

Aug. 18, 1942.

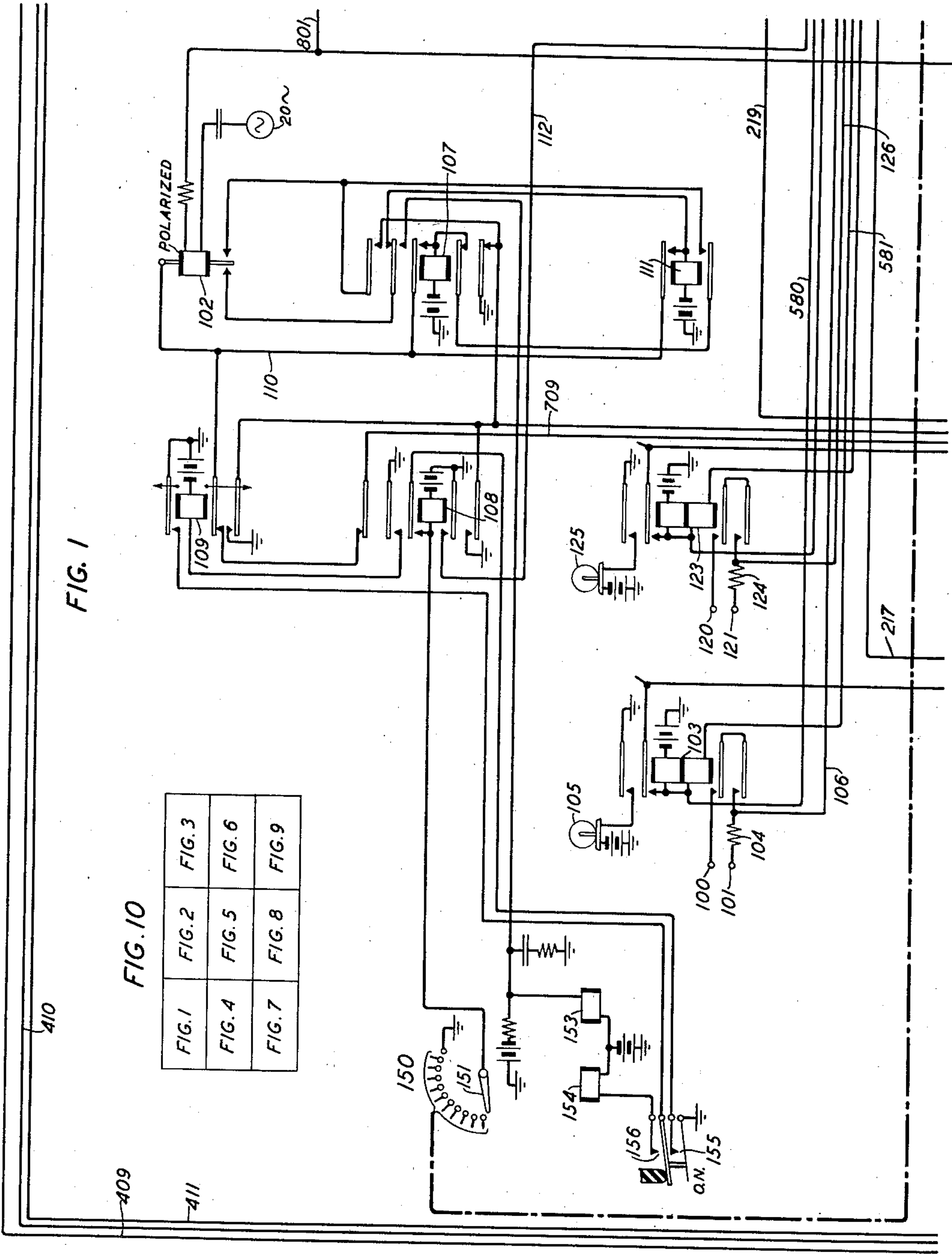
L. T. MEEDS

2,293,611

TELEPHONE SYSTEM

Filed Feb. 1, 1941

9 Sheets-Sheet 1



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TELEPHONE SYSTEM

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9 Sheets-Sheet 2

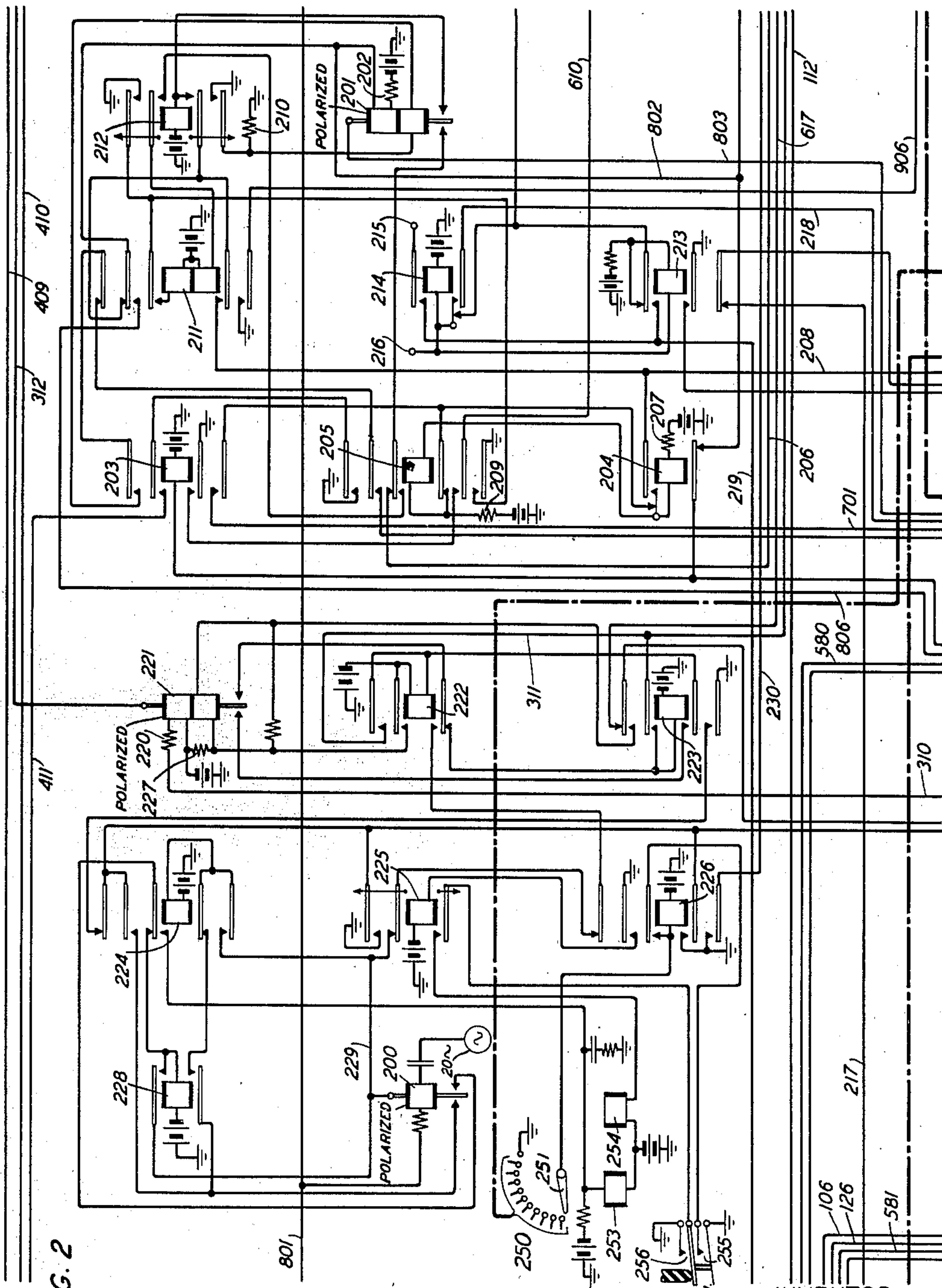


FIG. 2

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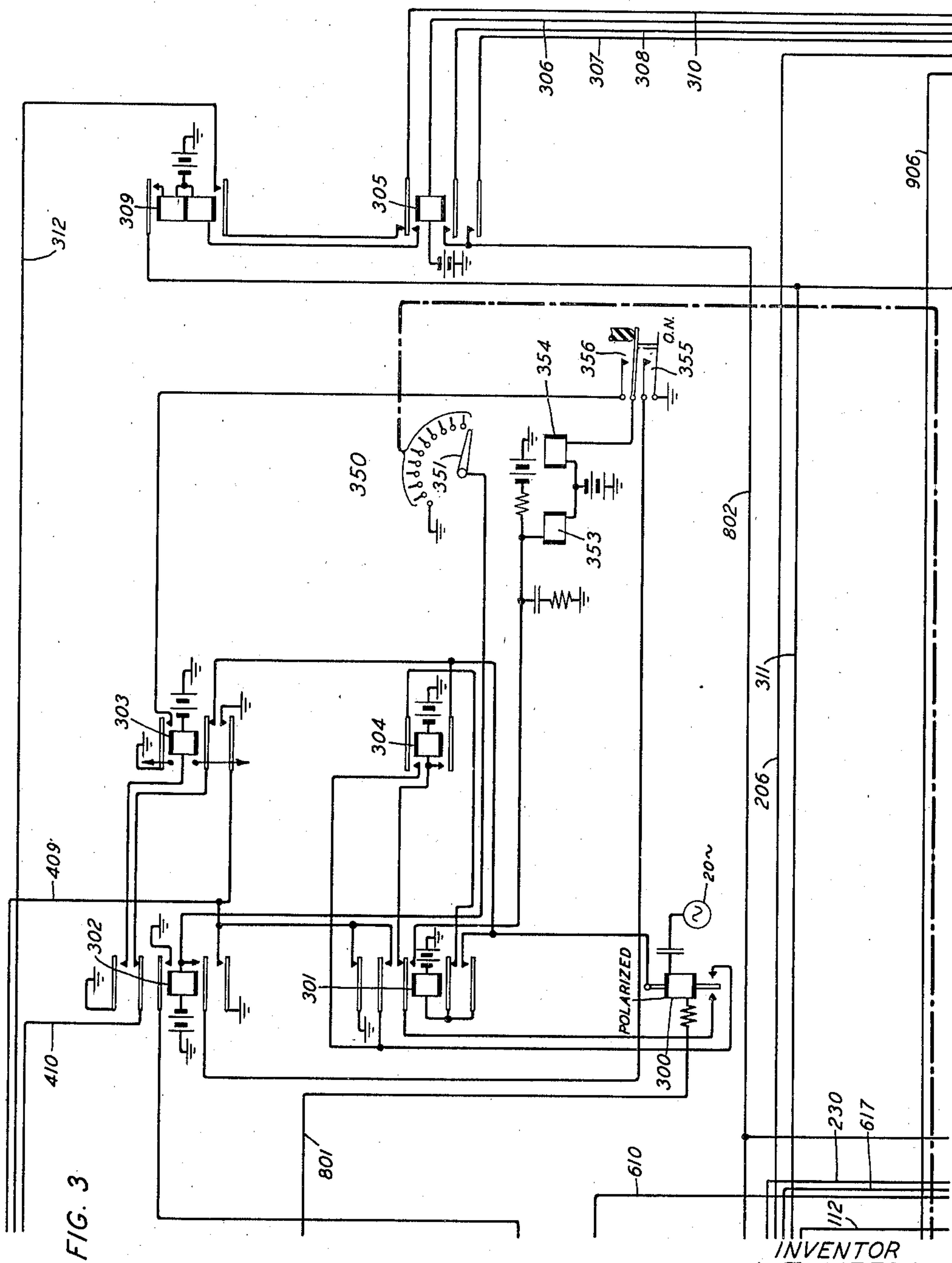
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TELEPHONE SYSTEM

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9 Sheets-Sheet 3



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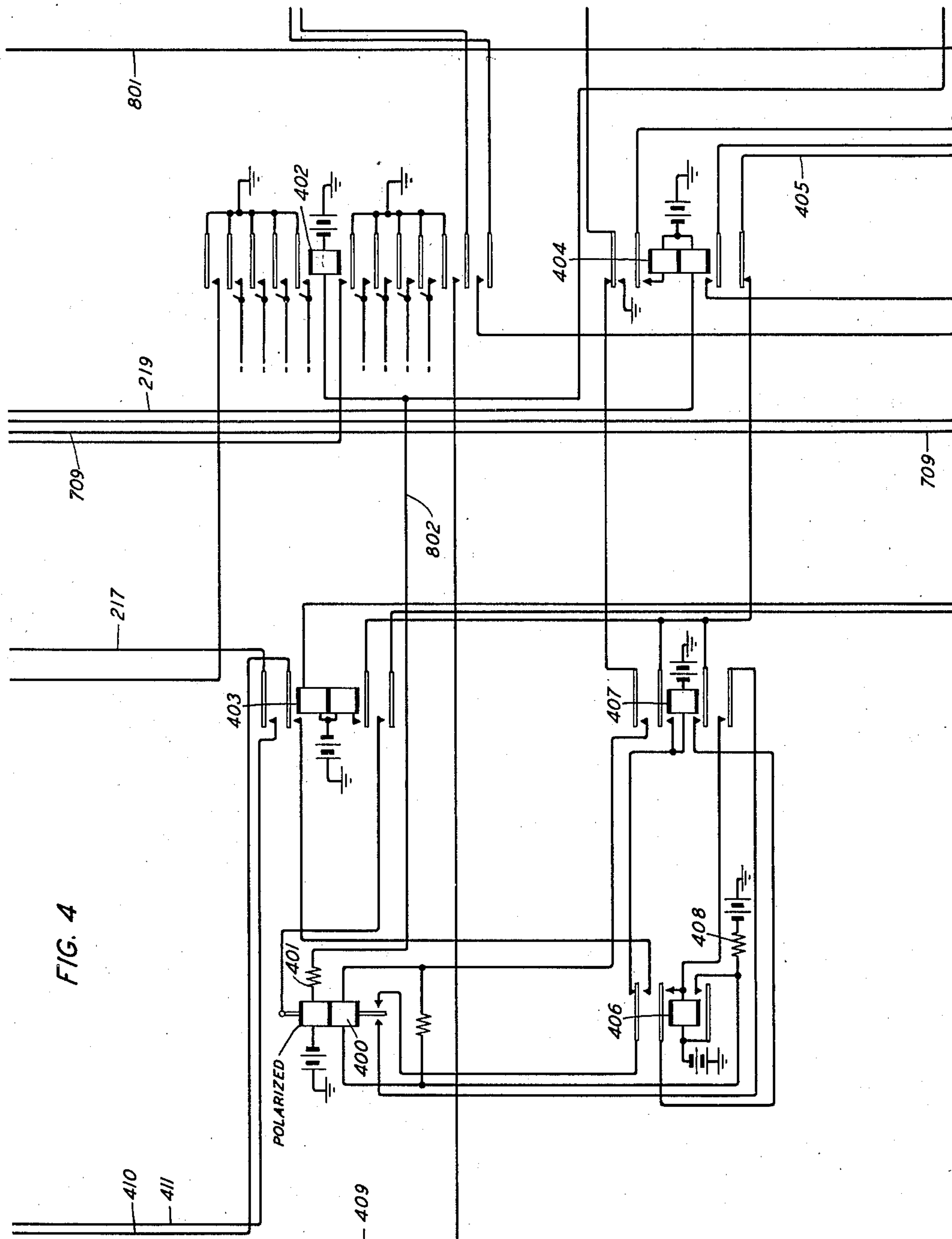
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TELEPHONE SYSTEM

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9 Sheets-Sheet 4



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TELEPHONE SYSTEM

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9 Sheets-Sheet 5

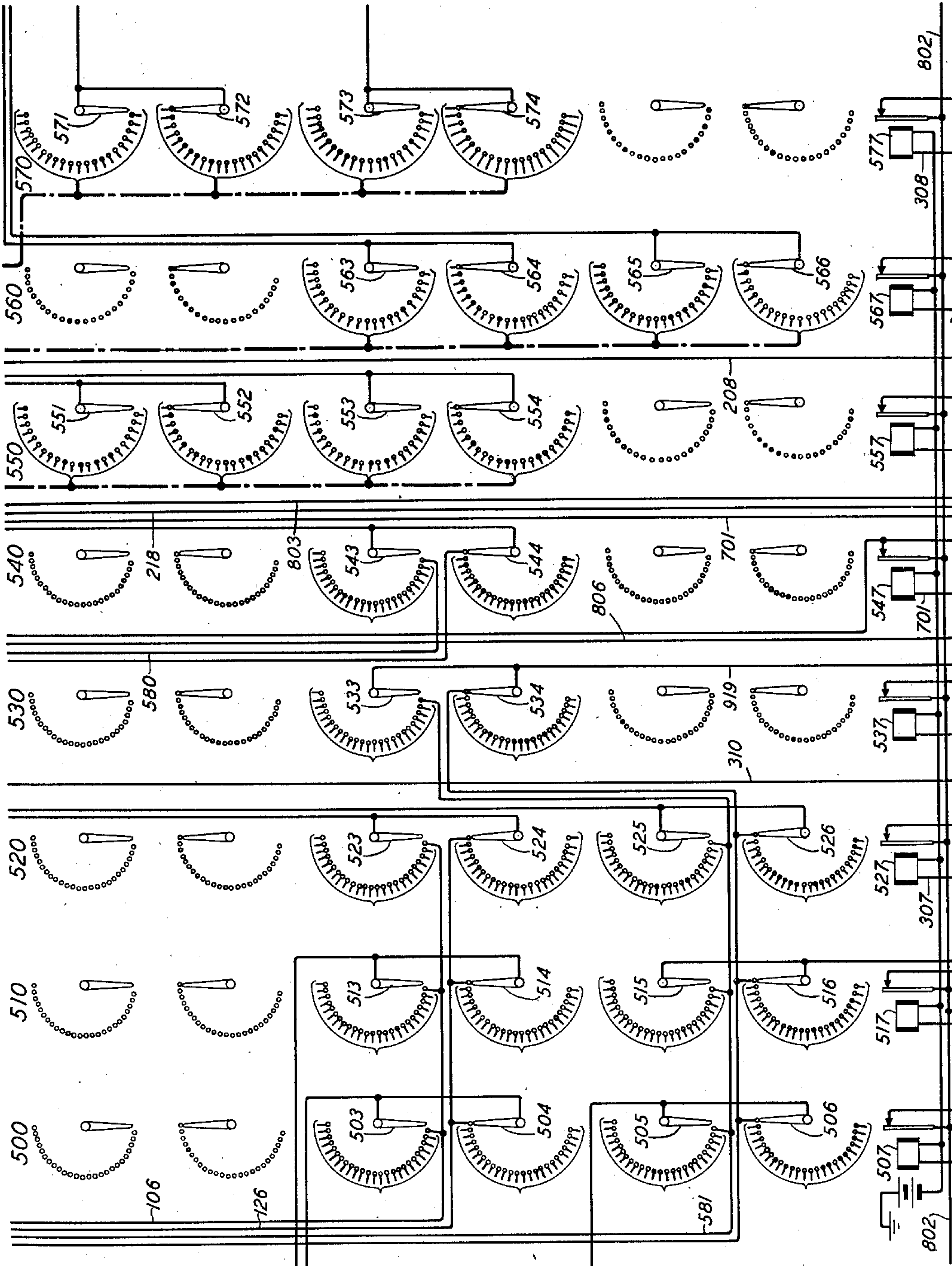


FIG. 5

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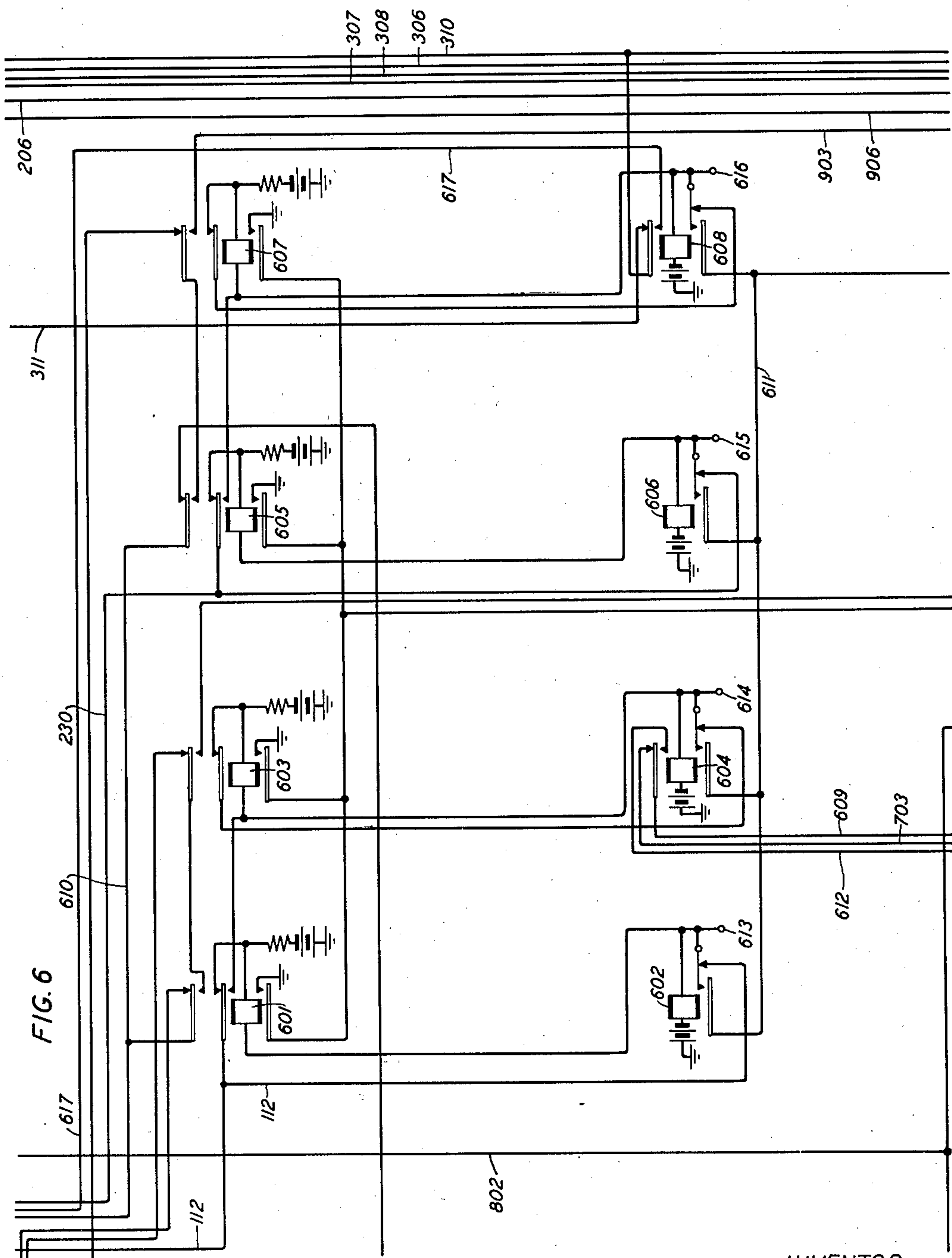
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TELEPHONE SYSTEM

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9 Sheets-Sheet 6



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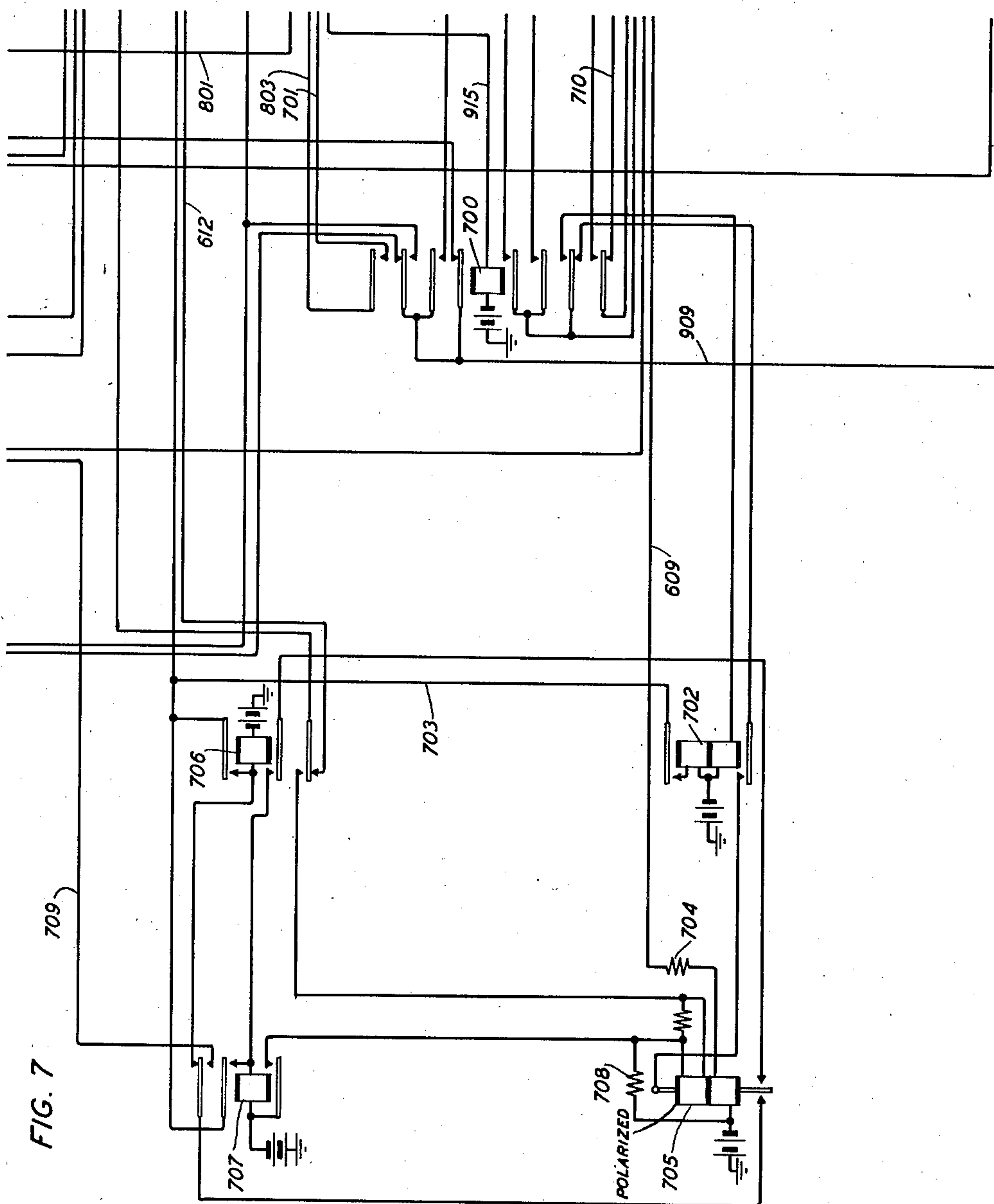
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TELEPHONE SYSTEM

Filed Feb. 1, 1941

9 Sheets-Sheet 7



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2,293,611

TELEPHONE SYSTEM

Filed Feb. 1, 1941

9 Sheets-Sheet 8

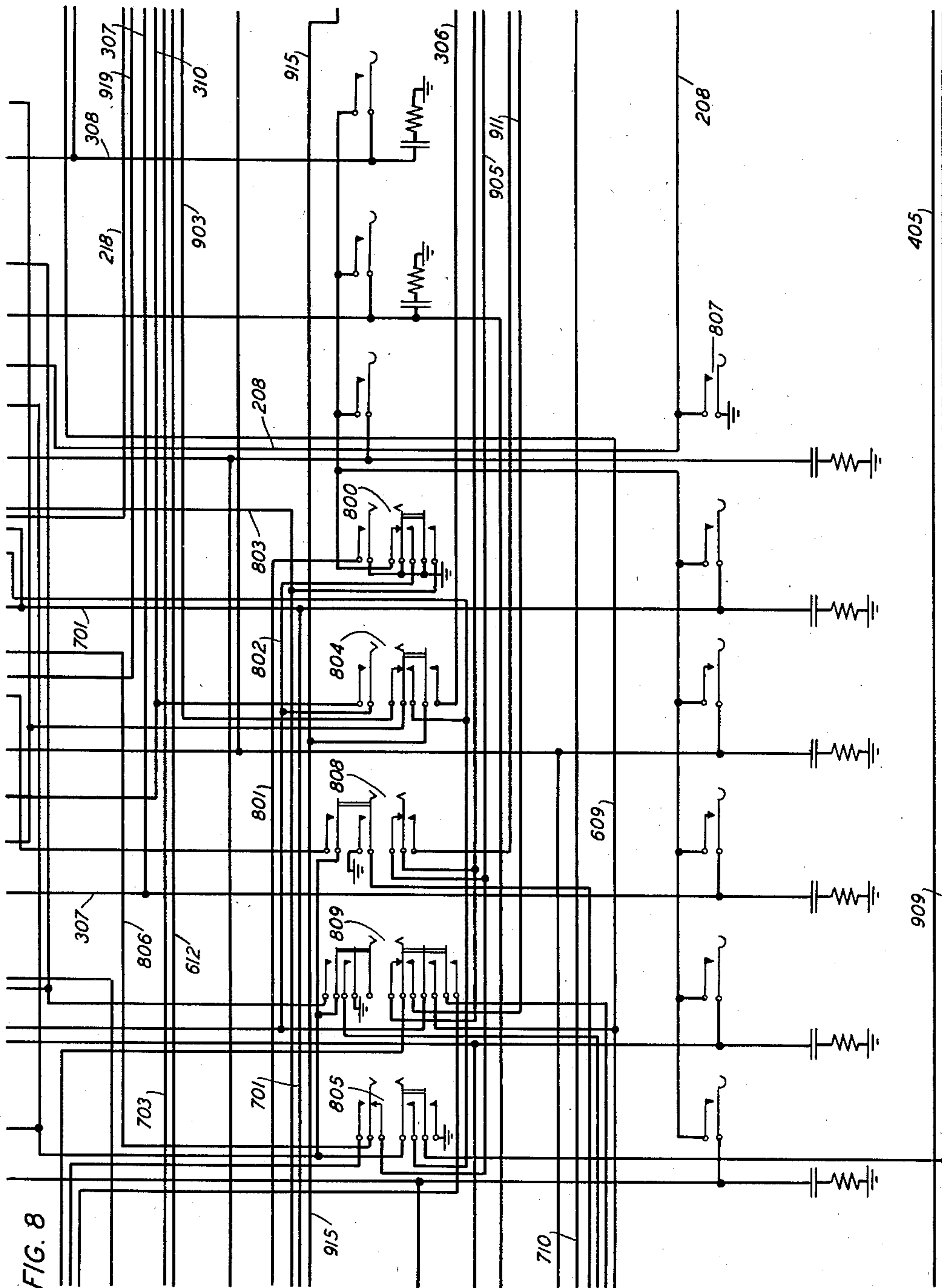


FIG. 8

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2,293,611

TELEPHONE SYSTEM

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9 Sheets-Sheet 9

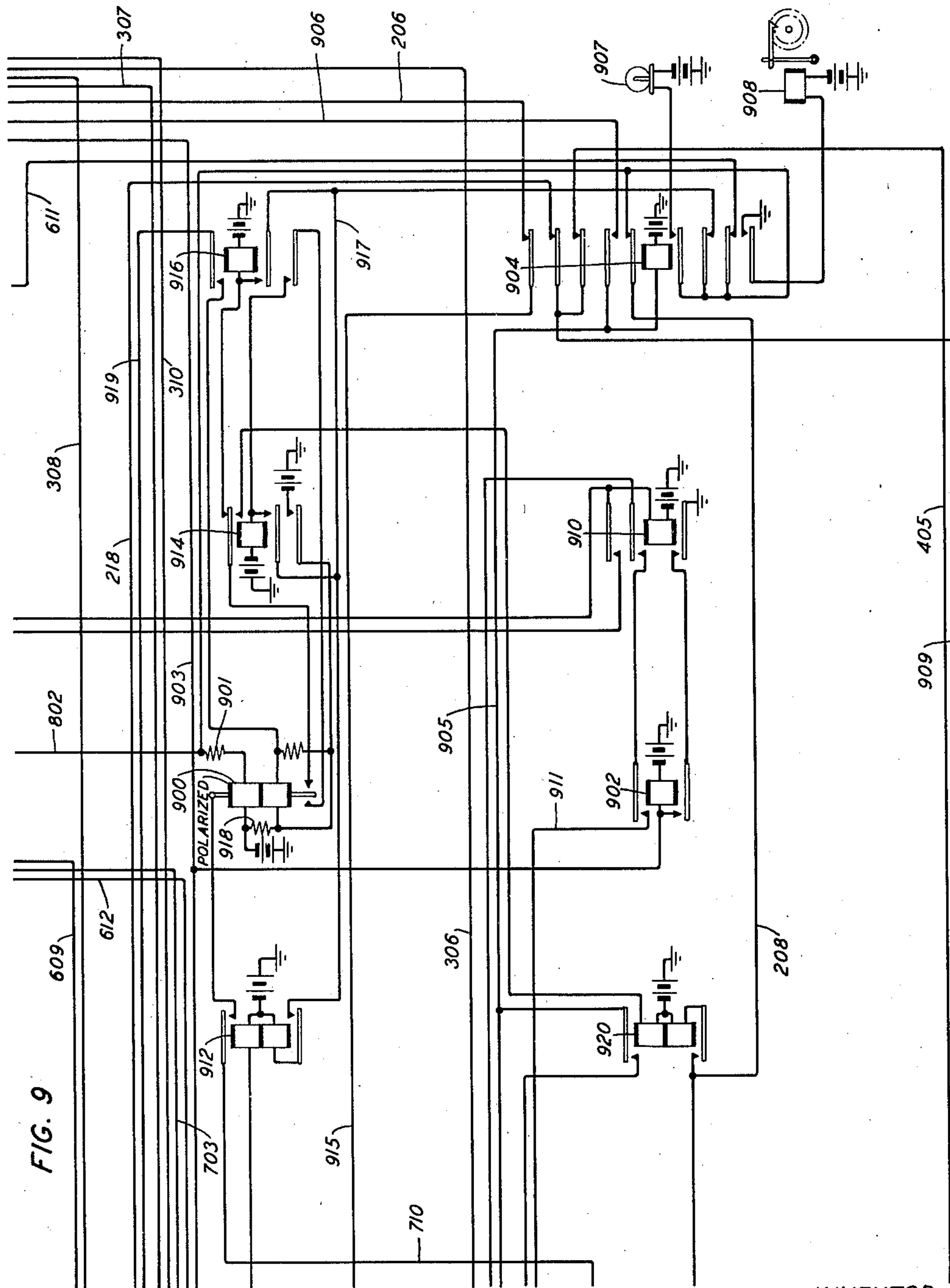


FIG. 9

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UNITED STATES PATENT OFFICE

2,293,611

TELEPHONE SYSTEM

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Application February 1, 1941, Serial No. 376,961

15 Claims. (Cl. 179—175.2)

This invention relates to telephone systems and has for its object to facilitate the testing of automatic telephone exchanges particularly when newly installed.

The vast number of connections made during the installation of an automatic telephone exchange require a thorough test of every part of the exchange before placing it in service. However, satisfactory individual tests may not result in satisfactory operation under service conditions, since the traffic load is a factor of great importance in the ability of an office to function.

In accordance with the present invention, means is provided to simulate service conditions by originating a large volume of calls over a group of lines and directing the calls to a variety of destinations in proportion to the expected service load.

By this means it becomes possible to determine whether the equipment will handle the expected maximum traffic with the proper margin of safety from the standpoint of condition, quantity and distribution of the circuits involved.

In addition, the call originating means of the present invention supplements the special circuit test equipment by creating a condition of service under which the individual pieces of equipment must function.

A further advantage provided by this call originating means may be found in the training given the maintenance force in the handling of troubles which may arise or may be artificially produced.

Specifically the invention provides means for seizing a plurality of line terminals one at a time and originating a call thereover. After an interval the lines are successively connected to a plurality of dialing means which are arranged to transmit different designations over each line. Subsequently, each set of line terminals is seized to simulate disconnection. Means is provided for determining the intervals between each seizure of given line terminals together with means for maintaining the intervals for all of the lines.

The means for seizing the line terminals comprises a plurality of rotary switches each of which has access to all of the lines. Manual means is provided for starting each switch, after which the switches advance in synchronism so that a different plurality of lines are acted on at each step.

The invention will be more clearly understood from a consideration of the following description in connection with the accompanying drawings, in which

Figure 1 shows the switch which controls the dialing of the thousands and hundreds digits, and two sets of line terminals;

Fig. 2 shows a switch for dialing the tens and units digits as well as certain control relays;

Fig. 3 shows the code dialing switch;

Fig. 4 shows the line seizure controlling equipment;

Fig. 5 shows the switches which connect with the line terminals;

Fig. 6 shows the numerical dialing control relays;

Fig. 7 shows the relays which start the number dialing;

Fig. 8 shows the control keys;

Fig. 9 shows the synchronizing relays; and

Fig. 10 shows the arrangement of Figs. 1 to 9.

This call originating circuit is particularly designed for testing the cross-bar type of telephone system such as disclosed in U. S. Patents No. 2,235,803, to W. W. Carpenter, March 18, 1941, and No. 2,232,371, to J. W. Dehn et al., February 18, 1941, but is equally applicable to other types of dial telephone systems.

Before starting the use of the call originator, fifty sets of originating line terminals are selected and connected with fifty sets of terminals such as terminals 100, 101 and 120, 121 in the call originator. In addition, forty-four telephone designations are selected and the brushes of switches 550, 560 and 570 are cross-connected to switches 350, 150 and 250 in accordance therewith. By spreading the lines selected over the originating equipment and selecting the designations to include a variety of office codes and number groups, as well as operator codes and unstand designations such as permanent signals, etc., a traffic load closely resembling the actual expected service load can be built up. For larger offices a plurality of these call originators may be used to create a sufficient load.

The test circuit consists essentially of five integral parts which function together as a single circuit unit. These five parts may be called

1. Dial tone seizure circuit.
2. Office code dialing circuit.
3. Thousands and hundreds digit dialing circuit.
4. Tens and units digit dialing circuit.
5. Line disconnect circuit.

Each of these five circuits connects with a pair of line terminals in succession and the interval between the connections of the five circuits with any single line is determined by a key which con-

trols the initial operation of the corresponding circuit. When started, the five circuits progress in synchronism, all five circuits completing their function before any one can advance. By varying the time of starting the different circuits, any reasonable sender holding time may be obtained. This overlapping arrangement permits five times as many calls to be originated as would be possible if the calls were originated singly. On the other hand, it produces a continuous load rather than the intermittent load which is produced by test circuits which originate a plurality of calls simultaneously and may conveniently supplement the use of the latter.

No means is provided in this circuit for checking the accuracy with which the connections are established. However, by connecting a condenser across the terminating line terminals corresponding to selected designations, to satisfy the marker, and preventing the operation of the intercept relays of the terminating markers, every case of trouble will cause a record to be made by the trouble indicator. Since the terminating trouble indicator gives the number called and identifies the marker, the sender and the incoming circuit involved, the large volume of calls given by the call originator quickly brings out any circuit failures likely to signal wrong numbers.

Dial tone seizure circuit

Referring now to the detailed functioning of the circuit, the operation is started by operating start key 800. This key grounds conductors 801, 802, and 803. Ground on conductor 801 completes the circuits of relays 102, 200, and 300 which, being connected to a source of pulsating current, now begin to pulse at a rate of twenty pulses per second. Ground on conductor 802 completes a circuit through resistance 401 and the upper winding of polarized relay 400 to battery to hold the back contact of that relay closed. For a similar purpose a circuit is closed by ground on conductor 802 through the upper winding of relay 201 and resistance 202 to battery and through resistance 901 to the upper winding of relay 900 and battery. In addition, ground on conductor 802 completes a circuit for relay 402. Relay 203 operates in a circuit from battery through its winding over the back contact of magnet 547 or over the back contact of relay 204 to conductor 802, while relay 902 operates in a circuit from battery through its winding, conductor 903, lower normal contact of key 804, back contacts of magnets 527 and 577 to grounded conductor 802.

With relay 201 energized as above described, a circuit is closed from ground on conductor 803, left, normal contact of relay 201, upper back contact of relay 205, conductor 206, uppermost back contact of relay 904, conductor 915; winding of relay 700 and battery. Relay 700 closes a circuit from ground on conductor 803, outer upper front contact of relay 700, conductor 701, winding of magnet 547, which controls switch 540, and battery and in parallel with magnet 547 over the outer lower contact of relay 203, normal contact and winding of relay 204, resistance 207 and battery. Magnet 547 and relay 204 operate. Relay 204 locks over its alternate contact, conductor 208, inner upper back contact of relay 904 to grounded conductor 802. At the same time relay 204 closes a circuit from battery through resistance 209, winding of relay 205, alternate contact of relay 204 to ground as

above traced. Relay 205 cannot operate, being shunted over its lower back contact by the operating circuit of relay 204. When magnet 547 and relay 204 have both operated, the circuit for relay 203 is opened and that relay releases, permitting relay 205 to operate. The operation of relay 205 opens the circuit of relay 700, causing that relay to release and release magnet 547 to advance switch 540 to its first operative position.

When magnet 547 releases, relay 203 reoperates. Relay 203 now closes a circuit from ground through resistance 210, lower winding of relay 201, outer upper contact of relay 203, outer upper back contact of relay 211, middle upper front contact of relay 205, brush 543, conductor 530, upper winding of line relay 103 and battery.

Relay 103 is individual to the line terminals 100 and 101 and is the first of fifty such relays whose corresponding line terminals have been connected to line terminals on the originating frames of the office.

If relay 103 is normal relay 201 receives sufficient current in the circuit traced to overcome the effect of the circuit through its upper winding and therefore closes its right, operated, contact to operate relay 212. Relay 212 locks over its inner lower contact, inner upper back contact of relay 211 to ground on conductor 802.

Relay 103 did not receive sufficient current to operate in series with resistance 210 but relay 212, in operating, connects direct ground to the winding of relay 201 in shunt of resistance 210, whereupon relay 103 operates. Relay 103 connects resistance 104 across the terminals 100 and 101 thereby simulating the action of a subscriber in originating a call. It also lights lamp 105 to indicate that the line terminals are in use. Relay 103 locks over its inner upper front contact to a contact of relay 402 which supplies the locking ground for all of the line relays.

The locking ground of relay 103 shunts the winding of relay 201 and causes that relay to reclose its left contact under the influence of its upper winding. With relay 205 operated, the release of relay 201 closes a circuit from ground on conductor 803, left contact of relay 201, inner upper front contact of relay 205, inner upper front contact of relay 212, lower winding of relay 211 and battery. The operation of relay 211 indicates that a line relay has been found normal, has been operated and has been locked. Relay 211 locks through its upper winding and inner upper contact to ground at the outer lower contact of relay 205 and in parallel therewith to ground at the outer upper contact of relay 212. At its inner upper back contact relay 211 opens the previously traced locking circuit for relay 212 but at its inner lower contact it closes a second circuit from the locking contact of relay 212 to conductor 208 which extends over the inner upper back contact of relay 904 to grounded conductor 802. Relay 212 is slow to release and therefore remains operated during the transfer of its locking circuit.

Since key 805 has not yet been operated, relay 211 in operating closes a circuit from ground on conductor 802, outer upper front contact of relay 211, conductor 306, normal contact of key 805, conductor 905 to the winding of relay 904 and battery. Relay 904 locks over its inner upper front contact and conductor 906, to ground at the inner lower front contact of relay 211. The operation of relay 904 indicates the completion of a cycle, which at this time only included the

simulated initiation of a call. Relay 904 lights lamp 907 as a visual indication of the end of the cycle and also operates peg count meter 908. Relay 904 opens the operating circuit of relay 700 and the locking circuits of relays 204 and 212 causing these relays to release, followed by relays 205, 211 and 904. The slow release character of relay 212 delays the release of relays 211 and 904 for a definite interval.

When relay 904 has released, relay 700 reoperates and the switch 540 is advanced to operate another line relay in the manner above described. Since the line relays lock to relay 402 which in turn operates directly from start key 800, the line relays remain locked and the line closures are maintained independent of the position of switch 540.

In the manner above described one line relay after another is operated, each placing a bridge across the corresponding tip and ring terminals causing the automatic equipment to connect an idle sender and district junctor with the line terminals. When any desired time has elapsed, preferably one sufficient to insure the connection of a sender with each line, key 807 is operated and, since it is a non-locking key, is held operated until the lighting of lamp 907 indicates the end of a cycle. Key 807 grounds conductor 208 holding relays 204, 205 and 212 operated. These relays in turn hold relays 211 and 904. Key 805 is now operated to start the functioning of the code dialing circuit. Key 807 is then released and after relay 904 releases, relay 700 reoperates.

Office code dialing circuit

The office code dialing circuit includes switches 500, 550 and 350. With key 805 operated ground is connected over conductor 909 to the first, second and third upper armatures of relay 700. Therefore, when relay 700 operates a circuit is closed over the inner upper front contact of relay 700 to the winding of magnet 507 and battery and over the second upper front contact to the winding of magnet 557 and battery and, in parallel therewith, through the upper winding of relay 403 and battery. Relay 403 locks over its inner lower contact, lower back contact of relay 404, conductor 405, third upper back contact of relay 904, conductor 909 to ground at the contact of key 805.

With key 805 operated the circuit of relay 203 extends, in addition to the paths previously traced, over the inner lower alternate contact of key 805 and over the back contacts of magnets 507 and 557 to grounded conductor 802 so that these magnets must also operate before relay 203 can release to bring about the release of relay 700 and the advance of switch 540. The release of relay 700 releases magnets 507 and 557 to step switches 500 and 550 to their first operative terminals.

Relay 700 in releasing also closes a circuit from ground on conductor 909, outer upper back contact of relay 700, outer lower contact of relay 403, right, normal, contact of relay 400, back contact of relay 406 to the winding of relay 407 and battery. Relay 407 locks in a circuit over its inner upper contact in parallel with relay 403 under the control of relay 904.

Relay 407 tests whether the first line relay has remained operated and locked by closing a circuit from battery through resistance 408, lower winding of relay 400, outer upper contact of relay 407, upper back contact of relay 404, brush

505 in its first operative position, conductor 581, lower winding and inner upper contact of line relay 103, to ground at the contact of relay 402. With locking ground present, relay 400 operates, closing a circuit from battery through the winding of relay 406, outer lower front contact of relay 407, left, operated, contact of relay 400, outer lower contact of relay 403, outer upper back contact of relay 700 to ground on conductor 909. Relay 406 locks over its inner upper front contact and the inner lower contact of relay 407 in parallel with relays 403 and 407.

Relay 406 connects direct battery in shunt of resistance 408 to the circuit of relay 400 and the lower winding of line relay 103. The lower winding of relay 103 is opposed to the upper winding at this time and the adjustment is such that with the increased current in the lower winding, the resultant magnetic flux is insufficient to hold relay 103 operated and it therefore releases. With the removal of the locking ground for relay 103, relay 400 also releases. However, the dial equipment is not released, since ground is connected to the ring terminal 101 over a circuit which may be traced from that terminal, through resistance 104, conductor 106, brush 503, lower contact of relay 402, conductor 409 to ground at the outer upper back contact of relay 301.

When relay 400 releases, it extends the ground which was connected as above traced to its armature, over its right contact, outer upper front contact of relay 406, inner upper contact of relay 403, conductor 410, back contacts of relays 302 and 303 to the armature of relay 300 which is pulsing at a rate of twenty pulses per second as previously described.

With the armature of relay 300 grounded the first subsequent closure of its left contact completes a circuit over the inner upper back contact of relay 301, winding of relay 304 and battery. Relay 304 operates and locks over its lower contact and the back contacts of relays 303 and 302 to ground on conductor 410. When relay 300 then closes its right contact, it extends ground over the upper contact of relay 304, lower back contact and winding of relay 301 to battery. Relay 301 also operates, locking in parallel with relay 304. With relay 301 operated the left contact of relay 300 is connected over the inner upper front contact of relay 301 to the winding of magnet 353, while the right contact of relay 300 is connected over the outer upper front contact of relay 301 to conductor 409 and the ring terminal 101. When relay 301 operated it disconnected steady ground from that terminal but since the right contact of relay 300 is closed at the time that relay 301 operates, the ring terminal is grounded over the contact of relay 300.

As relay 300 pulses, therefore, it alternately operates stepping magnet 353 and opens the ring conductor toward the dial equipment to transmit an impulse thereto. Relays 301 and 304 serve to prevent the transmission of mutilated first pulses to the magnet 353 and the dial equipment. In order to determine the value of the digit to be transmitted, the terminals of brush 351 are cross-connected to the terminals of brushes 553 and 554 in accordance with the selected designations. It may be noted that brushes 553 and 554, while connected in parallel are arranged at 180 degrees to one another so that only one brush is effective at a time. When brush 351 reaches the terminal cross-connected to the first terminal of brush 553, a circuit is closed from battery through the winding of relay 302, brushes 351 and 553,

lower back contact of relay 213, conductor 217, outer upper contact of relay 403, conductor 411, inner upper contact of relay 203 to ground at the outer upper front contact of relay 205. Relay 302 operates and locks over its inner lower front contact and off-normal contact 355 of switch 350.

With relay 302 operated, ground is connected to conductor 409 to hold the dial equipment. Relay 302 disconnects ground from the armature of relay 300 to stop the pulsing. It also closes an obvious circuit for relay 303 which in turn closes a circuit from ground at its upper contact, over off-normal contact 356 to the winding of release magnet 354 and battery, restoring the switch 350 to normal. With switch 350 normal, contacts 354 and 355 are opened and relay 302 releases, followed after an interval, due to the slow release character of relay 303, by the latter relay. Relay 303 is made slow enough to allow time between digits for the subscriber sender circuit relays to properly function and be ready for the next digit.

When relay 303 operated it also connected ground to conductor 409. In addition, relays 302 and 303 open the locking circuit of relays 301 and 304 thereby causing these relays to release and connect ground to conductor 409.

Relay 302 in operating closed a circuit from ground at its inner upper contact, normal contact and winding of relay 214 to battery. Relay 214 locks over its alternate contact, conductor 218, third upper back contact of relay 904 to ground over conductor 909. At the same contact relay 214 closes a circuit for relay 213 but relay 213 cannot operate, being shunted at its upper back contact by the operating circuit for relay 214. When relay 302 releases as above described, relay 213 operates, opening the circuit over brushes 553 and 554 and connecting ground to brushes 551 and 552.

When relay 303 recloses its back contact, the armature of relay 300 is again grounded and relays 301 and 304 operate followed by the transmission of the second code digit. Relay 302 operates at this time over brushes 351 and 551 to ground at the front contact of relay 213. Relay 303 is operated, relays 301 and 304 released and switch 350 restored to normal as previously described. With relay 213 operated, relay 302 closes a circuit from ground over the inner upper contact of relay 302, upper front contact of relay 213, conductor 219, lower winding of relay 404 and battery. Relay 404 closes a locking circuit for itself from battery through its upper winding and inner upper front contact, inner upper back contact of relay 700 to ground over conductor 909.

With relay 404 operated, a circuit is closed from ground over the outer upper front contact of relay 404, brush 505, conductor 501, two windings of relay 103 in series to battery. In this circuit the current flow in the lower winding of relay 103 aids that in the upper winding and relay 103 reoperates, locking as before. The operation of relay 404 also opens the locking circuit of relays 403, 406 and 407 and these relays release.

In the meantime the next line relay has been operated and locked over switch 540 and relay 211 operated as previously described. However, with key 805 operated the circuit by which relay 211 operated relay 904 is open. When relay 404 has also operated, a circuit is closed from battery through the winding of relay 904, conductor 905, lower normal contacts of keys 803 and 809, lower front contact of relay 404, upper alternate contact

of key 805, conductor 806, outer upper front contact of relay 211 to ground over conductor 802. Therefore, both cycles must have been completed before relay 904 can operate. Relay 904 performs the previously described functions with regard to the dial tone seizure circuit. For the code dialing circuit it releases relays 213, 214 and 404. When relay 212 has released, relay 904 releases and after the previously described operations relay 700 operates to start a new cycle.

Thousands and hundreds digit dialing circuit

Again any desirable number of cycles is permitted to take place as indicated by the lighting of lamp 907. Key 807 is again operated to prevent the release of relay 212 and when lamp 907 lights, key 809 is operated to start the dialing of the thousands and hundreds digits. Key 807 is then released, permitting relay 212 and the other relays to release.

With key 809 operated the circuit of relay 203 extends, in parallel with the branches above traced, over the inner lower alternate contact of key 805, outer upper contact of key 809 and the back contacts of magnets 517 and 567 to grounded conductor 802. Therefore, relay 203 can release only if magnets 507, 517, 547, 557 and 567 have operated as well as relay 204. At its middle lower alternate contact, key 809 connects grounded conductor 802 to conductor 609, which extends through resistance 704 and the lower winding of relay 705 to battery to hold the left, normal, contact of relay 705 closed.

When relay 700 operates, the circuits previously traced are closed, and in addition circuits are closed from battery through the winding of magnet 517 to the inner lower front contact of relay 700 and from battery through the winding of magnet 567 to the second lower front contact of relay 700 and thence in parallel to ground at the inner upper alternate contact of key 809. Magnets 517 and 567 operate in synchronism with the other magnets. Relay 700 also closes a circuit from ground on the inner upper contact of key 809 over the third lower front contact of relay 700, lower winding of relay 702 to battery. Relay 702 operates and locks in a circuit from battery through its upper winding and upper contact, conductor 703, upper back contact of relay 604, to ground on conductor 609.

When, subsequently, relay 700 releases, magnets 517 and 567 in turn release, advancing switches 510 and 560 into association with the line terminals 100 and 101. At this time a circuit is closed from battery through the winding of relay 706, back contact of relay 707, and left contact of relay 705, lower contact of relay 702, inner lower back contact of relay 700, to ground at the inner upper contact of key 809. Relay 706 locks to ground over conductor 703 as above traced. With relay 706 operated, a circuit is closed from battery through resistance 708, upper winding of relay 705, outer lower front contact of relay 706, brush 515 to conductor 501 and the lower winding of relay 103. As in the previously described circuit, if relay 103 is locked, relay 705 operates and closes a circuit from battery through the winding of relay 707, inner lower front contact of relay 706, right, operated, contact of relay 705, lower front contact of relay 702, inner lower back contact of relay 700 to ground at the contact of key 809. Relay 707 locks over conductor 703 and connects direct battery in shunt of resistance 708, releasing relay 103, which in releasing also releases relay 705. The ring

terminal 101 of the first line is now connected over conductor 106, and brush 513, lowermost front contact of relay 402, lowermost contact of key 809 to ground at the outer lower back contact of relay 107 so that the dial equipment does not release.

With relay 705 released, ground is extended from the contact of key 809 over the inner lower back contact of relay 700, lower contact of relay 702, left contact of relay 705, outer upper front contact of relay 707, conductor 709, back contacts of relays 108 and 109, to conductor 110 and the armature of relay 102 which is pulsing at twenty pulses per second as mentioned above.

The thousands and hundreds digit dialing circuit functions in the same manner as the code dialing circuit, the first cycle of relay 102 operating relays 111 and 107. Relays 111 and 107 lock to conductor 110, relay 107 connecting the left contact of relay 102 to the winding of the stepping magnet 153 of switch 150 and connecting the right contact of relay 102 to the ring line terminal, at the same time removing the holding ground. The terminals of brush 151 are cross-connected to terminals of brushes 563, 564, 565 and 566 in accordance with the selected designations. Therefore, when brush 151 reaches the terminal cross-connected to the first terminal of brush 563 a circuit is closed from battery through the winding of relay 108, brushes 151 and 563, outer upper back contact of relay 601, conductor 610, inner lower front contact of relay 205, inner lower contact of relay 203 to ground.

Relay 108 operates and locks to off-normal contact 155, in turn operating relay 109. In addition, relay 108 grounds the ring conductor, and disconnects ground from conductor 110 to arrest pulsing. Relay 109 operates release magnet 154, restoring switch 150 to normal. Relay 108 closes a circuit from ground at its inner lower contact, conductor 112, normal contact and winding of relay 602 to battery. Relay 602 locks over conductor 611, second lower back contact of relay 904 to grounded conductor 802. It also prepares the circuit of relay 601 which is shunted by the operating circuit for relay 602.

When switch 150 reaches normal, relay 108 releases, permitting relay 601 to operate. With relay 601 operated, the circuit of relay 108 over brushes 563 and 564 is opened and a new circuit is prepared over brushes 565 and 566, outer upper back contact of relay 603 and the outer upper front contact of relay 601, to ground over conductor 112 as previously traced.

When relay 108 releases, it opens the circuit of relay 109, which releases slowly to permit the sender functions to be completed. When relay 109 closes its back contact, relay 102 becomes operative again and the hundreds digit is sent out in the same manner as the thousands digit. When relay 108 operates following the hundreds digit, it closes a circuit from ground at its inner lower contact, conductor 112, inner upper front contact of relay 601, to the windings of relays 603 and 604. Relay 603 operates slightly later than relay 604 due to a shunt over the normal contact of relay 604 which opens as soon as the latter relay operates. Relay 604 closes a locking circuit for itself and relay 603 to conductor 611.

Relay 604 at its upper armature disconnects ground on conductor 609 from conductor 703, releasing relays 702, 706 and 707. When relay 706 releases ground is closed from conductor 609, over the upper front contact of relay 604, conductor 612, back contact of relay 706, brush 515

to conductor 581 and the windings of relay 103 in series. As before, relay 103 operates and locks to hold the dial equipment.

With relay 603 operated a circuit is closed from ground on conductor 610 over the outer upper front contacts of relays 601 and 603 to the winding of relay 910 and battery. Relay 910 locks to ground at the lower contacts of relays 601 and 603.

The operation of relay 910 indicates the completion of the function of the third circuit unit. In the meantime relay 211 has operated to indicate the completion of the cycle by the first circuit and relay 404 may or may not have been operated by the termination of the sending of the code digits. If relay 404 operates early it cannot cause the operation of relay 904, since the circuit by which the joint operation of relays 211 and 404 operated relay 904 is now open at key 809.

It will be remembered that at the time the start key was operated, relay 902 was operated. With relay 902 operated, the joint operation of relays 211, 404 and 910 completes a circuit for relay 904 which may be traced from battery through the winding of relay 904, conductor 905, lower normal contact of key 808, inner upper contact of relay 910, upper contact of relay 902, conductor 911, inner lower alternate contact of key 809, lower front contact of relay 404, upper alternate contact of key 805, conductor 806, upper front contact of relay 211 to grounded conductor 802.

Relay 904 operates and advances the three circuits to the next cycle as previously described. In operating, relay 904 also releases relays 601 to 604.

Again the circuits are permitted to advance through a few cycles, after which hold key 807 is operated to arrest the operation and, when lamp 907 lights to indicate the end of a cycle, key 804 is operated and key 807 released.

Tens and units digit dialing circuit

With key 804 operated the circuit of relay 902 is opened and that relay releases. Key 804 also extends the circuit of relay 203 over inner lower alternate contact of key 804, and the back contacts of magnets 527 and 577 to grounded conductor 802 so that these magnets must also operate prior to the release of relay 203. At its upper alternate contact, key 804 connects grounded conductor 802 to conductor 310, resistance 220, the upper winding of relay 221 and battery, holding the armature of that relay against its normal, right, contact. In addition it connects battery through relay 305, over conductor 306 and the outer lower alternate contact of key 804 to conductor 915 in parallel with relay 700 to, in effect, provide additional contacts for relay 700.

When relay 305 operates, in parallel with relay 700, it connects conductor 802, over its lower contacts to conductors 307 and 308, operating magnets 527 and 577. In addition, it closes a circuit from battery through the lower winding of relay 309, upper front contact of relay 305, conductor 310, upper contact of key 804 to grounded conductor 802. Relay 309 operates and locks in a circuit from battery through its upper winding and upper front contact, conductor 311, upper back contact of relay 608 to ground over conductor 310.

When relay 305 releases, switches 520 and 570 step to their first operative positions. Relay 305

also extends ground from conductor 310 over the back contact of relay 305, lower contact of relay 309, conductor 312, right contact of relay 221, back contact of relay 222, winding of relay 223 and battery. Relay 223 locks to conductor 311 and connects ground over its outer lower contact, outer upper back contact of relay 224, brush 523, to the ring conductor 106 to hold the dial equipment. Relay 223 also connects battery through resistance 227 and the lower winding of relay 221, outer upper front contact of relay 223, brush 525 to conductor 581, and the two windings of relay 103. With relay 103 locked, relay 221 operates, in turn operating relay 222 which locks to conductor 311. Relay 222 connects direct battery to the winding of relay 221, releasing relay 103 in the manner previously described, followed by the release of relay 221.

Ground on conductor 312 is now extended over the right contact of relay 221, lower front contact of relay 222, back contacts of relays 226 and 225 to conductor 229 and the armature of relay 200.

Relay 200, which is pulsing at twenty pulses per second, operates relays 228 and 224 to absorb the first cycle, these relays locking to conductor 229. With relay 224 operated the right contact of relay 200 is connected to the winding of the stepping magnet 253 of switch 250 while the left contact of relay 200 is connected to brush 523 and the ring line conductor. The tens digit is transmitted to the dial equipment and switch 250 advanced.

The terminals of switch 250 are cross-connected to the terminals of brushes 571 and 574 in accordance with the selected designations and, when brush 251 reaches the terminal cross-connected to the first terminal of brush 573, a circuit is closed from battery through the winding of relay 226, brushes 251 and 573, outer upper back contact of relay 605, conductor 610 to ground as previously traced. Relay 226 locks to off-normal contact 255, disconnects ground from conductor 229 to stop the pulsing and release relays 224 and 228, connects ground to the ring conductor to hold the dial equipment, and operates relay 225. Relay 225 operates release magnet 254 to restore the switch 250 to normal and adds ground to the ring conductor.

Relay 226 connects ground over its outer lower contact to conductor 230, normal contact and winding of relay 606 to battery. Relay 606 locks to conductor 611 preparing a circuit for relay 605. When switch 250 returns to normal relay 226 releases and relay 605 operates. Relay 226 opens the circuit of relay 225 but that relay releases slowly to permit the sender to prepare for the next digit.

With relay 225 released, conductor 229 is grounded again and the units digit is sent out. At this time the circuit of relay 226 extends over brushes 251 and 571, outer upper back contact of relay 607, outer upper front contact of relay 605 to ground over conductor 610. When relay 226 is operated by the arrival of brush 251 at the cross-connected terminal, the same operations take place as at the end of the tens digit. However, the connection of ground to conductor 230 now completes a circuit over the inner upper front contact of relay 605 to the windings of relays 607 and 608 which operate in the manner of relays 603 and 604.

The operation of relay 603 opens the locking circuit of relay 226, permitting that relay to release, and closes a circuit from ground on conductor 310, upper front contact of relay 608, con-

ductor 617, back contact of relay 223, brush 525 to conductor 581 and the windings of relay 103. Relay 103 operates and locks as previously described.

With relays 605 and 607 operated, ground on conductor 610 extends over the outer upper front contacts of relays 605 and 607, to conductor 903 and the winding of relay 902. The operation of relay 902 is now an indication that the tens and units digit dialing circuit has completed its operation. The circuit for operating relay 904 is, therefore, the same as before this latter dialing circuit was started. Relay 910 locks under the control of relays 601, 603, 605 and 607 while relay 902 locks under the control of relay 910. Relay 904 opens the locking circuits of relays 605 to 608 used in this circuit as well as those of the relays locked under its control in its other circuits.

When an additional number of cycles have taken place, key 807 is again operated to stop the circuit, key 808 is operated and key 807 released.

Line disconnect circuit

The operation of key 803 connects the back contact of magnet 537 in parallel with the other magnet contacts in the circuit of relay 203. It also connects ground over its inner upper contact to the outer lower armature of relay 700 to provide an operating circuit for magnet 537, and relay 912 which is closed when relay 700 operates.

Relay 912 locks in a circuit from battery through its lower winding and lower contact, conductor 917, inner lower back contact of relay 904 to grounded conductor 802. When relay 700 releases, ground from the contact of key 808 extends over the outer lower back contact of relay 700, conductor 710, upper contact of relay 912, right, normal, contact of relay 903, back contact of relay 914, winding of relay 916 and battery. Relay 916 locks to conductor 917.

With relay 916 operated a circuit is closed from battery through resistance 913, lower winding of relay 900, upper contact of relay 916, conductor 919, brush 533, conductor 581, lower winding of relay 103 to ground over the upper locking contact of relay 103. Relay 900 operates in this circuit, closing a circuit from ground on conductor 710, upper contact of relay 912, left, operated, contact of relay 900, outer lower contact of relay 916 to the winding of relay 914 and battery. Relay 914 operates and locks to conductor 917.

Relay 914 connects direct battery in shunt of resistance 913, causing relay 103 to release, in turn releasing relay 900. No circuit is provided to hold the dial equipment at this time, therefore the switches connected with line terminals 100 and 101 are permitted to restore.

When relay 900 releases, a circuit is closed from ground on conductor 710, upper contact of relay 912, right contact of relay 900, upper front contact of relay 914 to the winding of relay 920 and battery. Relay 920 operates and locks in a circuit from battery through its lower winding and contact to ground over conductor 208.

With key 808 operated the circuit for relay 904 used following the start of the tens and units dialing circuit is opened and a circuit closed which depends on the completion of its cycle by each of the five circuit units. This circuit may be traced from battery through the winding of relay 904, conductor 905, upper contact of relay 920, lower alternate contact of key 808, inner upper contact of relay 910, upper contact of relay 902, conductor 911, inner lower alternate contact of key 809,

lower front contact of relay 404, upper alternate contact of key 805, conductor 806, inner upper front contact of relay 211 to grounded conductor 802.

The circuit now proceeds to originate calls on the line terminals, one after another. Lamp 907 provides a visual indication of the speed with which the complete calls are put through while the line lamp, such as lamps 105 and 125, provide an indication of the spacing between the operations of the various units.

When it is desired to stop the circuit, key 800 is released releasing all relays which may be locked at the time. Switches which are off-normal may be restored by means of the stepping keys individual thereto which receive ground from key 800 in its normal position.

Terminals 215, 216 and 613 to 616 are used to control the dialing of irregular designations such as permanent signal, zero operator or partial dialing. To omit the corresponding digit, terminal 216 is cross-connected to the desired terminal of brush 553 or 554, terminal 215 to the terminal of brush 551 or 552, terminal 613 to that of brush 563 or 564 and so on.

For example, if a permanent signal condition is to be sent, in a particular position of switches 550, 560 and 570, all of the cross-connecting terminals 215, 216 and 613 to 616 will be connected to the brush terminals in this position. Therefore, as soon as relay 205 has operated and relay 203 reoperated, grounding conductor 217, as above described, a circuit will extend from conductor 217 over the lower back contact of relay 213, brush 553, terminal 216 to the windings of relays 213 and 214 which operate immediately.

With relays 213 and 214 operated a circuit is closed from ground at the lower front contact of relay 213, brush 551, terminal 215, upper contact of relay 214 to conductor 219 to operate relay 404. Similarly, when switch 560 reaches the corresponding position, the operation of relays 203 and 205 closes a circuit over conductor 610, back contact of relay 601, brush 563, terminal 613 to the windings of relays 601 and 602 which operate at once. Relay 601 extends the circuit to brush 565 and terminal 614 thereby operating relays 603 and 604 to in turn operate 910. In a similar manner relays 605 to 608 are operated to in turn operate relay 902. The release and reoperation of the line relay takes place whether or not the digits are transmitted. While in the circuit shown provision has been made for two digit office codes the adaptation for use in a three digit office would be made readily.

It may be noted that since switches 500, 510, 520, 530 and 540 have twenty-five sets of terminals and switches 550, 560 and 570 have twenty-two sets of terminals, different designations will be transmitted each time a line is seized until each designation has been sent out over each line.

What is claimed is:

1. In a telephone system, automatic switching equipment, lines having access to said switching equipment, and means to operate said equipment in simulation of service conditions comprising means for automatically connecting with and closing a particular plurality of said lines one at a time, other means for connecting with said lines and transmitting predetermined telephone designations over said lines in turn and additional means for connecting with each of said lines and opening said lines in turn.

2. In a telephone system, automatic switching equipment, lines having access to said switching

equipment, and means to operate said equipment in simulation of service conditions comprising means for automatically connecting with and closing a particular plurality of said lines one at a time, means effective after a predetermined number of said lines have been closed for connecting with said lines and transmitting predetermined telephone designations over said lines in turn and means effective after a further predetermined number of lines have been closed for connecting with each of said lines and opening said lines in turn.

3. In a telephone system, automatic switching equipment, lines having access to said switching equipment, and means to operate said equipment in simulation of service conditions comprising means for automatically connecting with and closing a particular plurality of said lines one at a time, means effective after a predetermined number of said lines have been closed for connecting with said lines and transmitting predetermined telephone designations over said lines in turn, means effective after a further predetermined number of lines have been closed for connecting with each of said lines and opening said lines in turn, and manual means for predetermining said number of lines and said further number of lines.

4. In a telephone system, automatic switching equipment, lines having access to said switching equipment, and means to operate said equipment in simulation of service conditions comprising means for successively originating a call, dialing an office code, dialing a numerical code and terminating a call over each of said lines at predetermined overlapping intervals and means for maintaining said intervals throughout the operation of said equipment.

5. In a telephone system, automatic switching equipment, lines having access to said switching equipment, and means to operate said equipment in simulation of service conditions comprising call originating means, means for connecting each of said lines in turn with said call originating means to originate a call thereover, a plurality of dialing means, means for connecting each of said dialing means with each of said lines in turn to transmit a telephone designation thereover, call terminating means, means for connecting said call terminating means with each of said lines in turn, manual means for controlling the relative time of connection of said call originating means, said dialing means and said call terminating means with the first of said lines and means for automatically advancing said connecting means and maintaining said relative time of connection with the remainder of said lines.

6. In a telephone system, automatic switching equipment, lines having access to said switching equipment, and means to operate said equipment in simulation of service conditions comprising call control means including as elements call originating means, a plurality of dialing means and call terminating means, connecting means for connecting each element of said call control means to said lines in turn and means to control said connecting means to simultaneously connect each element of said call control means with different lines.

7. In a telephone system, automatic switching equipment, lines having access to said switching equipment, and means to operate said equipment in simulation of service conditions comprising means for successively originating a call,

dialing an office code, dialing a numerical code and terminating a call over each of said lines at predetermined overlapping intervals, means for maintaining said intervals throughout the operation of said equipment, and means for controlling said dialing means to dial a different office code and numerical code in connection with calls originated over successive lines and with successive calls on any one of said lines.

8. In a telephone system, automatic switching equipment, lines having access to said switching equipment, means to operate said equipment in simulation of service conditions comprising means for automatically and repeatedly closing a particular plurality of said lines one at a time, means for transmitting telephone designations over said lines in turn, means for automatically opening said lines in turn, and means for controlling said designation transmitting means to transmit a different telephone designation over each of said lines following each closure of said lines.

9. In a telephone system, automatic switching equipment, lines having access to said switching equipment, means to operate said equipment in simulation of service conditions comprising a plurality of sets of line terminals connected to a plurality of said lines, a relay individual to each said set of line terminals, a plurality of multiposition switches, means to operate said switches to successively connect with each set of line terminals and the relay individual thereto in turn, means to operate each of said relays to close a bridge across the corresponding set of line terminals, means controlled over each of said switches in each position to release the connected said relay and substitute a dialing connection for said bridge, means to transmit a plurality of digits over said dialing connection, and means to reoperate said relay to restore said bridge.

10. In a telephone system, automatic switching equipment, lines having access to said switching equipment, means to operate said equipment in simulation of service conditions comprising a plurality of sets of line terminals connected to a plurality of said lines, a relay individual to each said set of line terminals, a plurality of multiposition switches, means to operate said switches to successively connect with each set of line terminals and the relay individual thereto in turn, means to operate each of said relays to close a bridge across the corresponding set of line terminals, means controlled over each of said switches in each position to release the connected said relay and substitute a dialing connection for said bridge, means to transmit a plurality of digits over said dialing connection, means to reoperate said relay to restore said bridge, an additional switch having access to said line terminals and means operated over said additional switch to release each of said relays in turn.

11. In a telephone system, automatic switching equipment, lines having access to said switching equipment, means to operate said equipment in simulation of service conditions comprising a plurality of sets of line terminals connected to a plurality of said lines, a plurality of multiposition rotary switches having access to said line terminals, means controlled over each switch for establishing a dialing connection with each set of line terminals in turn, a plurality of other rotary switches having a different number of positions, means effective in each position of said other switches for controlling said dialing con-

nections in accordance with different telephone designations, and means for advancing one of said multiposition switches and one of said other switches simultaneously through a plurality of rotations to dial a plurality of different designations over each set of line terminals.

12. In a telephone system, automatic switching equipment, lines having access to said switching equipment, and means to operate said equipment in simulation of service conditions comprising call control means including as elements call originating means, a plurality of dialing means and call terminating means, connecting means for connecting each element of said call control means to said lines in turn, means in each of said elements responsive to the operation of said element for preparing the associated connecting means for advance, and means under the joint control of the responsive means in all of said elements to simultaneously advance all of said connecting means.

13. In a telephone system, automatic switching equipment, lines having access to said switching equipment, and means to operate said equipment in simulation of service conditions comprising call control means including as elements call originating means, a plurality of dialing means and call terminating means, connecting means for connecting each element of said call control means to said lines in turn, manual means for successively starting each of said elements, means in each of said elements responsive to the operation of said element for preparing the associated connecting means for advance, means to advance said connecting means, and means under the control of said manual means for successively placing said advancing means under the joint control of the responsive means of the elements which have been started.

14. In a telephone system, automatic switching equipment, lines having access to said switching equipment and means to operate said equipment in simulation of service conditions comprising call originating means, first connecting means for connecting said call originating means with each of said lines in turn to establish a bridge across each line to originate a call thereover, the first means operated responsive to the establishment of said bridge to control the advance of said first connecting means to the next line, a plurality of dialing means, other connecting means for connecting each of said dialing means to each of said lines to transmit a telephone designation thereover, other means operated responsive to the completion of each of said dialing operations to control the advance of said other connecting means to the next line, call terminating means, additional connecting means for connecting said call terminating means with each of said lines in turn to disconnect said bridge, further means responsive to the disconnection of said bridge to control the advance of said additional means to the next line, manual means for controlling the relative time of connection of said first connecting means, said other connecting means and said additional connecting means with the first line of said plurality of lines, and means for automatically maintaining said relative time of connection for each of said lines.

15. In a telephone system, automatic switching equipment, lines having access to said switching equipment and means to operate said equipment in simulation of service conditions comprising call originating means, first connecting means for connecting said call originating means with

each of said lines in turn to establish a bridge across each line to originate a call thereover, the first means operated responsive to the establishment of said bridge to control the advance of said first connecting means to the next line, a plurality of dialing means, other connecting means for connecting each of said dialing means to each of said lines to transmit a telephone designation thereover, other means operated responsive to the completion of each of said dialing operations to control the advance of said other connecting means to the next line, call terminating means, additional connecting means for connecting said call terminating means with each of said lines

5 in turn to disconnect said bridge, further means responsive to the disconnection of said bridge to control the advance of said additional means to the next line, manual means for controlling the relative time of connection of said first connecting means, said other connecting means and said additional connecting means with the first line of said plurality of lines, and means operated under the joint control of said first responsive means, 10 said other responsive means and said additional responsive means to simultaneously advance all of said connecting means.

LLOYD T. MEEDS.