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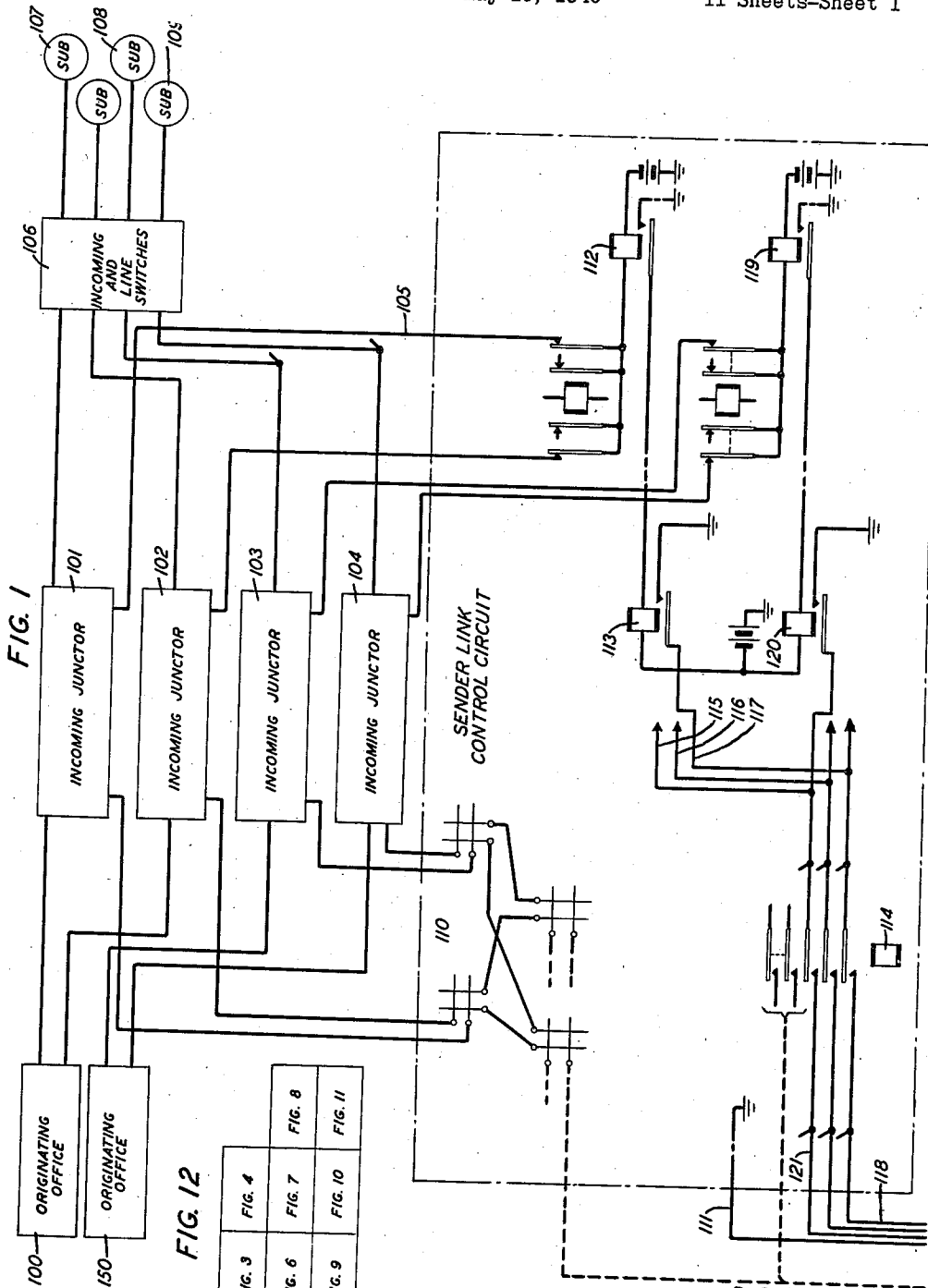
R. C. DAVIS ET AL

2,259,101

TELEPHONE SYSTEM

Filed May 15, 1940

11 Sheets-Sheet 1



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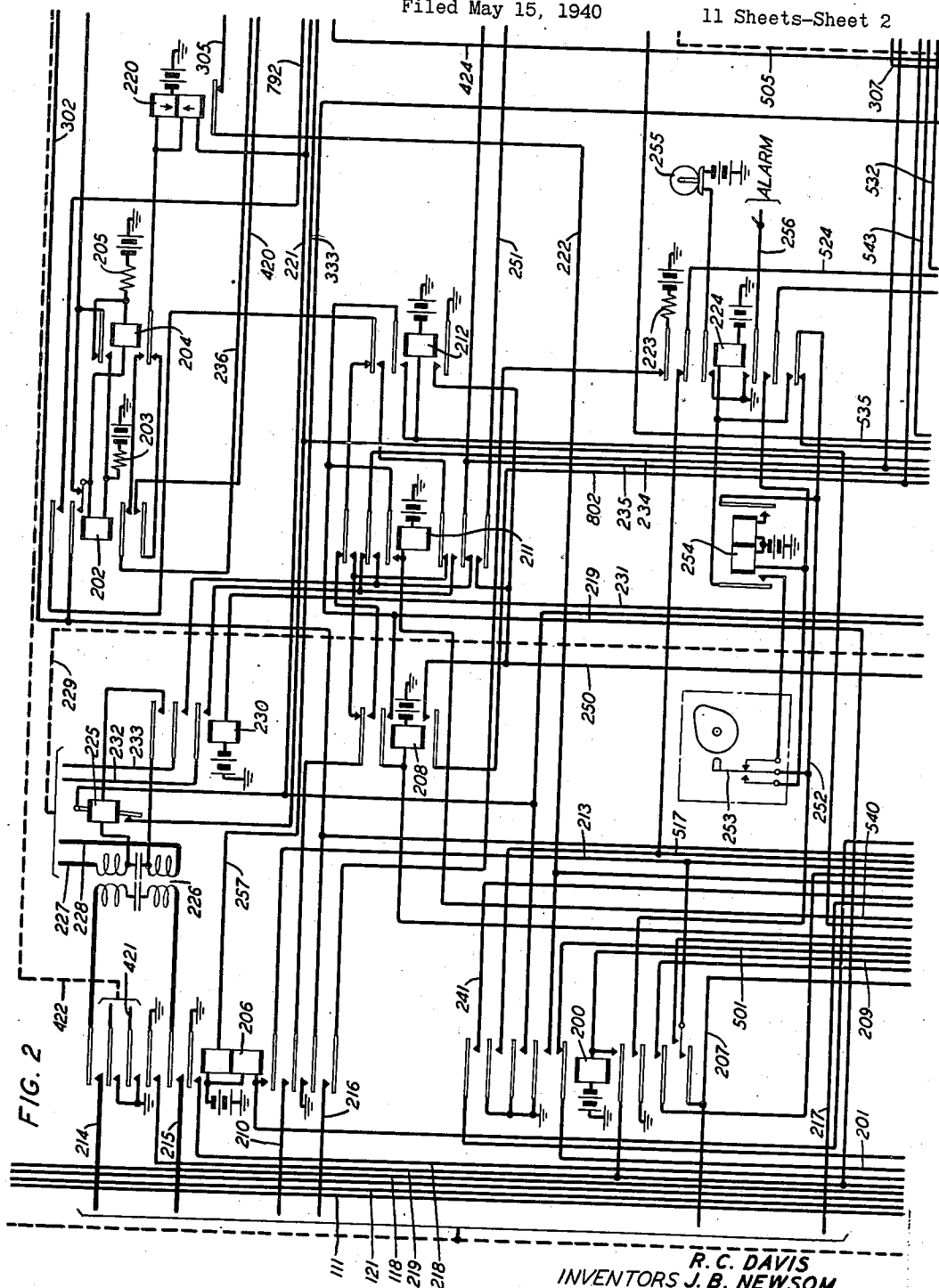
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11 Sheets-Sheet 2



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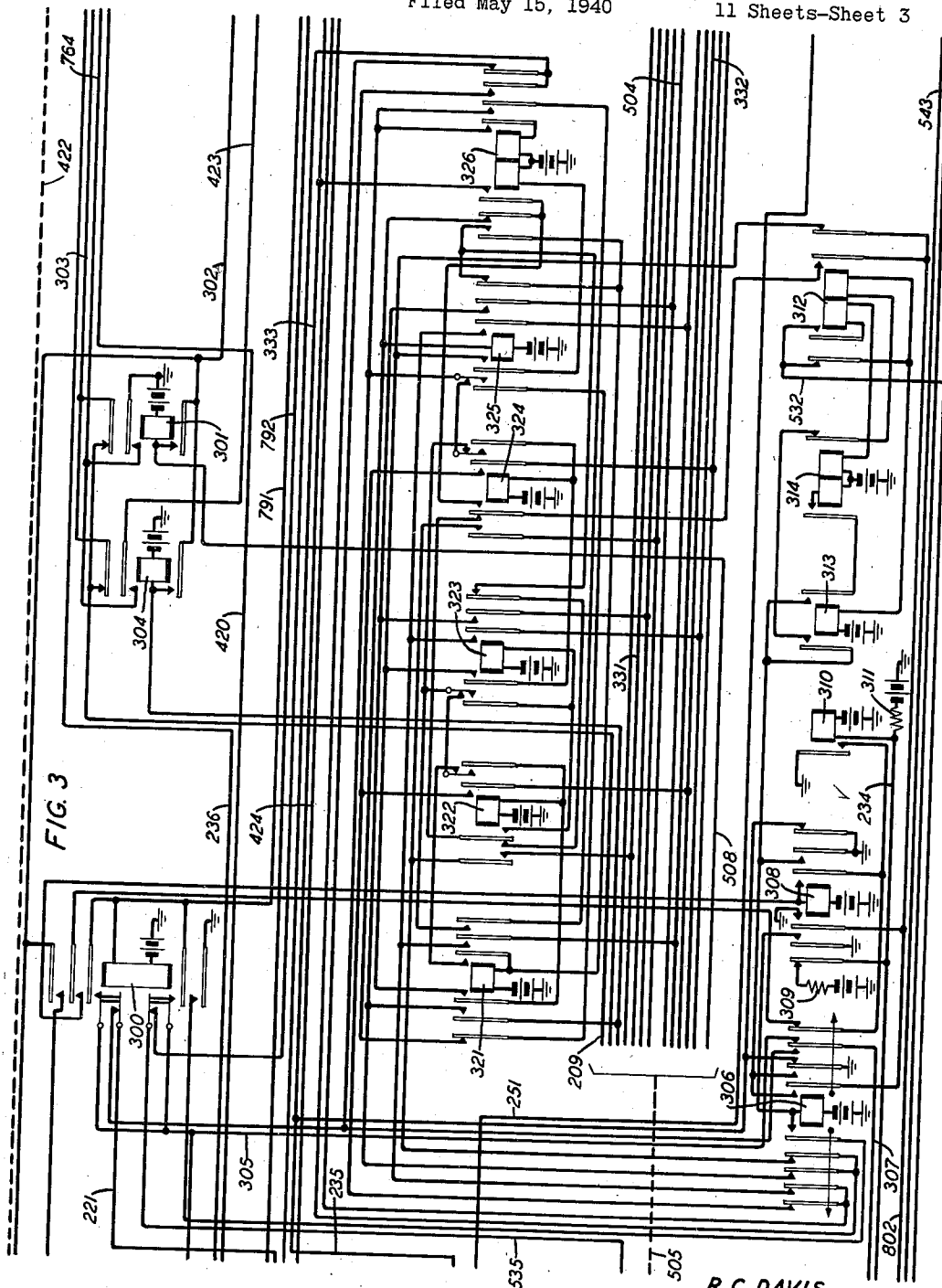
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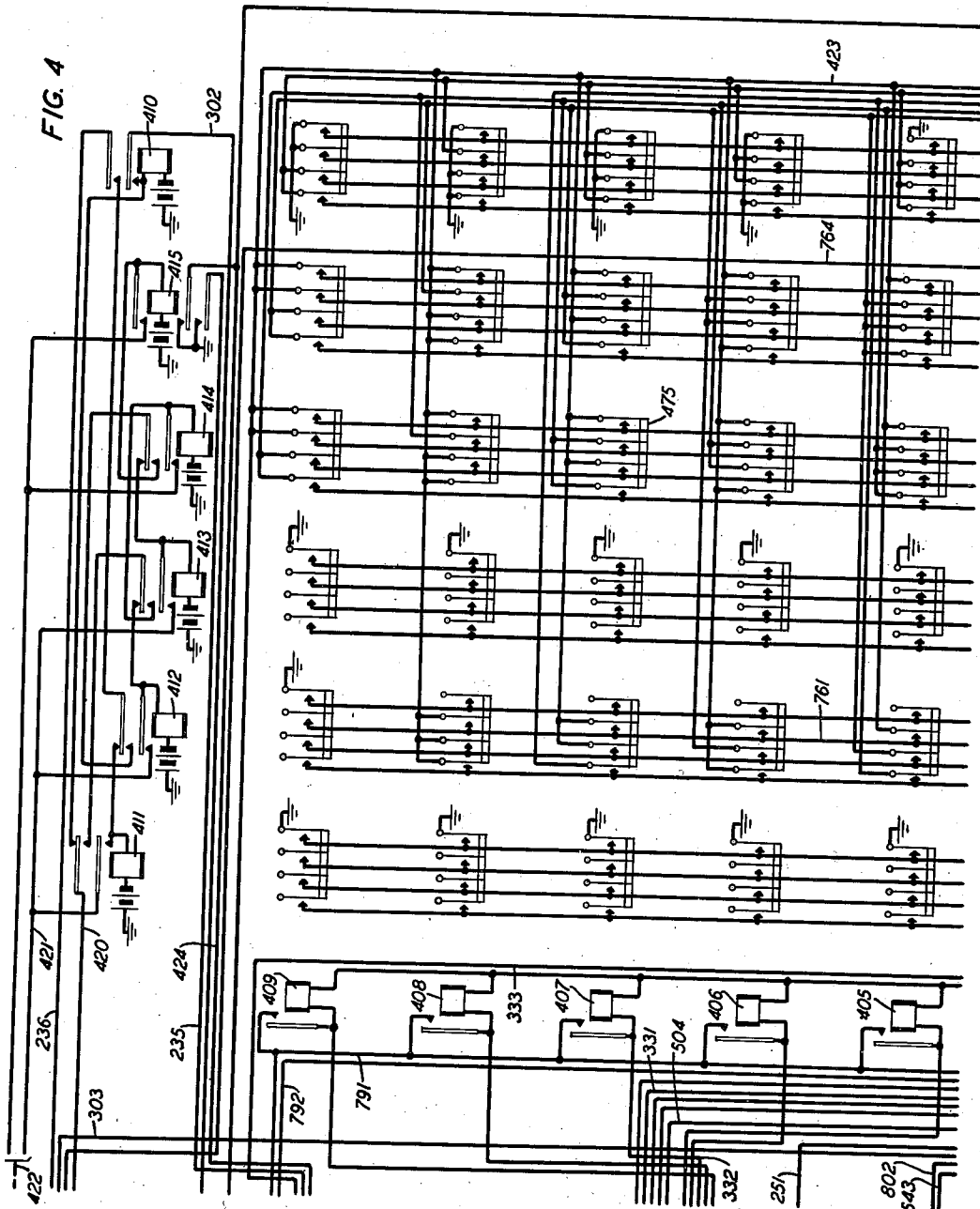
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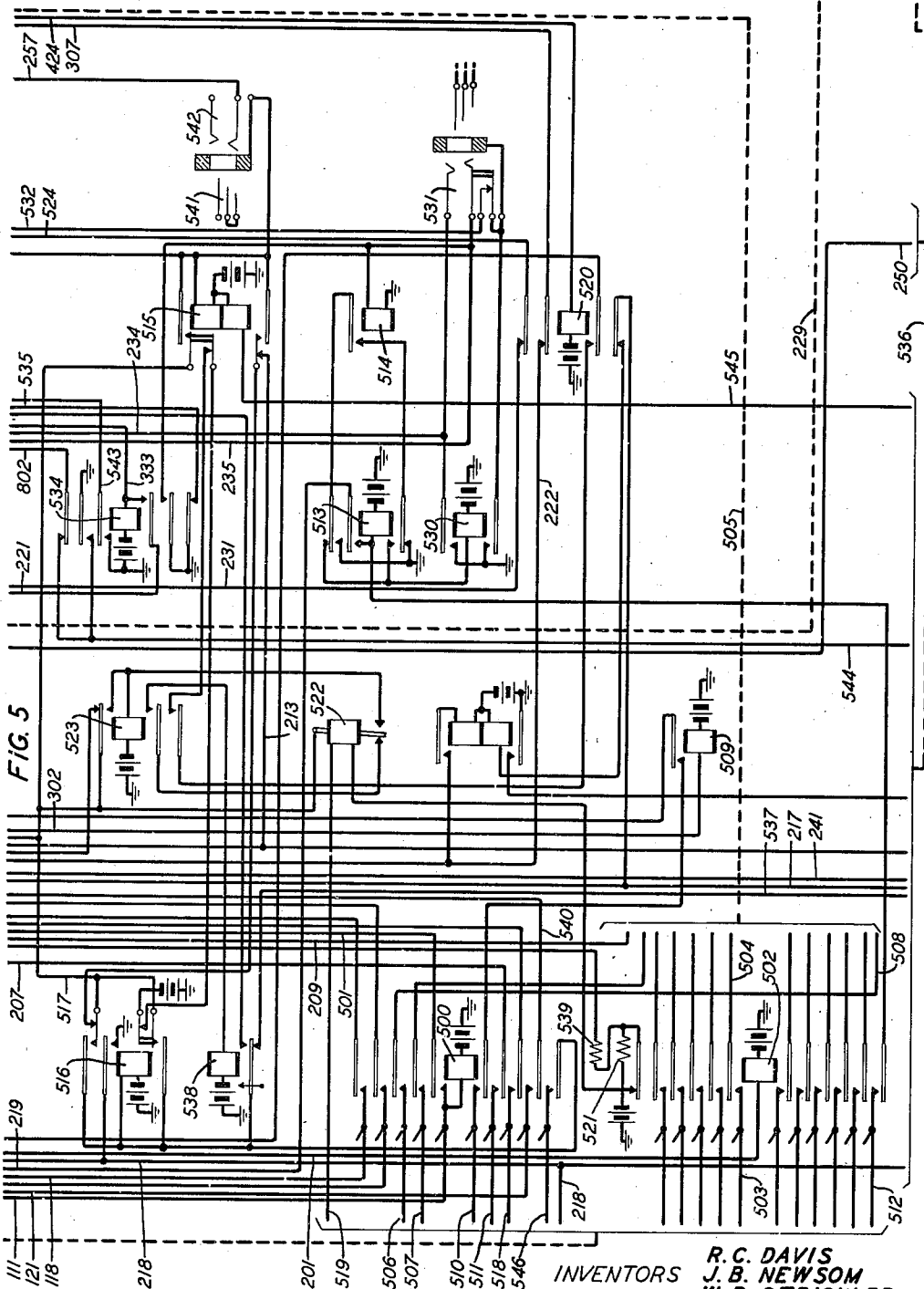
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TELEPHONE SYSTEM

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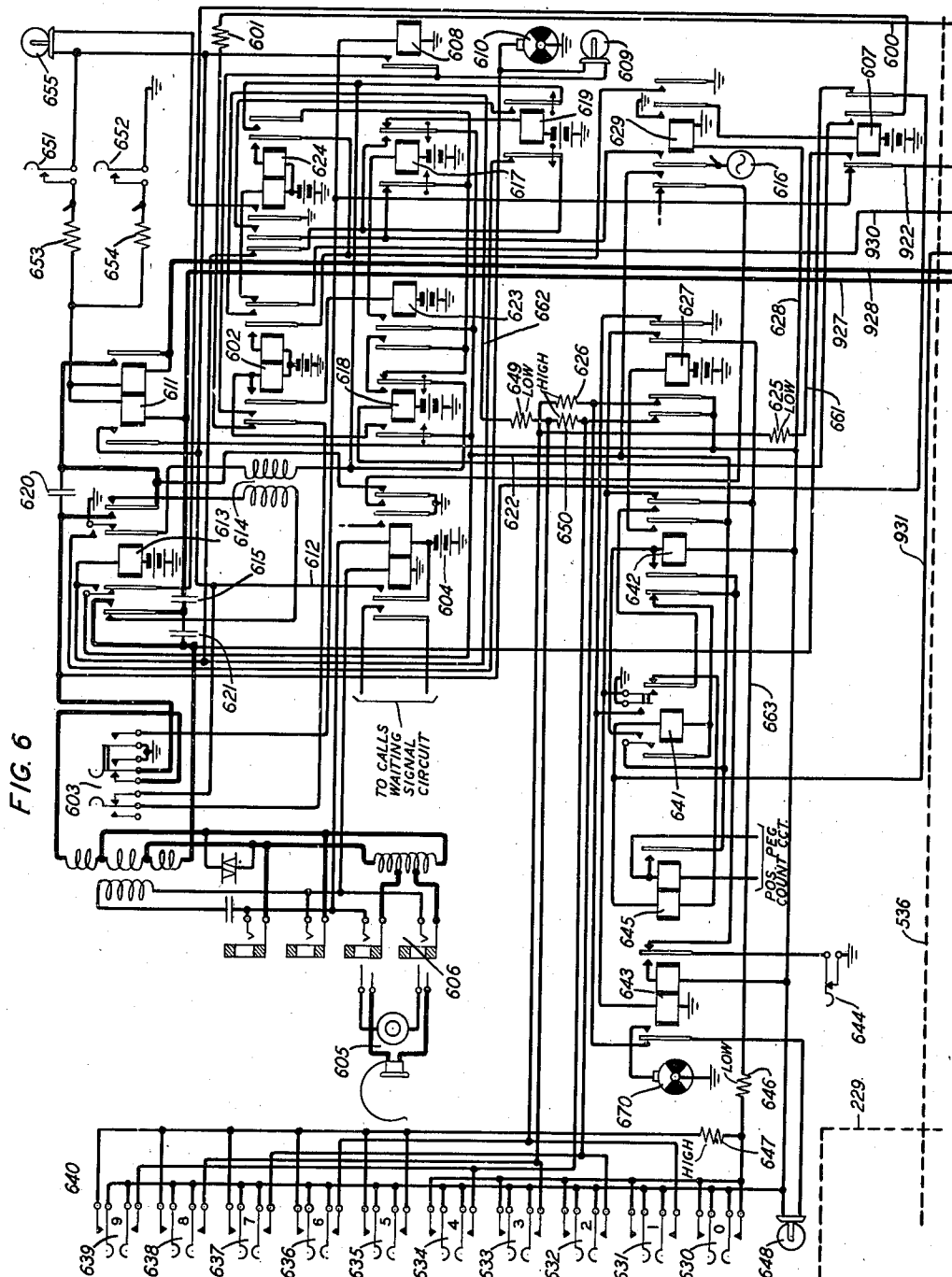
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TELEPHONE SYSTEM

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11 Sheets-Sheet 6



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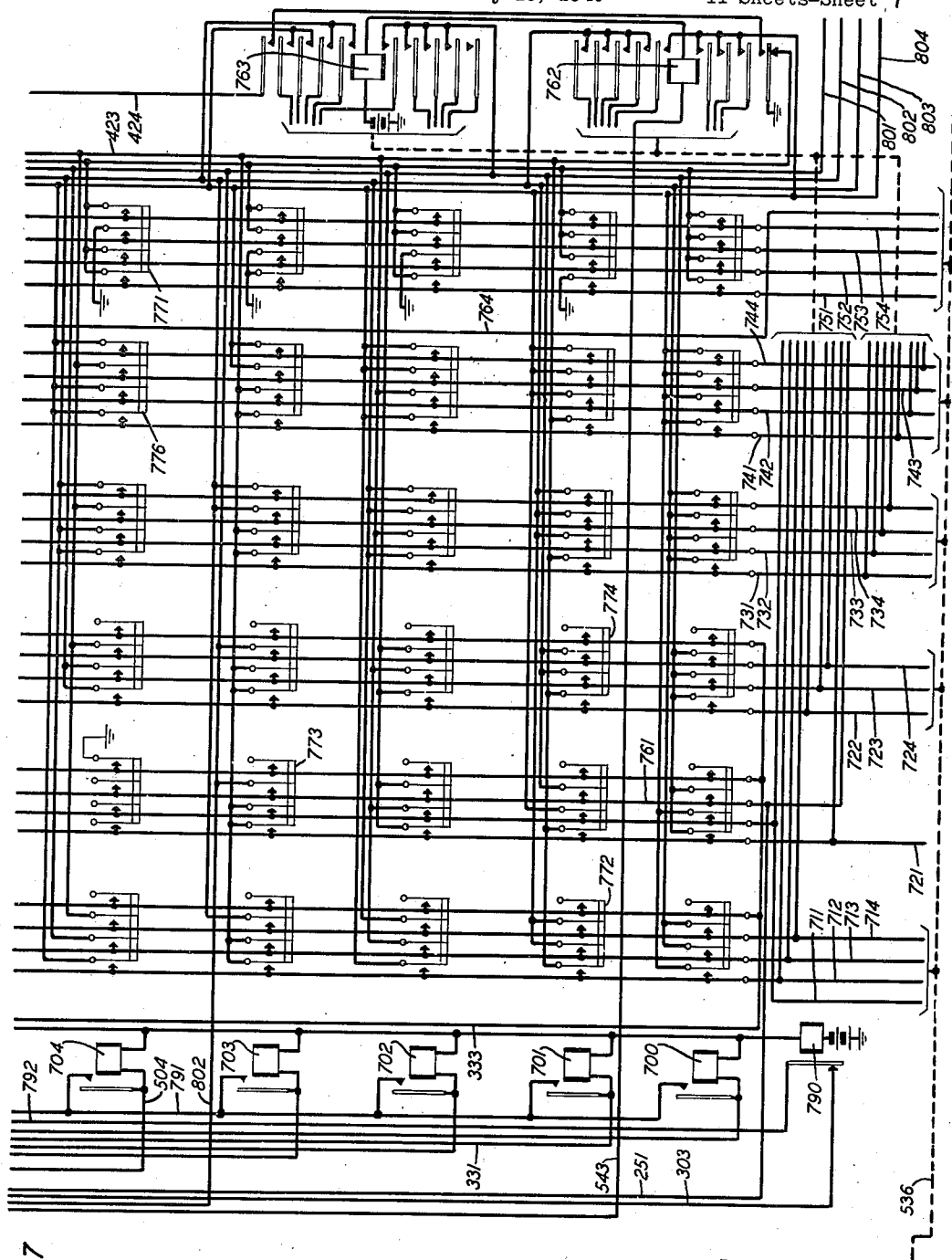


FIG. 7

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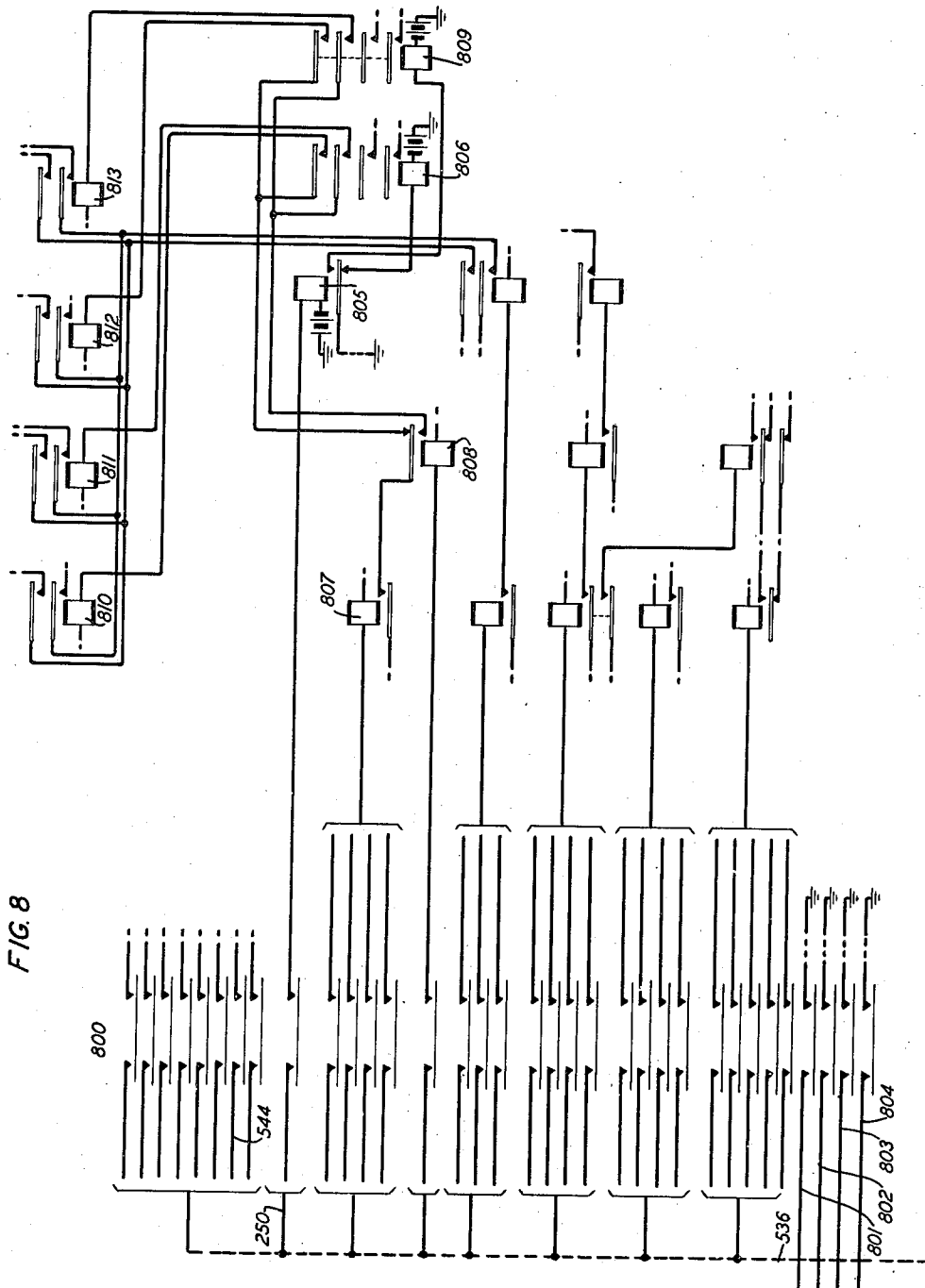


FIG. 8

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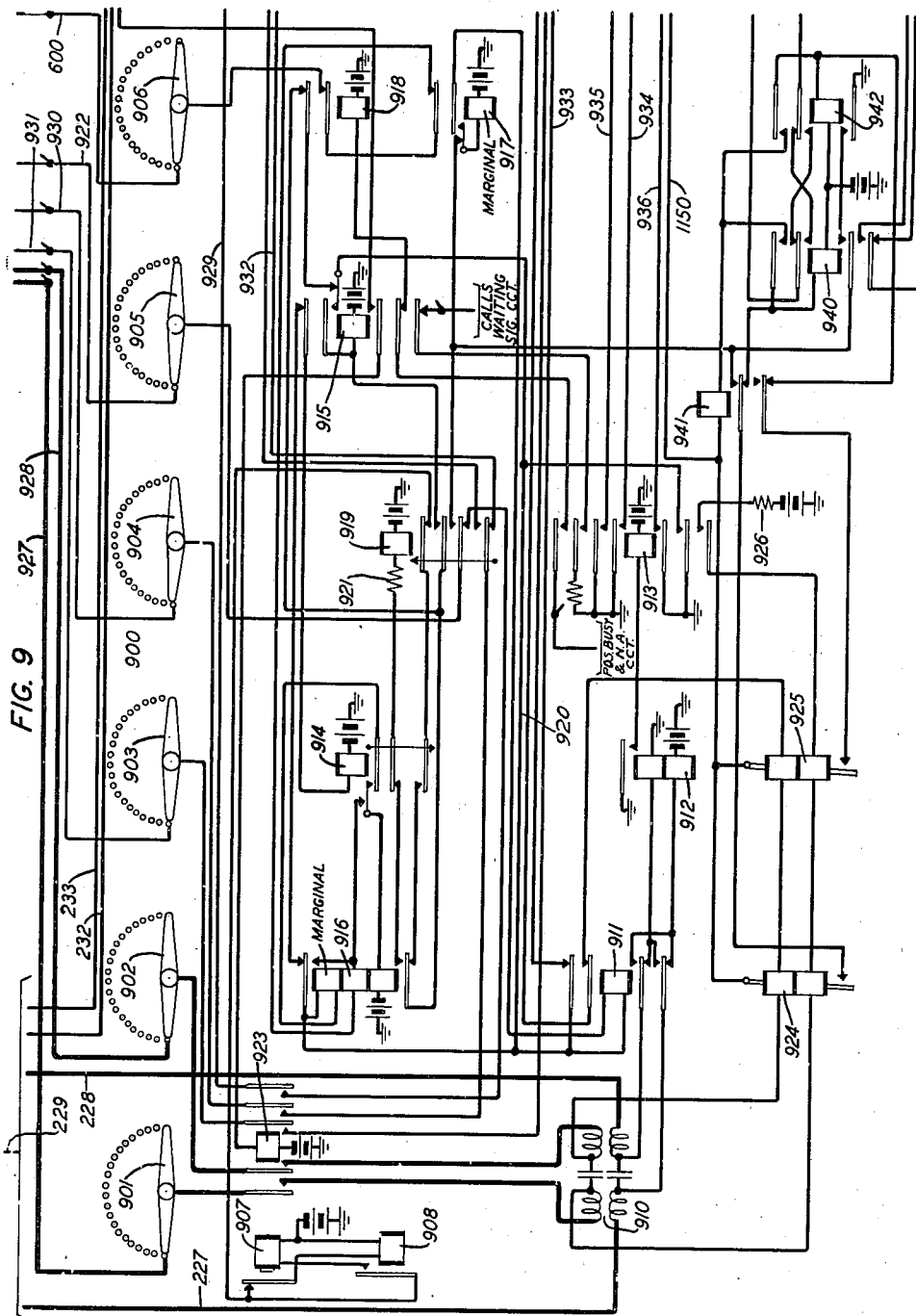
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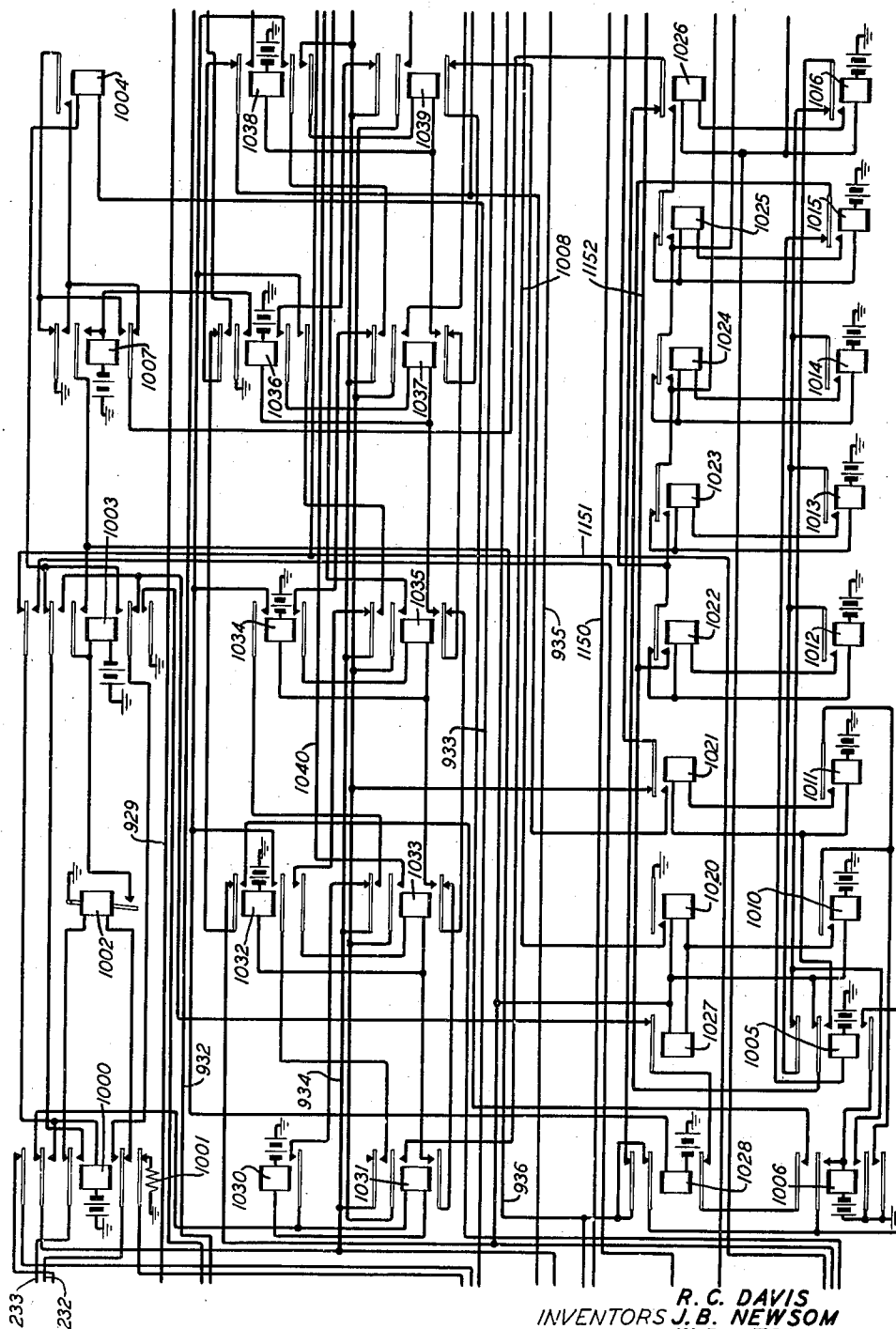
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FIG. 10



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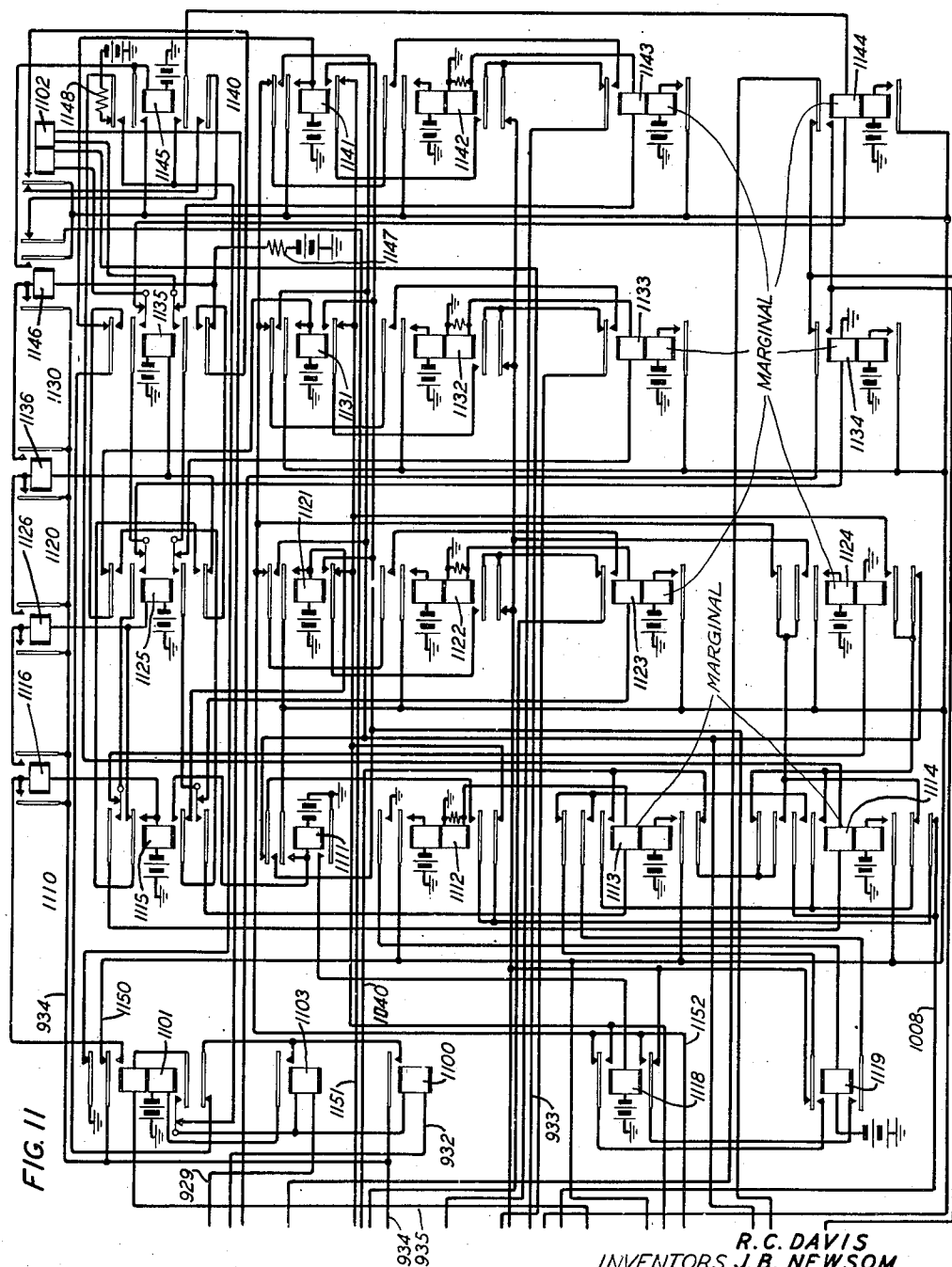
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UNITED STATES PATENT OFFICE

2,259,101

TELEPHONE SYSTEM

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Application May 15, 1940, Serial No. 335,240

11 Claims. (Cl. 179—27)

This invention relates to telephone systems and has for its object to facilitate the handling of calls requiring the services of an operator.

In general, it has been found desirable where only a few operators are needed at individual offices to place these operators at a centralized point where they may serve a number of such offices. Heretofore, in order to do this it has been necessary to carry the talking circuit through the centralized office thereby introducing sources of trouble.

In accordance with the present invention the talking circuits are freed of these sources of difficulty since instead of carrying the talking circuits through the centralized office, the functions of the registering equipment or senders have been divided into two parts, one performed at the switching office and the other performed at the centralized office, the two parts of the sender being permanently connected by a set of four conductors.

In accordance with the present invention where the incoming trunks or junctors have access to more than one office, means is provided to inform the calling operator that the office designation is required. The B operator is also provided with means for indicating to the sender to which of the offices the call is directed and the sender is provided with means for combining these indications into an office indication to the marker.

More specifically, during the connection of the incoming junctor and the terminating sender, a group circuit in the link control circuit sets up an indication in the terminating sender which shows whether the calling junctor has access to one or more than one office and in the former case gives the identity of the office. If the junctor serves a plurality of offices, the terminating sender passes this information to the centralized sender which, in turn, modifies the operation of the tone generation at the operator's position to inform the originating operator that the office identity should be given. The B operator receiving this information gives a discriminating indication to the centralized sender which passes this information to the terminating sender by modifying one of the numerical selections. The terminating sender in turn combines the information received from the group circuit and that from the centralized sender to control the marker to make selections in the proper office.

If the sender does not receive a complete designation it transmits a special reorder designa-

tion to the marker to cause the transmission of a reorder signal to the originating operator.

These and other features of the invention will be more apparent from a consideration of the following description in connection with the drawings in which:

Fig. 1 shows in diagrammatic form an originating office, a plurality of incoming junctors, terminating switches and a plurality of called lines. In addition, it shows a part of the sender link;

Figs. 2, 3, 4, 5 and 7 show parts of the sender at the terminating office, Figs. 2 and 5 showing the connection control relays, Fig. 3 showing the pulsing and counting relays, and Figs. 4 and 7 showing a cross-bar type register;

Fig. 6 shows the operator's position at the centralized office;

Fig. 8 shows a part of the marker;

Figs. 9, 10 and 11 show the recorder and position finder circuit located at the centralized office, Fig. 9 showing the position finder, Fig. 10 showing the steering relays and the counting relays, Fig. 11 showing the register relays; and

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

For a complete showing of the terminating marker, reference is hereby made to Patent No. 2,232,371, granted to J. W. Dehn et al., Feb. 18, 1941, while for a more complete discussion of the trunking arrangement serving a plurality of offices reference is made to the application of Hersey et al., Serial No. 335,241, filed May 15, 1940.

Briefly the operation of the present circuit is as follows: When a call originates at a manual operator's position in the originating office 100, the subscriber gives the wanted number to the A operator at that office. The A operator then selects an idle one of the incoming junctors 101 to 102 leading to the wanted office and inserts the plug of her cord in the jack leading to that junctor. The selection of the junctor causes the sender connector 110 to test for and connect with the terminating end of an idle B sender hereinafter to be called the terminating sender. When the terminating sender has been seized it establishes a talking connection through to the centralized end of the sender which will be known as the centralized sender. The position finder then hunts for and seizes an idle B operator's position. A tone signal is then transmitted from the B position to the A position and the A operator repeats the wanted number to the B operator. The B operator then sets up the num-

ber on her key-set 640 controlling thereby the registers 1110, 1120, 1130 and 1140 of Fig. 11. When the registration has been completed the B operator's position is released and the number is transmitted by means of reverive pulses to the terminating sender where it is recorded on the cross-bar register of Figs. 4 and 7. The number is then transferred to the terminating marker of Fig. 8 which selects the wanted line, sets up and tests a connection between the incoming junctor and the wanted line and then releases the sender which will, in turn, release the marker.

In the present disclosure it has been assumed that incoming junctors 101 and 102 from originating office 100 have access to the incoming and line switches shown at 106 and through them to lines 107 and 109 in office A. Incoming junctors 103 and 104 represent a group of incoming junctors from an originating office 150 which has access both to the lines of office A and to lines of office B which are not shown. Incoming junctors are arranged in groups and are connected with senders by means of the sender link 110. In the link control circuit each junctor of a group operates a group start relay such as relay 112 or 119 which brings about the connection of the link circuit to the group of junctors by the group relay 113 or 120 and the selection of a group of senders including an idle sender by the sender group relay such as relay 114. When these connections have been established an indication of the office at which the junctor terminates is prepared by the grounding of one of the conductors 115, 116 or 117. This indication becomes effective when the individual junctor and sender have been connected. According to the cross-connection as shown, the grounding of conductor 117 indicates a junctor terminating in office A, the grounding of conductor 116 indicates a junctor terminating in office B, while the grounding of conductor 115 indicates a junctor having access to either office A or office B.

Call to office A

Assume that the A operator at the originating office in the extension of a call to a subscriber at office A has selected the incoming junctor 101. This junctor operates group start relay 112 which in turn brings about the operation of junctor group relay 113 and sender group relay 114 and the operation of the switches of the link 110. Relay 113 grounds conductor 117 which is extended by the operation of sender group relay 114, to conductor 118 leading to the sender.

When the switches of link 110 are ready for operation the link control circuit connects ground to conductor 111 operating relay 500 in the selected sender. Relay 500 extends its operating ground over its inner upper front contact, conductor 501, inner upper back contact of relay 200, conductor 201 to the winding of relay 502 and battery. With relays 500 and 502 operated, a number of registrations are made in the sender. Relay 500 also prepares a number of other circuits over which the link control circuit prepares and tests the connection between the sender and the incoming junctor.

The identity of the office which is served by the incoming junctor 101 is recorded by the extension of conductor 118 over the outer upper front contact of relay 500 to the winding of relay 208 and battery.

The identity of the frame on which the incoming junctor is located is recorded by ground-

ing one of conductors 506 or 507 and one of the upper ten conductors leading to armatures of relay 502. Assuming that the frame on which the incoming junctor 101 is located is frame 14, conductors 506 and 503 will be grounded. In addition, since the frame is an even-numbered frame, ground will be connected to conductor 512 leading to the lowest armature of relay 502. The grounding of conductor 506 completes a circuit over the third upper front contact of relay 500, conductor 508, through cable 505 to the winding of relay 301 and battery. Relay 301 extends its operating ground to conductor 302, operating relay 509.

The grounding of conductor 503 completes a circuit over the inner upper front contact of relay 502, conductor 504, through the cable 505 to the winding of select magnet 704, winding of relay 790 and battery. Relay 790 is marginal and does not operate unless, due to some difficulty, an attempt is made to operate more than one select magnet. Magnet 704 extends its operating ground over conductor 791 to the winding of relay 300 and battery. Relay 300 operates and extends ground from conductor 302, over its outer upper front contact to the normal contacts and winding of relay 202, resistance 203 and battery. Relay 202 operates, locking directly to conductor 302, and preparing a circuit for relay 204 from battery through resistance 205, winding of relay 204, front contact of relay 202 to conductor 302. However, relay 202 does not operate, being shunted by the operating circuit for relay 202 which extends over the upper back contact of relay 204 to resistance 205.

The grounding of conductor 512 completes a circuit over the lowermost front contact of relay 502 to the winding of relay 513 and battery. Relay 513 reverses the direction of current flow over the contacts of stepping relay 514. Wear on the contact of relay 514 is reduced by having the current flow reversed for approximately half of the calls. This is accomplished by carrying the stepping circuit over the contacts of relay 513 and operating that relay only for calls over junctors appearing on even-numbered frames.

When relays 500 and 502 having been operated, the link control circuit tests the holding circuit between the sender and the link switches by operating the switches over a circuit including conductor 511, second lower front contact of relay 500, and conductor 207. If this circuit is complete, the control circuit then grounds conductor 510, completing a circuit which tests whether the frame tens registration has been made, extending over the inner lower front contact of relay 500, front contact of relay 509, which was operated by the frame tens relay, lower winding of relay 206 to battery. Relay 206 at its third lower front contact connects ground to conductor 302 to provide a holding circuit for relays 301, 202, etc. Relay 206 at its inner upper front contact connects ground to conductor 218, marking the sender busy to the link control circuit.

In response to this ground the link control circuit tests, to determine if one and only one frame registration has been made and if an office registration has been made, by connecting ground to conductor 210. The grounding of conductor 210 completes a circuit over the second lower front contact of relay 206, outer upper front contact of relay 208, outer upper back contact of relays 211 and 212, outer upper front contact of relay 202, conductor 792, back contact of relay 790, conductor 303, back contact of frame tens relay

304, conductor 209 through cable 505, to the winding of relay 200 and battery. Relay 200 locks over its inner lower front contact and conductor 219 to ground at the third upper front contact of relay 206 and provides a locking circuit for relay 206 which extends from battery through the lower winding and inner lower front contact of relay 206, conductor 213, lower normal contacts of relay 515, upper normal contacts of relay 516, conductor 517 to ground at the third upper front contact of relay 200. At its inner upper back contact relay 200 opens the circuit of relay 502 thereby opening the frame registration conductors. Relay 200 also connects ground on conductor 213 over its outermost lower contact to conductor 207 to provide a holding circuit for the link switches and extends the same ground over its fourth lower front contact and the third lower front contact of relay 500 to conductor 518 as a release signal to the link control circuit. The link control circuit responds to ground on conductor 518 by opening the circuit of relay 500 which now releases.

The sender now remains connected with the junctor by means of conductors 214 to 217 and 519 which extend over the link switches to the incoming junctor, the link switches being held as above described by ground on conductor 207 which extends to the hold magnets of the link switches. Relay 206 connects ground to conductor 219 to provide locking circuits for relays 200, 208, 211, 212 and 513, and both relays 200 and 206 provide other holding grounds as will appear hereinafter.

Upon grounding conductor 517, relay 200 also closes a circuit over the inner upper back contact of relay 224, conductor 524, outer upper back contact of relay 520, conductor 231 to the winding of relay 230 and battery. Relay 230 signals the centralized sender over the four conductors which connect the terminating sender with the centralized sender. To do so, it connects polarized relay 225 between the right windings of repeating coil 226 which is, in turn, connected by conductors 227 and 228 through cable 229 to repeating coil 910 in the centralized sender. At the same time, relay 230 prepares the fundamental circuit for receiving the designation from the centralized sender by connecting conductor 232 over the inner upper contact of relay 230, inner upper back contact of relay 211, conductor 234 to the winding of relay 310 and battery, which is connected in parallel with battery through resistance 311 and with battery through resistance 309 over the left back contact of relay 308. Conductor 233 is connected over the middle upper contact of relay 230, outer lower back contact of relay 211, conductor 235 to the winding of relay 514 and ground, relay 514 being shunted by ground at the inner right back contact of relay 306. The function of the centralized sender in response to this signal will be described hereinafter.

One of the circuits closed by relay 200 is a locking circuit for select magnet 704 and relay 300 which extends over the inner upper and lower front contacts of relay 300, conductor 305, back contact of relay 220, conductor 222 to ground at the inner upper front contact of relay 200. A parallel circuit extends over the middle right back contact of relay 306, conductor 307, inner upper back contact of relay 520 to conductor 222.

When relay 202 was operated as previously described, it connected the hold magnet 410 of the frame vertical on the register switch over the

upper back contact of magnet 411, conductor 420, lower front contact of relay 202, lower back contact of relay 204 to the windings of differential relay 226. The upper winding of relay 220 extends to battery and, as soon as relay 200 operates, the lower winding is extended over conductor 221 to ground at the second upper front contact of relay 200. The windings of relay 220 are so proportioned that the relay will not operate with the current which flows through the two windings in series or with the hold magnet connected to the two windings. However, the hold magnet 410 does operate, as soon as conductor 221 is grounded, closing the cross-point 771 prepared by select magnet 704, and locks over its inner upper front contact to grounded conductor 302. The extension of this locking ground to the windings of relay 220 shunts the lower winding thereof and operates the relay under the influence of its upper winding. The operation of relay 220 opens one branch of the locking circuit of select magnet 704 and relay 300.

When relay 502 released, a circuit was closed from battery through resistance 521, back contact of relay 502, winding of polarized relay 522 to conductor 519 leading to the junctor circuit. When relay 200 operates, grounded conductor 517 is connected over the upper back contact of relay 523, third lower front contact of relay 200, through resistance 539, back contact of relay 502 to the winding of relay 522 in shunt of battery through resistance 521. As a result of this connection, a relay in the junctor operates and locks and the locking ground for the junctor relay, extending back over conductor 519, causes current to flow through relay 522 in the operating direction. Relay 522 in operating closes a circuit from grounded conductor 517, right contact of relay 522 to the winding of relay 523 and battery. Relay 523 operates and locks directly to conductor 517. The operation of relay 206 also connects battery through resistance 223, outer upper back contact of relay 224, outer lower front contact of relay 206, to conductor 216, operating a relay in the junctor which puts the talking circuit into condition for communication between the A and B operators.

The connection of relay 225 across the conductors 227 and 228 closes a circuit in the centralized sender from battery through the lower winding of relay 912, outer lower back contact of relay 911, lower left winding of repeating coil 910 to conductor 227, through the relay 225 and repeating coil 226, conductor 228, lower right winding of repeating coil 910, inner lower front contact of relay 911, upper winding of relay 912 to ground. Relay 912 operates and closes an obvious circuit for relay 913.

The operation of relay 913 starts the position finder hunting for an idle operator's position by closing a circuit from battery through the winding of relay 914, upper back contact of relays 915 and 916, conductor 920 to ground at the middle lower front contact of relay 913. Relay 914 closes a circuit from battery through the lower winding of relay 916, middle lower front contact of relay 914, upper winding of relay 916 to grounded conductor 920 to prepare the relay for quick operation. It also closes a circuit from grounded conductor 920, upper winding of relay 916, inner lower front contact of relay 914, middle winding of relay 916, upper back contact of relay 917, inner upper contact of relay 918, to brush 906 of position finder 900. At its outer front contact relay 914 closes a circuit from battery through

the winding of relay 903, back contact of stepping magnet 907, inner lower back contact of relay 919, outer front contact of relay 914, lower back contact of relay 916, upper outer contact of relay 918, upper normal contacts of relay 915 to grounded conductor 920. Relay 908 operates in this circuit and at its left contact closes a circuit from battery through the winding of magnet 907 to the operating circuit of relay 908. Magnet 907 operates, opening the circuit of relay 908, which releases in turn releasing magnet 907 to step the brushes of position finder 900. The release of magnet 907 recloses the circuit of relay 908 and the same cycle is repeated until an idle position is found.

When a position such as the position of Fig. 6 is occupied, the insertion of the plugs of the operator's headset 605 in the position jack 606 closes a circuit from battery through the right winding of relay 604, through the plug and jack connection and the transmitter of the headset to ground through the left winding of relay 604. Relay 604 operates, connecting battery over its inner left contact, conductor 612, left normal contacts of key 603, left back contact of relay 602, resistance 601 to conductor 600. As soon as brush 906 encounters the terminal to which conductor 600 is attached, relay 916 operates, opening the circuit of relay 908 and magnet 907 and bringing the position finder to rest. It is apparent that, if the position finder is resting on an idle position, relay 916 will immediately operate and the position finder will not advance.

Relay 916 locks in a circuit from battery on conductor 600, brush 906, inner back contact of relay 916, outer upper contact of relay 917, middle winding and upper front contact of relay 915 to grounded conductor 920. Relay 916 releases relay 914 and when relay 914 closes its back contact, a circuit is completed from battery through the winding of relay 919, resistance 921, back contact of relay 914, lower front contact of relay 916, outer contact of relay 918, normal contacts of relay 915 to grounded conductor 920. Relay 919 operates, closing a circuit from battery through the winding of relay 915, inner lower front contact of relay 919, outer upper back contact of relay 918, upper normal contacts of relay 915 to grounded conductor 920. Relay 915 locks over its upper alternate contacts to conductor 920 and closes a holding circuit for relay 919 under the control of relay 916. In addition, relay 919 closes a circuit from battery through the winding and normal contacts of relay 917, middle lower front contact of relay 919, brush 905, conductor 922, left back contact of relay 607 to the winding of relay 608 and ground. Relay 917 is marginal and does not operate but relay 608 operates. Relay 608 closes a circuit from battery over the inner left front contact of relay 604, conductor 612, contact of relay 608 through lamp 609 to ground through interrupter 610 to warn the operator that her position has been seized. Relay 915 closes a circuit from battery through the winding of relay 923, lower front contact of relay 915, outer upper back contact of relay 1000, outer upper back contact of relay 911 to ground over conductor 920. Relay 923 connects the outer ends of the upper windings of repeating coil 910, over brushes 901 and 902, conductors 927 and 928 to the position circuit. The inner end of the upper right winding of coil 910 extends through the upper windings of polarized relays 924 and 925, inner upper back contact of relay 911 to ground over the outer lower back

contact of relay 1000 and through resistance 1001. The inner end of the upper left winding of coil 910 extends through the lower windings of relays 924 and 925 to battery over the outer lower front contact of relay 913 through resistance 926.

In the position circuit conductor 927 extends through the windings of relay 611 to conductor 928. Therefore, relay 611 operates and at its right contact extends conductor 928 over the outer right back contact of relay 613 to the secondary winding of tone coil 614. Conductor 927 extends through condenser 615 over the outer left back contact of relay 613 to the other side of the secondary winding of tone coil 614. Relay 611 at its left contact closes a circuit from battery on conductor 612 to the winding of relay 629 and ground. Relay 629 operates and closes a circuit from tone source 616, inner left front contact of relay 629, left back contact of relay 617, right back contact of relay 618, primary winding of tone coil 614 to ground at the inner right back contact of relay 613, thereby transmitting a tone over the conductors 927 and 928, brushes 901 and 902, through repeating coil 910, conductors 227 and 228, through repeating coil 226, contacts of relay 206, conductors 214 and 215 and thence to the position of the A operator. The operator of Fig. 6 may also hear the tone through condensers 620 and 621.

Relay 629 also closes an obvious circuit for relay 607 and completes a circuit for relay 619 which may be traced from battery through the winding of relay 619, right back contact of relay 617, conductor 622, outer left contact of relay 629, to ground at the outer right front contact of relay 604. Relay 607 disconnects conductor 922 from the winding of relay 608 permitting relay 608 to release and disconnect battery from lamp 609. With relays 629 and 607 operated, a circuit is closed from battery through the winding of relay 618, right front contact of relay 607, inner left back contact of relay 613, to grounded conductor 622. Relay 618 is slow to operate and, after an interval, opens the circuit through the primary winding of tone coil 614, thereby interrupting the tone. Relay 618 closes a circuit from battery through the left winding of relay 602, left front contact of relay 618 to ground on conductor 622. Relay 602 locks through its right winding and inner right front contact to ground at the outer right contact of relay 629 and extends its operating ground to the winding of relay 623. In addition, relay 602 reconnects lamp 609 over the outer left front contact of relay 602, left normal contacts of key 603 to battery on conductor 612. Relay 623 operates and recloses the primary circuit of tone coil 614 which now extends over the right front contact of relay 618 and the outer left front contact of relay 623 instead of over the back contact of relay 618. A second tone is therefore transmitted to the A operator. Relay 623 also closes a circuit from ground on conductor 622, inner contact of relay 623 through the winding of relay 617 and battery. Relay 617 is also slow to operate and after an interval again opens the primary circuit of the tone coil to interrupt the second impulse of tone. In addition, relay 617 closes a circuit from ground on conductor 622, right front contact of relay 617, left back contact of relay 624 to the winding of relay 613 and battery. Relay 613 operates, locks over its left alternate contacts to ground on conductor 622, short-circuits condensers 620 and 621 and connects ground over its right alternate contacts to lamp 609 in shunt

of interrupter 610 whereby lamp 609 glows steadily to inform the operator that she has been connected to the A operator's position.

The A operator then passes the wanted number to the B operator and the B operator operates the keys of her key-set to record the number given. Assuming that the called number is 3674 the B operator will operate keys 633, 636, 637 and 634 in succession.

During the transmission of the tone and previous to the operation of the key-set, the sender and the key pulsing circuits are prepared for operation by the establishment of three registering circuits. The operation of relay 602, as previously described, disconnects battery from conductor 600 thereby releasing relay 916 which in turn releases relay 919. With relay 919 released, the first registering conductor 922 is disconnected from relay 917 and connected over the middle back contact of relay 919, outer right front contact of relay 923, conductor 929, winding of relay 1103, normal contact of relay 1101, right winding of relay 1102, lower normal contacts of relay 1135, upper winding of units register relay 1143, lower winding of units register relay 1142 to ground. The release of relay 919 also extends the second registering conductor 930 from brush 904, middle right contact of relay 923, outer back contact of relay 919, conductor 932 through the winding of relay 1100 and thence to ground as traced from the winding of relay 1103. The third registering conductor 931 extends from brush 903, inner right front contact of relay 923, conductor 933, through the left winding of relay 1102 but the circuit is incomplete at this time.

In the position circuit, conductor 922 extends over the left front contact of relay 607, conductor 661, through resistances 625 and 626, inner left contact of relay 627, conductor 628, left front contact of relay 611 to battery on conductor 612, while conductor 930 extends over the outer right front contact of relay 602, conductor 662, through resistances 649 and 650, outer left contact of relay 627 to battery over conductor 628 as traced. Conductor 931 extends through the winding of relay 641, left back contact of relay 642, right back contact of relay 643 to ground over key 644.

Relay 1100 and 1103, as well as relay 1102 and the units register relays, operate in the circuits above traced. Relays 1100 and 1103 close a circuit from ground at the inner upper front contact of relay 913, conductor 934, front contact of relay 1100, front contact of relay 1103, through the lower winding of relay 1101 and battery. Relay 1101 operates in this circuit, opening the circuit of relay 1102 and the register relays which release. It also closes a holding circuit for itself from battery in the position circuit, through the windings of relays 1100 and 1103 as traced, alternate contacts and upper winding of relay 1101, conductor 935 to ground at the second upper front contact of relay 913. Relay 1101 also closes a circuit from ground on conductor 934, upper front contact of relay 1101, windings of relays 1116 and 1115 to battery. Relays 1115 and 1116 operate, relays 1116 closing at its left contact a locking circuit for the two relays to ground on conductor 934. At its right contact relay 1116 also closes a circuit from grounded conductor 934 to the windings of relays 1126 and 1125 and battery. Relays 1125 and 1126 operate, relay 1126 closing a locking circuit for itself and an operating circuit for relays 1136 and 1135. Relay 1136 locks relays 1135 and 1136 to conductor 934 and operates relay 1146 through re-

sistance 1147. Relay 1146 also locks to conductor 934.

With relay 1135 operated, a circuit is closed from battery through resistance 1148, upper back contact of relay 1145 through the upper winding of relay 1114, upper alternate contacts of relays 1115, 1125 and 1135, left winding of relay 1102 to conductor 933, completing the third registering circuit which was previously traced to conductor 933 and operating relay 641 in the position circuit. Relays 641 and 1102 operate in this circuit but relay 1102 is ineffective at this time. Relay 641 closes a locking circuit for itself over its outer left contact to ground on conductor 622 and extends this ground over its inner left contact to the winding of relay 642 and battery on conductor 628. Relay 642 locks over its left front contact and right back contact of relay 643 to ground on key 644, opens the operating circuit for relay 641 and closes a circuit from battery through the winding of relay 627, inner right front contact of relay 642 to grounded conductor 622. Relay 627 disconnects battery from conductors 930 and 922 thereby releasing relays 1100, 1103 and 1101 in the register circuit. The release of relay 1101 connects ground from conductor 934 over the inner upper back contact of relay 1101 to conductor 1150, thereby completing a circuit over the right front contact of relay 1146 to the winding of relay 1145 and battery. Relay 1145 locks to conductor 1150, disconnects battery from conductor 933 and extends that conductor to ground at the outer upper back contact of relay 1101.

The operation of relay 1145 releases relay 641 which now extends conductor 931 through the left winding of relay 645, back contact of relay 641, outer right front contact of relay 642, conductor 663 to the key-set through resistances 646 and 647. When relay 611 operated connecting battery to conductor 628, it lighted lamp 648 in a circuit to ground at the outer right contact of relay 627. Relay 641 closes a temporary overlapping circuit for lamp 648. When relay 627 is operated and relay 641 releases lamp 648 is extinguished, indicating that the sender is ready to receive the designation.

The sender and position circuits are now ready for registration. When the operator depresses key 633, battery is connected from conductor 628 over the lower contact of key 633 through low resistance 649 to conductor 662 and over the upper contact of key 633 through low resistance 646 to conductor 663. Conductors 662 and 663 extend as previously traced to conductors 932 and 933, respectively. Conductor 932 extends through the winding of relay 1100, normal contacts of relay 1101, right winding of relay 1102, lower alternate contacts of relays 1135, 1125 and 1115, upper winding of relay 1113, lower winding of relay 1112 to ground, while conductor 933 extends through the left winding of relay 1102, upper alternate contacts of relays 1135, 1125 and 1115, upper winding of relay 1114, outer upper front contact of relay 1145, to ground at the outer upper back contact of relay 1101. Relays 1100 and 1102 operate. Since only low resistance 649 was included in the circuit over conductor 932, marginal relay 1113 operates in that circuit as well as relay 1112, and since only low resistance 646 was included in the circuit over conductor 933, relay 1114 operates. The operation of relay 1100 closes a circuit from grounded conductor 934, front contact of relay 1100, lower back contact of relay 1101, upper front contacts of relays

1135 and 1125, inner lower front contact of relay 1115, winding of relay 1111 and battery. Relays 1111, 1112, 1113 and 1114 lock to conductor 1150. Relays 1111 and 1112 close obvious circuits for relays 1118 and 1119.

The operation of relay 1102 closes a circuit from grounded conductor 1150, front contact of relay 1102, outer lower front contacts of relays 1135 and 1125, inner upper front contact and winding of relay 1115 to battery. This circuit is in shunt of relay 1116 and causes that relay to release but holds relay 1115 operated until the key is released at the key-set, when relay 1115 also releases transferring the registering circuits to the hundreds register 1120.

The operation of key 636 to record the hundreds digit connects battery through resistance 625 to conductor 661 and battery through resistances 647 and 646 to conductor 663. Conductor 661 extends as previously traced to conductor 929, through the winding of relay 1103, normal contacts of relay 1101, right winding of relay 1102, lower alternate contacts of relays 1135 and 1125, lower normal contacts of relay 1115, upper winding of relay 1123, lower winding of relay 1122 to ground. Since only a low resistance is included in this circuit, relays 1122 and 1123 both operate, locking to conductor 1150. Conductor 633 extends as previously traced to the upper alternate contacts of relay 1125 and over the upper normal contacts of relay 1115 to the lower winding of relay 1124 and ground. Since high resistance 647 was included in this circuit, relay 1124 does not operate. Relay 1102 in operating closes a circuit from ground on conductor 1150, front contact of relay 1102, outer lower front contacts of relays 1135 and 1125, inner upper back contact of relay 1115, to the winding of relay 1125 and battery. Relay 1126 is shunted by this circuit and releases, relay 1125 being held operated until the key is released at the key-set when relay 1125 also releases, transferring the registering circuits to the tens register 1130.

The operation of key 637 for the tens digit connects high resistance battery to both conductors 661 and 663, resulting in the operation of relays 1103, 1102 and 1132 in a manner similar to that described for previous registrations. Register relay 1132 locks to grounded conductor 1150. Relay 1102 now shunts relay 1136 and holds relay 1135 which releases when the key is released, to transfer the registration circuits to the units register 1140.

The operation of key 634 to record the units digit connects low resistance battery to conductor 663 and high resistance battery to conductor 662 thereby operating relays 1100, 1102, 1144, 1142 and 1141. The operation of relay 1102 completes a circuit from grounded conductor 1150, front contact of relay 1102 over the lower back contact of relay 1135, to battery through resistance 1147 thereby releasing relay 1146. With relay 1146 released, as soon as relay 1102 closes its back contact at the end of the pulse, a circuit is closed from grounded conductor 1150, back contact of relay 1102, outer lower front contact of relay 1145, right back contact of relay 1146, conductor 1151, upper back contact of relay 1003 through the winding of relay 1000 and battery. Relay 1000 locks over its outer upper front contact to grounded conductor 934 and prepares for the transfer of the designation from the centralized sender to the terminating sender.

Relay 1000 operated, disconnects ground from

the windings of relays 924 and 925 thereby opening the circuit of relay 611 which releases, disconnecting battery from conductor 628 and releasing relays 642 and 629. With relay 629 released relays 607 and 602 also release and ground is disconnected from conductor 622 thereby releasing relay 613. The release of relay 602 restores the connection of battery through resistance 691 to conductor 600 thereby placing the position circuit in condition to be selected in connection with another call. In addition, relay 1000 opens the circuit of relay 923 disconnecting the position finder from the centralized sender circuits.

Relay 1000 in operating also disconnects the conductors 232 and 233 from the winding of relay 1002 and completes the fundamental circuit for transferring the designation to the terminating sender. This circuit was prepared when relay 913 operated by the operation of relays 1005 and 1006. Relay 1005 operates in a circuit from battery through its winding, back contact of relay 1015, outer upper back contact of relay 1028, conductor 936 to ground at the inner lower front contact of relay 913. With relay 1005 operated, the circuit of relay 1006 extends from battery through the winding of that relay, lower front contact of relay 1005, inner upper back contact of relay 1028 to ground over conductor 936. Relay 1006 locks over the inner upper back contact of relay 1028 to grounded conductor 936 independent of relay 1005. Therefore, when relay 1009 operates, a circuit is closed in the centralized sender from conductor 232, lower front contact of relay 1000, lower back contact of relay 1003, back contact of relay 1027, lower back contact of relay 1028, outer upper front contact of relay 1006, winding of stepping relay 1004, inner upper back contact of relay 1003, inner upper front contact of relay 1000 to conductor 233.

The closure of the fundamental circuit in the centralized sender causes the operation of relay 310 in the terminating sender. Relay 310 closes a circuit from battery through the winding of relay 308, middle upper front contact of relay 300, which has been held operated following the registration of the frame designation, outer right back contact of relay 306 to ground at the front contact of relay 310. Relay 308 locks to the front contact of relay 310 independent of relay 306 and closes an obvious circuit for relay 306 which locks to ground over the outer lower front contact of relay 300. The operation of relay 306 opens the second locking circuit for relay 300 and that relay releases, leaving relay 306 dependent upon relays 308 and 310.

With relays 306 and 308 operated, ground is disconnected from conductor 235 permitting the stepping relay 514 to operate. Relay 514 closes a circuit from ground over the outer upper front contact of relay 513, front contact of relay 514, lower front contact of relay 513 to the winding of relay 530 and battery. Relay 530 closes a circuit from ground over its lower contact, normal contacts of jack 531, conductor 532, left back contact of relay 312, winding of relay 313 to battery. Relay 313 closes a holding circuit from battery through its winding, right winding of relay 312, back contact of relay 314, left contact of relay 313 to ground at the outer right front contact of relay 308, but relay 312 does not operate, being shunted by the operating circuit of relay 313.

Relay 530 at its upper front contact connects ground to conductor 234 thereby holding relay

310 operated and shunting the windings of the stepping relays 514 and 1004 causing these relays to release. The release of relay 514 opens the circuit of relay 530 and that relay in turn releases. This alternate operation and release of relays 514 and 530 generates reverte pulses which are counted by both senders.

At the terminating sender the operation of relays 308 and 306 connects ground to the right armatures of relay 312. When relay 530 releases after the first reverte pulse, relay 312 operates in the holding circuit of relay 313 and closes a circuit from ground at the inner left front contact of relay 308, right front contact of relay 312, left back contact of relays 324 and 322, right back contacts of relays 323 and 325 to the winding of relay 321 and battery. Relay 321 operates and locks over its inner right front contact, normal contacts of relays 322, 323, 324 and 325, outer right front contact of relay 306 to ground over conductor 307. A parallel locking circuit extends from the contact of relay 325 over the upper normal contacts of relay 300 to grounded conductor 221. The next operation of relay 530, grounding conductor 532 closes a circuit over the left front contact and left winding of relay 312 through the right winding of relay 314 and battery. Relay 314 opens the operating circuit of relay 313 and that relay releases. When relay 530 releases, relays 314 and 312 also release. A circuit is then closed from ground over the right back contact of relay 312, inner left front contact of relay 321 to the winding of relay 322 and battery. Relay 322 locks over the chain circuit previously traced, opening the locking circuit for relay 321 which releases. Subsequent operations of relay 530 cause relays 313, 314 and 312 to operate as above described so that for each odd pulse ground is closed to the counting relays over the front contact of relay 312 and for each even pulse ground is connected to the counting relays over the back contact of relay 312. The third, fourth, fifth and sixth pulses operate relays 323, 324, 325 and 326, respectively. Relay 325 locks over the back contact of relay 321, therefore remaining operated when relay 326 is operated. Relay 326 locks through its right winding and inner right front contact over the outer right front contact of relay 306 to conductor 307 independent of the other counting relays and therefore remaining operated during any subsequent pulses. The seventh, eighth, ninth and tenth pulses operate relays 321, 322, 323 and 324, respectively, relay 321 releasing relay 325.

The regular terminating sender is arranged to receive the wanted number from the originating sender in the form of three selections known as incoming brush, incoming group and final brush selections, which are translated from the thousands and hundreds digits of the wanted number, followed by final tens and final units selections corresponding directly to the tens and units digits of the wanted number. Therefore, in order to provide for the simple modification of terminating senders to work with a centralized B operator's equipment or vice versa, the terminating end of the present sender is likewise equipped with a cross-bar register having five verticals for receiving five selections and translating them into a numerical designation for transmission to the marker.

In the centralized end of the sender the five selections are controlled by the steering relays 1030 to 1039. When relay 513 operated grounding conductor 934, a circuit was closed over the

middle upper back contact of relay 1000 through the windings of relays 1030 and 1031 in series to battery, relay 1030 closing a locking circuit through the windings of relays 1030 and 1031, front contact of relay 1030, upper back contact of relay 1033 to grounded conductor 934, independent of relay 1000.

With relays 1030 and 1031 operated, the operation of relay 1004, by the establishment of the fundamental circuit, closes a circuit from ground over the upper back contact of relay 1007, front contact of relay 1004, lower back contact of relay 1007, back contacts of relays 1026 and 1021, inner upper front contact of relay 1031, conductor 1008, middle upper front contact of relay 1114, outer upper front contact of relay 1113, lower front contacts of relays 1119 and 1118, conductor 1152, upper front contact of relay 1005, winding of relay 1011 to battery. Relay 1011 locks through the winding of relay 1021 to ground at the lowermost contact of relay 1006, but relay 1021 does not operate, being shunted by the operating circuit for relay 1011. When relay 530 operates, shunting the stepping relays of the two senders, relay 1004 releases, permitting relay 1021 to operate. When relay 530 releases permitting relay 1004 to reoperate, the counting relay circuit extends, as above traced, to the upper armature of relay 1021 and thence over the front contact of relay 1021, upper back contacts of relays 1038, 1036 and 1032 to the winding of relay 1010 and battery. Relay 1010 operates, locking through the windings of relays 1027 and 1020 in parallel to ground at the outer lower front contact of relay 1006. When relay 1004 is shunted and releases for the second time, relays 1027 and 1020 operate in this locking circuit. The operation of relay 1027 opens the fundamental circuit, releasing relays 310, 514 and 1004, and bringing the selection to an end.

Relay 1020 closes a circuit from ground at its contact over the lower back contacts of relays 1039, 1037, 1035 and 1033, lower front contact of relay 1031 to the winding of relay 1032 and battery. Relay 1032 closes a locking circuit for itself through the winding of relay 1033, outer lower front contact of relay 1032, upper back contact of relay 1035 to grounded conductor 934. Relay 1032 also closes a circuit from grounded conductor 934, outer upper front contact of relay 1031, inner lower contact of relay 1032 to the winding of relay 1028 and battery. Relay 1028 further opens the fundamental circuit and disconnects grounded conductor 936 from the operating and locking circuits of relay 1006 causing that relay to release and open the fundamental circuit at an additional point. Relay 1028 also opens the operating circuit of relay 1005 and that relay releases. The release of relay 1006 opens the locking circuit of the counting relays and these relays release. The release of relay 1020 permits relay 1033 to operate in the locking circuit of relay 1032 and open the locking circuit of relays 1030 and 1031 so that these relays release. The release of relay 1031 opens the circuit of relay 1028 and that relay releases, restoring the circuits of relays 1005 and 1006 which now reoperate. With relay 1006 reoperated the fundamental circuit is reclosed and the centralized sender is ready to transmit the next selection.

At the terminating sender the two reverte pulses which satisfy the centralized sender cause the operation of relays 321 and 322 leaving relay 322 operated and locked when the fundamental

circuit was opened. The release of relay 310 in turn releases relays 308 and 306. With relay 306 released, a circuit is closed from ground at the lower back contact of relay 534, conductor 535, lower normal contacts of relay 300, right back contact of relay 326, first left back contact of relay 306, outer left front contact of relay 322, conductor 331, winding of select magnet 701, winding of relay 790 and battery. Magnet 701 prepares the cross-points at the No. 1 level of the register switch and extends its operating ground to the winding of relay 300 as previously described. Relay 300 locks over the back contacts of relays 220 and 306 as before, thereby also locking the select magnet 701. At its outer upper front contact relay 300 connects ground on conductor 332 over the upper front contact of relay 204 to resistance 203 and battery in shunt of the winding of relay 202 which thereupon releases. Relay 204 is held operated over the normal contact of relay 202 after that relay releases. With relay 202 released and relay 204 operated, the windings of relay 220 are connected over the lower front contact of relay 204, lower back contact of relay 202, conductor 236, outer upper contact of hold magnet 410, upper back contact of hold magnet 412, to the winding of magnet 411 and battery. Magnet 411 closes cross-point 772 and locks over its inner upper front contact, conductor 421, through cable 422 to ground at the fourth upper front contact of relay 206. The closure of this locking circuit extends ground back to the upper winding of relay 220 causing that relay to operate opening one locking circuit for relay 300.

When the fundamental circuit is reclosed at the centralized office, relays 310, 308 and 306 reoperate and relay 300 releases, in turn releasing relay 204. The remaining selections are performed in essentially the same manner, relay 300 operating relays 202 and 204 on alternate selections and releasing them on the following selections.

Since the thousands and hundreds digits have been translated into incoming brush, incoming group and final brush selections, with relays 1032 and 1033 operated to control incoming group selection, the counting relay circuit extends as previously traced to the armature of relay 1021, over the back contact of that relay, inner upper front contact of relay 1033, conductor 1040, inner upper front contact of relay 1113, inner upper front contact of relay 1114, lower back contact of relay 1124, back contact of relay 1023, winding of relay 1013 and battery. For this selection, when relays 1011 and 1021 are operated, after three reverte pulses the counting relay circuit extends over the front contact of relay 1021, upper back contacts of relay 1038 and 1036, upper front contact of relay 1032, lower back contact of relay 940, winding of relay 1010 to battery. At the end of the selection, the fundamental circuit is broken as above, resulting in the operation of steering relays 1035 and 1034 and the release of relays 1032 and 1033. In the terminating sender the four reverte pulses leave relay 324 operated, resulting in the operation of select magnet 703 and hold magnet 412, closing cross-point 773.

With relays 1034 and 1035 operated, the selection is controlled by the hundreds register 1120 alone and the counting relay circuit may be traced over the back contact of relay 1021 over the inner upper front contact of relay 1035, upper front contact of relay 1123, outer upper front

contact of relay 1122, upper back contact of relay 1121, conductor 1152, upper front contact of relay 1005, winding of relay 1011 and battery. Two pulses satisfy the centralized sender resulting in the closure of cross-point 774 at the terminating sender.

The final tens selection takes place with relays 1036 and 1037 operated. In this case, the counting relay circuit extends as traced to the back contact of relay 1021, inner upper front contact of relay 1037, back contact of relay 1133, lower front contact of relay 1132, lower back contact of relay 1131, back contact of relay 1022 to the winding of relay 1012 and battery. The first two pulses permit relays 1022 and 1021 to operate, whereupon the counting relay circuit is transferred over the front contact of relay 1021, upper back contact of relay 1038, outer upper front contact of relay 1036, upper back contact of relay 1134 to the winding of relay 1016 and battery. The third pulse permits relay 1020 to operate, which transfers the counting relay circuit to the winding of relay 1015 which operates when the stepping relay reoperates. Relay 1015 in operating releases relay 1005. As a result of the fourth, fifth, sixth and seventh pulses, relays 1025, 1024, 1023 and 1022 operate. With relay 1022 operated, the counting relay circuit is extended over the front contact of relay 1022, back contact of relay 1005 to the winding of relay 1010 so that eight pulses satisfy the sender. As outlined previously, eight reverte pulses operate relays 321 to 326, leaving relay 326 operated, followed by relays 321 and 322, relay 322 remaining operated at the end of the eighth pulse. Therefore, when relay 306 releases following the opening of the fundamental circuit, the select magnet circuit extends from grounded conductor 535, lower normal contacts of relay 300, outer right front contact of relay 326, outer left back contact of relay 306, inner right front contact of relay 322, conductor 332, winding of select magnet 407 and battery. With select magnet 407 operated, the operation of hold magnet 414 closes cross-point 475.

The final units selection takes place in a manner similar to the selections above described and results in the closure of cross-point 776. After final units selection has been transmitted relays 1010, 1020 and 1027 are operated as above, opening the fundamental circuit. Since no circuit exists for relay 1028, there is no means for reclosing the fundamental circuit and it remains open until the centralized sender is released.

In the terminating sender when hold magnet 415 operates after the registration of the final units selection, ground is connected to conductor 235 in shunt of the winding of stepping relay 514 to prevent any false pulses by that relay. Magnet 415 also closes a circuit from ground over its inner lower front contact, conductor 424, winding of relay 520 and battery. Relay 520 opens the circuit of relay 230 which opens the four conductors leading to the centralized sender. Opening the connections between conductors 227 and 228 releases relay 912 which in turn releases relay 913 removing the locking grounds from the various circuits and restoring the centralized sender to normal.

Relay 520 also opens the locking circuit for relay 300 previously controlled by relay 306 permitting relay 300 to release, in turn releasing relay 204. In addition, relay 520 closes a circuit from battery over the lower normal contacts of relay 516, upper normal contacts of relay 515, outer lower front contact of relay 523, front con-

tact of relay 520, outer upper front contact of relay 200, to conductor 241 which extends through cable 536 to the marker connector 800 indicated at the left of Fig. 8. When the connector is operated the cross-bar register is connected to the marker and the recorded number transmitted thereto, the register translating the selections back into a numerical designation.

With cross-points 772, 773, 774, 475, 776 and 771 closed, the following conductors are grounded directly by cross-points which are supplied with ground over conductor 423 and the back contact of relay 762; thousands conductors 712, 711; hundreds conductors 721, 722; tens conductors 732 and 734; units conductor 743 and frame conductor 753. Frame tens conductor 764 is grounded over the upper front contact of relay 301.

The marker connects ground through the marker connector 800 to conductors 801, 802, 803 and 804. It will be observed that ground over one of these conductors is connected by the cross-points to each of the conductors which do not receive ground over conductor 423. For example, thousands conductors 711 and 712 are grounded by cross-points 773 and 772, respectively. The remaining thousands conductors 713 and 714 are grounded by cross-point 772 from ground supplied over conductor 803. The office identification conductor 250 is grounded over the lower front contact of relay 208 and conductor 802. Reorder conductor 544 is grounded over the upper back contact of relay 534 and conductor 802.

Therefore ground is connected either directly or indirectly to all of the registering conductors connecting the sender with the marker. As a result, all of the register relays in the marker are operated to close a chain circuit (not shown) as a check for faults in the connections between the sender and marker. If the chain circuit is closed, ground is removed from conductors 801 to 804 and the registration remaining in the marker is used to select, test and establish a connection with the wanted line. During these operations the marker is connected directly with the incoming junctor under the control of a circuit completed over conductor 217.

In the selection of the wanted line the marker combines the thousands and hundreds registrations to operate a relay representing a block of five hundred numbers. A number of such relays are indicated by relays 810 to 813. Where the incoming junctor serves more than one office these numbers may occur in either office and the marker must discriminate between the offices. With conductor 250 grounded over conductor 802, relay 805 is released following the establishment of the chain circuit and operates relay 806 over its back contact. With relay 806 operated, the circuit of the 500-block relay closed by the thousands and hundreds registers represented by relays 807 and 808, respectively, extends over front contacts of relay 806 to relays 810 and 811 which are individual to the A office.

When the marker has completed its function, it connects ground to conductor 537 closing a circuit over the lower back contact of relay 538 to the winding of release relay 516 and battery. Relay 516 disconnects battery from the marker connector 800 thereby releasing both the connector and the marker. In addition, relay 516 locks over its outer upper and lower front contacts to grounded conductor 517 under the control of relay 208 and connects ground to conductor 218 to hold the sender busy until released. The operation of relay 516 disconnects ground from

conductor 213 and the locking circuit of relay 206 but that relay, as well as the hold magnets of the link switches, remains operated until ground is removed from conductor 213 by the marker connector. When this occurs relay 206 and the link switches release, followed by relay 209. With relays 206 and 209 released the holding circuits for the various relays of the sender are opened and the sender is restored to normal.

Call over a junctor terminating at office B

The operation, if the junctor were incoming to office B, would be essentially the same as above described except that conductor 116 is grounded, operating relay 212 in the terminating sender. With relay 212 operated the office identification conductor 250 leading to the marker is grounded directly, over the lower front contact of relay 212. In the marker the direct grounding of conductor 250 holds relay 805 operated, resulting in the operation of relay 809 and the extension of the operating circuit for the 500-block relays to relays 812 and 813 individual to the B office.

Call over a junctor terminating at both office A and office B

Assuming that the connection has been extended over incoming junctor 104 belonging to the group of junctors which have access to more than one office, relay 119 will be operated, in turn operating group relay 120. If the same group of senders is seized, sender group relay 114 will also be operated. The operation of relay 120 connects ground to conductor 115 over the contact of relay 114 to conductor 121. When the sender is seized and relay 500 operated, this ground is extended over the fourth lower front contact of relay 500 to conductor 540, winding of relay 211 and battery. Relay 211 locks to conductor 219 when relay 206 operates. The operating circuit of relay 200 which extends as previously traced to the upper back contact of relay 212 now is completed over the upper back contact of relay 212, outer upper front contact of relay 211, upper back contact of relay 208, second lower front contact of relay 206 to conductor 210.

When relay 230 operates, connecting the terminating sender with the centralized sender, conductor 232 is connected over the inner upper front contact of relay 230, inner lower front contact of relay 211, conductor 235 to the winding of relay 514 and ground, while conductor 233 is connected over the middle upper front contact of relay 230, middle upper front contact of relay 211, conductor 234 to the winding of relay 310 and battery. Battery and ground are, therefore, reversed on the fundamental circuit connecting the two senders. In the centralized sender the current flowing through the winding of polarized relay 1002 is in a direction to operate that relay which in turn operates relay 1003. Relay 1003 locks over its inner upper front contact to grounded conductor 936. Relay 1003 reverses the direction of current flow through the stepping relay 1004 to compensate for the reversal at the terminating sender. During the interval between the operation of relay 923 and the release of relay 919, relay 1003 also connects ground over its outer lower front contact, outer lower front contact of relay 919, middle right front contact of relay 923, brush 904, conductor 939, right back contact of relay 602 to the left winding of relay 624 and battery. Relay 624 locks in a circuit from battery through its right wind-

ing and inner right front contact to ground at the outer right front contact of relay 629 and closes the circuit of lamp 655 to indicate that the incoming call requires an office indication.

When relay 629 operates, the primary circuit of the tone coil extends from source 616, inner left front contact of relay 629, left back contact of relay 617, outer right front contact of relay 624, primary winding of coil 614 to ground at the inner right back contact of relay 613. As before, relay 629 operates relay 607 in turn operating relay 618 but the tone circuit is held closed over the contacts of relays 624 and 619 in shunt of the contact of relay 618. Relay 618 operates relay 602 which in turn operates relay 623. Relay 623 operates relay 617 which opens the circuit of relay 619. Relay 619 releases after an interval and opens the circuit of the tone coil and stops the tone. With relay 602 operated, the previously traced circuit of relay 613 is open, but the release of relay 619 closes a substitute circuit over the back contact of relay 619 and the front contact of relay 617 to conductor 622. Therefore the A and B operators hear a single prolonged tone to inform them that the office designation is to be given.

When the operator receives the office name, she operates either key 651 or 652 according to the identity of the wanted office. Key 651 corresponding to office A connects battery over conductor 612 through resistance 653, through the two windings of relay 611 in parallel to conductors 927 and 928. These conductors are connected as previously traced through the windings of polarized relays 924 and 925. With battery connected to conductors 927 and 928, relay 925 operates closing a circuit from ground on conductor 1150, contact of relay 925, lower back contact of relay 941 to the winding of relay 942 and battery. Relay 942 in operating locks over its outer upper front contact through the winding of relay 941 to ground over conductor 1150. With relay 1003 operated, relay 1000 cannot operate until the office registration has been made since the circuit of relay 1000 now extends from battery through the winding of that relay, outer upper front contact of relay 1003, upper back contact of relay 940 and the inner upper front contact of relay 942 to ground over conductor 1151 as before.

If key 652 corresponding to office B, is operated, it connects ground through resistance 654 to conductors 927 and 928, and relay 924 operates, in turn operating relay 940. Relay 940 also locks through the winding of relay 941 and closes the operating circuit for relay 1000. In addition, during incoming group selection, the counting relay circuit is modified by the operation of relay 940. With relay 940 operated, incoming group selection takes place as previously described until relay 1021 is operated. When relay 1021 operates, the circuit extends over the front contact of relay 1021, upper back contacts of relays 1038 and 1036, upper front contact of relay 1032, lower front contact of relay 940 to the winding of relay 1016 and battery. Five additional pulses permit the operation of relays 1026, 1025, 1024, 1023 and 1022 in the locking circuits of relays 1016, 1015, 1014, 1013 and 1012, respectively. As previously described, the operation of relay 1015 releases relay 1005 and relay 1022 directs the counting relay circuit over the back contact of relay 1005 to the winding of relay 1010. It will, therefore, appear that the effect of operating relay 940 is to

add five pulses to the train of pulses required by the incoming group registration.

In the terminating sender, the pulse receiving arrangement functions as described, one of the digits 5 to 8 being recorded on the incoming group vertical of the register switch. In order to inform the marker of the identity of the wanted office, with relay 211 operated, conductor 250 over which marker transfer relay 805 is controlled may be connected either to direct ground or to conductor 802 depending upon the registration on the incoming group vertical. The circuit may be traced from conductor 250 over the outer lower front contact of relay 211, conductor 251 to the vertical conductor 761 of the incoming group vertical of the register. Over any one of the lower four cross-points, which correspond to normal registration, for example, cross-point 773, conductor 761 is connected to conductor 802. Over the fifth and tenth cross-points, the circuit is open since no such registration is to be expected, while over the lower four cross-points of Fig. 4 conductor 761 is connected over conductor 423 to ground at the lower back contact of relay 762.

Trouble timing

In the terminating sender when relay 200 operates, it connects ground over its second lower front contact to conductor 252 thereby grounding the cam spring of interrupter 253. When interrupter 253 closes its left contact it extends ground through the left winding of relay 254 to battery, operating relay 254 which locks through its right winding and right front contact to conductor 252. With relay 254 operated the closure of the right contact of interrupter 253 completes a circuit from ground over the interrupter contact, left contact of relay 254, winding of relay 224 to battery. Relay 224 locks over its outer lower front contact to conductor 252, lights lamp 255 and connects ground to conductor 256 to sound an alarm. At its outer upper contact relay 224 disconnects battery from conductor 216 to release the junctor. At its inner upper back contact relay 224 opens the circuit of relay 230 thereby releasing the centralized sender. With relay 224 operated, the next closure of the left contact of interrupter 253 completes a circuit from ground on that contact, over the middle lower front contact of relay 224, upper winding of trouble release relay 515. Relay 515 locks through its upper winding and over its upper contact to grounded conductor 517 and disconnects battery from conductor 241 extending to the marker connector 800 thereby releasing the connector and the marker. In addition, relay 515 opens the locking circuit of relay 206, which releases when the marker connector releases, in turn releasing relay 515. In general, the trouble release relay functions to release the sender in the same manner as release relay 516. However, if it is desired to prevent the release of the sender, in order to examine it after a trouble has caused it to time out, a plug 541 may be inserted in hold jack 542. In this case when relay 515 operates, a circuit is completed from battery through the upper winding of relay 206, conductor 257, ring and sleeve of jack 542 connected together by plug 541, lower alternate contacts of relay 515, upper normal contacts of relay 516 to grounded conductor 517. The marker is released, but the sender remains busy until released by the removal of plug 541 from jack 542. The timing operation, above described, be-

comes effective if the operation of the sender fails to progress properly at any stage following the operation of relay 200. If no frame tens registration is made, relay 509 cannot operate and relay 206 fails to operate, while if both frame tens relays operate, two select magnets operate for frame registration or the office register relays operate incorrectly, relay 200 cannot operate and the timing arrangement associated with the link control circuit functions.

Position troubles

If the operator before completing the registration realizes that she has operated the wrong key, she may release the partial registration and make a new registration by operating key 644. The operation of key 644 opens the locking circuit of relay 642 and that relay releases, in turn releasing relay 627. The release of relay 627 again connects battery to conductors 661 and 662, thereby operating relays 1100 and 1103 which in turn operate relay 1101. The operation of relay 1101 disconnects ground from conductor 1150 releasing all of the register relays. As before, relay 1101 reoperates the transfer relays 1115, 1116, 1125, 1126, etc., preparing the registers for reoperation. Since the office register relays 940 and 942 lock to conductor 1150 they are also released and must be reoperated by the operation of one of the office identification keys 651 and 652.

If the operator starts to operate her key-set before the sender is ready to receive the registration, the operation of any one of the keys connects battery through resistance 646 alone or in series with resistance 647, over the outer right front contacts of relays 642 and 641 through the left winding of relay 643 to ground. Relay 643 locks in a circuit from battery on conductor 628, right winding and right front contact of relay 643 to ground over key 644 and connects ground through interrupter 670 to lamp 643 causing that lamp to flash as a warning to the operator. The operation of key 644 releases relay 643 and restores the sender to condition for registration as above described.

Reorder

If the position circuit is not released by the completion of the registration, the operator may disconnect by operating position disconnect key 603. At its left contact key 603 disconnects battery from conductor 600 thereby opening the circuit of relay 916 to cause the sender to release the position. If relay 611 had not operated so that relays 629 and 607 also are not operated and indicating that relays 916 and 919 are still operated, key 603 connects ground over its outer right contact to the left back contact of relay 607, conductor 922, brush 905, middle lower front contact of relay 919 through the normal contacts and winding of relay 917, causing that relay to operate. Relay 917 locks through the winding of relay 911 to grounded conductor 920, and disconnects relay 916 from brush 906 to release the position. Relay 911 reverses the connection of battery and ground through relay 912 to conductors 227 and 228 thereby operating relay 225 in the terminating sender. Relay 225 closes a circuit from grounded conductor 221, contact of relay 225, conductor 333, winding of relay 534 and battery.

If relay 611 fails to release, holding relay 613 operated, ground is connected over the inner right operated contact of key 603, outer right front contact of relay 613, through the right

front contact of relay 611 to conductor 928, and through the windings of relay 611 to conductor 927, brushes 901 and 902, left front contacts of relay 923, upper windings of repeating coil 910, windings of relays 924 and 925, to battery and ground as previously traced. Relay 924 operates in this circuit. If an office registration has been made so that relay 941 is operated, a circuit is completed from grounded conductor 1150, contact of relay 924, lower front contact of relay 941 to the normal contacts and winding of relay 917 and battery. If no office registration has been made, the operator closes key 603 twice. In that case, since relay 941 is not operated, for the first operation of key 603 the circuit extends over the inner lower back contact of relay 941 to the winding of relay 940 which locks through the winding of relay 941 as previously described. On the second operation of key 603, relay 917 is operated as above, in turn operating relay 911. Relay 917 is also operated if both office relays 940 and 942 are operated, the circuit extending from ground over the lower front contact of relay 942, inner lower front contact of relay 940 to the normal contacts and winding of relay 917 and battery, causing the operation of relay 534 as above described.

When relay 534 is operated it locks over its inner lower front contact to grounded conductor 221 and connects ground over its outer lower front contact in shunt of the winding of relay 514 to stop further pulsing. At its lower back contact, relay 534 disconnects ground from conductor 535 to prevent any further registrations. At its inner upper front contact relay 534 connects ground over conductor 543 through the windings of relays 762 and 763 to battery. At its upper back contact relay 534 disconnects conductor 802 from the reorder conductor 544 leading to the marker and connects direct ground thereto over its outer upper front contact. With relays 762 and 763 operated, ground is disconnected from the cross-bar register and connected over the outer lower front contact of relay 762, outer upper front contact of relay 763, conductor 424, to the winding of relay 520 and battery. Relay 520 summons the marker which receives a reorder signal over conductor 544. With relays 762 and 763 operated, ground supplied by the marker to conductor 804 is connected over four contacts of relay 762 to the units registration conductors and over contacts of relay 763 to part of the thousands registration conductors. Ground on conductor 803 is connected over contacts of relay 762 to the tens registration conductors and over contacts of relay 763 to the remaining thousands registration conductors and ground on conductor 802 is connected to the hundreds registration conductors. Ground on conductor 801 serves to check the frame registrations, etc., as on an ordinary call. Therefore, with relays 762 and 763 operated, the numerical registration is canceled and temporary circuits are completed for the register relays of the marker to permit that circuit to function. As far as the sender is concerned the completion of the connection is the same as for a regular call.

Relay 534 is also operated if trouble in the centralized sender prevents the opening of the fundamental circuit. It will be remembered that, at the end of ten pulses, relay 326 was operated and locked and relay 324 was operated. If a subsequent pulse is received, a circuit is closed from ground over the right front contact

of relay 312, inner left front contact of relay 324, inner left front contact of relay 326, conductor 333 to the winding of relay 534 and battery.

In addition, relay 534 is operated if a registration is received which is inconsistent with the selection being made. There being but five possible registrations corresponding to the five brushes on an incoming selector, four incoming groups and five possible registrations corresponding to the five brushes on a final selector, any higher registration is an erroneous one. In the case of the incoming group selection, an additional five pulses may be received to identify the B office. Therefore, only the registration of 5 or 10 pulses is clearly in error. From inspection it will be seen that the right contacts of the cross-points corresponding to such incorrect registrations have been connected to ground so that the closure of one of these cross-points connects ground to conductor 333 operating relay 534.

If the call is abandoned by the A operator, ground is removed from conductor 519 by the incoming junctor. Relay 522 closes its left contact thereby closing a circuit from ground on conductor 517, left contact of relay 522, inner lower front contact of relay 523, winding of relay 538 and battery. Relay 538 is slow to operate to prevent improper release. When it closes its contact it completes a circuit from grounded conductor 252, lower back contact of relay 324, front contact of relay 533 to the winding of relay 516 and battery. Relay 516 proceeds to release the sender as previously described.

Both the marker and the link circuit can release the sender in case of trouble, the marker by grounding conductor 545 which operates trouble release relay 515 and the link by grounding conductor 546, which, prior to the release of relay 500, operates release relay 516.

What is claimed is:

1. In a telephone system, a unitary register sender comprising an operator controlled registering device and a full mechanical registering device permanently connected over a plurality of conductors, and means for transferring registrations from said operator controlled device to said full mechanical registering device.

2. In a telephone system, a first office, automatic switching equipment at said office, a second office, an operator's position at said second office, a single register sender including registering means in each of said offices, means for setting up registrations on one of said registering means under the control of said operator's position, means for transferring the registrations from said one registering means to the other registering means, and means under the control of said other registering means to control said automatic switching equipment.

3. In a telephone system, a plurality of offices, trunks having access to said offices in common, a sender common to said offices, means to connect said sender to one of said trunks, an operator's position, means to connect said sender with said operator's position by means of a talking circuit and a plurality of registering circuits, means for recording the wanted line designation over said registering circuits, and means for simultaneously transmitting a discriminatory signal over said talking circuit indicative of the office in which said line is located.

4. In a telephone system, first operators' positions, a second operator's position, trunk cir-

cuits terminating in individual offices, trunk circuits terminating in a plurality of offices, means at a first operator's position for seizing one of said trunks, registering equipment and switch control equipment common to said trunks, means responsive to the seizure of a trunk terminating in an individual office for recording the identity of the office in said registering equipment, means for varying the operation of said switch control equipment in accordance with said record, means responsive to the seizure of a trunk terminating at a plurality of offices for establishing a special record in said registering equipment, means responsive to said special record for transmitting a distinctive signal to said operators' positions, means under the control of said second operator for setting up a secondary record of the identity of the office requested by said first operator, and means under the joint control of said special record and said secondary record to determine the operation of said switch control equipment.

5. In a telephone system, a first operator's position, a trunk circuit appearing at said operator's position and terminating in a plurality of offices, a full mechanical registering device associate with said trunk circuit, an operator controlled registering device permanently connected with said full mechanical registering device over two pairs of conductors, a second operator's position, means to connect said first operator's position with said second operator's position over said trunk circuit, said full mechanical registering device, one pair of said conductors and said operator controlled registering device, means responsive to the seizure of said trunk circuit to indicate to said full mechanical registering device that said trunk terminates in a plurality of offices, means to transmit said indication to said operator controlled sender over said other pair of conductors, means under the control of said second operator to transmit a signal characteristic of the wanted office over said other pair of conductors, and means under the joint control of said indication and said signal for controlling the establishment of a connection between said trunk and the wanted line.

6. In a telephone system, a sender, a marker, registers in said sender and said marker, a plurality of circuits connecting said sender registers and said marker registers, means for transferring a telephone designation from said sender to said marker by connecting ground under the control of said sender registers to a plurality of said circuits, means controlled from said marker for connecting ground to the remainder of said circuits, means in said marker responsive to the grounding of all of said circuits, operator controlled means for setting said sender registers, reorder means in said sender operated if said operator controlled means fail to function, and means under the control of said sender reorder means to transmit a reorder signal to said marker and to connect ground to all of said conductors independent of said registers.

7. In a telephone system, a sender, a marker, registers in said sender and said marker, a plurality of circuits connecting said sender registers and said marker registers, means for transferring a telephone designation from said sender to said marker by connecting ground under the control of said sender registers to a plurality of said circuits, means controlled from said marker for connecting ground to the remainder of said circuits, means in said marker

responsive to the grounding of all of said circuits, operator controlled means for setting said sender register, reorder means in said sender operated if said operator controlled means fail to function, and means under the control of said sender reorder means to disable said sender registers, to transmit a reorder signal to said marker and to connect ground to all of said conductors under the control of said marker.

8. In a telephone system, a first office, automatic switching equipment at said office, a second office, operators' positions at said second office, a registering device in said first office common to said automatic switching equipment, a registering device in said second office individual to the registering device in said first office and common to said operators' positions, and means controlled from said operator's position for successively registering a telephone designation on said registering devices and controlling said switching equipment.

9. In a telephone system, a plurality of offices, trunks having access to said offices in common, a sender common to said offices, means to connect said sender to one of said trunks, means to indicate to said sender that said trunk is common to said offices, operator controlled means to record the numerical designation of a wanted line and a discriminatory signal indicative of the office in which said line is located, and means under the joint control of said trunk indication and said discriminatory signal to alter said numerical designation.

10. In a telephone system, a plurality of offices, automatic switching equipment at said offices, a central office, means for operating said automatic switching equipment under the control of said central office comprising register senders, each sender having one registering device in one of said plurality of offices and a second registering device in said central office, means for setting up a registration on said second registering device, means for transferring said registration from said second registering device to said one registering device and means to control said automatic switching equipment from said one registering device.

11. In a telephone system, a plurality of offices, automatic switching equipment at said offices, a central office, operators' positions at said central office and means for operating said automatic switching equipment under the control of said operators' positions comprising register senders, each sender having one registering device in one of said plurality of offices and a second registering device in said central office, means for setting up a registration on said second registering device under the control of one of said operators' positions, means for transferring said registration from said second registering device to said one registering device and means to control said automatic switching equipment from said one registering device.

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