

April 2, 1946.

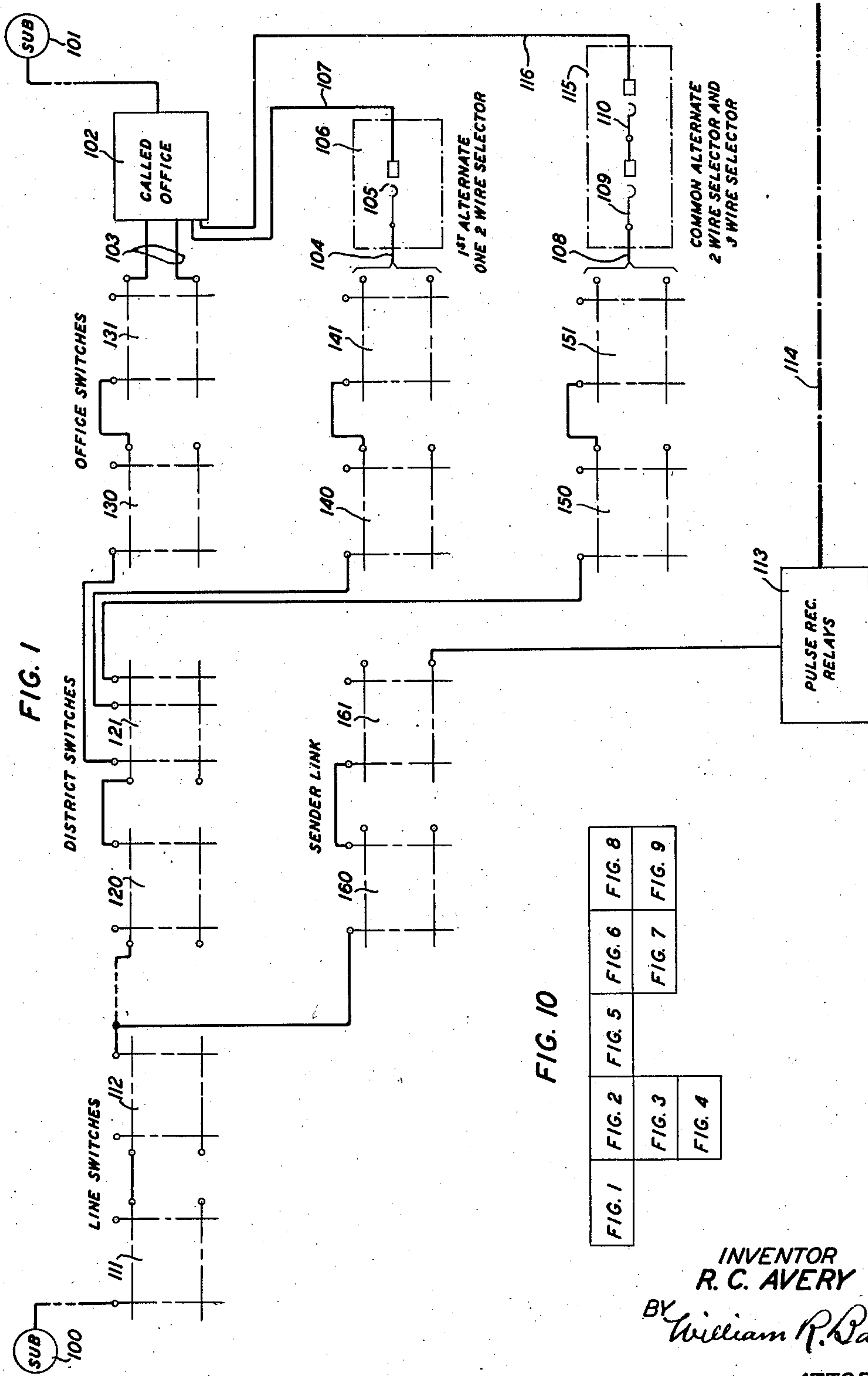
R. C. AVERY

2,397,829

TELEPHONE SYSTEM

Filed Sept. 26, 1944

9 Sheets-Sheet 1



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TELEPHONE SYSTEM

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9 Sheets-Sheet 2

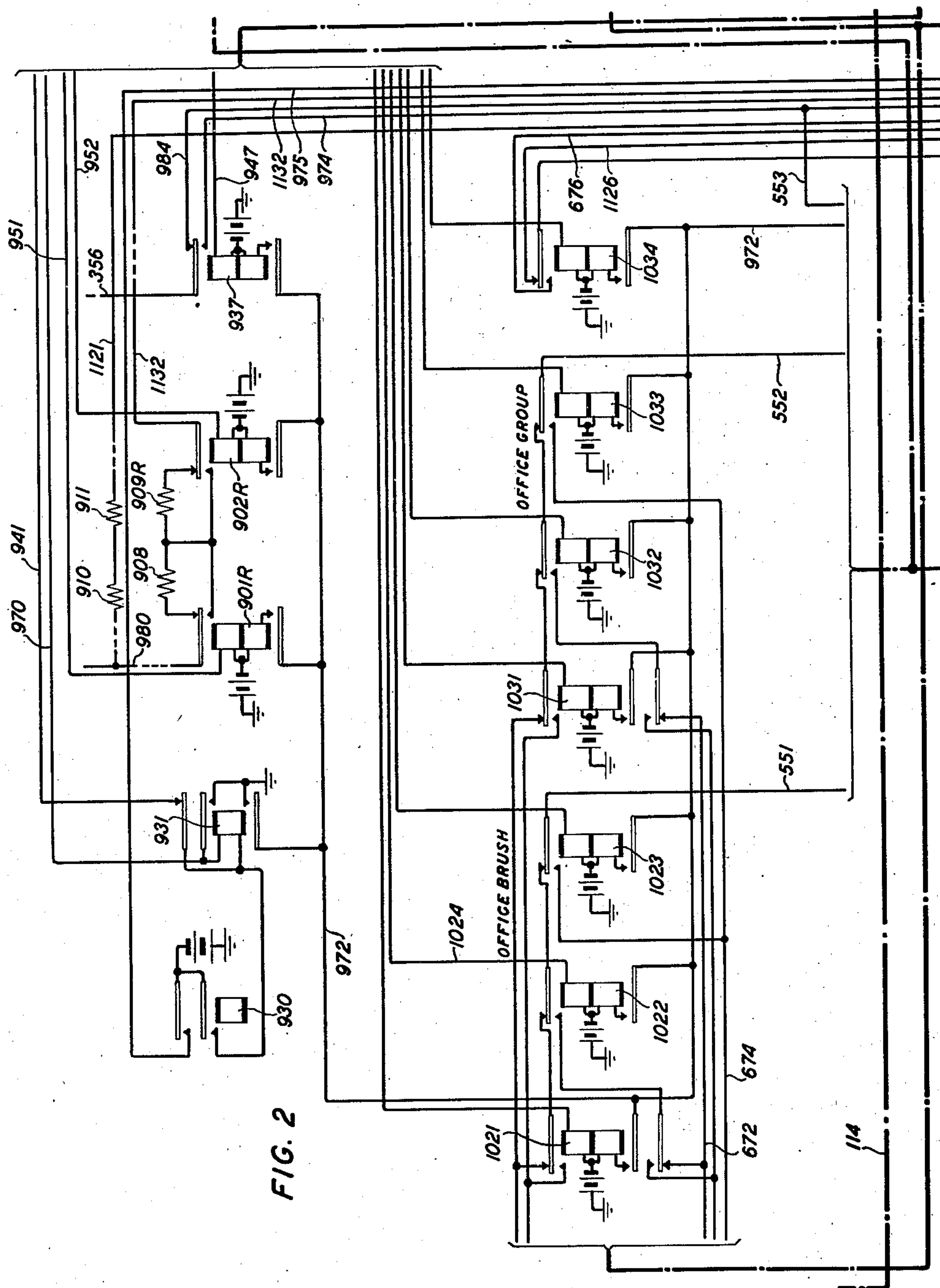


FIG. 2

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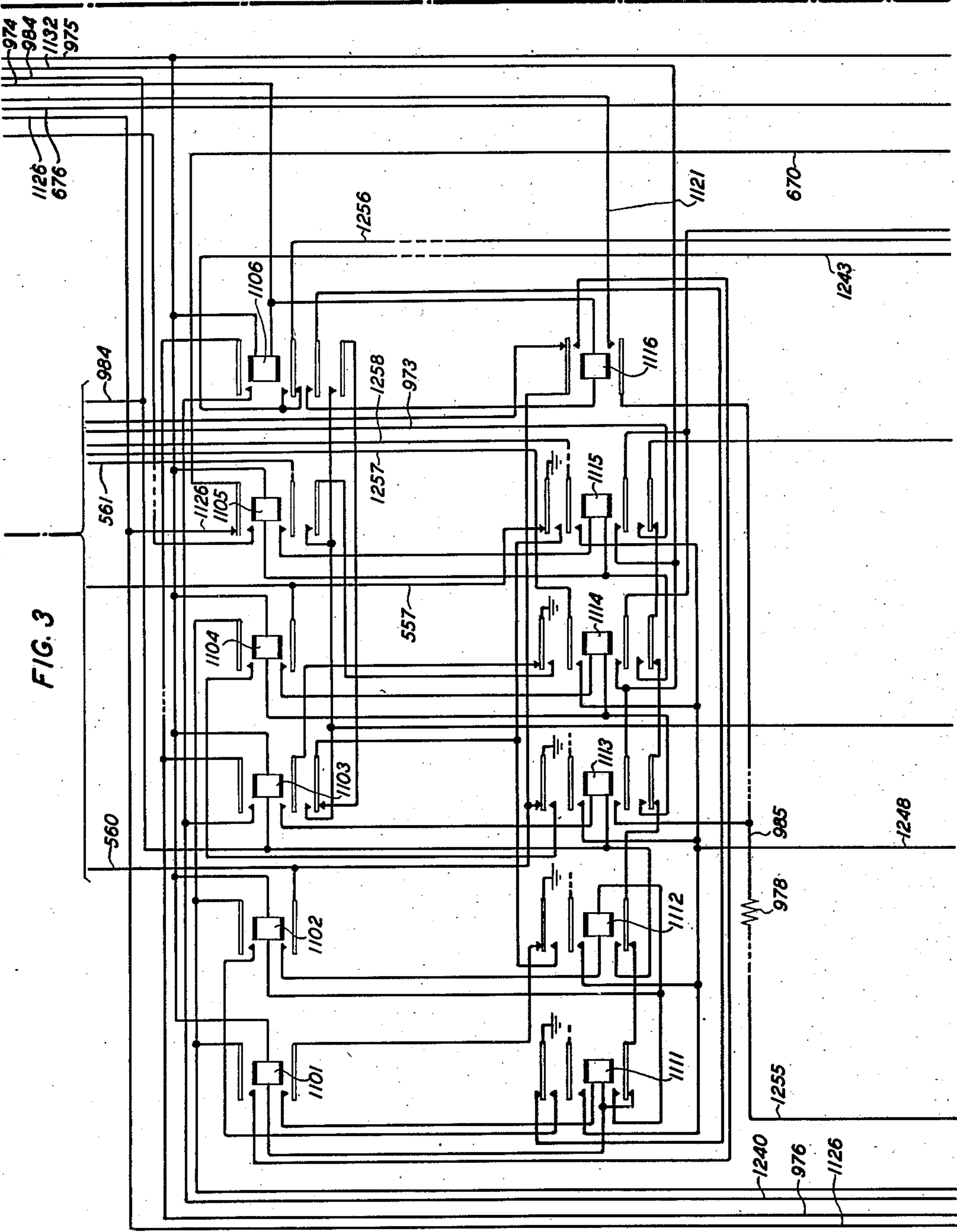
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9 Sheets-Sheet 3



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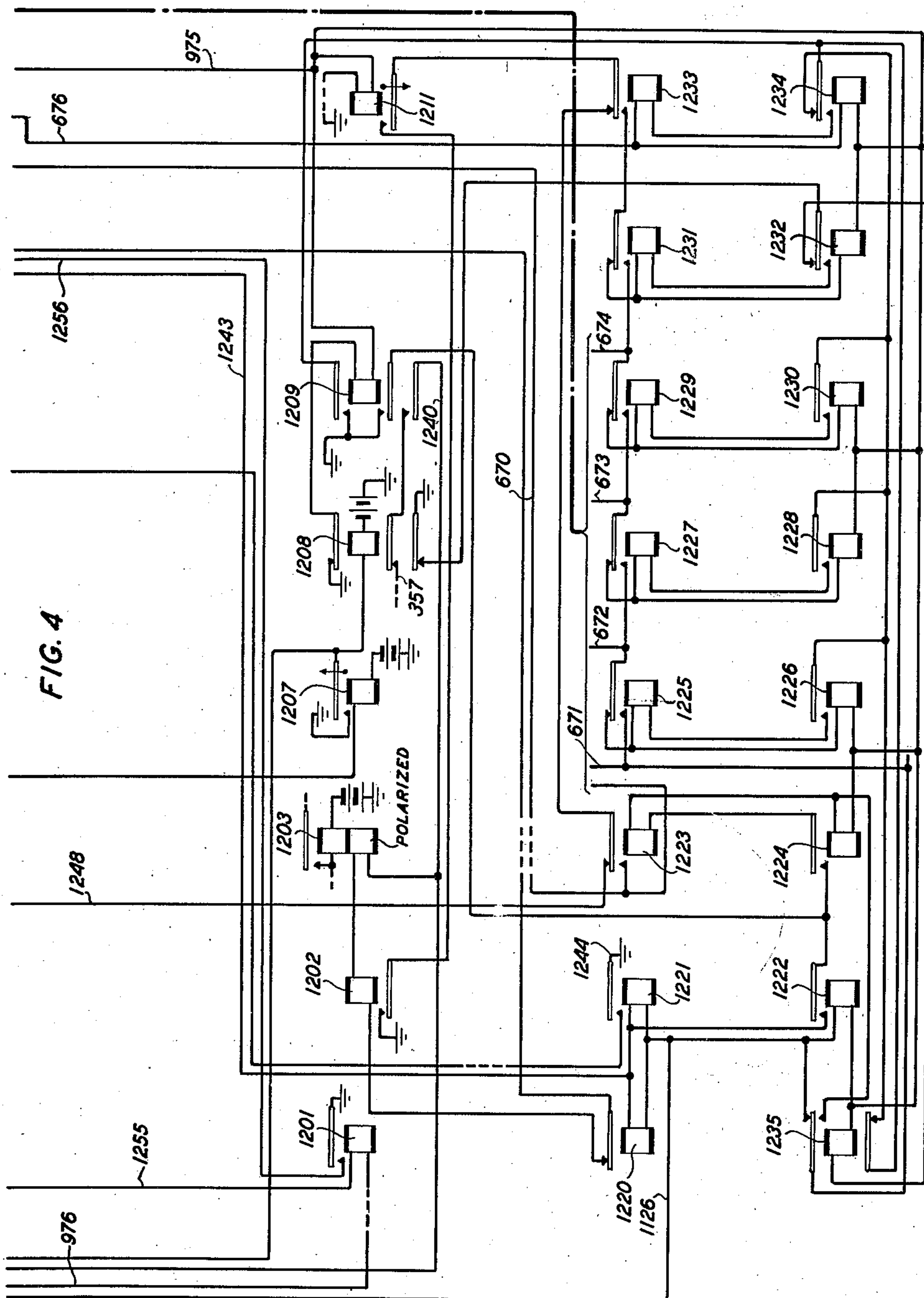
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Filed Sept. 26, 1944

9 Sheets-Sheet 4



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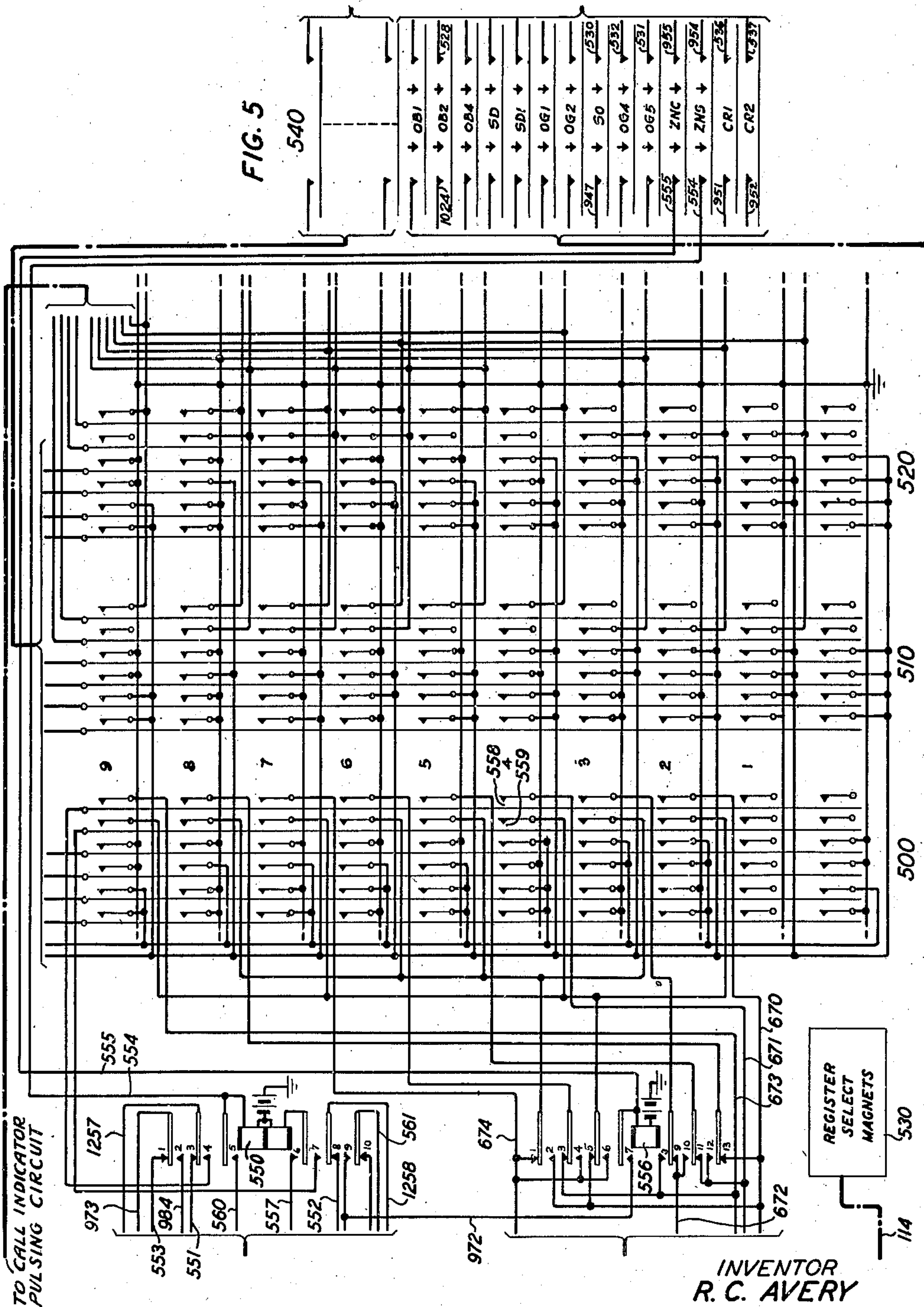
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TELEPHONE SYSTEM

Filed Sept. 26, 1944

9 Sheets-Sheet 5



April 2, 1946.

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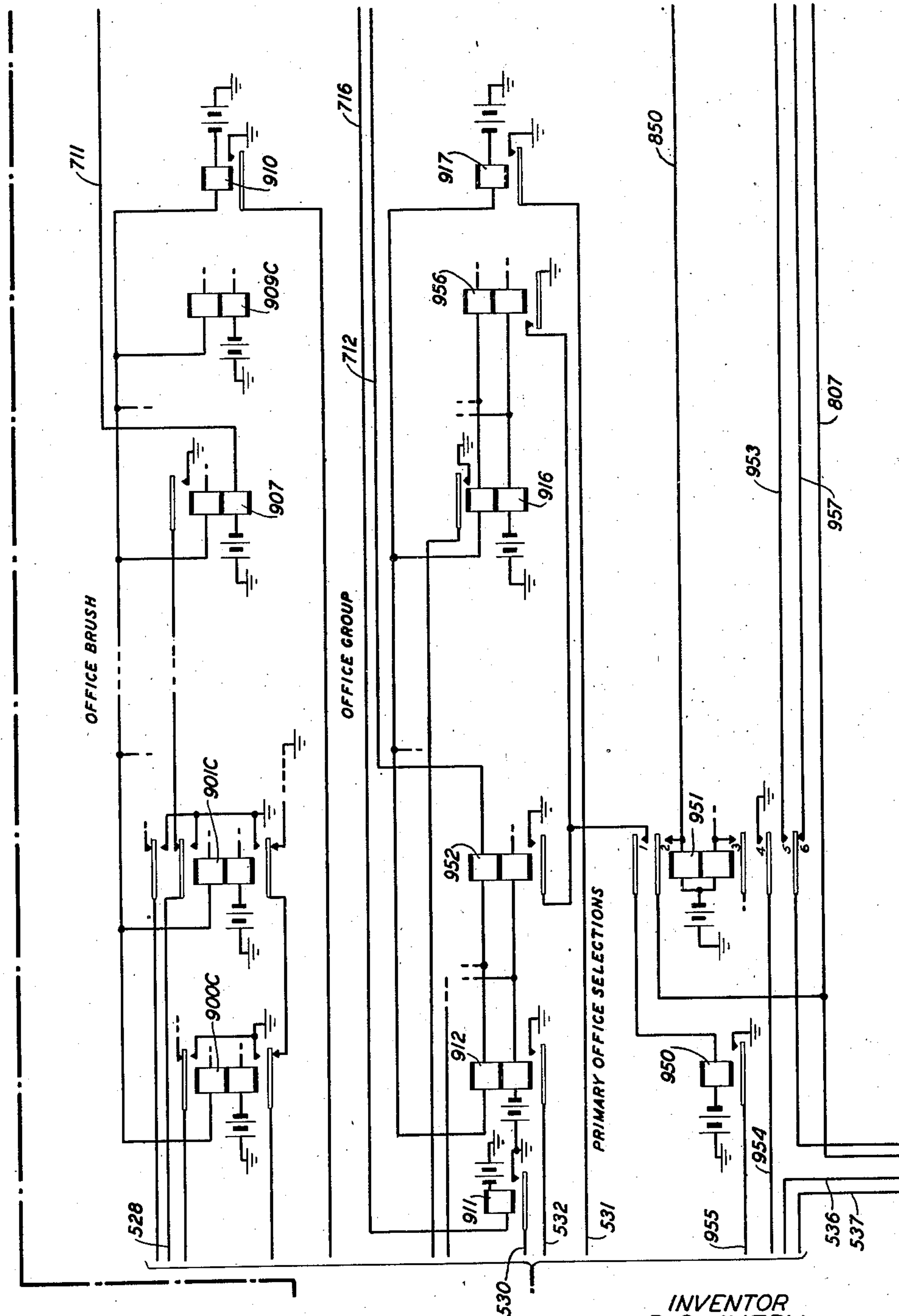
2,397,829

TELEPHONE SYSTEM

Filed Sept. 26, 1944

9 Sheets-Sheet 6

FIG. 6



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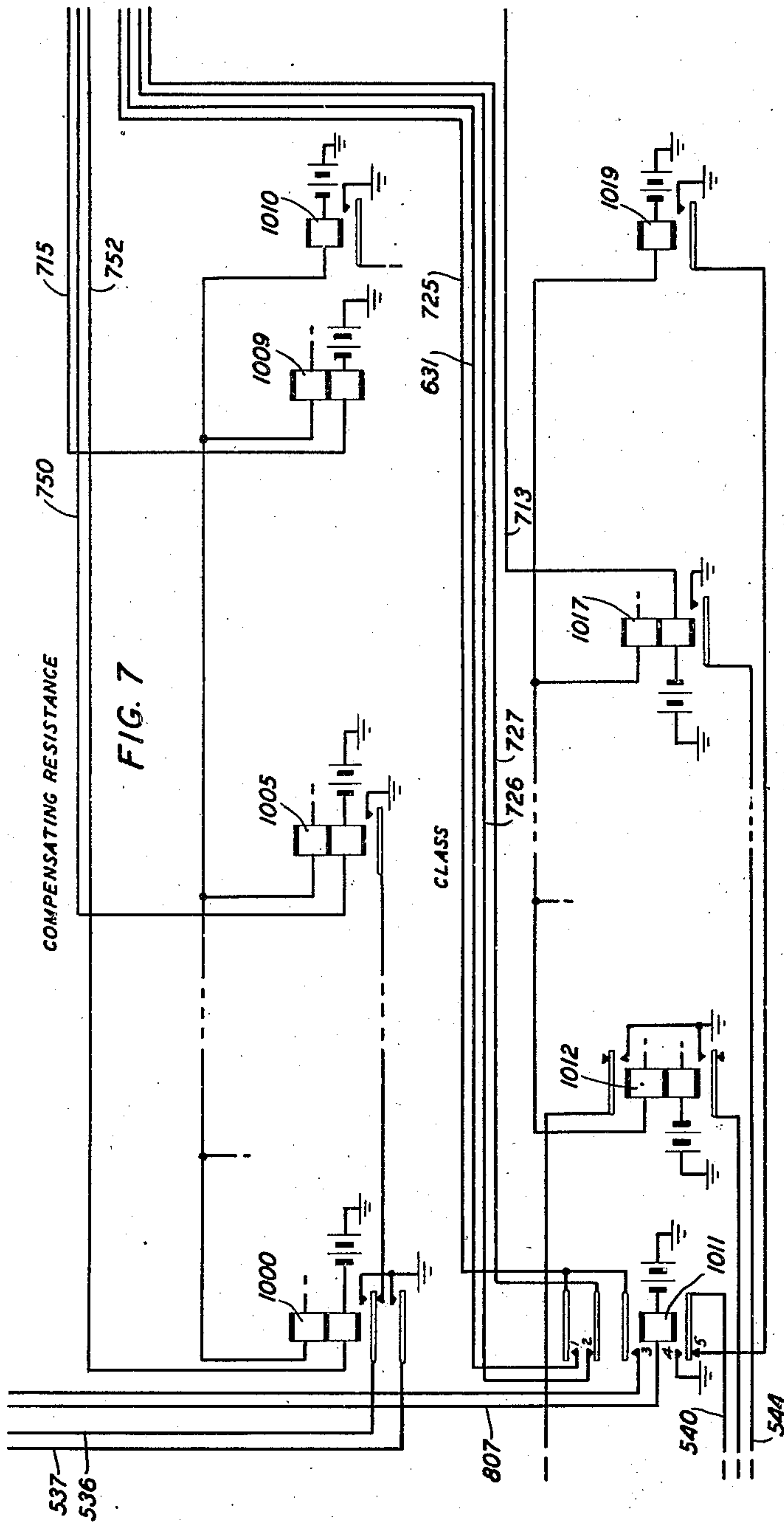
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Filed Sept. 26, 1944

9 Sheets-Sheet 7



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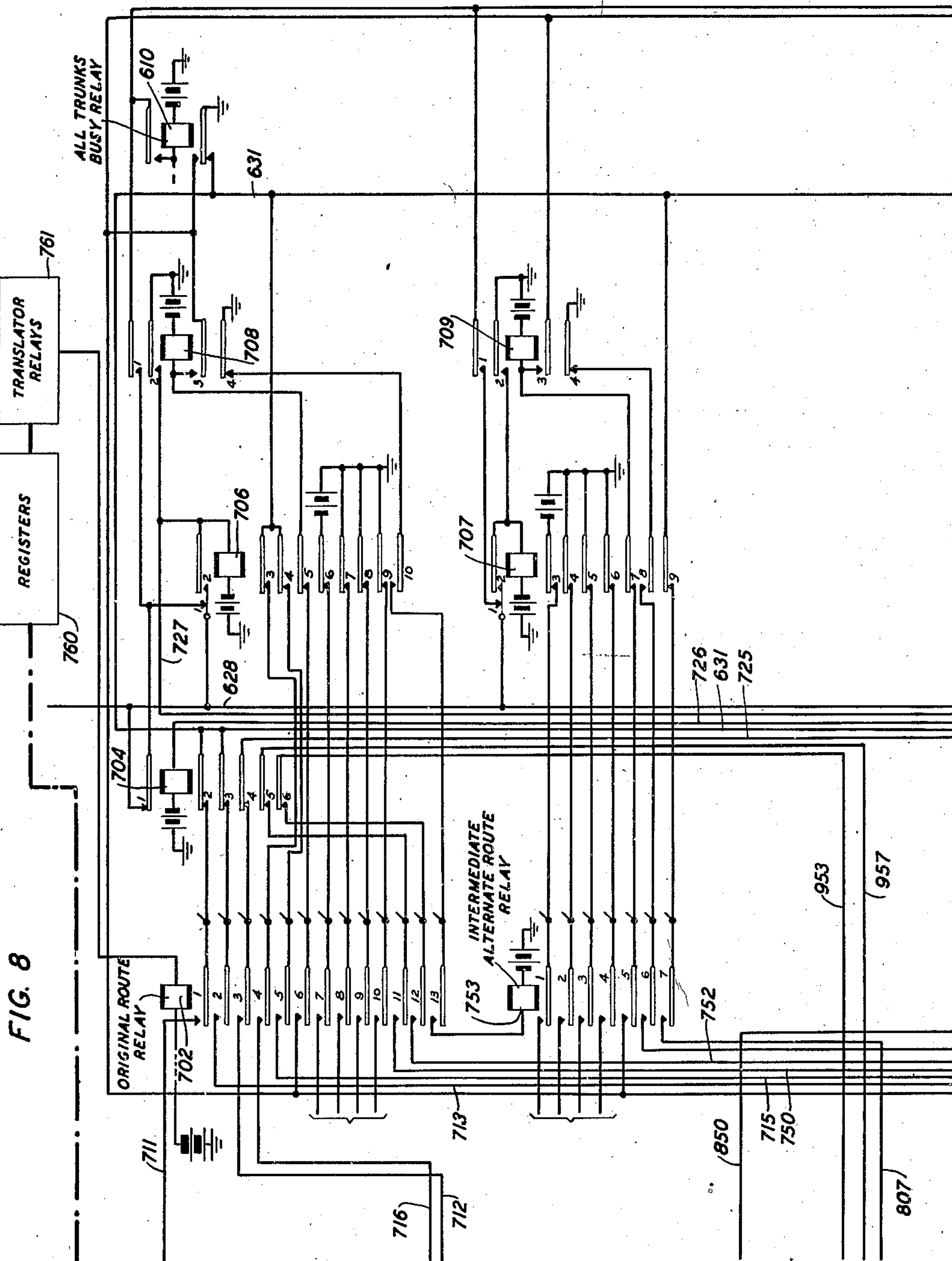
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9 Sheets-Sheet 8



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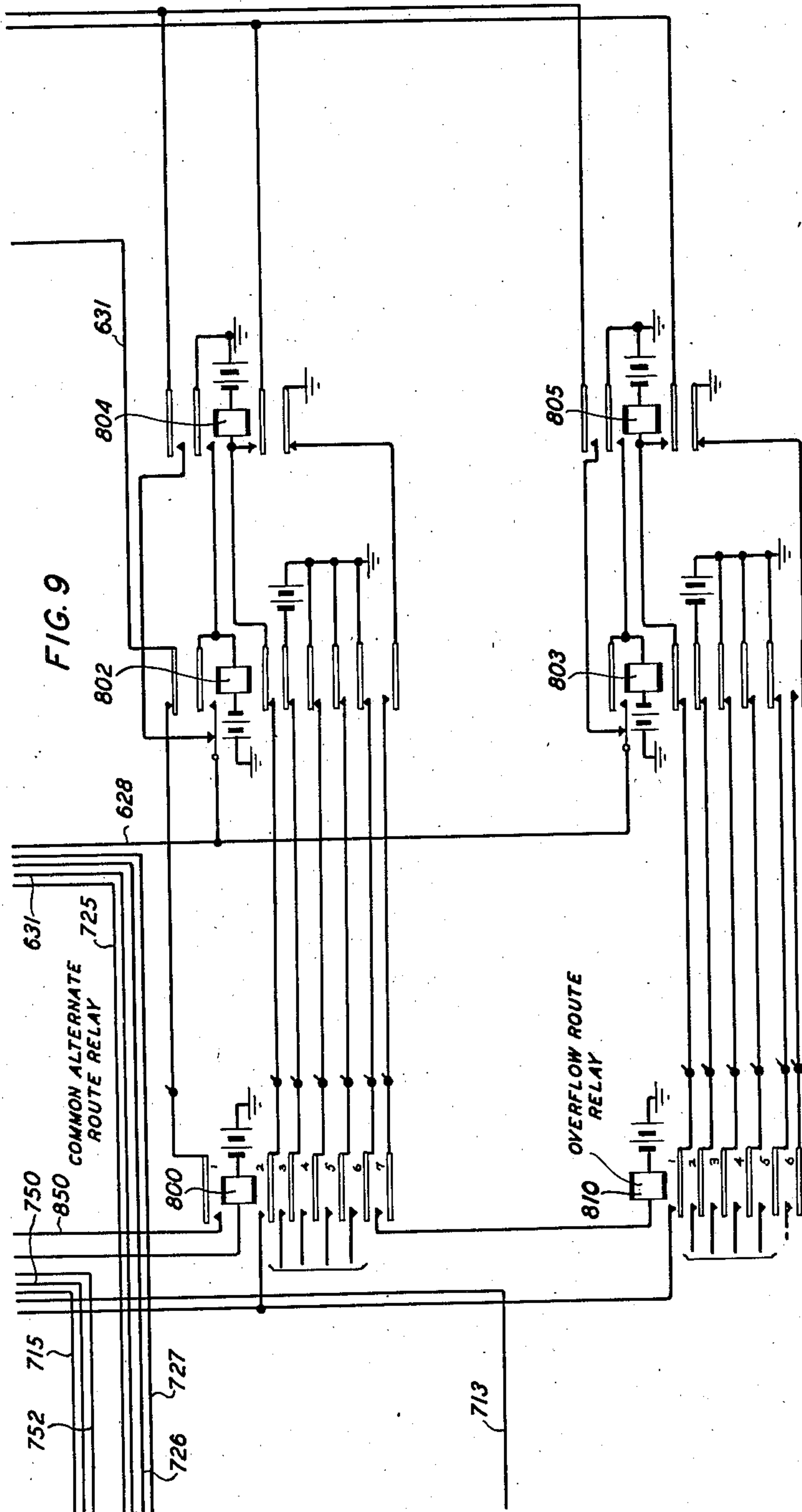
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9 Sheets-Sheet 9



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UNITED STATES PATENT OFFICE

2,397,829

TELEPHONE SYSTEM

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Application September 26, 1944, Serial No. 555,826

13 Claims. (Cl. 179—18)

This invention relates to telephone systems and has for its object to facilitate the provision of alternate routes between telephone exchanges.

Alternate routes have long been used in the establishment of toll connections under the manual control of the operator. The automatic selection of an alternate route through a tandem office in response to an all-trunks busy condition on the direct route has been suggested heretofore but in such prior arrangements only one alternate route of the type controlled by revertive pulsing has been provided and it has been necessary to include special equipment in the sender for each selection required for such an alternate route.

In accordance with the present invention it is possible to provide a plurality of alternate routes through a plurality of intermediate offices, all controlled by means of revertive pulsing. In general, one set of selections determined by the marker may be used for the selections in any of the intermediate offices, but should an additional set of selections be required in any one office, in accordance with a further feature of the invention these selections are controlled from one of the code registers of the sender. More specifically the A code register is used to control these selections.

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

Figure 1 shows in diagrammatic form a direct route and two alternate routes between a calling and a called subscriber.

Figs. 2 to 5 show portions of a subscriber's sender, Fig. 2 showing an office brush register, an office group register and certain other control relays, Fig. 3 showing the steering relays, Fig. 4 showing the counting relays and other control relays, and Fig. 5 showing a part of the cross-bar register as well as the marker connector.

Figs. 6 to 9 show portions of the marker, Fig. 6 showing parts of the office brush and office group registers, Fig. 7 showing parts of the class and compensating resistance registers, Fig. 8 showing the original route relay and one alternate route relay, and Fig. 9 showing two other alternate route relays; and

Fig. 10 shows the manner in which Figs. 1 to 9 should be arranged.

In general the circuits disclosed in Figs. 2 to 5 are based upon the disclosure of United States Patent 2,106,360, to R. Raymond, January 25, 1938, and the circuits disclosed in Figs. 6 to 9 are based upon the disclosure of United States Pat-

ent 2,227,488, to Collis, Dehn, Hersey and New-som, January 7, 1941. Wherever possible the same reference numerals are used as were used in the above patents.

5 In a system built up in accordance with the present invention, revertive pulsing is used in all alternate routes which may include one office selector at an intermediate office, a train of two office selectors at such an office, a cross-bar tan-
10 dem office arranged for one set of office selections or a cross-bar tandem office arranged for two sets of office selections. In order that it shall not be necessary to establish a different selection registration for each type of route, the
15 outgoing trunks to a given terminating office are arranged to appear in corresponding positions in the outgoing frames of the intermediate offices. Therefore, the same office selections may be used for an alternate route requiring only one set of
20 selections and for the second set of selections in routes requiring two sets of selections.

In intermediate offices requiring two sets of selections, the outgoing trunks and the secondary office selectors are arranged in primary groups and the primary selectors have the function of
25 selecting the required primary group. The primary group in which the outgoing trunks are located is determined by the first or A digit of the office code, and the group selections are under the control of that digit as registered in the
30 sender. However these selections may be modified by the marker, if necessary, in order to provide a choice of two primary groups for any trunk group. The relationship between the primary
35 groups and the A code digit will be made more apparent hereinafter.

As shown in Fig. 1 if the subscriber at substation 100 wishes to talk with the subscriber at substation 101 associated with the called office 102, the connection would normally be established through the district switches 120, 121 and office switches 130, 131 to a trunk of trunk group 103 and through the equipment at the called office 102 to the wanted line 101. If all of the direct
40 trunks leading to office 102 are busy, the connection would then be set up over the district switches 120, 121, office switches 140, 141, trunk 104 leading to the two-wire office selector 105 in the first alternate office 106 and thence over the
45 trunk 107 to the called office 102 and the wanted substation 101. If all of the trunks leading to office 106 including trunk 104 are also busy, a second alternate route will be employed leading from the district switches 120, 121 by way of
50 office switches 150, 151 over trunk 108 to the

two-wire office selector 109 and the three-wire office selector 110 at the common alternate office 115 and thence over trunk 116 to the called office 102 and the wanted substation 101.

It is to be understood that the arrangement shown is merely illustrative. The direct and alternate route trunks may appear on the same office frames, while in general the direct trunks to one office would be spread over a number of switches in two or more office frames. Furthermore, while only two alternate routes have been shown, one employing a single two-wire panel type office selector and the other a chain of two panel type selectors, more than two alternate routes might be used, all of which might employ a single selector in the intermediate offices or all of which might employ two selectors in the intermediate offices. In addition one or more of the alternate routes might be through a cross-bar tandem office of the type disclosed and claimed in United States Patent 2,281,636, to W. B. Strickler, May 5, 1942.

Assuming that a call is originated by the subscriber at substation 100, whose line terminates in the primary line switch 111, a train of operations is started which selects an available path to an idle sender and operates select and hold magnets on the primary and secondary line switches and sender link switches to close that path from the subscriber's line to the sender. This connection is shown through line switches 111 and 112 and sender link switches 160 and 161 to the pulse receiving relays indicated by box 113.

The subscriber then dials the office code of the desired terminating office. Each digit is received by the pulse receiving relays 113 and transmitted over conductors indicated by cable 114 to the select magnets 530 of the cross-bar register switch shown in Fig. 5 to control the setting of the switch verticals. The first or A code digit is recorded on vertical 500, the second or B code digit is recorded on vertical 510 and the third or C code digit is recorded on vertical 520. When these three digits have been recorded relay 930 is operated, under the control of the hold magnet (not shown) which completes the operation of the third digit vertical 520, as described in the above-identified Raymond patent. Relay 930, when operated, connects battery over the back contact of relay 931 to conductor 941 to cause the marker-connector 540 to be operated to connect the sender with an idle marker, for example the one partly shown in Figs. 6 to 9. As shown in Fig. 5 and described in detail in the above-mentioned Raymond patent the cross-point of each digit register grounds one or more of four conductors in accordance with a code. The marker-connector 540 connects the twelve code conductors as well as the checking conductors through to the registers of the marker indicated by the rectangle 760.

The registration set up on marker register 760 is transmitted to a set of translator relays 761 which bring about the operation of a certain route relay such as relay 702. Three route relays 702, 753 and 800 may be used in completing this call to its destination. Relay 702 is definitely assigned to the particular office code which was dialed and no other. It operates when the office code has been received in the marker, it remains operated throughout this engagement of the marker, it controls the testing of the trunks of the original route to the terminating office and it transmits to the sender the information required for the extension of the call to the terminating office in case the original route is used and some

other information required in case one of the alternate routes is used. Route relay 753 may be assigned to several office codes for terminating offices reached by an alternate route through the two-wire office selector 105 at intermediate office 106. This route relay is operated in case no idle trunk is found in the group of trunks leading directly to the wanted office. It then remains operated throughout the engagement of the marker and controls the testing of the trunks of the alternate route. Route relay 800 is assigned to a large number of office codes for terminating offices reached by a common alternate route through the common or tandem office 111. This route relay controls the testing of the group of trunks leading to the tandem office 111. Relay 810 is a route relay operated for the purpose of directing the call to an overflow trunk in case no idle or alternate trunk can be found.

Corresponding armature springs of all route relays controlling original routes are multiplied to those of relay 702 as indicated, relays 704, 706 and 708 being common thereto. Similarly the armature springs of all route relays controlling intermediate alternate routes are multiplied together and are controlled by relays 707 and 709, while the armature springs of all route relays controlling common alternate routes are multiplied together and are controlled by relays 802 and 804. Armatures 7 to 10 of relay 702, armatures 1 to 4 of relay 753, and armatures 2 to 5 of relays 800 and 810 are used for controlling the test of the group of outgoing trunks by the marker. These functions are described in the above-identified patent to Collis, Dehn, Hersey and Newsom, but since this operation is not an essential part of the present invention it will not be described, it being merely assumed that such test is performed.

Relay 702 in addition to controlling the test for an idle trunk outgoing to the wanted office, transmits information to the sender. Conductor 631 is normally connected to ground at the back contact of the all-trunks-busy relay 610. Therefore, with relay 702 operated, ground is connected over contact 3 of relay 706, contact 4 of relay 702 to conductor 716 and through the winding of relay 911 to battery. At contact 3 relay 702 prepares a circuit from conductor 725 to conductor 712 through the upper windings of relays 952 and 912 to battery through the winding of relay 917.

Relays 912, 952, 916, and 956 form part of the office group register of the marker. Contact 3 of route relay 702 and the corresponding contacts of other original route relays are cross-connected to the windings of the office group relays in accordance with the office group in which the trunks leading to the wanted office appear. Since, as pointed out above, all trunks leading to a particular office are arranged to appear in the same position before the last office selector having access to that office, only a single set of office selections is necessary. However, since in the typical trunk arrangement employed for the present disclosure there is no office selector in the original route, skip office relay 911 is operated to inform the sender that no office selections are required on the original route, while the circuit prepared for relays 952, 912 and 917 prepares to identify the group of trunks required for the alternate routes. Conductor 712 may be connected to either the upper or lower winding of the register relay, the upper winding being supplied by battery through the winding of relay 917 to add five to the number of the office group selected by

the register relay. Conductor 712 may also be connected directly to the winding of relays 912, 916, etc. to indicate that any secondary office selectors which may be used appear in the first primary group of the two such groups associated with the A digit of the office code. When conductor 712 is connected as shown through the windings of relays 952 and 912, in series, or through any other similar pair of relays, a circuit is closed as pointed out hereinafter to modify any primary group selections to be made by the sender.

At its contact 2, route relay 702 closes a circuit from ground on conductor 631, contact 3 of relay 704, contact 2 of relay 702, conductor 713, lower winding of relay 1017 to battery. Relays 1012 to 1019 constitute the class register of the marker and serve to transmit to the sender an indication of the nature of the terminating office and thereby the manner in which the called line designation is to be transmitted to that office. The contacts of the route relay may be cross-connected to either the upper or the lower windings of the register relays, the circuits through the upper windings being extended to the winding of relay 1019 which serves to ground an additional conductor leading to the sender.

At its contact 5 route relay 702 closes a circuit from ground on conductor 631, contact 4 of relay 706, contact 5 of relay 702, conductor 715, through the lower winding of relay 1009 to battery. Relays 1000 to 1010 constitute the compensating resistance register and serve to transmit to the sender an indication of the amount of resistance to be included in the fundamental circuit. As in the case of the other registers, the contacts of the route relays may be cross-connected either to the lower windings which terminate directly in battery or to the upper windings which extend to battery through the winding of relay 1010. Relay 1010 when operated causes the inclusion of a high resistance at a particular state of the operation of the sender.

At its contact 1, relay 702 closes a circuit from ground on conductor 631, contact 2 of relay 704, contact 1 of relay 702, conductor 711, lower winding of relay 907 to battery. Relays 900C to 910 constitute the office brush register and serve to transmit to the sender an indication of the office brush selection to be made when such selection is required. As in the case of the other registers, the contact of the route relay may be cross-connected to either the upper or lower winding of the register relays, the upper winding being connected to battery through the winding of relay 910 which is employed to transmit to the sender information concerning the number of digits to be expected.

It will be apparent that several other circuits are prepared by route relay 702 but these circuits do not become effective at this time.

The operation of route relay 702 has therefore served to operate register relays 907, 911, 1009 and 1017 thereby grounding conductors 528, 530, and 544. These conductors are connected by the marker connector 540 through to the sender where conductor 528 extends over conductor 1024 to the upper winding of relay 1022 and battery. Conductor 530 is extended over conductor 947 to the upper winding of skip-office relay 937 and battery. Since the present invention is not concerned with the functions of the sender in connection with the completion of the call at a terminating office, the class relays of the sender have been omitted.

Relays 937 and 1022 operate and prepare locking circuits for themselves to conductor 972. If the marker finds an idle direct trunk leading to the terminating office it grounds conductor 970 bringing about the operation of relay 931 which in turn grounds conductor 972 to lock-in the registrations set up under the control of the route relay 702. The marker then sets up a connection over the district and office switches to the selected trunk.

Direct route

Let us assume first that a direct connection has been successfully established. As previously mentioned, when the code was recorded on the registers of Fig. 5, relay 930 was operated, connecting battery over the back contact of relay 931 to conductor 941 to summon the marker. When the marker grounds conductor 970 thereby operating relay 931, battery is disconnected from conductor 941 causing the marker connector to release and the marker to be made available for the decoding stage of another call. Relay 930 also connects battery to conductor 975 thereby closing a circuit through the winding of relay 1209 to ground at the upper back contact of relay 1208, through the winding of relay 1211 to ground over a circuit not shown, and through the winding of relay 1235, back contact of relay 1232 to ground at the lower back contact of relay 1208. Relays 1209, 1211 and 1235 are therefore normally operated after the marker has been seized. After the marker has received and decoded the office code resulting in the operation of the relay 937, it establishes a connection with the district and office switches and causes the sender to connect ground to conductor 356. A circuit is thereupon closed to ground on conductor 356, front contact of relay 937, conductor 974, winding of relay 1106 to battery on conductor 975. Relay 1106 operates, closing a locking circuit for itself through the winding of relay 1116, front contact of relay 1106 to ground at the upper back contact of relay 1111. Relay 1116 cannot operate at this time being shunted by the operating circuit for relay 1106. When the district and office switches have been operated, ground is removed from conductor 356 and relay 1116 operates.

With relays 1106 and 1116 operated, a trunk test circuit is closed extending from the ring conductor of the interoffice trunk through the office and district switches, through the sender link switches to conductor 980, one or both of the resistances 910 and 911, selected in a manner similar to resistances 908R and 909R, conductor 1121, lower front contact of relay 1116, resistance 978, conductor 1255, winding of test relay 1201, conductor 976, upper front contact of relay 1106, conductor 1240, front contact of relay 1209, back contact of relay 1208 to conductor 357 and thence back to the tip conductor of the selected trunk. When the selector at the called office 102 is ready to make selections, battery and ground are connected to the circuit traced and relay 1201 operates closing a circuit from battery on conductor 975, winding of relay 1222, windings of relays 1220 and 1221 in parallel conductor 1243, front contact of relay 1106, conductor 1256, to ground at the front contact of relay 1201. Relays 1222, 1221 and 1220 operate and lock over the front contact of relay 1222 to ground over the inner lower contact of relay 1209. Relay 1221 closes a circuit from battery on conductor 975, winding of relay 1101, back contacts of relays 1111, 1112, 1113, 1114 and 1115, front contact of relay 1221

to ground over conductor 1244. Relay 1101 operates in this circuit closing a locking circuit for itself, through the winding of relay 1111, front contact of relay 1101 to ground at the back contact of relay 1112. Relay 1111 does not operate at this time since its winding is shunted by the operating circuit for relay 1101. Relay 1101 also closes a circuit from ground at the upper back contact of relay 1113, upper front contact of relay 1116, upper front contact of relay 1101, winding of relay 1208 to battery. Relay 1208 opens the fundamental circuit permitting relay 1201 to release. It also opens the energizing circuit for relay 1209 which now releases, opening the locking circuits for relays 1220 to 1222 and permitting these relays to release. When relay 1221 releases relay 1111 operates opening the locking circuit for relays 1106 and 1116 and these relays release. The circuit is now ready to make incoming and final selections at the called office or to transmit the designation to that office in the way determined by the class registration derived from the route relay and the office designation. Reference is made to the above-identified Raymond patent for a description of the operations for controlling the terminating office.

Intermediate alternate route

Returning now to the marker. Assume that, with route relay 702 operated, the marker after testing all of the direct trunks was unable to find any idle direct trunk to the office 102. Therefore the all-trunks-busy relay 610 is operated. Relay 610 removes ground from conductor 631 disconnecting ground from conductors 711, 713, 715 and 716, releasing the register relays and cancelling the registration set up under the control of the original route relay 702. At its lower front contact, relay 610 closes a circuit over contact 6 of route relay 702, contact 5 of relay 706 to the winding of relay 708 and battery. Relay 708 operates in this circuit locking over its contact 3 to ground under the control of relay 610, and closing a holding circuit for relay 610 over the upper contact of relay 610, contact 1 of relay 708, contact 1 of relay 706 to off-normal ground on conductor 628. Relay 708 at its contact 2 closes an obvious circuit for relay 706 which locks to off-normal ground on conductor 628. Relay 708 at its contact 2 also connects ground to conductor 727 which extends over the contact 2 of relay 1011 and conductor 726 to the winding of relay 704 and battery. Relay 704 operates in this circuit and is held operated over the front contact of relay 706 to grounded conductor 628. Relay 706 opens the circuits for controlling trunk selection, thereby releasing all connections between the marker and the office frame and in turn releasing the all-trunks-busy relay 610 and relay 708. When relay 708 recloses its contact 4, it completes a circuit over contact 10 of relay 706 and contact 13 of the original route relay 702 to the winding of the intermediate alternate route relay 753.

Relay 753 at its contacts 1 to 4 closes the circuits for controlling the test of the trunks leading to the intermediate alternate office 106. Since the alternate route includes a two-wire office selector, route relay 753 also closes a circuit from ground on conductor 631, contact 9 of relay 707, contact 7 of relay 753, conductor 807, winding of relay 1011 to battery. Relay 1011 at its contact 2 opens the holding circuit for relay 704 and that relay releases to restore the circuits for setting up the office selection registration as well as the

class registration. At this time the circuit for setting the compensating resistance register may be traced from ground on conductor 631, contacts 1 and 3 of relay 1011, contact 6 of relay 951, conductor 957, contact 5 of relay 704, contact 11 of relay 702, conductor 750 to the winding of relay 1005 and battery. Relay 1005 operates and connects ground to conductor 536 to prepare the operating circuit for the compensating resistance register relay of the sender. With relay 1011 operated, the circuit for setting the office group register may be traced from grounded conductor 631 over contact 1 of relay 1011, conductor 725, contact 4 of relay 704, contact 3 of relay 702, conductor 712 to the upper windings of relays 952 and 912, winding of relay 917 and battery. Relay 912 grounds conductor 532 and relay 917 grounds conductor 531 to operate the corresponding office group register relays of the sender. Relay 952 is ineffective at this time. Relay 1011 also grounds conductor 540 to operate the corresponding relay in the sender which is not shown. The circuit for office brush register relay 907 is closed as previously described, relay 907 grounding conductor 528. The previously traced circuit for class register relay 1017 is also closed. In the sender the grounding of conductors 528, 532, 531, and 536 causes the operation of compensating resistance relay 901R, office brush register relay 1022 and office group register relays 1033 and 1034. The skip office relay 937 is normal. As described in connection with the direct route, when the marker has found an idle trunk to the intermediate alternate office 106, relay 931 is operated, connecting ground to conductor 972 to lock in the registration set up by the marker and disconnecting battery from conductor 941 to release the marker connector.

As previously described, when the marker has found an idle trunk, it causes the connection of ground to conductor 356. Since relay 937 is not operated in this case, a circuit is extended over the back contact of relay 937, conductor 984, winding of relay 1103 to battery on conductor 975. Relay 1103 operates in this circuit and closes a locking circuit for itself through the winding of relay 1113, inner lower contact of relay 1103 to ground at the upper back contact of relay 1114, but relay 1113 cannot operate, being shunted by the operating circuit of relay 1103. When the marker has completed the connection with the selected trunk, ground is removed from conductor 356 and relay 1113 operates. The fundamental circuit for testing the condition of the selected trunk is now completed, this circuit extending as previously traced from the ring conductor of the selected trunk to conductor 980, front contact of relay 901R, resistance 909R, back contact of relay 902R, conductor 1132, front contact of relay 1113, conductor 985, resistance 978, conductor 1255, winding of trunk test relay 1201, conductor 976, upper front contact of relay 1103, conductor 1240, front contact of relay 1209, back contact of relay 1208, to conductor 357 and thence back to the tip conductor of the selected trunk. Relay 1201 operates in this test circuit as previously described, in turn operating relays 1220 to 1222 which lock under the control of relay 1209. Since relays 1103 and 1113 are operated, the operation of relay 1221 closes a circuit from ground on conductor 1244, contact of relay 1221, back contacts of relays 1115 and 1114, front contact of relay 1113, winding of relay 1104 to battery on conductor 975. Relay 1104 operates and locks through the winding of relay 1114, front

contact of relay 1104 to ground at the back contact of relay 1115. Relay 1114 does not operate being shunted by the operating circuit of relay 1104. However, relay 1104 closes a circuit from ground at the front contact of relay 1113, front contact of relay 1104, winding of relay 1208 and battery. Relay 1208 opens the fundamental circuit, permitting relay 1201 to release. It opens the operating circuit for relay 1209 which releases, in turn releasing the counting relays 1220 to 1222. When relay 1221 releases, it opens the energizing circuit for relay 1104 permitting relay 1114 to operate. Relay 1114 in operating opens the locking circuit for relays 1103 and 1113 and these relays release, in turn releasing relay 1208, reoperating relay 1209 and preparing the sender for office brush selection.

With relays 1104 and 1114 operated, the fundamental circuit extends from conductor 989 over the front contact of relay 901R, resistance 909R, back contact of relay 902R, conductor 1132, front contact of relay 1114, back contact of relay 1220, winding of stepping relay 1202, lower winding of polarized relay 1203, front contact of relay 1209, back contact of relay 1208 to conductor 357. Relay 1202 in operating closes the counting relay circuit, which may be traced from ground at the front contact of relay 1202, front contact of relay 1211, back contact of relay 1233, back contact of relay 1223, conductor 1248, front contact of relay 1114, conductor 1257, contact 3 of relay 550, conductor 551, back contact of relay 1023, front contact of relay 1022, back contact of relay 1021, conductor 672, back contact of relay 1225, winding of relay 1226, to battery on conductor 975. Relay 1226 operates in this circuit locking through the winding of relay 1225, front contact of relay 1226, back contact of relay 1234 to ground at the upper contact of relay 1209. Relay 1225 does not operate at this time being shunted by the operating circuit of relay 1226. At office 106 the selector 105 is moved upward in the brush selecting operation and in such movement repeatedly connects a momentary ground to the fundamental circuit in shunt of the winding of stepping relay 1202 and that relay releases at each revertive pulse. The first release permits relay 1225 to operate. When the momentary revertive ground is removed, relay 1202 reoperates, reclosing the counting relay circuit which extends as previously traced to conductor 672 and over the front contact of relay 1225 to the front contact of relay 1235, the winding of relay 1224 and battery. Relay 1224 operates and locks through the winding of relay 1223, relay 1223 remaining unoperated. A second revertive pulse permits relay 1223 to operate. With relay 1223 operated the counting relay circuit is extended over the front contact of relay 1223 to conductor 670, back contact of relay 1105, conductor 1126, winding of relay 1222 to battery. Relay 1222 operates, locking through the windings of relays 1220 and 1221 in parallel as previously described. The third revertive pulse permits the operation of relays 1220 and 1221. Since the fundamental circuit now extends over the back contact of relay 1220, the operation of relay 1220 opens the fundamental circuit to bring to an end the brush selecting operation of the selector 105. Relay 1221 closes a circuit from ground over its front contact, back contact of relay 1115, front contact of relay 1114 to the winding of relay 1105 and battery. Relay 1105 locks through the winding of relay 1115 but the operation of relay 1115 awaits the opening of the operating circuit of relay 1105. Relay 1105 op-

erates relay 1207 which in turn operates relay 1208 to bring about the release of relay 1209, the release of the counting relays 1220 to 1226, the release of steering relays 1104 and 1114, the operation of relay 1115 and the restoration of the fundamental circuit and the counting relay circuit.

The fundamental circuit for office group selection is the same as traced for office brush selection except that it passes over the front contact of relay 1115 instead of the contact of relay 1114. The counting relay circuit extends as previously traced to conductor 1248 and thence over the inner upper front contact of relay 1115, conductor 1258, contact 8 of relay 550, conductor 552, front contact of relay 1033, conductor 674, back contact of relay 1229, winding of relay 1230 and battery. When relay 1202 operates in the fundamental circuit, relay 1230 operates and locks through the winding of relay 1229, relay 1229 operating in response to the release of relay 1202 by the first revertive pulse. When this pulse ends, relay 1228 operates. In response to the next three revertive pulses, relays 1227, 1226, 1225, 1224 and 1223 are operated and locked. As before, the operation of relay 1223 transfers the counting relay circuit from conductor 1248 to conductor 670, but with relay 1105 operated this circuit now extends over the front contact of relay 1105, front contact of relay 1034, conductor 676, to the winding of relay 1234 and battery. Relay 1234 operates when the fourth pulse ends, locking through the winding of relay 1233 to ground at the upper contact of relay 1209. At its back contact relay 1234 opens the locking circuit for relays 1225 to 1230 and these relays release. The fifth revertive pulse permits relay 1233 to operate and transfers the counting relay circuit from the armature of relay 1223 to the armature of relay 1231. When relay 1202 reoperates following the fifth revertive pulse, relay 1232 operates, opens the operating circuit for relay 1235 and causes that relay to release. The sixth, seventh, eighth and ninth pulses cause the operation of relays 1231 to 1225. With relay 1225 operated and relay 1235 released, the counting relay circuit is extended through the winding of relay 1222 to battery so that relay 1222 operates upon operation of relay 1202 at the end of the ninth pulse. The tenth revertive pulse causes the operation of relays 1220 and 1221 in the locking circuit of relay 1222.

The functions of relays 1220 and 1221 are substantially the same as previously described. Since relays 1105 and 1115 are operated during the office group selection, the operation of relay 1221 closes a circuit from ground over the front contact of relay 1221, outer lower front contact of relay 1115, conductor 973, contact 1 of relay 550, conductors 553 and 974 to the winding of relay 1106 and battery. Relay 1106 closes a circuit from ground at the front contact of relay 1115, back contact of relay 1103, front contact of relay 1106, to the winding of relay 1207 and battery. Relay 1207 performs the function previously described for restoring the counting relays, releasing relays 1105 and 1115 and operating relay 1116. With relays 1106 and 1116 operated, the fundamental circuit for testing the trunk leading to the terminating office is completed and the functions of the sender continue as though a direct trunk had been selected at the beginning.

Common alternate route

Assume now that no trunks were available to the intermediate alternate office and it became

necessary to use the common alternate group leading through office 111. It will be remembered that when the marker tested the trunks to the intermediate alternate office 106, route relays 702 and 753 were operated, together with relay 706, but relay 704 had been released. If the all-trunks-busy relay 610 is again operated, ground is connected over the lower contact of relay 610, contact 5 of relay 753, contact 7 of relay 707 to the winding of relay 709 and battery. Relay 709 locks under control of relay 610 and closes a holding circuit for relay 610 over the upper contact of relay 610, contact 1 of relay 709, contact 1 of relay 707 to off-normal ground on conductor 628. At contact 2 relay 709 closes an obvious circuit for relay 707 which locks over its contact 2 to off-normal ground on conductor 628, opening the holding circuit for relay 610 and the operating circuit for relay 709. At contacts 3, 4, 5 and 6, relay 707 opens the circuits which control the selection of the trunk to the intermediate office 106 and at contact 9 it opens the circuit for operating relay 1011. When the trunk test relays have released, relay 610 releases, in turn releasing relay 709. When relay 709 releases it closes a circuit from ground, contact 4 of relay 709, contact 8 of relay 707, contact 6 of relay 753, to the winding of common alternate route relay 800 and battery.

Relay 800 at contacts 3 to 6 connects battery and ground to the circuits necessary for selecting an idle trunk to office 115. At its contact 1 relay 800 closes a circuit from ground on conductor 631, contact 1 of relay 802, contact 1 of relay 800, conductor 850, upper winding of primary office relay 951 and battery. Relay 951 operates and extends its operating ground over its contact 2 to conductor 807 thereby operating relay 1011. With relay 1011 operated and relay 704 non-operated, the same class and office selection register relays are operated. Relay 951 is used to modify the selection of the compensating resistance in accordance with the requirement of the common alternate route, whereby the circuit for operating the compensating resistance register extends from ground on conductor 631, contacts 1 and 3 of relay 1011, contact 5 of relay 951, conductor 953, contact 6 of relay 704, contact 12 of relay 702, conductor 752, lower winding of relay 1000 and battery. With relay 1000 operated ground is connected to conductors 536 and 537, causing the operation of both relay 910R and relay 902R in the sender.

As mentioned hereinbefore, the individual offices of the exchange area have been grouped in accordance with the first or A digit of the office code. When so grouped, certain groups will be found to contain many more offices than others. In order to provide sufficient trunks to reach all terminating offices through a common office, it is necessary to provide an additional or primary office selector, which may conveniently be of the type having five brushes, each brush ordinarily serving ten groups of trunks. By applying a busy condition to the sleeve terminals of the terminal sets usually used as overflow terminals, the selector may be arranged to have access to ten groups of secondary office selectors corresponding to the ten digits. As is well known, the digits 1 and 0 are not used as the first digit of an office code. Therefore there are two spare groups of terminals. In addition, while, as above mentioned, certain first digits correspond to large numbers of offices, other first digits represent only a small number of offices. Assuming a typical ex-

change area, the secondary office selectors having access to the two largest numbers of offices will be arranged to appear in the primary office selector in groups of terminals individually assigned to the A digit and also in one of the groups of terminals belonging to the two least congested digits, the latter group of terminals being placed directly above the former group of terminals. Similarly the selectors normally serving the latter two digits are paired with those serving two other digits, with the terminals of the latter group above those of the former group, etc. The two spare groups are paired with the fourth and eighth groups so assigned. Since the A code vertical may be cross-connected to the counting relays as desired, this arrangement provides a considerable flexibility of distribution for the trunk groups and permits the location of excess trunk groups from congested digits in a second primary group while requiring only a simple adjustment of the selection at the primary office selector.

If a group of trunks is located in the primary office group identified by the A digit of the corresponding office code, the office group register operating circuits will be cross-connected to include only one relay of the selected pair of relays, for example, only relay 912, while if the group of trunks is located in the second primary group, the office group register operating circuit will be cross-connected to include both of the relays of the pair, that is both relays 952 and 912. Relay 952 has no function unless it becomes necessary to select a route leading through two office selectors such as office 111.

In this case the primary group relay 951 is operated and in combination with relay 952 closes a circuit for group shift relay 950. Relay 951 grounds conductor 954 leading to the sender and relay 950 grounds conductor 955. Conductors 954 and 955 are extended over the marker-connector 540 to conductors 554 and 555, respectively, operating relays 550 and 556. Relay 550 locks in a circuit from battery through its lower winding and contact 6, conductor 557 to ground at the back contact of relay 1115 and in a circuit from battery through its upper winding and contact 5, conductor 560 to ground at the back contact of relay 1113. Relay 556 locks over its contact 7 to grounded conductor 972.

As in the case of the intermediate alternate office, since relay 937 is not operated, the connection of ground to conductor 356 operates relay 1103 and the disconnection of that ground permits the operation of relay 1113 in a locking circuit of relay 1103. The fundamental circuit for testing the trunks to the common office is the same as previously traced except that since both relays 901R and 902R are operated, neither of the resistances 908 and 909R are included in the circuit. The operation of relay 1201 in this circuit causes the operation of relays 1220 to 1222, as before, and relay 1221 operates relay 1104. The operation of relay 1208 and the release of the counting relays, followed by the operation of relay 1114, take place as previously described. The fundamental circuit for the first selection at the common office is also the same as the circuit for making the first selection at the intermediate office except for the difference in the compensating resistance. The counting relay circuit now extends from ground at the front contact of relay 1202, front contact of relay 1211, back contact of relay 1233, back contact of relay 1223, conductor 1248, front contact of relay 1114, conductor 1257, contact 4 of relay 550, contact 553 of the A code

register vertical 500 (assuming that the A code digit was 4), conductor 671, front contact of relay 1235, winding of relay 1224 to battery on conductor 975. When the fundamental circuit is completed at the office 111 and relay 1202 operates, this counting relay circuit is completed operating relay 1224. As the primary office selector 109 operates in its brush selecting function, it connects revertive pulses to the fundamental circuit, shunting relay 1202 as previously described. The first revertive pulse permits relay 1223 to operate in the locking circuit of relay 1224 while the second revertive pulse permits relays 1220 and 1221 to operate in the locking circuit of relay 1222. Relay 1221 operates relay 1105 and the operation of relays 1207 and 1208, release of relay 1209, release of the counting relays, operation of relay 1115, the reestablishment of the fundamental circuit and the release of relays 1104 and 1114 all take place as previously described.

With relays 1105 and 1115 operated, the counting relay circuit may be traced as above to conductor 1248 and thence over the front contact of relay 1115, conductor 1258, contact 7 of relay 550, contact 559 of the A code register 500, contact 6 of relay 556 to conductor 674, back contact of relay 1229, winding of relay 1230 to battery. Five revertive pulses bring about the operation of relays 1220 to 1222, relay 1220 opening the fundamental circuit to bring the selector 109 to rest, with the selected brush set in position to hunt for an idle trunk in the upper half of its terminal bank. Relay 1115 in operating opens the locking circuit for relay 550 but that relay is now held operated in the circuit previously traced through its upper winding to ground at the back contact of relay 1113. Therefore when relay 1221 operates it closes a circuit from ground at its contact, over the front contact of relay 1115, conductor 973, contact 2 of relay 550, conductor 984, winding of relay 1103 to battery. Relay 1103 operates and locks through the winding of relay 1113 but relay 1113 is not operated at this time. Relay 1103 operates relay 1207 which in turn operates relay 1208 releasing relay 1209 and the counting relays to permit the operation of relay 1113. Relays 1105 and 1115 are locked over conductor 561, contact 9 of relay 550 to ground over conductor 972. Relay 1113 in operating opens the second locking circuit for relay 550 and that relay releases, in turn releasing relays 1105 and 1115. The sender is now ready to test whether the secondary office selector 110 is ready to operate. The trunk test and selections are made precisely as for the office selector at the intermediate alternate office, the setting of the office brush and group registers being the same as in that case, the only exception being that as previously mentioned the fundamental circuit now contains a different compensating resistance.

As previously mentioned, the cross-connections of the A code register to the counting relays would be determined by the distribution of the office names among the code digits. For the typical arrangement disclosed, with relay 556 normal the digit 2 selects the zero group, that is the lower half of the bank served by the zero brush. With relay 556 operated the zero brush is also selected, but it is positioned to hunt over the upper half of its bank or the No. 1 primary office group, which group is normally assigned to digit 8. With relay 556 operated, the registration of digit 8 causes brush 1 to be selected and positioned to hunt over the lower half of its bank which is the No. 2 pri-

mary office group. Primary office group No. 2 is normally assigned to the digit 4, but with relay 556 operated, the registration of the digit 4 causes brush 1 to be selected and positioned to hunt over the upper half of its bank or over primary office group No. 3. From the foregoing and an inspection of the circuits controlled by relay 556 it will be apparent that the A code digit as set up on the sender register determines the selection of a basic group of terminals at the primary office selector and that the operation of relay 556 under the control of the marker causes the selection of the next higher group of terminals as a form of overflow group.

If all the trunks to the common alternate office are also busy, the operation of the all-trunks-busy relay 610 may be used to operate the overflow route relay 810.

It will be clear from a consideration of the foregoing description that any desirable number of alternate routes might be employed since the selection of the trunk to the alternate route office is under the control of the alternate route relay while the selections to be performed at the alternate route office are determined by the original route relay and the A code register if required. It is also apparent that crossbar tandem offices might also serve as alternate routes since they are also set by means of revertive pulses.

What is claimed is:

1. In a telephone system, an originating office, a terminating office, an intermediate office, first trunks connecting said originating office with said terminating office, other trunks connecting said originating office with said intermediate office, additional trunks connecting said intermediate office with said terminating office, a plurality of switches in said intermediate office for connecting said other trunks to said additional trunks to constitute an alternate route between said originating office and said terminating office, a plurality of registers in said originating office, a route relay, means for operating said route relay under the joint control of said plurality of registers, means under the control of said route relay for establishing a direct connection between said originating office and said terminating office over one of said first trunks, and means effective if all of said first trunks are busy to operate said switches under the control of one of said registers and said route relay to establish an alternate connection through said intermediate office.

2. In a telephone system, an originating office, a terminating office, an intermediate office, first trunks connecting said originating office with said terminating office, other trunks connecting said originating office with said intermediate office, additional trunks connecting said intermediate office with said terminating office, a train of selectors in said intermediate office for connecting said other trunks to said additional trunks to constitute an alternate route between said originating office and said terminating office, a plurality of registers in said originating office, a route relay, means for operating said route relay under the joint control of said plurality of registers, means under the control of said route relay for establishing a direct connection between said originating office and said terminating office over one of said first trunks, and means effective if all of said first trunks are busy to establish an alternate connection through said intermediate office, comprising means under the control of one of said registers to operate one of said selectors in said in-

intermediate office and means under the control of said route relay to operate the succeeding selector in said intermediate office.

3. In a telephone system, an originating office, a terminating office, an intermediate office, first trunks connecting said originating office with said terminating office, other trunks connecting said originating office with said intermediate office, additional trunks connecting said intermediate office with said terminating office, a train of selectors in said intermediate office for connecting said other trunks to said additional trunks to constitute an alternate route between said originating office and said terminating office, a plurality of registers in said originating office, a route relay, means for operating said route relay under the joint control of said plurality of registers, means under the control of said route relay for establishing a direct connection between said originating office and said terminating office over one of said first trunks, and means effective if all of said first trunks are busy to establish an alternate connection through said intermediate office, comprising means under the control of one of said registers to operate one of said selectors in said intermediate office and means under the control of said route relay to operate the succeeding selector in said intermediate office, and other means under the control of said route relay to modify the control of said one register.

4. In a telephone system, an originating office, a terminating office, an intermediate office, first trunks connecting said originating office with said terminating office, other trunks connecting said originating office with said intermediate office, additional trunks connecting said intermediate office with said terminating office, primary and secondary office selectors in said intermediate office for connecting said other trunks to said additional trunks to constitute an alternate route between said originating office and said terminating office, a plurality of registers in said originating office, a route relay, means for operating said route relay under the joint control of said plurality of registers, means under the control of said route relay for establishing a direct connection between said originating office and said terminating office over one of said first trunks, and means effective if all of said first trunks are busy to establish an alternate connection through said intermediate office, comprising means under the control of one of said registers to operate one of said primary selectors in said intermediate office to select a group of secondary office selectors, means under the control of said route relay to operate the selected secondary office selector in said intermediate office, and other means under the control of said route relay to modify the control of said one register to select a different group of secondary office selectors.

5. In a telephone system an originating office, a terminating office, direct trunks connecting said originating office and said terminating office, a first intermediate office, a first group of alternate trunks connecting said originating office and said first intermediate office, office selectors at said first intermediate office, a first group of terminating trunks connecting said first intermediate office and said terminating office, and appearing in a particular group of terminals in said office selectors, a second intermediate office, a second group of alternate trunks connecting said originating office with said second intermediate office, primary and secondary office selectors at said second intermediate office, a sec-

ond group of terminating trunks connecting said second intermediate office and said terminating office and appearing before said secondary office selectors in a group of terminals corresponding to that occupied by said first group of terminating trunks in said office selectors, selection control equipment at said originating office, means in said selection control equipment to operate a route relay individual to said terminating office, and means under the control of said route relay to set up a registration effective to control either said office selectors at said first intermediate office or one of said secondary office selectors at said second intermediate office to extend a connection to said terminating office.

6. In a telephone system an originating office, a terminating office, direct trunks connecting said originating office and said terminating office, a first intermediate office, a first group of alternate trunks connecting said originating office and said intermediate office, office selectors at said first intermediate office, a first group of terminating trunks connecting said first intermediate office and said terminating office, and appearing in a particular group of terminals in said office selectors, a second intermediate office, a second group of alternate trunks connecting said originating office with said second intermediate office, primary and secondary office selectors at said second intermediate office, a second group of terminating trunks connecting said second intermediate office and said terminating office and appearing before said secondary office selectors in a group of terminals corresponding to that occupied by said first group of terminating trunks in said office selectors, selection control equipment at said originating office comprising a plurality of registers, a route relay individual to said terminating office, means under the joint control of said plurality of registers for operating said route relay, means under the control of said route relay to set up a registration effective to control either said office selectors at said first intermediate office or one of said secondary office selectors at said second intermediate office to extend a connection to said terminating office, and means under the control of one of said registers to operate a primary office selector at said second intermediate office to select a secondary office selector having access to said terminating office.

7. In a telephone system an originating office, a terminating office, direct trunks connecting said originating office and said terminating office, a first intermediate office, a first group of alternate trunks connecting said originating office and said intermediate office, office selectors at said first intermediate office, a first group of terminating trunks connecting said first intermediate office and said terminating office, and appearing in a particular group of terminals in said office selectors, a second intermediate office, a second group of alternate trunks connecting said originating office with said second intermediate office, primary and secondary office selectors at said second intermediate office, a second group of terminating trunks connecting said second intermediate office and said terminating office and appearing before said secondary office selectors in a group of terminals corresponding to that occupied by said first group of terminating trunks in said office selectors, selection control equipment at said originating office comprising a plurality of registers, a route relay individual to said terminating office, means under the joint control of said plurality of registers for operating said route

relay, means under the control of said route relay to set up a registration effective to control either said office selectors at said first intermediate office or one of said secondary office selectors at said second intermediate office to extend a connection to said terminating office, means under the control of one of said registers to operate a primary office selector at said second intermediate office to select a secondary office selector having access to said terminating office, and other means under the control of said route relay to modify the control of said one register over said primary office selectors.

8. In a telephone system, an originating office, a terminating office, direct trunks connecting said originating office and said terminating office, a first intermediate office, a first group of alternate trunks connecting said originating office and said intermediate office, office selectors at said first intermediate office, a first group of terminating trunks connecting said first intermediate office and said terminating office, and appearing in a particular group of terminals in said office selectors, a second intermediate office, a second group of alternate trunks connecting said originating office with said second intermediate office, primary and secondary office selectors at said second intermediate office, a second group of terminating trunks connecting said second intermediate office and said terminating office and appearing before said secondary office selectors in a group of terminals corresponding to that occupied by said first group of terminating trunks in said office selectors, selection control equipment at said originating office comprising a plurality of registers, a route relay individual to said terminating office, means under the joint control of said plurality of registers for operating said route relay, means under the control of said route relay to set up a registration effective to control either said office selectors at said first intermediate office or one of said secondary office selectors at said second intermediate office to extend a connection to said terminating office, and means under the joint control of one of said registers and said route relay to operate one of said primary office selectors at said second intermediate office to select a secondary office selector having access to said terminating office.

9. In a telephone system, an originating office, a plurality of terminating offices identified by three digit codes, direct trunks connecting said originating office with said terminating offices, an intermediate office, other trunks connecting said originating office with said intermediate office, completing trunks connecting said intermediate office with said terminating offices, primary and secondary office selectors at said intermediate office for connecting said other trunks with said completing trunks to constitute alternate routes between said originating office and said terminating offices, said secondary office selectors arranged in basic groups and overflow groups in accordance with the first digit of said code, means to control the operation of said primary office selectors in accordance with said first digit to select a basic group of office selectors and means at said originating office operated in accordance with the complete code to modify the control of said primary office selectors to select an overflow group of selectors.

10. In a telephone system, an originating office, a plurality of terminating offices identified by three digit codes, direct trunks connecting said originating office with said terminating offices,

an intermediate office, other trunks connecting said originating office with said intermediate office, completing trunks connecting said intermediate office with said terminating offices, primary and secondary office selectors at said intermediate office for connecting said other trunks with said completing trunks to constitute alternate routes between said originating office and said terminating offices, said secondary office selectors arranged in two adjacent groups before said primary office selectors, registers in said originating office for registering the three digits of the terminating office code, means under the control of the first code register to control the operation of said primary office selector to select one of said groups of secondary office selectors, and means under the control of all of said registers for modifying the control exerted by said first code register to cause the selection of the adjacent group of secondary office selectors.

11. In a telephone system an originating office, a terminating office, direct trunks connecting said originating office and said terminating office, a first intermediate office, a first group of alternate trunks connecting said originating office and said intermediate office, office selectors at said first intermediate office, a first group of terminating trunks connecting said first intermediate office and said terminating office, a second intermediate office, a second group of alternate trunks connecting said originating office with said second intermediate office, primary and secondary office selectors at said second intermediate office, a second group of terminating trunks connecting said second intermediate office and said terminating office, selection control equipment at said originating office, including a plurality of code registers, means under the joint control of all of said code registers for operating a route relay individual to said terminating office, means under the control of said route relay for selecting an idle path to said terminating office, said selecting means effective to successively test said direct trunks, said trunks to said first intermediate office and said trunks to said second intermediate office, a series of steering relays, means under the control of said steering relays for operating said selectors, and means under the control of said route relay for preventing the operation of said steering relays, for operating said steering relays through a single cycle of operations or for operating said steering relays through a plurality of cycles in accordance with the selected path to said terminating office.

12. In a telephone system an originating office, a terminating office, direct trunks connecting said originating office and said terminating office, a first intermediate office, a first group of alternate trunks connecting said originating office and said intermediate office, office selectors at said first intermediate office, a first group of terminating trunks connecting said first intermediate office and said terminating office, and appearing in a particular group of terminals in said office selectors, a second intermediate office, a second group of alternate trunks connecting said originating office with said second intermediate office, primary and secondary office selectors at said second intermediate office, a second group of terminating trunks connecting said second intermediate office and said terminating office and appearing before said secondary office selectors in a group of terminals corresponding to that occupied by said first group of terminating trunks in said office selectors, selection control equip-

ment at said originating office, including a plurality of code registers, means under the control of said code registers for operating a route relay individual to said terminating office, means under the control of said route relay for selecting an idle path to said terminating office, said selecting means effective to successively test said direct trunks, said trunks to said first intermediate office and said trunks to said second intermediate office, means under the control of said route relay for setting up a registration identifying the position of said terminating trunks, means under the control of one of said code registers for identifying the position of said secondary office selectors before said primary office selectors, a series of steering relays, means under the control of said steering relays for operating said selectors, and means under the control of said route relay for preventing the operation of said steering relays, for operating said steering relays through a single cycle of operation in connection with said route relay controlled identifying means or for operating said steering relays through two cycles of operation in connection with said code register controlled identifying means and said route relay controlled identifying means; in accordance with the selected path to said terminating office.

13. In a telephone system, an originating office, a terminating office, direct trunks connecting said originating office and said terminating office, a first intermediate office, a first group of alternate trunks connecting said originating office and said intermediate office, office selectors at said first intermediate office, a first group of terminating trunks connecting said first intermediate office and said terminating office, and appearing in a particular group of terminals in said office selectors, a second intermediate office, a sec-

ond group of alternate trunks connecting said originating office with said second intermediate office, primary and secondary office selectors at said second intermediate office, a second group of terminating trunks connecting said second intermediate office and said terminating office and appearing before said secondary office selectors in a group of terminals corresponding to that occupied by said first group of terminating trunks in said office selectors, selection control equipment at said originating office including a plurality of code registers, means under the control of said code registers for operating a route relay individual to said terminating office, means under the control of said route relay for selecting an idle path to said terminating office, said selecting means effective to successively test said direct trunks, said trunks to said first intermediate office and said trunks to said second intermediate office, means under the control of said route relay for setting up a registration identifying the position of said terminating trunks, means under control of one of said code registers for identifying the position of said secondary office selectors before said primary office selectors, a primary office selection relay operated if the path selected extends through said second intermediate office, a set of steering relays for controlling selections at said intermediate offices, means to operate said steering relays through one cycle in connection with said code register controlled identifying means, means responsive to the completion of said one cycle to release said primary office selection relay and means to thereafter operate said steering relays through a second cycle in connection with said route relay controlled identifying means.

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