other office, means for extending calls from each of said offices to said other office, means to store said calls, and means to extend the calls to an idle one of said operators' positions in the order in which the calls are stored.

6. In a telephone system, a plurality of offices, an order receiving office, a plurality of operators' positions at said order receiving office, means for extending calls from each of said offices to said order receiving office, means to store said calls, and means to extend the calls to an idle one of said operators' positions in the order in which the calls are stored.

7. In a telephone system, a plurality of offices, a centralized information office, a plurality of trunks connecting each of said offices with said information office, a plurality of operators' circuits, means to extend calls to said information office over said trunks, a plurality of storing circuits, means to associate a storing circuit with each trunk over which a call has been extended, a start circuit, and means controlled by said start circuit to cause the association of said trunks with operators' circuits in the order in which they are associated with storing circuits.

8. In a telephone system, a plurality of offices, a centralized information office, a plurality of trunks connecting each of said offices with said information office, a plurality of operators' circuits, means to extend calls to said information office over said trunks, a plurality of storing circuits, means to associate a storing circuit with each trunk over which a call has been extended, a start circuit, and means controlled by said start circuit if one of said operators is idle to cause the association of said trunk with an idle operator's circuit.

9. In a telephone system, a plurality of offices, a centralized information office, a plurality of trunks connecting each of said offices with said information office, a plurality of operators' circuits, means to extend calls to said information office over said trunks, a plurality of storing circuits, means to associate said storing circuits with the trunks over which said calls have been extended, means controlled through a storing circuit when one of said operators is idle to cause the trunk associated therewith to connect itself with an idle operator's circuit and means to render said storing circuits effective in the same order in which they were associated with trunks.

10. In a telephone system, a plurality of offices, a centralized information office, a plurality of trunks connecting each of said offices with said information office, a plurality of operators' circuits, means to extend calls to said information office over said trunks, an allotter, a plurality of storing circuits, means controlled by said allotter to allot said storing circuits for association with trunks over which calls have been extended in a predetermined order, means controlled through said storing circuits if one of said operators is idle to cause the trunk associated therewith to connect itself with an idle operator's circuit, a start circuit, and means controlled by said start circuit to render said storing circuits effective in the same order in which they were allotted.

11. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, an allotter, means for extending calls to said trunk circuits, means controlled by said allotter for extending calls from said trunk circuits to said operators' positions as long as one of said operators' positions is idle and means common to said operators' positions effective when all of said operators' positions are busy for storing a predetermined number of calls.

12. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, an allotter, means for extending calls to said trunk circuits, means controlled by said allotter for extending calls from said trunk circuits to said operators' positions as long as one of said operators' positions is idle, means effective when all of said operators' positions are busy for storing a predetermined number of calls, and means for extending said stored calls to operators' positions as said operators become idle.

13. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, an allotter, means for extending calls to said trunk circuits, means controlled by said allotter for extending calls from said trunk circuits to said operators' positions as long as one of said operators' positions is idle, means effective when all of said operators' positions are busy for storing a predetermined number of calls, means for extending said stored calls to operators' positions as said operators become idle, and means for storing additional calls as said storing circuits become idle in a predetermined arbitrary order.

14. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, an allotter, means for extending calls to said trunk circuits, means controlled by said allotter for extending calls from said trunk circuits to said operators' positions as long as one of said operators' positions is idle, means effective when all of said operators' positions are busy for storing a predetermined number of calls, and means for extending said stored calls to operators' positions as said operators become idle in the order in which the calls were stored.

15. In a telephone system, a plurality of offices, a centralized information office, a plurality of trunks connecting each of said offices with said information office, a plurality of operators' circuits, means to extend calls to said information office over said trunks, a plurality of storing circuits, an allotter, a switch in said allotter, a start circuit, a switch in the said start circuit, a plurality of storing circuits appearing in the switch of said allotter and the switch of said start circuit in the same order, means controlled by said allotter to cause the association of storing circuits with trunks over which calls have been extended in a particular order, means controlled over each storing circuit for causing the trunk circuit associated therewith to pick an idle operator's position, and means controlled by said start circuit to render said storing circuits effective in the same order as said allotter.

16. In a telephone system, a plurality of offices, a centralized information office, a plurality of trunks connecting each of said offices with said information office, a plurality of operators' circuits, means to extend calls to said information office over said trunks, a plurality of storing circuits, an allotter, a switch in said allotter, a start circuit, a switch in the said start circuit, a plurality of storing circuits appearing in the switch of said allotter and in the switch of said start circuit in the same order, means controlled by said allotter to cause the association of storing circuits with trunks over which calls have been extended in a particular order, means controlled over each storing circuit for causing the trunk circuit associated therewith to pick an idle operator's position, and means controlled by said start circuit to render said storing circuits effective in the same order as said allotter, said start circuit being effective only if one of said operators' positions is idle.

17. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, a plurality of storing circuits, means responsive to the extension of a call to one of said trunk circuits to store a call by associating one of said storing circuits with said trunk circuit, means in said trunk circuit for connecting with an operator's position, and a start circuit for said connecting means, said start circuit being effective only if a stored call and an idle operator's position exist simultaneously.

18. In a telephone system, a plurality of trunk circuits, means to extend a call to one of said trunk circuits, an allotter, a plurality of storing circuits, means in said allotter for pre-allotting a storing circuit, means responsive to the extension of said call to said trunk circuit to cause said pre-allotted storing circuit to connect with said trunk circuit, means for interlocking said trunk circuit and said storing circuit, means responsive to said interlocking means to advance said allotter to pre-allot another storing circuit, a start circuit, a plurality of operators' positions, means effective if one of said operators' positions is idle to extend said start circuit to said trunk circuit and means responsive to said extension to cause said trunk circuit to connect with an idle operator's position.

19. In a telephone system, a plurality of trunk circuits, means to extend a call to one of said trunk circuits, an allotter, a plurality of storing circuits, means in said allotter for pre-allotting a storing circuit, means responsive to the extension of said call to said trunk circuit to cause said pre-allotted storing circuit to connect with said trunk circuit, means for interlocking said trunk circuit and said storing circuit, means responsive to said interlocking means to advance said allotter to pre-allot another storing circuit, a start circuit, a plurality of operators' positions, means effective if one of said operators' positions is idle to extend said start circuit to said trunk circuit, means responsive to said extension to cause said trunk circuit to connect with an idle operator's position, and means responsive to said connection to unlock said storing circuit from said trunk circuit.

20. In a telephone system, an operating desk, trunks incoming to said desk, means for extending calls to said trunks, means for storing and distributing said calls to the operators' positions at said desk, said means comprising equipment provided in dupli-

cate, both portions of said equipment normally operative, and means effective if one portion fails to operate correctly to enable the other portion to do the work of both.

21. In a telephone system, an operating desk, trunks incoming to said desk, means for extending calls to said trunks, means for storing and distributing said calls to the operators' positions at said desk, said means comprising equipment provided in duplicate, both portions of said equipment normally operative and means effective if one portion fails to operate correctly to enable the other portion to do the work of both, and a meter for recording the number of times each portion fails to operate correctly.

22. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, a pair of allotter switches each normally serving a particular group of trunk circuits, means responsive to the seizure of an allotter by one of said trunk circuits to cause the association of said trunk circuit with an operator's position, means responsive to said association to advance said allotter, and means effective if said allotter is not advanced within a predetermined time to render the other of said pair of allotters effective to serve the trunks of both groups.

23. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, a pair of allotter switches each normally serving a particular group of trunk circuits, means responsive to the seizure of an allotter by one of said trunk circuits to cause the association of said trunk circuit with an operator's position, means responsive to said association to advance said allotter, and means effective if said allotter is not advanced within a predetermined time to render the other of said pair of allotters effective to serve the trunks of both groups, and a meter for recording the number of times said allotter fails to advance.

24. In a telephone system, a plurality of trunk circuits, a plurality of sets of circuits for successive association with said trunk circuits, switch means to direct the association of one of said trunk circuits with one of each of said sets of circuits, means for normally advancing said switching means to direct the association of trunk circuits with others of said sets of circuits, and timing means associated with each of said switching means for advancing said switching means if said other advancing means fail to operate within predetermined lengths of time.

25. In a telephone system, a plurality of trunk circuits, a plurality of sets of circuits for successive association with said trunk circuits, switch means to direct the association of one of said trunk circuits with one of each of said sets of circuits, means for normally advancing said switching means to direct the association of trunk circuits with others of said sets of circuits, timing means associated with each of said switching means for advancing said switching means if said other advancing means fail to operate within predetermined lengths of time, and means to prevent the operation of the timing means associated with a particular switching means if all of the sets of circuits under the direction of said switching means are in use.

26. In a telephone system, a plurality of trunk circuits, a plurality of other circuits for association with said trunk circuits, an allotter for allotting said other circuits, means responsive to the association of one of said circuits with a trunk circuit to advance said allotter, a timing device for advancing said allotter if said responsive means fails to operate within a predetermined length of time, and means to disable said timing device if all of said other circuits are busy.

27. In a telephone system, a plurality of trunk circuits, a plurality of other circuits for association with said trunk circuits, an allotter for allotting said other circuits comprising a pair of switches each normally operative and having access in common to said circuits, means responsive to the extension of a call to one of said trunk circuits to seize said allotter, means responsive to the association of one of said other circuits with said trunk circuit to advance both of said switches, a timing device for advancing said switches if said first advancing means fails to operate within a predetermined length of time, and other timing means for disabling one of said switches if said allotter is not advanced within a greater predetermined length of time.

28. In a telephone system, a plurality of trunk circuits, a plurality of other circuits for association with said trunk circuits, an allotter for allotting said other circuits comprising a pair of switches each normally operative and having access in common to said circuits, means responsive to the extension of a call to one of said trunk circuits to seize said allotter, means responsive to the association of one of said other circuits with said trunk circuit to advance both of said switches, a timing device for advancing said switches if said first advancing means fails to operate within a predetermined length of time, other timing means for disabling one of said switches if said allotter is not advanced within a greater predetermined length of time, and means for disabling both of said timing means if all of said other circuits are busy.

29. In a telephone system, a plurality of trunk circuits, an allotter, a plurality of storing circuits, means to extend a call to one of said trunk circuits, means in said allotter to cause the association of a storing circuit with said trunk circuit, means normally responsive to said association for advancing said allotter to allot another storing circuit,

and means effective if said advancing means fails to operate properly to cause the continued allotment of the same storing circuit.

30. In a telephone system, a plurality of trunk circuits, an allotter, a plurality of storing circuits, means to extend a call to one of said trunk circuits, means in said allotter to cause the association of a storing circuit with said trunk circuit, a relay, means normally responsive to said association for operating said relay, means controlled by said relay for advancing said allotter to allot another storing circuit, and means effective if said relay fails to operate to cause the continued allotment of the same storing circuit.

31. In a telephone system, a plurality of trunk circuits, an allotter, a plurality of storing circuits, means to extend a call to one of said trunk circuits, means in said allotter to cause the association of a storing circuit with said trunk circuit, a relay, means responsive to said association for operating said relay, means to release said relay, means responsive to the operation and release of said relay to advance said allotter to allot another storing circuit, and means effective if said relay fails to operate to cause the continued allotment of the same storing circuit.

32. In a telephone system, a plurality of trunk circuits, an allotter, a plurality of storing circuits, means to extend a call to one of said trunk circuits, means in said allotter to cause the association of a storing circuit with said trunk circuit, a relay, means responsive to said association for operating said relay, means responsive to the operation of said relay to release said relay and to advance said allotter to allot another storing circuit, and means effective if said relay fails to release to cause the continued allotment of the same storing circuit.

33. In a telephone system, a plurality of trunk circuits, an allotter, a plurality of storing circuits, means to extend a call to one of said trunk circuits, means in said allotter to cause the association of a storing circuit with said trunk circuit, means normally responsive to said association for advancing said allotter to allot another storing circuit, a timing device, and means controlled by said timing device effective if said first advancing means fails to operate properly to advance said allotter.

34. In a telephone system, a plurality of trunk circuits, an allotter, a plurality of storing circuits, means to extend a call to one of said trunk circuits, means in said allotter to cause the association of a storing circuit with said trunk circuit, means normally responsive to said association for advancing said allotter to allot another storing circuit, a timing device, means controlled by said timing device to operate said advancing means, and means effective if said advancing means fails to operate properly to cause the continued allotment of the same storing circuit.

35. In a telephone system, a plurality of switches, a trunk circuit appearing in the passive contacts of one switch and the active contacts of another switch, a conductor associated with said switch, means responsive to the seizure of said trunk circuit to apply an identifying potential to one of said passive contacts over said conductor, means responsive to the engagement of said one switch with said passive contact to disconnect the identifying potential from said conductor and to extend said conductor to the controlling means of said other switch.

36. In a telephone exchange system, a switch, a trunk circuit terminating in the active contacts of said switch, a plurality of telephone circuits appearing in the passive contacts of said switch, a conductor associated with said trunk, means responsive to the seizure of said trunk to prepare a test circuit over said conductor for identifying an idle telephone circuit, means responsive to the engagement of an idle telephone circuit to prepare a release circuit over said conductor, and manual means associated with said telephone circuit for operating said release means.

37. In a telephone system, a plurality of groups of trunk circuits, an allotter circuit, a plurality of storing circuits having access in common to said trunk circuits, means to operate said allotter circuit to pre-allot a particular storing circuit, means to extend a call to one of said trunk circuits, means responsive to such extension to cause the pre-allotted storing circuit to hunt for and connect with said trunk circuit and means in said allotter to indicate to the storing circuit the group of trunks to which said trunk belongs.

38. In a telephone system, a plurality of groups of trunk circuits, an allotter circuit, a plurality of storing circuits, a plurality of switches in each storing circuit, each switch having a plurality of sets of brushes, each switch and each brush set having access to a different group of trunks, means to operate said allotter circuit to pre-allot a particular storing circuit, means to extend a call to one of said trunk circuits, means responsive to such extension to cause the pre-allotted storing circuit to hunt for and connect with said trunk circuit, and means in said allotter to indicate the switch and brush set to be employed in hunting for said trunk.

39. In a telephone system, a trunk circuit, an operator's position, means automatically responsive to the extension of a call to said trunk circuit to associate said trunk circuit with said operator's position and means under the control of said operator comprising a differential relay in said trunk circuit

for disconnecting said trunk circuit from said operator's position.

40. In a telephone system, a trunk circuit, an operator's position, means automatically responsive to the extension of a call to said trunk circuit to associate said trunk circuit with said operator's position, a differential relay in said trunk circuit for disconnecting said trunk circuit from said operator's position, means responsive to said association to establish a balanced circuit through said differential relay and operator controlled means to unbalance said circuit to operate said relay.

41. In a telephone exchange system, a pair of switches, means for seizing either of said switches, a plurality of sets of conductors, said switches having access to said sets of conductors in common, apparatus controlled over each of said sets of conductors, means individual to each switch effective when both switches are engaging the same sets of conductors to initiate the operation of said apparatus and means effective if said switches are not engaging the same set of conductors to bring said switches into engagement with the same set of conductors and for delaying the operation of said apparatus until said switches engage the same set of conductors.

42. In a telephone exchange system, a pair of switches, means for seizing either of said switches, a plurality of sets of conductors, said switches having access to said sets of conductors in common, apparatus controlled over each of said sets of conductors, means individual to each switch effective when both switches are engaging the same sets of conductors to initiate the operation of said apparatus and means responsive to the seizure of one of said switches and effective if said switches are not engaging the same set of conductors to operate said switch to bring said switches to the same set of conductors and for delaying the operation of said apparatus until said switches engage the same set of conductors.

43. In a telephone system, a plurality of storing circuits, an allotter comprising a pair of switches having access in common to said storing circuits, means to operate said switches simultaneously to allot said storing circuits in a predetermined order and means effective if said switches are not in engagement with the same storing circuit to operate one of said switches to bring it into engagement with the storing circuit engaged by the other.

44. In a telephone system, a plurality of trunk circuits, an allotter comprising a pair of switches each serving a different portion of said trunks, said switches having access in common to said storing circuits, means for operating said switches so that the same storing circuit is normally pre-allotted by both switches, means responsive to the extension of a connection to one of said trunk circuits and controlled by the corresponding switch to cause the pre-allotted storing circuit to connect with said trunk circuit and means effective if both switches are not in engagement with the same storing circuit to delay the operation of said storing circuit while said switch is brought into engagement with the same storing circuit as the other switch.

45. In a telephone system, a plurality of trunk circuits, a plurality of operators' positions, an allotter comprising a pair of switches each serving a different portion of said trunk circuits, said switches having access in common to said storing circuits, means for operating said switches so that the same storing circuit is normally pre-allotted by both switches, means responsive to the extension of a connection to one of said trunk circuits and controlled by the corresponding switch to cause the pre-allotted storing circuit to connect with said trunk circuit, means effective if both switches are not in engagement with the same storing circuit to delay the operation of said storing circuit while said switch is brought into engagement with the same storing circuit as the other switch, and means thereupon effective to extend said trunk circuit to an operator's position.

In witness whereof, we hereunto subscribe our names this 26th day of August, 1929.

WARREN W. CARPENTER.
JACK F. DAHL.
RICHARD C. DAVIS.
LINUS E. KITTREDGE.