Jan. 25, 1938. R. RAYMOND 2,106,360

TELEPHONE SYSTEM

Filed June 19, 1935 12 Sheets-Sheet 1

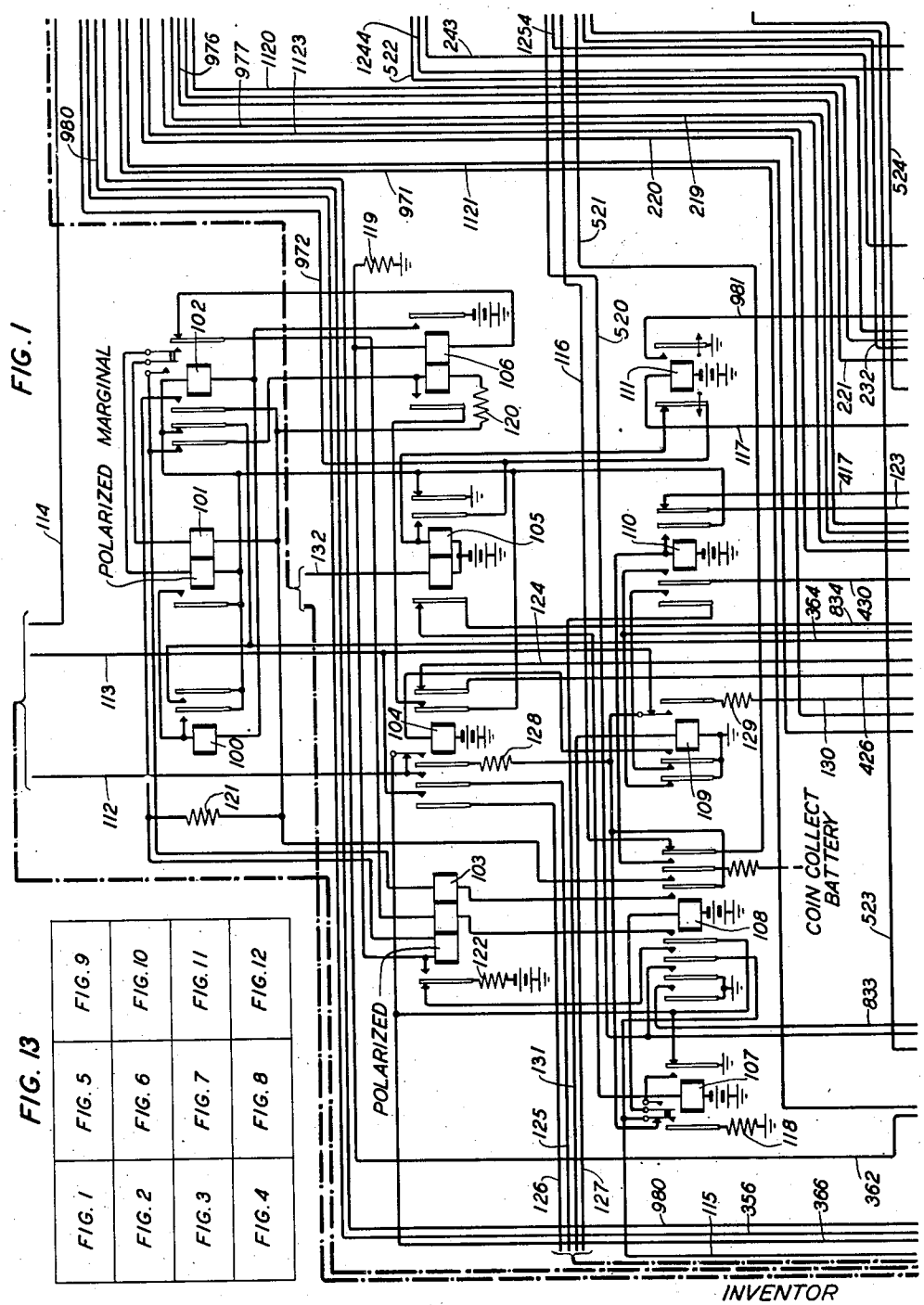

FIG. 1

FIG. 13

FIG. 9	FIG. 10	FIG. 11	FIG. 12
FIG. 5	FIG. 6	FIG. 7	FIG. 8
FIG. 1	FIG. 2	FIG. 3	FIG. 4

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TELEPHONE SYSTEM

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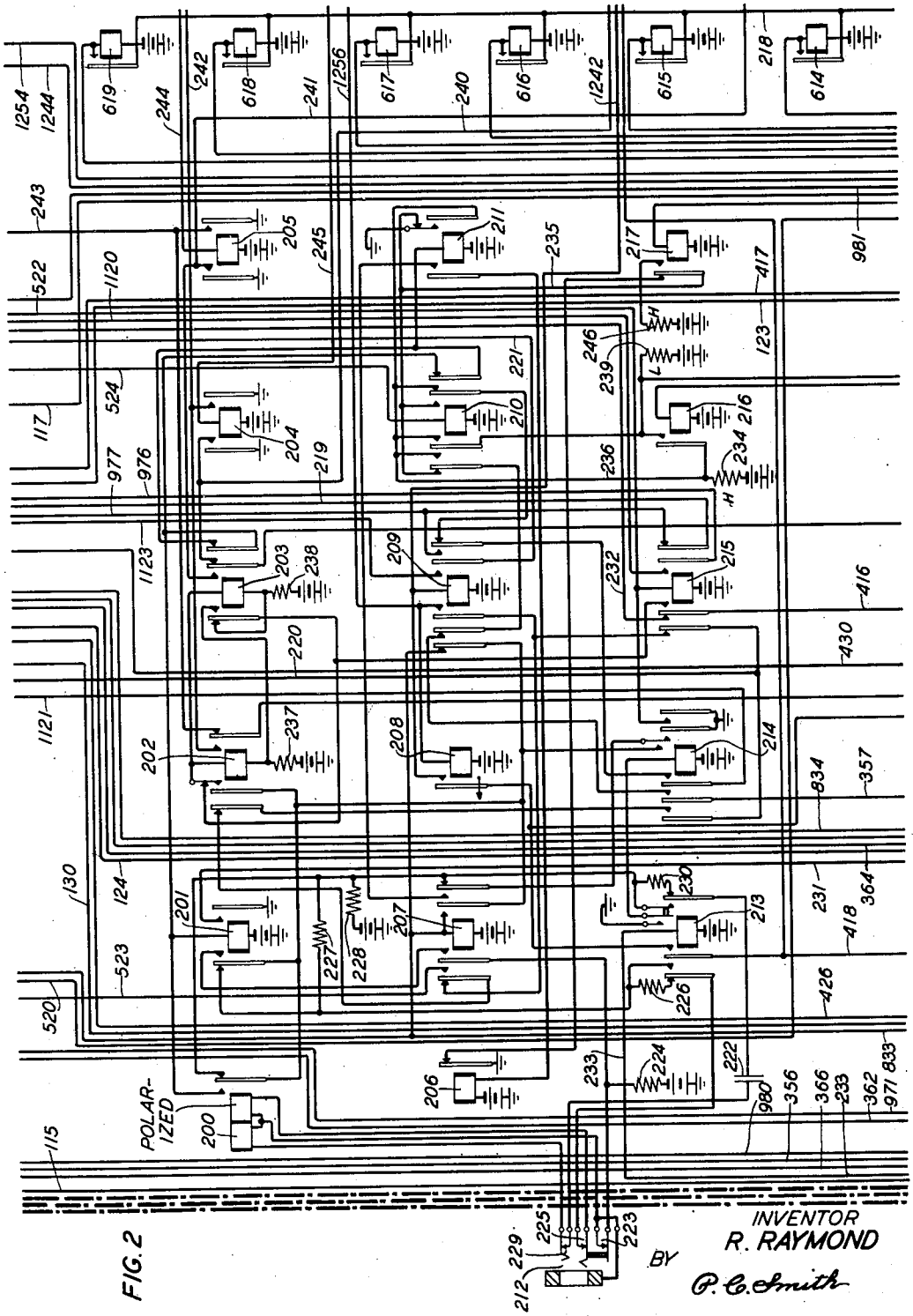

FIG. 2

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Filed June 19, 1935 12 Sheets-Sheet 3

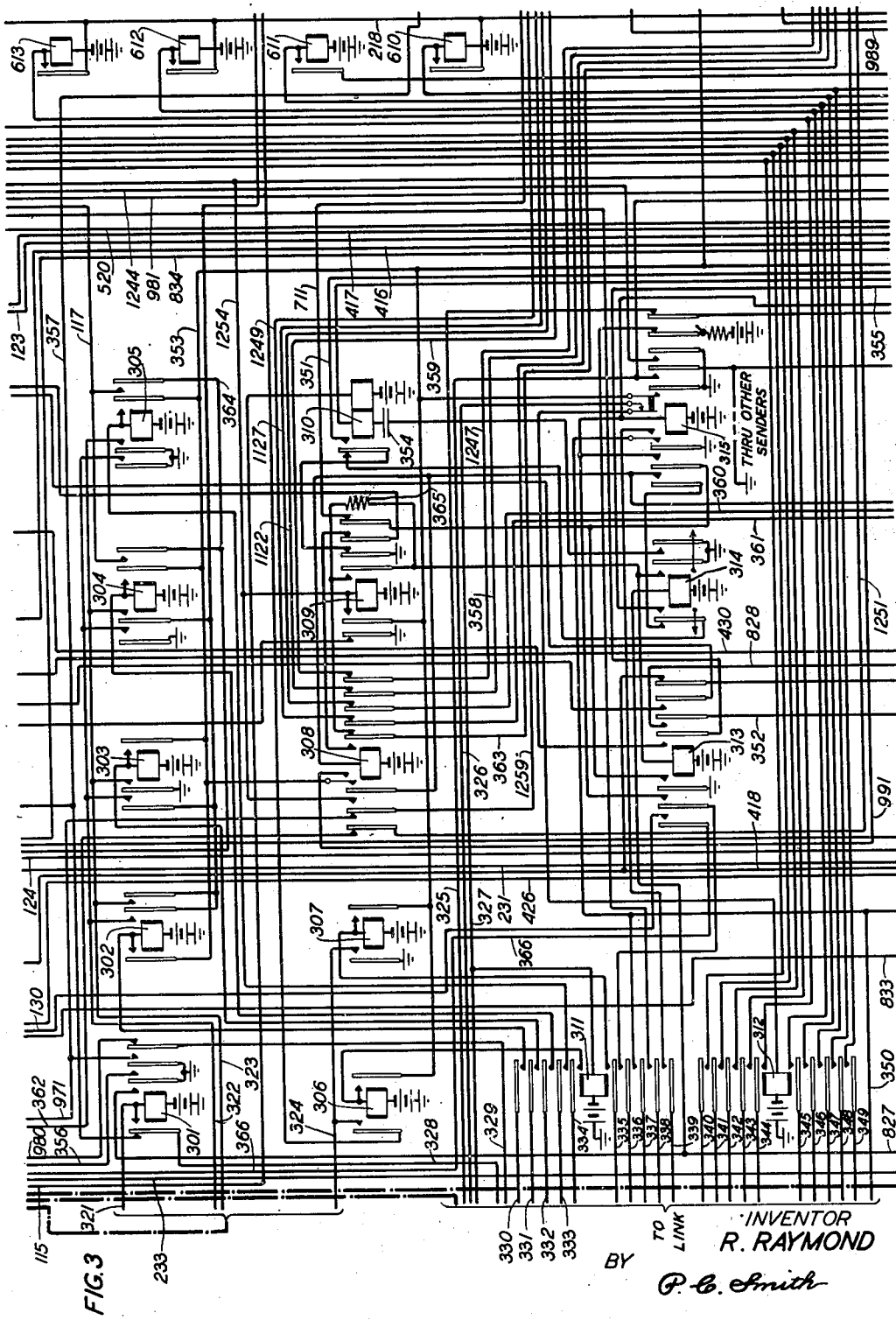

FIG. 3

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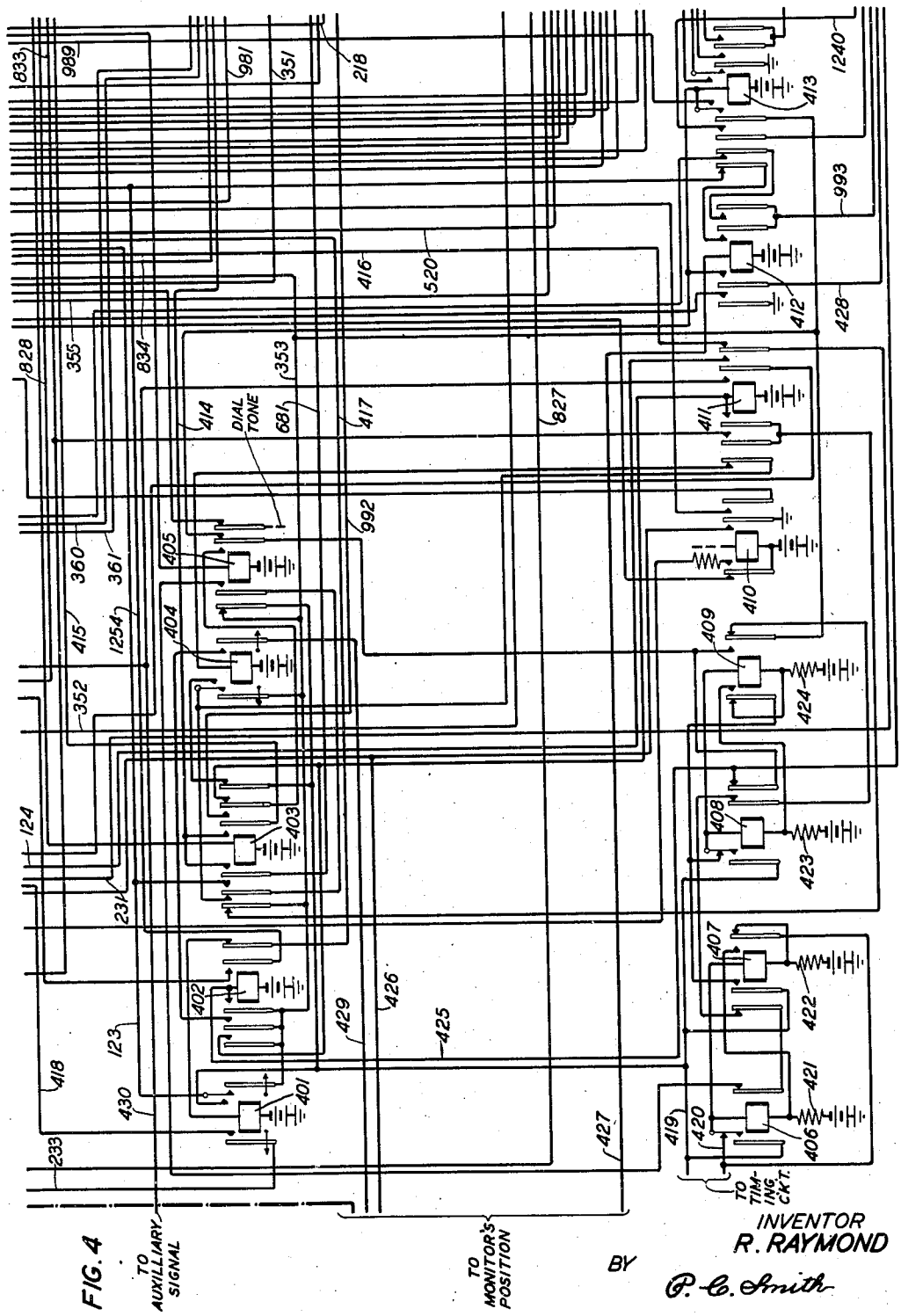

FIG. 4

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TELEPHONE SYSTEM

Filed June 19, 1935 12 Sheets-Sheet 5

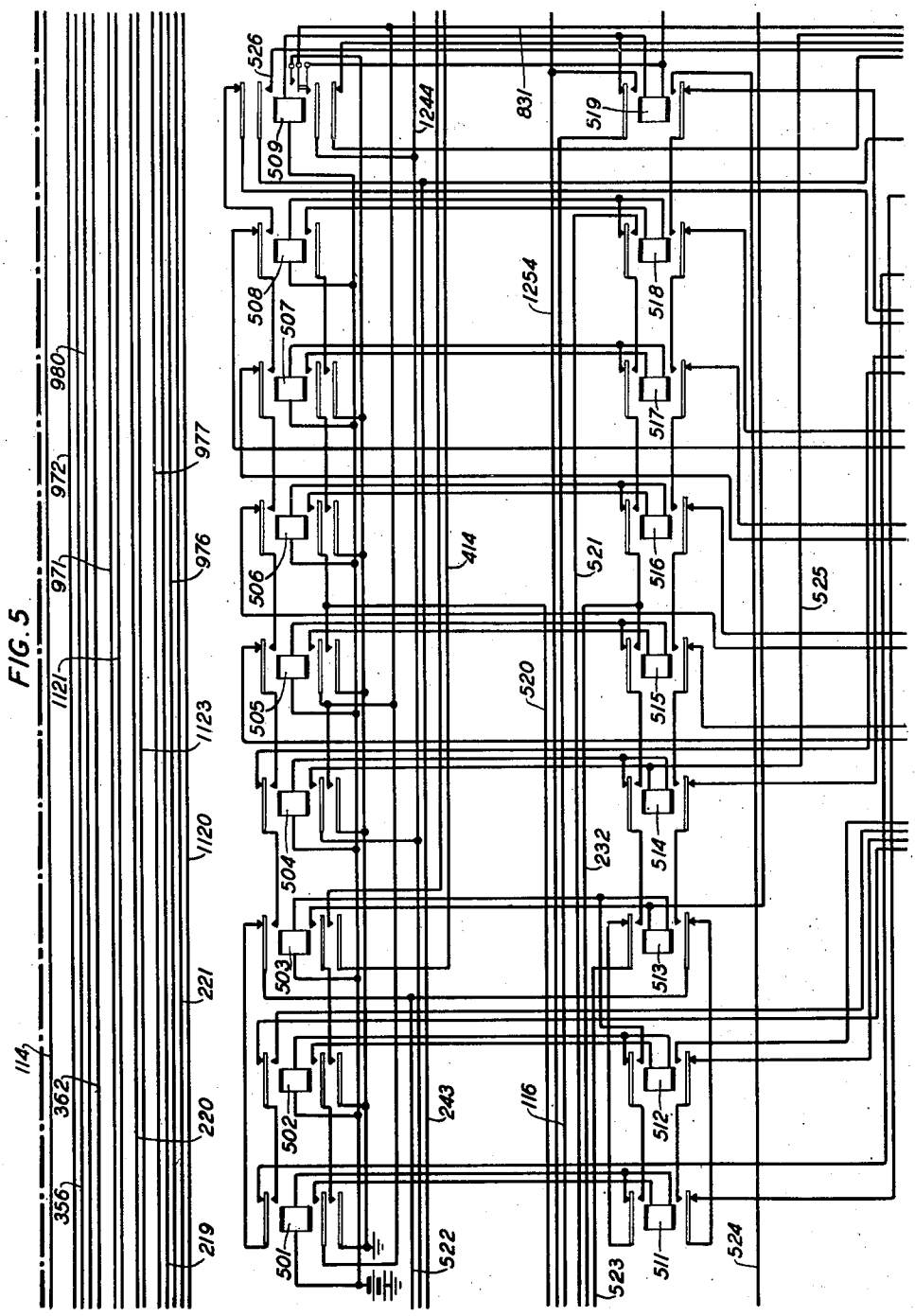

FIG. 5

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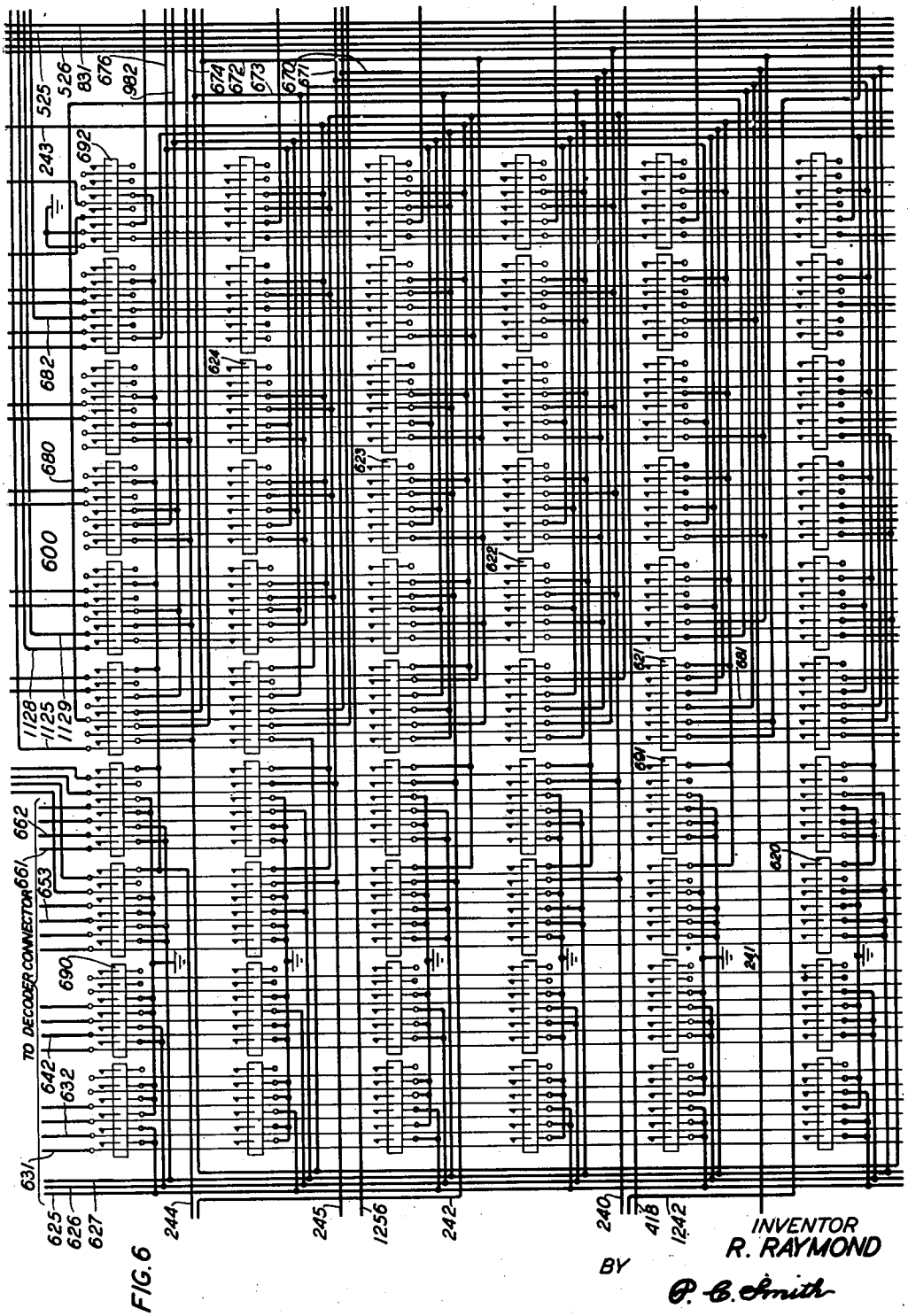

FIG. 6

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TELEPHONE SYSTEM

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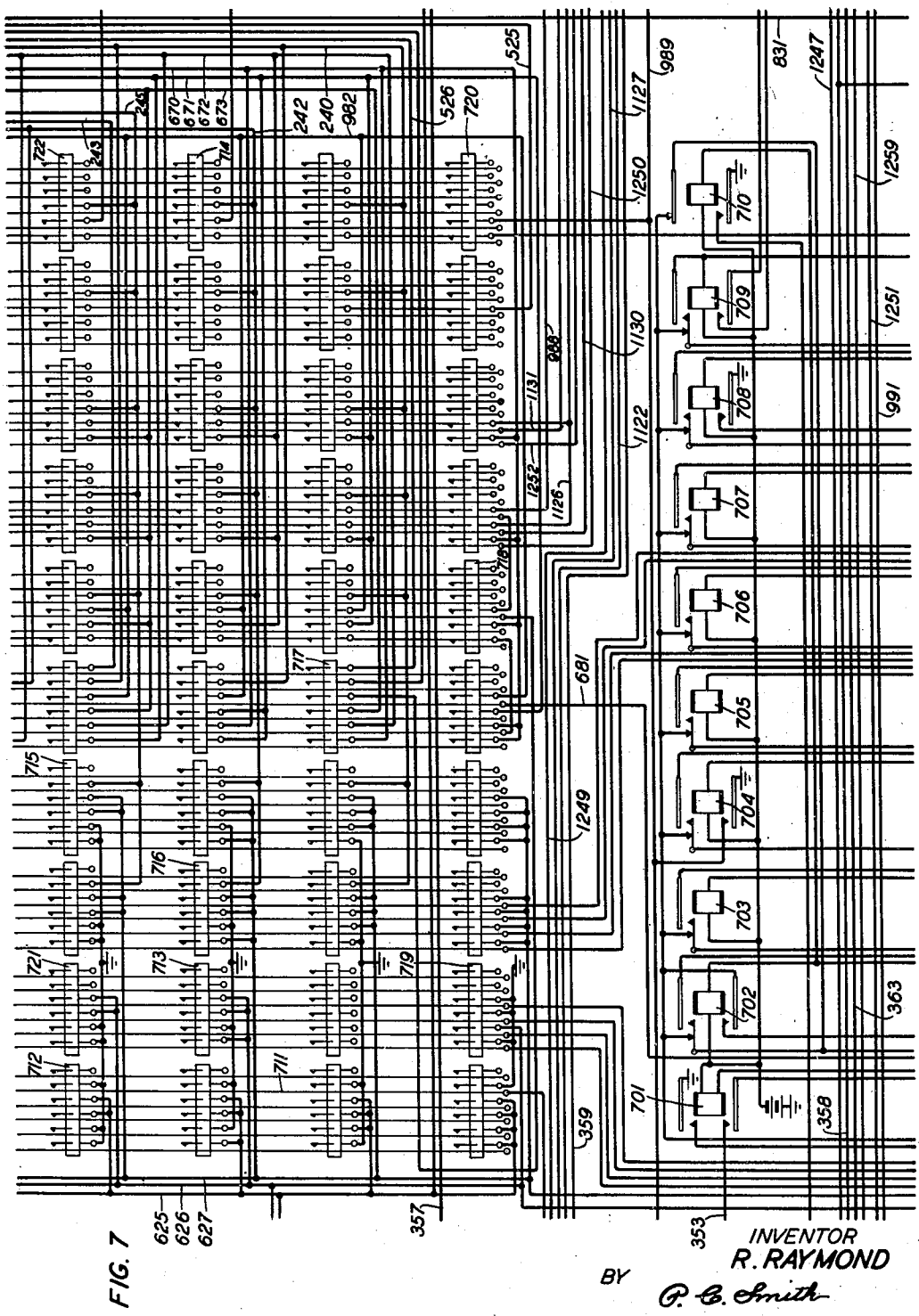

FIG. 7

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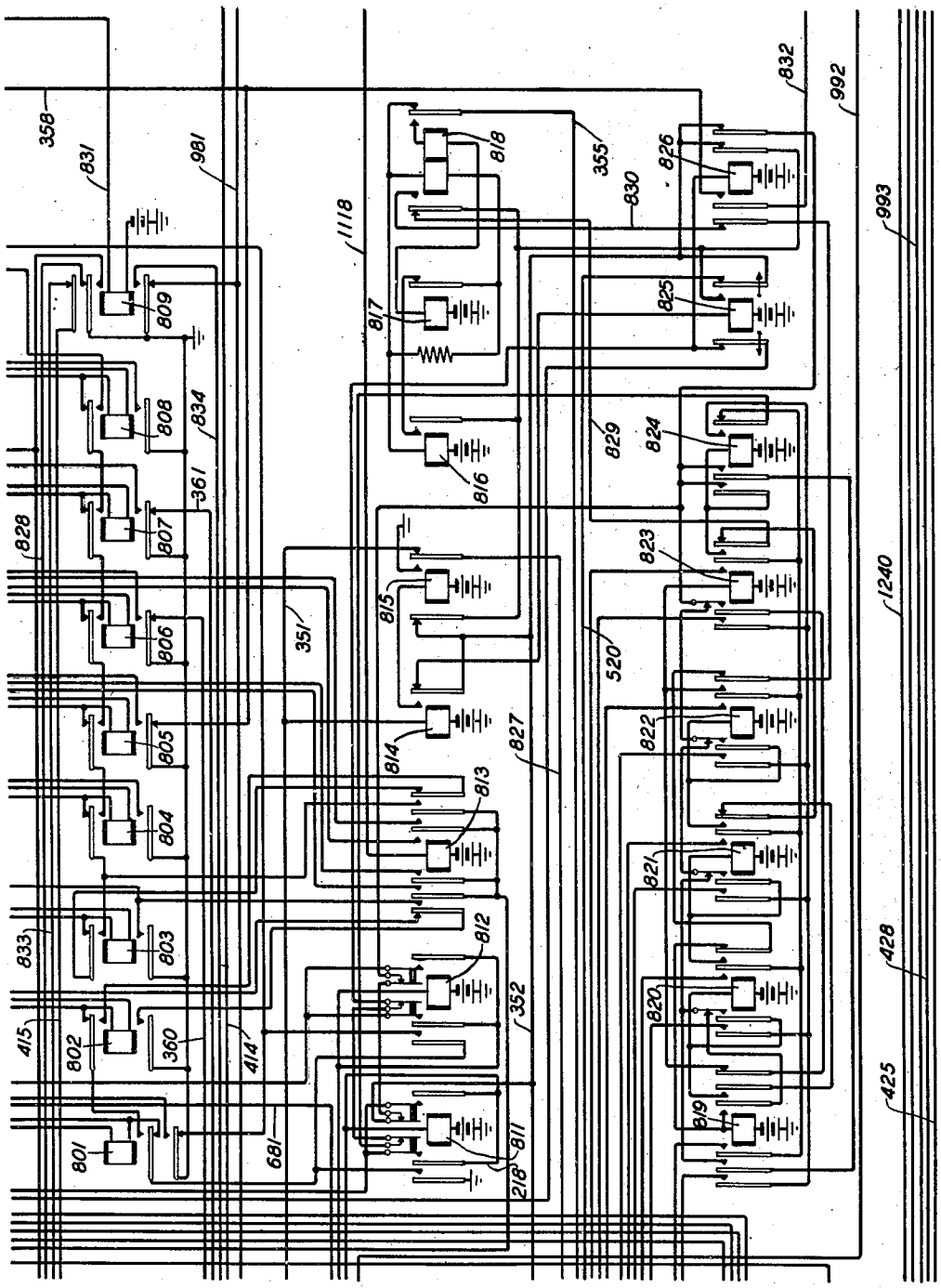

FIG. 8

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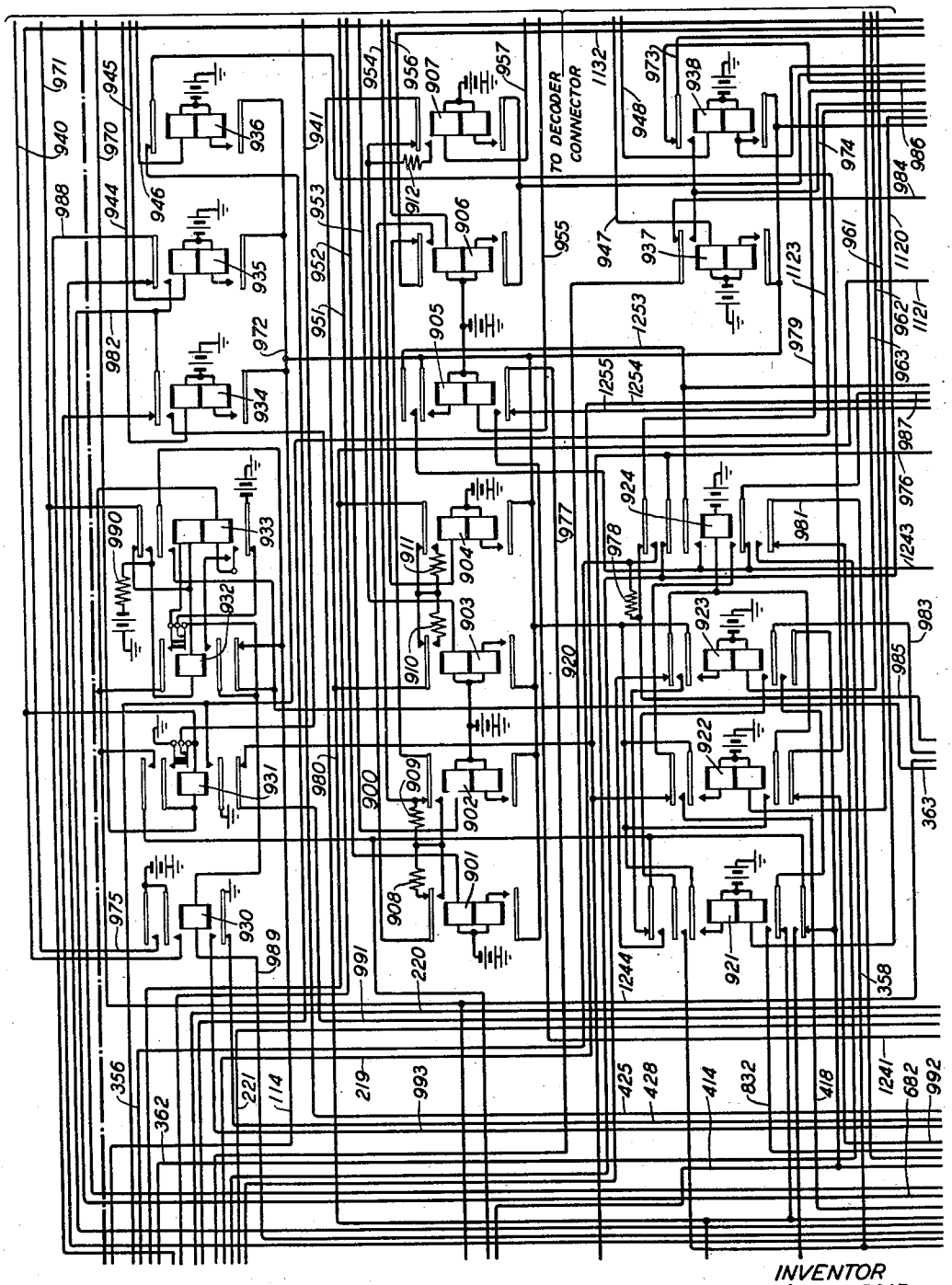

FIG. 9

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TELEPHONE SYSTEM

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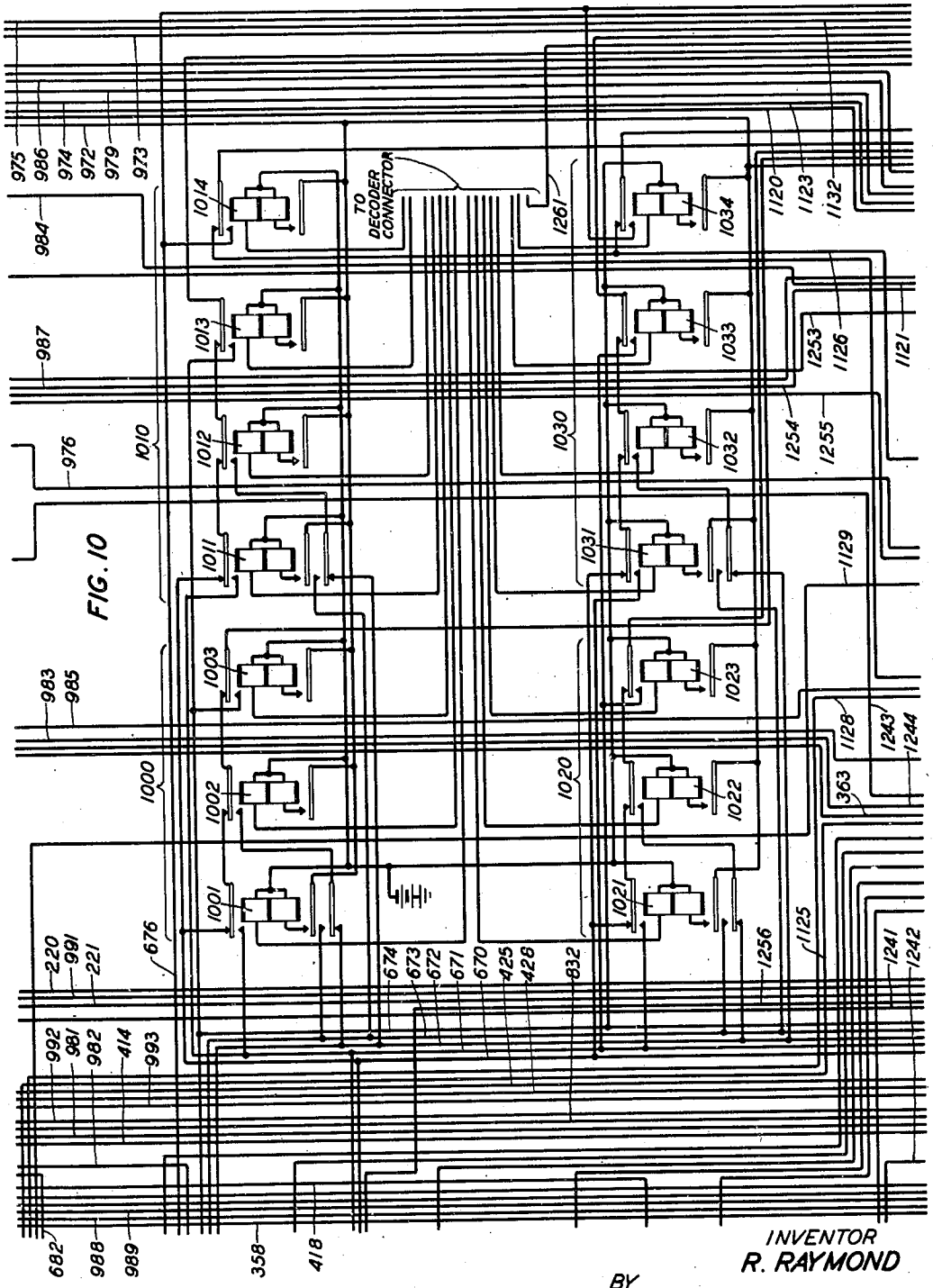

FIG. 10

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TELEPHONE SYSTEM

Filed June 19, 1935 12 Sheets-Sheet 11

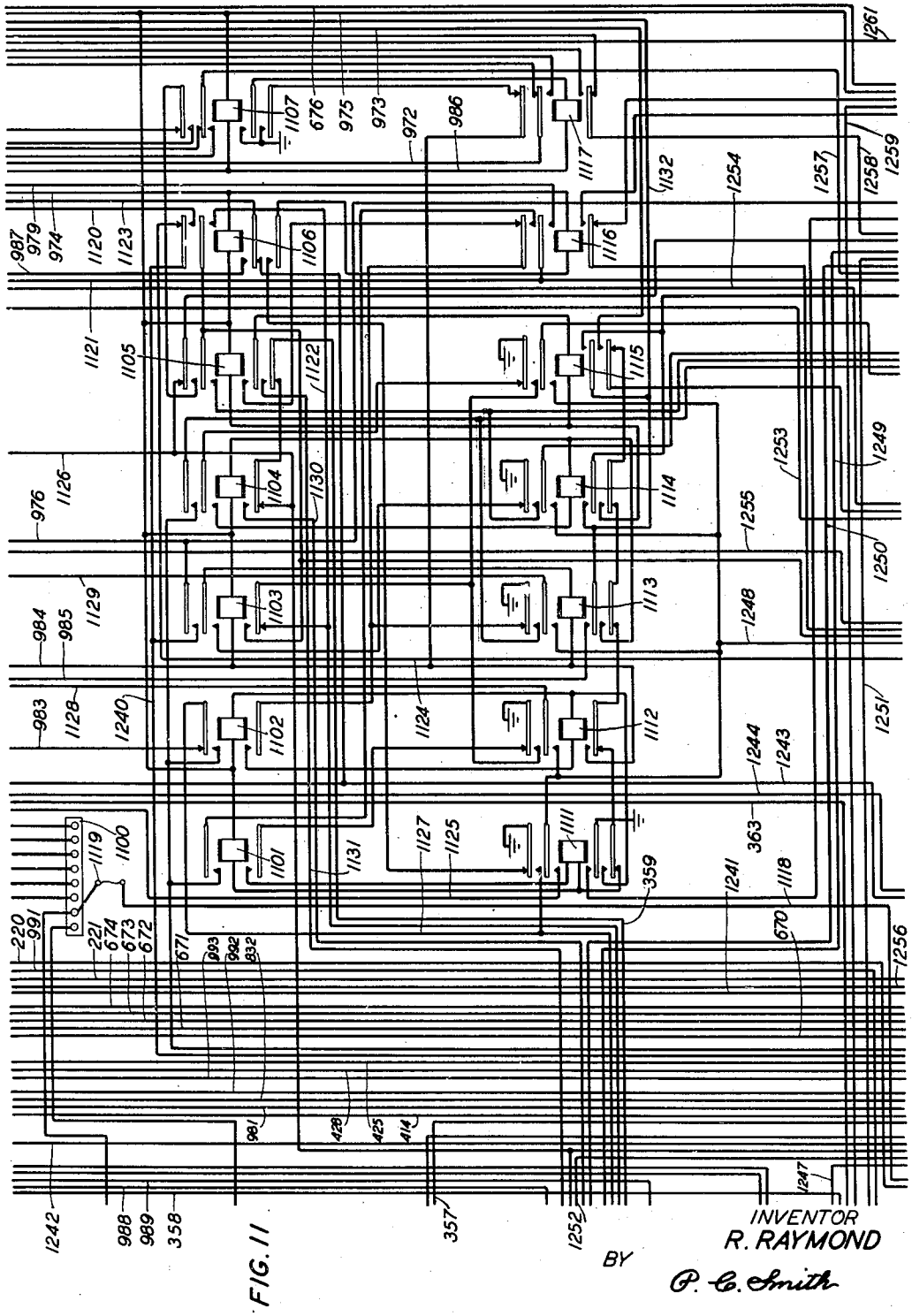

FIG. 11

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TELEPHONE SYSTEM

Filed June 19, 1935 12 Sheets-Sheet 12

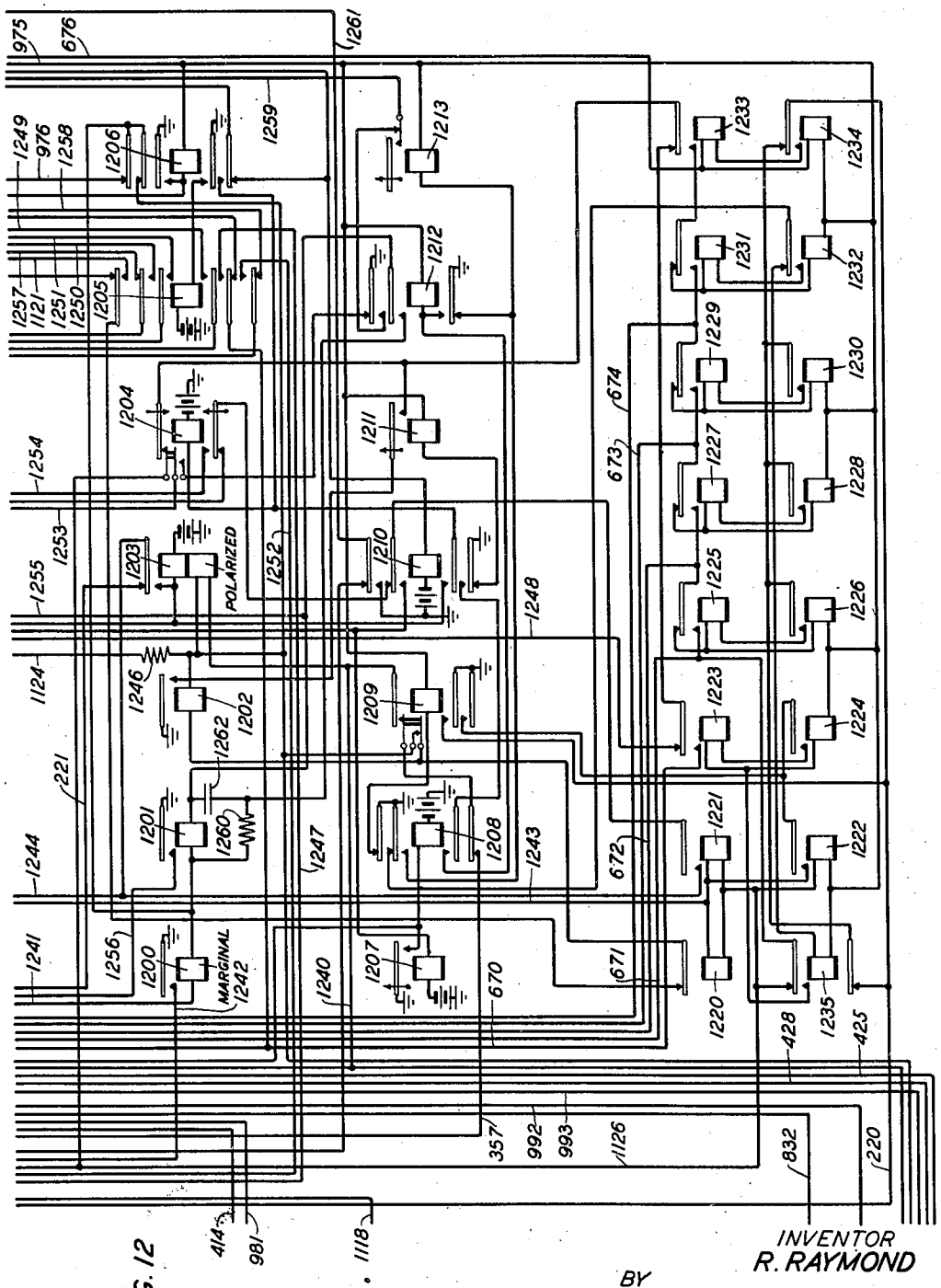

FIG. 12

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Patented Jan. 25, 1938 2,106,360

UNITED STATES PATENT OFFICE

2,106,360

TELEPHONE SYSTEM

Ralph Raymond, Nyack, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application June 19, 1935, Serial No. 27,340

24 Claims. (Cl. 179—6.3)

This invention relates to telephone systems and more particularly to those systems in which telephone connections are established by means of automatically operative selector switches under the control of a sending mechanism common to a plurality of subscriber's lines.

It is the object of the invention to improve the common sending mechanism to render it more reliable in operation and less expensive to install and maintain in efficient operating condition.

Heretofore in sending mechanism of this character such for example as is disclosed in the Patent No. 1,862,549, granted June 14, 1932 to R. Raymond and W. J. Scully, switches of the well-known sequence switch type have been employed for performing certain of the operating functions. These switches, of which there are three in each sender, require the installation of a driving motor and power shaft on each sender frame. Since all of the remaining apparatus of the sender frame is of the relay type, the elimination of these switches and the substitution therefor of relays to perform their functions would considerably simplify the maintenance of the sender and then the entire maintenance of the sender in good operating condition would be practically reduced to relay adjustment. The substitution of relays with their better contacts for switches having base metal contacts would give decidedly better circuit operating efficiency.

In accordance with the present invention relays have been provided for performing all of the functions of the sender, thus eliminating the sequence switches and the power installation for driving them. More specifically a train of sequentially operating relays is employed in place of the control sequence switch for controlling the selective operations of the selector switches in accordance with the setting of the registers of the sender. A group of transfer relays and impulse generating relays is employed for generating and transmitting codes of impulses in accordance with the setting of the registers of the sender on calls to manual offices equipped with call indicator apparatus and on calls to tandem offices thus replacing a second sequence switch which formerly performed these functions and a group of relays is employed for performing timing functions to replace a third sequence switch. The impulse generating relays not only generate codes of impulses for the establishment of manual and tandem calls, but also serve for generating impulses for timing certain operations of the sender such as a delay interval during which the calling subscriber may dial a station's digit and a delay interval for making preliminary coin test for the deposit of a coin if the sender is equipped to serve calls from subscriber's line having coin boxes.

A clearer understanding of the invention may be had from a consideration of the following description in connection with the accompanying drawings which disclose a complete register sender. In general

Fig. 1 shows the coin test circuits,

Fig. 2 shows the pulse generating relays,

Fig. 3 shows the subscriber class and district frame recording relays together with certain general control relays,

Fig. 4 shows the timing and monitoring circuits,

Fig. 5 shows the transfer relays for call indicator pulsing,

Figs. 6 and 7 show the cross-bar switch used as a dial register,

Fig. 8 shows the incoming recording relays and the locking relays of the dial register,

Fig. 9 shows the class and compensating resistance registers,

Fig. 10 shows the office registers,

Fig. 11 shows the selection sequence relays, and

Fig. 12 shows the selection control relays and the counting relays.

This sender is particularly designed to function in a telephone system employing cross-bar switches. Such a system is disclosed in Patent No. 2,093,117 granted September 14, 1937 to W. W. Carpenter, and a general reference is hereby made to that patent.

Ten senders, like the one disclosed, are mounted on one frame and are associated together in a group. Of the twenty-nine conductors, by which the sender is connected to the link circuits, conductors 330 to 350 are multipled to all ten senders, while conductors 325 to 329 and 112 to 114 are individual to this sender.

When the sender is idle, battery is connected to conductor 325 over the back contact of relay 410 and the outer right back contact of relay 315. When a subscriber originates a call, a line switch control circuit and a link control circuit are taken into use and these circuits function to find a district circuit or junctor which has access to a group of senders, preferably containing more than one idle sender. The calling line is then connected to the selected district junctor and the sender.

Assuming that the sender disclosed has been seized for service, the link control circuit con-

nects ground to conductor 327, completing a direct circuit for relay 311, and a circuit for relay 312 over the innermost normal contact of relay 315. Relays 311 and 312 connect conductors 338 to 349 through to the sender equipment. When the line and link control circuits operate the line and link switches, the talking conductors of the calling line are connected through to conductors 112 and 113. Conductor 112 extends to ground over the left normal contact of relay 104 and the right back contact of relay 107, while conductor 113 extends over the right normal contact of relay 109, left normal contact of relay 107, conductor 115 to battery through the right winding of relay 310. If the connection over the line and link switches and the subscriber's loop is complete, relay 310 operates, closing a circuit from ground at the inner right back contact of relay 309, front contact of relay 310, conductor 351 to the winding of relay 314 and battery. A circuit also extends from conductor 351 over the right back contact of relay 315, conductor 327 to the winding of relay 314 and battery. Relay 314 closes an obvious circuit for relay 313, which in turn connects ground from the inner upper back contact of relay 309, conductor 328, middle right front contact of relay 313 to conductor 352, thereby completing a circuit over the front contact of relay 314 to battery through the winding of relay 315. Relay 315 at its right armature transfers the circuit of relay 314 from the ground supplied by relay 310 to ground at the contact of relay 315. Since relay 314 is slow to release, it maintains its contacts closed during the transfer. Relay 314 connects ground from its inner right contact through resistance 365, innermost right back contact of relay 308, conductor 363, lower back contact of relay 932 to conductor 114 to control the district junctor.

Relay 313 in operating, connects battery through the winding of relay 315, over the middle left contact of relay 313 and the second lower contact of relay 311 to conductor 336 as an indication to the link control circuit that the line conductors have been closed. Ground from the link control circuit operates relay 315 which locks over its third left contact to ground at the inner left contact of relay 313. Relay 315 disconnects battery from conductor 325 to remove the idle indication, and closes at its middle right front contact a point in the all-senders-busy chain circuit. It also conects ground over its second left contact to conductor 350 to hold the line and link switches operated, independent of the line and link control circuits. In addition it connects ground over its innermost left contact and the lowermost contact of relay 311 to conductor 339 as a release signal to the link control circuit. Furthermore it opens the circuit of relay 312 which releases, opening conductors 340 to 349. When the link control circuit releases in response to the release signal, relay 311 also releases, opening the remainder of the common conductors.

During the time that relays 311 and 312 were operated, a registration was made of the class of service of the calling line and the number of the district frame involved. This information is furnished by the link control circuit in the form of ground to one of the class of service leads 330 to 333, one of the frame tens leads 334 and 335 and one of the frame units leads 340 to 349. Assuming, for example, that the link control circuit grounds conductors 331, 335 and 346, relays 303 and 307 will operate and lock over conductor 353 to ground at the inner right front contact of relay 315.

The frame units indication is registered on the cross-bar type dial register 600. To indicate the relationship between the select magnets and the switch structure, they have been numbered 610 to 619 although they appear in Figs. 2 and 3. With conductor 346 grounded, select magnet 613 operates, preparing the contacts of the No. 3 level of the register. Magnet 613 also extends its operating ground over its local contact, and conductor 218 to the winding of relay 811 and battery. Relay 811 closes a circuit from battery through the winding of the frame hold magnet 701, inner back contact of relay 801 to ground at the outer left front contact of relay 811. Magnet 701 operates, closing a locking circuit for itself through the winding of relay 801, lower contact of magnet 701 to grounded conductor 353. It also closes a circuit from battery through the winding of relay 826, left back contact of relay 825, to ground at the upper front contact of magnet 701. Magnet 701 closes the contacts of cross-point 712, at the No. 3 level prepared by the operated select magnet 613. The cross-point connects ground to conductor 711, which extends over the outer right back contact of relay 309 and the third left contact of relay 315 to the winding of relay 315 and battery, locking relay 315.

When relay 312 released as previously described, the circuit of select magnet 613 was opened and that magnet released in turn releasing relay 811 and permitting relay 801 to operate in the locking circuit of hold magnet 701. Cross-point 712 is maintained closed as long as magnet 701 remains operated.

When relay 314 operated, a circuit was closed from ground at its outer right contact through condenser 354, left winding of relay 310, outer right back contact of relay 405 to the source of dial tone. A tone is thereby induced in the subscriber's dialing circuit and is heard in the substation receiver as an indication that dialing may start.

Call to panel office

Assume for the purposes of this description that the wanted number is Chelsea 3–5678. When the subscriber dials the first letter C, which is the equivalent of the digit 2, the circuit of relay 310 is opened twice, causing relay 310 to close its back contact twice. Relays 814 and 815 also release. Relay 814 is fast both to operate and release in order that it may follow relay 310 as closely as possible. Relay 815 is also fast to release.

At the first release of relay 814, a circuit is closed from battery through the winding of relay 825, back contact of relay 814 to grounded conductor 352. Relay 825 operates and is sufficiently slow to release to remain operated throughout the impulsing for the digit, in spite of the repeated momentary breaking of its operating path. Relay 825 in operating, opens the circuit of relay 826 which releases, remaining released throughout the reception of the digit impulses.

Relays 816, 817 and 818 serve to transmit the dial pulses over conductors 829 and 830 alternately to the pulse counting or recording relays 819 to 824. At its first release, relay 310 connects ground from the inner right back contact of relay 309, over the back contact of relay 310 and the left front contact of relay 314 to conductor 355, right back contact of relay 818, winding of relay 816 to battery. Relay 816 operates, closing

a circuit from battery through its winding, left winding of relay 818, back contact of relay 817, front contact of relay 816, over the front contact of relay 825 or the inner right back contact of relay 826 to grounded conductor 352. This circuit also extends to grounded conductor 352 over the outer right back contact of relay 826 and the normal contacts of relays 811 and 812. Relay 818 does not operate, being shunted by the operating circuit of relay 816. When relay 310 reoperates at the end of the first pulse, relay 818 operates, closing a circuit from grounded conductor 352, inner right back contact of relay 826, left front contact of relay 818, conductor 830, left back contact of relay 826, right back contacts of relays 822 and 820, winding of relay 819 to battery. Relay 819 locks over its inner right front contact, normal contacts of relays 820, 821, 822, 823, 812 and 811 to grounded conductor 352, thereby recording one pulse.

Relay 818 in operating prepares a circuit from battery through the winding of relay 817, right winding and right front contact of relay 818 to conductor 355. When relay 310 releases in response to the second pulse, grounding conductor 355, relay 818 is held operated and relay 817 operates, opening the holding circuit for relay 816 which now releases. At the end of the second pulse relays 817 and 818 also release closing a circuit from grounded conductor 352, inner right contact of relay 826, left back contact of relay 818, conductor 829, right back contacts of relays 823 and 821, outer right front contact of relay 819, to the winding of relay 820 and battery. Relay 820 locks over its left alternate contact and the normal contacts of relays 821, 822, 823, 812 and 811 to grounded conductor 352. Relay 820 also opens the locking circuit of relay 819 so that relay 820 alone of the pulse counting relays remains operated at the end of the digit. While relay 310 remains operated between digits, relays 814, 815 and 826 remain operated and relay 825 releases.

The cycle of operations described above for relays 816, 817 and 818 repeats for every two pulses of a digit. If the number of pulses is even, as above, the last pulse leaves the three relays normal. If the number is odd, relay 817 is left normal and relays 816 and 818 release after relays 815 and 826 have reoperated and relay 825 has released to break all ground connections which could hold them operated. This triple, parallel ground serves to establish locking ground for relays 816 and 818 promptly at the start of each series of pulses and to hold it steadily until well after the end of the series.

When relay 825 closes its left contact following the dialing of the first digit, a circuit is closed from ground at the upper front contact of magnet 701, left back contact of relay 825, left normal contacts of relays 811 and 812, right back contact of relay 824, inner right front contact of relay 820 to the winding of select magnet 612 and battery. Magnet 612 operates, preparing the No. 2 level of contacts and extends its operating ground over conductor 218 to the winding of relay 811 and battery. Relay 811 closes a holding circuit for itself over its right front contact, normal contact of hold magnet 702 and in parallel therewith over the back contact of magnet 710, front contact of relay 801 to ground. At the same time it closes a circuit from ground over its outer left contact, inner front contact of relay 801, upper back contact of relay 802, windings of magnet 702 and auxiliary magnet 710 to battery. Magnet 702 closes a locking circuit for itself, and the auxiliary hold magnet 710, through the winding of relay 802, upper front contact of magnet 702, outer front contact of relay 801 to ground. The operation of relay 811 opened the operating circuit of select magnet 612 but that magnet is held over the locking circuit of relay 811. Magnet 702 closes the cross-point 713 prepared by magnet 612 and when fully operated opens its normal contact releasing relay 811 and magnet 612. The operation of relay 811 also releases relay 820, restoring the pulse recording relays, ready for the next digit. Auxiliary hold magnet 710 closes cross-point 714 in the corresponding vertical. In addition magnet 710 closes a circuit from ground at its front contact through the winding of relay 405 to battery, opening the dial tone circuit.

It will be observed from the foregoing that the release of relay 825 is ineffective to operate one of the select magnets 610 to 619 until hold magnet 701 has been properly operated by the registration of the district frame number and therefore that the first digit dialed cannot be falsely registered on the first or frame vertical of the dial recorder.

If a false pulse is transmitted, or the digit one is mistakenly dialed for the first digit, relays 816 and 818 are operated as above described, in turn operating relay 819. When relay 825 falls back, the select magnet circuit is closed as above traced to the back contact of relay 824 and thence over the inner left front contact of relay 819 to the winding of the No. 1 select magnet 611. This magnet extends its operating ground to the winding of relay 812. The locking circuit of relay 812 extends over the front contact of magnet 702 and therefore cannot be closed until after the first digit has been registered. Likewise relay 812 is ineffective to operate magnets 702 and 710 since the ground supplied to the outer left contact of relay 812 for the purpose of operating the hold magnets is opened at the front contact of relay 801 and is not reclosed until magnet 710 has closed one of the cross-points in its vertical. Relay 812 opens the holding circuit for relay 819 so that relay 819, magnet 611 and relay 812 restore in succession and the circuit is in condition to record the proper digit.

It may also be noted that relay 812 is effective to record the digit one on the frame vertical since a ground for operating the frame magnet 701 is supplied over the back contact of relay 801.

The second letter of the office code, H, is the equivalent of the digit 4 and the relays 816, 817 and 818 perform two complete cycles. Relays 819 and 820 operate in response to the first two pulses as previously described. After the third pulse relays 817 and 818 are held operated, grounding conductor 830 and closing a circuit over the left back contact of relay 826, right back contact of relay 822, outer right front contact of relay 820 to the winding of relay 821 and battery. Relay 821 locks over its inner left front contact and the normal contacts of relays 822, 823, 812 and 811 to grounded conductor 352, at the same time opening the locking circuit of relay 820 which releases. At the end of the fourth pulse relays 816, 817 and 818 are normal, connecting ground to conductor 829, to complete a circuit over the right back contact of relay 823, outer right front contact of relay 821 to the winding of relay 822 and battery. Relay 822 locks over its inner left front contact and the normal contacts of relays 823, 812 and 811 to grounded conductor 352, releasing re-

lay 821. Since this is the last pulse of the digit, relay 825 is released as above described connecting ground from the front contact of magnet 701 over the left back contact of relay 825, left normal contacts of relays 812 and 811, right back contact of relay 824, inner right front contact of relay 822, to the winding of select magnet 614 and battery. Magnet 614 prepares the contacts in the No. 4 level of the switch and extends its operating ground over conductor 218 to the winding of relay 811. Relay 811 locks itself and magnet 614 over its front contacts, normal contact of hold magnet 703, left back contact of relay 813, lower front contact of relay 802 to ground. At its normal contacts it opens the locking circuit of relay 821 and the operating circuit of magnet 614 and at its outer left front contact closes a circuit from ground, over the inner front contact of relay 801, upper front contact of relay 802, right back contact of relay 813, back contact of relay 803 to the winding of hold magnet 703 and battery. Magnet 703 closes a locking circuit for itself through the winding of relay 803, front contact of magnet 703, left back contact of relay 813, front contact of relay 802 to ground. When magnet 703 has fully operated it opens the locking circuit of relay 811 and magnet 614. Magnet 703 holds cross-point 620 closed.

In recording the third code digit three, relay 821 is operated and locked, and, on the release of relay 825, operates select magnet 613 which prepares the No. 3 level of contacts. Magnet 613 operates relay 811 which, since relay 803 is operated, locks under the control of magnet 704 and operates that magnet. Magnet 704 locks in series with relay 804, locking cross-point 715 and releases relay 811 and magnet 613.

For the thousands digit 5, relays 819, 820 and 821 are operated and released as before by the first four pulses, the fifth pulse operating relay 823 over conductor 830 and the front contact of relay 822. Relay 823 locks in a circuit from battery through its winding, back contact of relay 819, inner left front contact of relay 823, normal contacts of relays 812 and 811 to grounded conductor 352. Relay 823 also releases relay 822 and when relay 825 falls back operates select magnet 615. Relay 811, hold magnet 705 and relay 805 function to close cross-point 621.

When the hundreds digit 6 is recorded, the first five pulses cause the successive operation and release of relays 819, 820, 821, and 822, relay 823, being operated alone at the end of the fifth pulse. The sixth pulse causes the grounding of conductor 829, operating relay 824 over the front contact of relay 823. Relay 824 locks over its outer left contact and the normal contacts of relays 812 and 811 to grounded conductor 352. Since relay 823 locked over the back contact of relay 819 it is also operated when relay 825 releases at the end of the digit and a circuit is closed from ground at the upper front contact of magnet 701, back contact of relay 825, left normal contacts of relays 812 and 811, right front contact of relay 824, outer left front contact of relay 823 to the winding of select magnet 616 which prepares the contacts of the No. 6 level of the register. Magnet 706 and relay 806 are operated under the control of magnet 616 and relay 811 to close cross-point 622.

In recording the tens digit 7, relays 819 to 822 are operated and released and relays 823 and 824 operated and locked by the first six pulses as for the hundreds digit. The seventh pulse reoperates relay 819 over the back contacts of relays 820 and 822. Relay 819 releases relay 823 and locks over the normal contacts of relays 820 to 823 as before. Since relay 824 locked independently of the other counting relays it remains operated, and when relay 825 releases, the select magnet circuit extends over the right front contact of relay 824 and the outer left front contact of relay 819 to the winding of select magnet 617. Magnets 617 and 707 and relays 811 and 807 cooperate to operate and lock cross-point 623.

To record the units digit 8, relays 819 to 823 are operated and released and relay 824 locked. Relays 819 and 820 are reoperated and relay 819 released for the second time. With relays 820 and 824 operated, select magnet 618 is operated and cooperates with hold magnet 708 to lock cross-point 624. When the seventh and last digit has been recorded, hold magnets 701 to 708 and 710 are operated and locked through locking relays 801 to 808. Magnet 708 in operating closes a circuit from ground at its lower front contact through the winding of relay 403 to battery. The function of relay 403 will be described hereinafter.

When the office code had been completely received, as indicated by the operation of magnet 704, the sender is ready to summon a decoder. For this purpose, magnet 704 closes a circuit from ground at its lower front contact, conductor 989, winding of relay 930, normal contact of relay 932, lower back contact of relay 933 to battery. Relay 930 connects battery directly to conductor 940, and over the normal contact of relay 931 to conductor 941. The decoder connector responds to this signal to connect the sender with the decoder over a large number of conductors as indicated. Conductors 940, 941, 970 and 971, and 321 are control conductors. Conductors 322 to 324 and the conductors shown at the upper left corner of Fig. 6 are for transmitting to the decoder the code, subscriber class and frame identification which has previously been recorded in the sender. Conductors 944 to 948, 951 to 957 and 961 to 963 and the group shown on Fig. 10, are for receiving the decoded information from the decoder. The decoder and decoder connector function as described in the above identified Carpenter patent.

Since subscriber class relay 303 and frame tens relay 307 were operated, ground is connected to conductors 323 and 324 to transmit this information to the decoder. With cross-points 712, 713, 620 and 715 closed in the dial register, conductors 631, 632, 642, 653, 661 and 662 are grounded to transmit the units digit of the frame indication and the code designation to the decoder. It is to be noted that the ungrounded conductors are connected by the relay or cross-point to one of conductors 625, 626 and 627. These conductors are used by the decoder in making a test of the continuity of all of the registering conductors each time that the decoder is used.

Assuming that the wanted number represents a subscriber's line in a panel type office reached by direct trunks from the originating office, after the decoder has completed its decoding operation, class relay 921 is operated. None of the office register relays of Fig. 10 will be operated, but conductors 947 and 948 will be grounded by the decoder, operating the skip office relays 937 and 938. Since short direct trunks are to be used, compensating resistance relays 903, 904 and 905 are operated. Since this call is to a full mechanical office, no fifth digit or stations digit is

to be expected and relays 934 and 935 are operated.

The decoder from the frame indication received from the sender establishes a connection with the district frame and then connects ground to conductor 321 operating relay 301. Relay 301 extends this ground over its left front contact to conductor 328 leading through the link switches to the district junctor where it operates a relay which in turn extends the lead through the district frame connector to another point in the decoder where another ground is applied to it. This second ground holds relay 301 operated after the direct connection with the decoder, by way of conductor 321, has been broken.

Having closed this indirect holding circuit for relay 301, the decoder connects ground to conductor 970, closing a circuit through the winding of relay 931 to battery at the inner upper front contact of relay 930. Relay 931 locks to ground at its inner upper front contact and at its upper normal contact opens the ground connected to start conductor 941, thereby permitting the release of the decoder connector and in turn of the decoder. At its lower front contact relay 931 connects ground to conductor 972 which supplies locking ground for the class and a part of the compensating resistance relays, for the office register relays of Fig. 10, and over the back contact of relay 1117 for compensating resistance relays 906 and 907. In addition, ground over conductor 972 extends over the back contact of relay 111 to the right winding of relay 105 which operates and locks to conductor 972 independent of relay 111. The closure of these locking circuits is thus delayed so that the register relays may be released and set up in a different pattern if the decoder reroutes the call.

The selection of an outgoing trunk and the connection of the district junctor to that trunk take place under the control of the decoder, as described in the above identified Carpenter patent, and when these functions are completed the decoder removes the ground by which relay 301 was held operated. While relay 301 was operated it connected ground to conductor 356, front contact of relay 937, conductor 974, winding of relay 1106, conductor 975, to battery at the outer upper contact of relay 930. Relay 1106 operates in this circuit and closes a locking circuit for itself through the winding of relay 1116, outer lower front contact of relay 1106, to ground at the upper back contact of relay 1111. Relay 1116 does not operate, being shunted by the operating circuit of relay 1106. When the decoder releases relay 301, it is an indication that the connection has been completed as far as the outgoing trunk and that the sender may assume control of the further extension of the connection. Relay 1116 then operates to close the fundamental circuit for trunk test.

When relay 930 operated. connecting battery to conductor 975 as above described, relay 1213 operated from ground at the lower back contact of relay 1212; relay 1211 operated from ground at the lower back contact of relay 1210; relay 1209 operated from ground at the outer upper back contact of relay 1208 and relay 1235 operated over the back contact of relay 1232 from ground at the inner upper back contact of relay 1208.

For a call to a panel type office, the trunk test circuit should not be closed until after the thousands digit has been registered and therefore, the operation of relay 1106 prepares a circuit from battery, through the winding of relay 1207, inner upper front contact of relay 1106, conductor 1122, fourth right contact of relay 308, conductor 358, lower back contact of relay 805 to ground, holding relay 1207 operated until relay 805 has been operated. With relay 1207 operated, an obvious circuit is closed for relay 1208 which holds the fundamental circuit open until the thousands digit has been recorded. Relays 1209 and 1235, are also released as long as relay 1208 is held operated.

After relay 301 releases, relay 1116 operates and when the thousands digit has been recorded, the fundamental circuit is closed from the fundamental tip conductor 328, left back contact of relay 301, conductor 357, lower back contact of relay 1208, upper front contact of relay 1209, conductor 1240, outer upper front contact of relay 1106, conductor 1120, inner upper back contact of relay 924, conductor 976, outer upper back contact of relay 1206, winding of marginal trunk test relay 1200, conductor 1241, lower front contact of relay 905, conductor 977, right back contact of relay 215, conductor 219, resistance 978, outer upper back contact of relay 924, conductor 979, inner upper front contact of relay 1116, conductor 1121, front contact of relay 904, through resistances 911 and 910, front contact of relay 903, conductor 980, right back contact of relay 301 to the fundamental ring conductor 329.

When this circuit is established and the trunk and incoming selector are ready, relay 1200 operates, connecting ground over conductor 1242 to the winding of relay 209 and battery. Relay 209 in turn closes a circuit from battery through the winding of relay 208, left front contact of relay 209, outer left back contact of relay 215, conductor 220 to ground at the inner lower contact of relay 1209. Relay 208 at its contact closes a holding circuit for relay 209 to ground at the left back contact of relay 309. Relay 209 also closes a circuit from battery at the outer upper contact of relay 930, conductor 975, winding of relay 1222, windings of relays 1220 and 1221 in parallel, conductor 1243, inner lower back contact of relay 924, conductor 987, inner lower front contact of relay 1106, conductor 1123, inner right front contact of relay 209, conductor 221, back contact of relay 1203, conductor 1244 to ground at the outer right front contact of relay 315. Relays 1220, 1221 and 1222 lock over the front contact of relay 1222 to ground at the outer lower contact of relay 1209. Relay 1221 in operating closes a circuit from battery on conductor 975, winding of relay 1101, lower back contacts of relays 1111, 1112, 1113, 1114 and 1115, back contact of relay 1204, inner upper back contact of relay 1210, front contact of relay 1221 to ground over conductor 1244. Relay 1101 closes a locking circuit for itself through the winding of relay 1111, lower front contact of relay 1101, to ground at the upper back contact of relay 1112, but relay 1111 does not operate, being shunted by the operating circuit of relay 1101. Relay 1101 closes a circuit from battery through the winding of relay 1208, upper front contact of relay 1101, outer upper front contact of relay 1116, to ground at the upper back contact of relay 1113. Relay 1208 opens the circuit of relay 1209 which releases, opening the fundamental circuit at its upper front contact, thereby releasing relay 1200 and opening the operating circuit of relay 209. At its inner lower contact relay 1209 opens the circuit of relay 208

which releases relay 209. At its outer lower contact relay 1209 opens the locking circuit of relays 1220, 1221 and 1222 releasing them.

The release of relay 1221 permits relay 1111 to operate in the locking circuit of relay 1101. Relay 1111 in operating opens the locking circuit of relays 1106 and 1116 and these relays release. When relay 1116 opens its outer upper front contact relay 1208 releases, permitting relay 1209 to reoperate. Relay 1111 also closes a circuit from ground at its inner lower front contact through the winding of relay 1206 to battery over conductor 975. Relay 1206 locks to ground on its upper front contact and closes an obvious circuit for relay 1205. These relays prepare the sender for incoming and final selections.

With relays 1209 and 1205 operated, the fundamental circuit is closed for incoming brush selection and extends from the fundamental tip conductor 328 to the upper front contact of relay 1209 as previously traced and thence through the lower winding of polarized relay 1203, winding of stepping relay 1202, back contact of relay 1220, outer upper front contact of relay 1205, conductor 1121 and thence to the fundamental ring conductor 329 as before.

Relay 1202 operates in series with the selector relay, but the current flow is not in the direction to operate polarized relay 1203. In addition the winding of relay 1203 is shunted by a circuit over conductor 1240, upper back contact of relay 1106, conductor 1124 and resistance 1246.

The counting relay circuit for incoming brush selection, closed by relay 1202 extends from ground over the contact of relay 1202, front contact of relay 1211, back contacts of relays 1233 and 1223, conductor 1248, inner upper front contact of relay 1111, over conductor 1125 to the first left contacts of the thousands vertical of the dial register 600, over the contact closed at cross-point 621, conductor 672, back contact of relay 1225, winding of relay 1226, to battery over conductor 975. Relay 1226 operates, locking through the winding of relay 1225, front contact of relay 1226, back contact of relay 1234 to ground at the inner lower contact of relay 1209, but relay 1225 does not operate.

When the selector at the terminating office sends back the first revertive pulse by shunting the sender relay, stepping relay 1202 releases permitting relay 1225 to operate and transfer the counting relay circuit over the front contacts of relays 1225 and 1235 to the winding of relay 1224 and battery over conductor 975. When the revertive pulse ends and relay 1202 reoperates, relay 1224 operates and locks through the winding of relay 1223 to ground at the outer lower contact of relay 1209. The second revertive pulse permits relay 1223 to operate. The counting relay circuit then extends as traced to the back contact of relay 1233, front contact of relay 1223, conductor 670, middle lower front contact of relay 1205, conductor 1247, outermost right contact of relay 308, conductor 359, lower back contacts of relays 1105 and 1104, conductor 1126, winding of relay 1222 and to battery over conductor 975. Relay 1222 locks through the windings of relays 1220 and 1221 in parallel, front contact of relay 1222 to ground at the outer lower contact of relay 1209. When relay 1202 releases in response to the third revertive pulse, relays 1220 and 1221 operate.

Relay 1220 opens the fundamental circuit to terminate the brush selecting operation of the incoming selector. Relay 1221 closes a circuit from grounded conductor 1244, front contact of relay 1221, inner upper back contact of relay 1210, lower back contact of relay 1204, lower back contacts of relays 1115, 1114, 1113 and 1112, outer lower front contact of relay 1111, winding of relay 1102 to battery on conductor 975. Relay 1102 locks through the winding of relay 1112, lower front contact of relay 1102, to ground at the upper back contact of relay 1113. Relay 1102 also closes a circuit from ground at the outer upper front contact of relay 1111, conductor 1127, upper front contact of relay 1102, winding of relay 1208 and battery. Relay 1208 releases relay 1209 and these relays further open the fundamental circuit. Relay 1209 also opens the locking circuits for the counting relays, which thereupon release. The release of relay 1221 permits relay 1112 to operate in the locking circuit of relay 1102. Relay 1112 opens the locking circuit of relays 1101 and 1111 and these sequence relays release. Relay 1102 prepares an additional circuit for relay 1208 which extends from conductor 1127 over the middle right back contact of relay 308, conductor 360, back contact of relay 306 to ground, if the hundreds digit has not yet been recorded to operate relay 306.

With relay 1111 released and relay 306 operated, relay 1208 releases, permitting relay 1209 to reoperate and the fundamental circuit is closed for incoming group selection. In this case the counting relay circuit extends from ground at the front contact of stepping relay 1202 to conductor 1248 as before and thence over the inner upper front contact of relay 1112, conductor 1128, to the left row of contacts of the hundreds vertical, over the contact closed at cross-point 622, conductor 680, third left contact closed at cross-point 621, conductor 673, back contact of relay 1227, winding of relay 1228 to battery on conductor 975. Relays 1228 and 1227 respond to the first revertive impulse while relays 1226 to 1220 respond to the next three impulses in the same manner as for incoming brush selection.

When relays 1220, 1221 and 1222 operate, the fundamental circuit is opened as previously described. Since relay 1112 is now operated, relay 1221 operates relay 1103 which in turn locks through the winding of relay 1113 to ground at the back contact of relay 1114. Relay 1103 closes a circuit from ground at the upper front contact of relay 1112, lower front contact of relay 1103, to the winding of relay 1207 and battery. Relay 1207 in turn operates relay 1208 which releases relay 1209, thereby releasing the counting relays and permitting relay 1113 to operate. With relay 1113 operated, relays 1102 and 1112 release in turn releasing relays 1207 and 1208 and reoperating relay 1209 to establish the circuits for final brush selection.

For this selection, the counting relay circuit extends to conductor 1248 as before, over the inner upper front contact of relay 1113, conductor 1129, second left contacts of the hundreds vertical, contact closed at cross-point 622, conductor 671, front contact of relay 1235, winding of relay 1224 to battery on conductor 975. Relays 1220 to 1224 function as previously described in response to two revertive pulses.

Relay 1220 opens the fundamental circuit to stop the final selector. Relay 1221 operates relay 1104 which locks through the winding of relay 1114 to ground at the upper back contact of relay 1115. Relay 1104 operates relay 1208

which releases relay 1209 to further open the fundamental circuit and release the counting relays. With relay 1221 released, relay 1114 operates, releasing relays 1103 and 1113. A further holding circuit for relay 1208 may be traced from the outer upper front contact of relay 1104, inner lower front contact of relay 1205, conductor 1249, second right contact of relay 308, conductor 361, lower back contact of relay 807 to ground. Therefore, the circuit for final tens selection cannot be established until the tens digit has been recorded.

When the fundamental circuit is reclosed for this selection, relay 1202 reoperates closing the counting relay circuit which extends as previously traced to conductor 1248, inner upper front contact of relay 1114, middle upper front contact of relay 1205, conductor 1250, to the left contacts of the tens vertical, contact closed at cross-point 623, conductor 672, back contact of relay 1225, winding of relay 1226 to battery on conductor 975. The first two revertive pulses operate relays 1226, 1225, 1224 and 1223. Relay 1223 extends the counting relay circuit over its front contact, conductor 670, middle lower front contact of relay 1205, conductor 1247, outermost right contact of relay 308, conductor 359, lower back contact of relay 1105, lower front contact of relay 1104, conductor 1130, second left row of contacts of the tens vertical, contact closed at cross-point 623, conductor 676, winding of relay 1234 to battery on conductor 975. The third pulse, therefore, operates relays 1234 and 1233, and locks them to ground at the inner lower contact of relay 1209. Thereupon the counting relay circuit is extended over the front contact of relay 1233 to the back contact of relay 1231 and the winding of relay 1232. In addition, the operation of relay 1234 opens the locking circuits of relays 1225 and 1226 and these relays release. The next pulse operates relays 1232 and 1231, which lock to ground at the inner upper contact of relay 1208. Relay 1232 opens the circuit of relay 1235 which releases. The next three pulses operate relays 1230 to 1225, inclusive, and since relay 1235 is released, relay 1225 extends the counting relay circuit over its front contact and the upper back contact of relay 1235 to the winding of relay 1222. The eighth revertive pulse operates relays 1220 and 1221 in the locking circuit of relay 1222, terminating the tens selection.

Relay 1221 operates relay 1105, which locks through the winding of relay 1115, inner lower front contact of relay 1105, upper back contact of relay 1116, to ground at the upper back contact of relay 1113. Relay 1105 operates relay 1207 which in turn operates relay 1208, releasing relay 1209 and the counting relays. The release of relay 1221 permits relay 1115 to operate and release relays 1104 and 1114. Relay 1207 is held operated after relay 1114 releases over the inner upper front contact of relay 1205, conductor 1251, outer left back contact of relay 308, conductor 362, outer lower back contact of relay 924, conductor 981, lower back contact of relay 809 to ground if registrations have not been completed.

It will be remembered that magnet 708 in operating operated relay 403, and that the decoder operated delay relays 934 and 935, indicating that neither five digit numbers nor stations letters were to be expected. Therefore, as soon as relay 403 operated, a circuit was closed from battery through the windings of relays 509 and 519 in series, over the upper front contact of relay 934, conductor 982, fourth left contact closed at cross-point 621, conductor 681, inner left front contact of relay 403, conductor 414, outer lower back contact of relay 921, outer upper front contact of relay 931 to grounded conductor 1244. Relays 509 and 519 lock over the outer lower front contact of relay 509 to grounded conductor 1244 and close a circuit from battery through the winding of relay 809, conductor 831, inner lower front contact of relay 509 to ground. Therefore, relay 809 operates to permit the closure of the fundamental circuit for final units selection as soon as the units digit is registered. Relay 809 also removes the ground from conductor 352 to prevent false registration in case of belated dialing or switchhook manipulation.

The counting relay circuit for final units selection extends to conductor 1248, inner upper front contact of relay 1115, outer lower front contact of relay 1205, conductor 1252, left contacts of the units vertical, contact closed at cross-point 624, conductor 673, back contact of relay 1227, winding of relay 1228 to battery. Relays 1228 to 1223 are operated under the control of the first three revertive pulses. Relay 1223 extends the counting relay circuit as traced for final tens selection to conductor 359, over the outer lower front contact of relay 1105, conductor 1131, second left contact of the units vertical closed at cross-point 624, to conductor 676. The following six pulses operate relays 1234 to 1225, and relays 1222, 1221, and 1220 as previously described.

Relay 1221, when operated, closes a circuit from grounded conductor 1244, front contact of relay 1221, inner upper back contact of relay 1210, lower back contact of relay 1204, outer lower front contact of relay 1115, conductor 973, front contact of relay 938, conductor 974, winding of relay 1106 to battery on conductor 975. Relay 1106 operates and closes a circuit for relay 1207 over its inner upper front contact, lower back contact of relay 1103 to ground at the outer upper front contact of relay 1115. Relay 1207 operates relay 1208, releasing relay 1209 and the counting relays, thereby permitting the operation of relay 1116 in the locking circuit of relay 1106, releasing relays 1105, 1115, 1207 and 1208 and reoperating relay 1209.

When relay 1208 releases and relay 1209 reoperates to reclose the fundamental circuit, the incoming selector at the terminating office transmits a single long pulse of reversed battery over the fundamental circuit to the sender. Relays 1202 and 1203 are both operated in response to the reversed battery. Relay 1203 locks over its upper front contact to grounded conductor 1244. It also extends this locking ground over the lower front contacts of relays 1116 and 1206 to the winding of relay 1204 and battery. With relay 1204 operated, the operation of relay 1202 closes a circuit from ground over the front contact of relay 1202, front contact of relay 1211, outer upper front contact of relay 1204, conductor 1126, winding of relay 1222 to battery on conductor 975. Relay 1222 locks through the windings of relays 1220 and 1221, front contact of relay 1222 to ground at the outer lower contact of relay 1209. Slightly after the closure of the circuit of relay 1222, relay 1204 closes a circuit from ground at the upper back contact of relay 1212, inner upper contact of relay 1204, conductor 1253, outer upper contact of relay 905, conductor 1243, to the windings of relays 1220, 1221 and 1222. The purpose of this circuit is to insure the operation of these relays in case the reverse

battery impulse is too short to permit relay 1222 to operate in the manner above described. It is also carried over the contact of relay 905 so as to be ineffective for calls over long trunks where relay 1202 may operate late.

At an interval following the reverse battery pulse from the incoming selector, direct battery is connected to the trunk and the selector awaits trunk closure by the district junctor. The removal of the reverse battery releases relay 1202 permitting relays 1220 and 1221 to operate. Relay 1220 opens the fundamental circuit in the sender to prevent a false trunk closure signal. Relay 1221 closes a circuit from ground on conductor 1244, front contact of relay 1221, inner upper back contact of relay 1210, lower front contact of relay 1204, conductor 1254, winding of relay 309 to battery. Relay 309 locks over its left contact to grounded conductor 353, marking the completion of the sender's function on the call.

Relay 309 at its inner right contact closes a shunt around resistance 365, thereby operating a marginal relay in the district junctor, which establishes the talking circuit and holding circuits for the line switches, district and office switches.

Relay 309 also disconnects ground at its inner right back contact from the armature of relay 310, thereby releasing relays 314, 315, 314 and 313. Relay 314 disconnects ground from conductor 114. With relay 309 operated and relay 313 released, relay 315 also releases, opening the link in the senders-busy chain, disconnecting ground from conductors 353 and 1244, thus removing the off-normal grounds and releasing the locked relays of the sender. It likewise reconnects the idle battery to the fourth lower contact of relay 311. Furthermore, it disconnects ground from conductor 350 and the lowermost contact of relay 311. The disconnection of ground from conductor 350 releases the sender link switches and so disconnects the sender from the district junctor.

Call to cross-bar office

This type of call differs from the call to a panel type office in only a few minor details since the incoming sender in a cross-bar office transmits simulated revertive pulses, which cause the subscriber's sender to function in the same manner as do the selectors of the panel office. For a call to a cross-bar office, class relays 921 and 923 are operated. Relay 905 is not operated and therefore the trunk test employs relay 1201 instead of relay 1200.

The call also differs in that trunk test may not be made until the hundreds digit has been recorded. It will be remembered that relays 1106 and 1116 are operated for trunk test. With class relays 921 and 923 operated the operation of relay 1106 closes a circuit from battery through the winding of relay 1207, inner upper front contact of relay 1106, conductor 1122, fourth right back contact of relay 308, conductor 358, middle upper front contact of relay 921, inner lower contact of relay 923, conductor 983, upper back contact of relay 1102, conductor 1127, third right back contact of relay 308, conductor 360, lower back contact of relay 806 to ground. Relay 1207 holds relay 1208 operated and the fundamental circuit open until after the hundreds digit has been recorded.

Since relay 921 is operated, a circuit is closed, when relay 931 operates on the release of the decoder, from grounded conductor 1244, outer upper front contact of relay 931, outer lower front contact of relay 921, windings of relays 513 and 503 in series to battery. With these relays operated an additional holding circuit exists for relay 1207 extending from conductor 358 over the left front contact of relay 826, which is held operated between digits, conductor 832, inner lower front contact of relay 921, outer lower front contact of relay 923, conductor 414, outer lower contact of relay 503, outer upper front contact of relay 931 to grounded conductor 1244. The trunk test circuit, therefore, cannot be established until after the first pulse of the tens digit has been received to operate relay 825 and release relay 826.

Call through tandem office

In tracing the operation of the sender in controlling the completion of a call through a tandem office, it will be assumed that the call originates at a substation equipped with a coin box, that the wanted office is reached through two distant office selectors, that the wanted office employs party line designations and five-digit numbers between 10,000 and 10,499 and that Walker 5–1078 is the number of the wanted subscriber.

The seizure of the sender results in the operation of relays 311 and 312, whereupon the frame relay and the subscriber class relay are operated. Frame relay 306 and class relay 305 may be assumed to be operated. When the tip and ring conductors are completed through the line and link switches relay 310 operates, in turn operating relays 314, 314, 313 and 315. Relay 315 is operated over conductor 336 and locks under the control of relay 313. Relay 315 releases the link control circuit, holds the link and line switches and releases relay 312, relay 311 being released by the link. The units digit of the district frame is recorded as previously described, and assuming it to be the same as before, results in the closure of cross-point 712 and the operation and locking of magnet 701 and relay 801 and the operation of relay 826.

The recording of the wanted number takes place in the manner previously described, resulting in the closure of cross-points 690, 716, 691, 717, 718, 623, 624 and 692 accompanied by the operation and locking of magnets 701 to 708 and 710 and relays 801 to 808, inclusive. Relays 405 and 403 are operated by magnets 710 and 708, respectively. The seizure of a decoder and the transfer of the recorded information also take place as previously described.

Under the conditions assumed, the decoder grounds certain conductors so that neither of the stations delay relays 934 and 935 are operated; compensating resistance relays 902, 903 and 907 may be operated, but relay 905 is not operated, being used only with calls to panel offices. Class relay 922 is used for this type of call. Relay 936 is operated but relays 937 and 938 are not operated. For controlling selections by the distant office selectors, relays 1001, 1013, 1022, 1031, 1032 and 1034 may be operated. These relays lock under the control of relay 931 with the exception of relay 907 which is further controlled by relay 1117. With class relay 922 operated, relay 924 operates over the lower front contact of relay 922 and grounded conductor 972.

Since the stations delay relays indicate that a fifth digit may be expected, but none is actually dialed, the operation of relay 809 to indicate that dialing has been completed is delayed. When relay 931 is operated by the release signal from the decoder, a circuit is closed from grounded

conductor 1244, outer upper front contact of relay 931, outer lower back contact of relay 921, conductor 414, inner right front contact of relay 403, conductor 415, outer upper back contact of relay 809, conductor 833, winding of relay 207 to battery. Relay 207 starts relays 200 and 201 to pulsing slowly to measure a three to five second interval for the reception of the possible fifth digit.

Relay 200 is a non-biased, condenser-timed polarized relay which closes its front contact when energized in one direction, closes its back contact when energized in the other direction, and leaves either contact closed when not energized. When current is first passed through the right winding in either direction, its force is neutralized by an opposing current in the left winding caused by the discharge of the timing condenser 222 and its recharge in the opposite sense. When the condenser has been discharged and recharged, current ceases to flow in the left winding and the right winding causes the armature to move over from one contact to the other. The alternate back and forth movement of the armature can be retarded as desired by selecting the proper condenser and resistances. Both ends of both windings are normally connected to battery, the inner ends in common through contact 223 of jack 212 and resistance 224. The outer end of the right winding is connected to battery by way of contact 225 of jack 212, left back contact of relay 213, and resistance 226, back contacts of relays 201 and 200, and resistance 228, while the outer end of the left winding is connected to battery by way of contact 229 of jack 212, condenser 222, right back contact of relay 213, and resistances 230 and 228. By shunting one or the other battery connection with ground, current is caused to flow through the right winding of relay 200 in one direction or the other, and in the left winding always in the opposing direction. With relay 213 normal, the presence of resistances 226 and 230 causes relay 200 to operate very slowly for timing stations delay and coin test. With relay 213 operated, relay 200 operates quickly for transmitting call indicator pulses. With relays 200 and 201 normal, resistance 227 is shunted as above traced, with either relay operated the resistance is introduced in series with the right winding of relay 200 to delay the closure of its back contact and thus to equalize the alternate pulses. The constants for the pulsing arrangement would be chosen to give an average pulse of .065 second for call indicator pulsing and .5 to .75 second for timing. Jack 212 affords a means for testing the windings of relay 200 separately.

Relay 207 in operating, connects its operating ground over its inner right front contact, to the armature of relay 200 and the left armature of relay 201, thereby connecting ground over the back contacts of these armatures in shunt of battery through resistance 228. Therefore, relay 200 closes its front contact, extending ground to the winding of relay 201. Relay 201 in operating disconnects ground from in shunt of battery through resistance 228 and connects ground over its left front contact and the inner left front contact of relay 207 in shunt of battery through resistance 224. This reversal of current flow causes relay 200 to open its front contact and close its back contact, releasing relay 201 which in turn closes its back contact and the cycle repeats. Relay 213 is not operated, and therefore pulsing continues at the slow speed.

Relay 201 at each operation completes a circuit from ground over its right contact, conductor 231, right back contact of relay 411, conductor 416, inner left back contact of relay 215, to conductor 232. This circuit extends at the first operation of relay 201 over the upper back contact of relay 516 to the winding of relay 506 and battery. Relay 506 operates, locking through the winding of relay 516, inner lower contact of relay 506, conductor 520, right back contact of relay 825, conductor 352, middle right front contact of relay 313, connector 828, inner upper back contact of relay 809 to ground. Relay 516 remains unoperated, being shunted by the operating ground for relay 506 until relay 201 releases. At the second operation of relay 201, relay 507 operates, locking through the winding of relay 517 and the inner lower contacts of relays 507 and 506 to ground as traced over conductor 520. Relay 517 operates on the subsequent release of relay 201. Similarly the third cycle of operations by relays 200 and 201 operates and locks relays 508 and 518.

With relay 518 operated, the operating circuit is extended from conductor 232 over the front contacts of relays 516, 517 and 518, conductor 521, right back contact of relay 108, conductor 116, upper back contact of relay 519, winding of relay 509 to battery. Relay 509 operates in response to the next timing impulse and locks through the winding of relay 519, outer lower front contact of relay 509 to grounded conductor 1244, and at the end of the impulse relay 519 operates. Relay 509 in operating closes a circuit from battery through the winding of relay 809, conductor 831, inner lower front contact of relay 509, which closes shortly after the locking contact closes, to ground. Relay 809 opens the locking circuit for relays 506 to 508 and 516 to 518 permitting these relays to release. Relay 809 also opens the circuit of relay 207 which releases, removing ground from the armatures of relays 200 and 201 and stopping the timing pulses.

If relay 934 had been operated and relay 935 unoperated, indicating that five digit numbers might be expected, but no stations letters were used, relays 509 and 519 would have been operated as soon as the units digit was received, since the closure of cross-point 623 (or any one of the cross-points in the fifth to ninth levels of the tens vertical) completes a circuit from battery through the windings of relays 509 and 519 in series, upper front contact of relay 934, conductor 982, cross-points 623, 718 and 717, conductor 681, inner left front contact of relay 403, conductor 414, outer lower back contact of relay 921, outer upper front contact of relay 931 to grounded conductor 1244.

It will be remembered that it was assumed that the calling substation was one provided with a prepayment coin box which was indicated by the operation of relay 305. With relay 305 operated a circuit is closed from battery through the winding of relay 111, conductor 117, outer right contact of relay 305, conductor 364, inner left back contact of relay 102, to ground at the right back contact of relay 105. Relay 111 connects ground over its right contact to conductor 981 in parallel with the back contact of relay 809 to hold relay 1207 operated and prevent the closure of the trunk test circuit until the coin test has been satisfied. Relay 111 also opens the circuit previously traced for operating relay 105 when the decoder releases.

When relay 809 operates to indicate that dial-

ing has been completed and the line free for coin test, since relay 105 is unoperated, a circuit is closed from ground at the lower front contact of relay 809, conductor 834, left contact of relay 105, through the winding of relay 107 to battery. The contacts of relay 107 are so arranged that it first connects ground through resistance 118 to conductor 115 at its left make-before-break contact to provide a holding circuit for line relay 310, then disconnects relay 310 and ground from the subscriber's line, and then closes ground over its right and inner left following contacts to the winding of relay 108, operating that relay. Relay 108 connects the tip conductor of the subscriber's line over conductor 112, left normal contact of relay 104, inner left contact of relay 108, middle winding of relay 103, right back contact of relay 102, through the right winding of relay 106 to ground through resistance 119. It also connects the ring conductor over conductor 113, right normal contact of relay 109, inner right front contact of relay 108, right winding of relay 103, outer left back contact of relay 102, left winding of relay 106, resistance 120, middle right front contact of relay 108, to the coin collect battery. If the resistance to ground at the substation is sufficiently low, relay 106 operates, locking in a circuit from the coin collect battery through its left winding as traced over its left front contact, inner right back contact of relay 104, to ground at the right back contact of relay 105.

The line is then tested to see whether the ground detected by relay 106 is or is not a direct ground applied for the purpose of obtaining a free call. Relay 106 closes a circuit from battery over its right contact through the winding of relay 102 to ground at the right back contact of relay 105. Relay 102 disconnects the line conductors from relay 106 and extends the tip conductor 112 over its outer right front contact to the left winding of relay 101, and ground at the right back contact of relay 105. It also extends the ring conductor 113 over its inner right contact through the right winding of relay 101 to the middle right front contact of relay 108 and the coin collect battery. If the ground at the substation is the high resistance one due to a coin in the box, relay 101 will not get enough current to operate, but it does operate if a direct ground is present. Relay 102 opens the operating circuit of relay 111 which releases, in turn releasing relay 1207 and closing a circuit from battery through the right winding of relay 105, back contact of relay 111, conductor 972, to ground at the inner lower front contact of relay 931. Relay 105 locks over its right front contact to grounded conductor 972, at its right back contact releases relays 102 and 106 and at its left contact opens the circuit of relay 107 which releases in turn releasing relay 108.

The operation of relay 105 indicates the complete satisfaction of the coin test and sender functions may now proceed. The operation of the coin test circuits under unstandard conditions will be described hereinafter.

During the coin test, at which time relay 310 which controls the release of the sender is held operated in the local circuit above traced, the release of the sender is maintained under control of the switchhook by the use of relay 103. This relay is polarized by a circuit from coin collect battery, middle right front contact of relay 108, resistance 121, left winding of relay 103 to ground through resistance 119. With the receiver off the switchhook, relay 103 operates in any of the coin test circuits above traced. If the receiver is restored to the switchhook, relay 103 releases connecting battery through resistance 122 over the back contact of relay 103 and the second left contact of relay 108 to conductor 115 in shunt of ground through resistance 118, thereby releasing relay 310 to cause the release of the sender as will be described hereinafter.

In the meantime, office selections may be in progress under the control of the office registrations set up in the sender by the decoder. When the decoder operated relay 301, since the skip office relay 937 had not been operated, a circuit was closed from ground at the middle right front contact of relay 301, conductor 356, back contact of relay 937, conductor 984, winding of relay 1103 to battery over conductor 975. Relay 1103 locks in a circuit through its winding and the winding of relay 1113, inner upper contact of relay 1103, to ground at the upper back contact of relay 1114. Relay 1113 remains unoperated, being shunted by the operating circuit of relay 1103 until the decoder releases relay 301 as a signal that the connection with the first distant office selector has been established.

With relay 1113 operated, the fundamental circuit extends from conductor 328, left back contact of relay 301, conductor 357, lower back contact of relay 1208, upper front contact of relay 1209, conductor 1240, outer upper contact of relay 1103, conductor 976, outer upper back contact of relay 1206, winding of relay 1201, shunted by resistance 1260 and condenser 1262, conductor 1255, back contact of relay 905, conductor 977, right back contact of relay 215, conductor 219, resistance 978, conductor 985, inner lower front contact of relay 1113, conductor 1132, upper back contact of relay 906, upper front contact of relay 902, resistance 908, upper back contact of relay 901, resistance 912, upper front contact of relay 907, conductor 980, right back contact of relay 301 to conductor 329.

If the outgoing trunk and office selector are normal, relay 1201 operates, closing a circuit from ground over its contact, conductor 1256 through the winding of relay 208 to battery. Relay 208 closes a circuit from battery through the winding of relay 209, contact of relay 208 to ground at the left back contact of relay 309. Relay 209 closes a holding circuit for relay 208 over the left front contact of relay 209, outer left back contact of relay 215, conductor 220 to ground at the inner lower contact of relay 1209 which operates as previously described when the decoder is released. Relay 209 also closes a circuit from battery on conductor 975, winding of relay 1222, windings of relays 1221 and 1220 in parallel, conductor 1243, lower back contact of relay 1106, conductor 1123, inner right front contact of relay 209, conductor 221, back contact of relay 1203, to grounded conductor 1244. Relays 1220, 1221 and 1222 lock over the front contact of relay 1222 to ground at the outer lower contact of relay 1209. Relay 1221 closes a circuit from ground on conductor 1244, contact of relay 1221, inner upper back contact of relay 1210, back contact of relay 1204, lower back contacts of relays 1115 and 1114, outer lower front contact of relay 1113, winding of relay 1104 to battery over conductor 975. Relay 1104 locks through the winding of relay 1114, inner upper contact of relay 1104, to ground at the upper back contact of relay 1115,

but relay 1114 does not operate, being shunted by the operating circuit of relay 1104.

Relay 1104 closes a circuit from battery through the winding of relay 1208, outer upper contact of relay 1104 to ground at the outer upper front contact of relay 1113. Relay 1208 releases relay 1209 and both relays open the fundamental circuit releasing relay 1201. Relay 1209 also opens the locking circuit for relay 208 which in turn releases relay 209 and the locking circuit for relays 1220, 1221 and 1222. The release of relay 1221 permits relay 1114 to operate and prepare the sender for first office brush selection. Relay 1114 opens the locking circuit of relays 1103 and 1113 which release, in turn releasing relay 1208 which permits relay 1209 to reoperate and reestablish the fundamental circuit.

The fundamental circuit for first office brush and group selections extends as previously traced to conductor 1240, through the lower winding of relay 1203, winding of relay 1202, back contact of relay 1220, outer upper back contact of relay 1205, inner lower front contact of relay 1114, or for the subsequent selection over the similar contact of relay 1115, to conductor 1132 and thence, as traced, for the first office test. Relay 1202 operates, closing a counting relay circuit under the control of first office brush register 1020 which may be traced from ground at its contact, front contact of relay 1211 which was operated as previously described, back contacts of relays 1233 and 1223, conductor 1248, inner upper front contact of relay 1114, inner upper back contact of relay 1205, conductor 1257, inner upper back contact of relay 1107, back contact of relay 1023, upper front contact of relay 1022, lower back contact of relay 1021, conductor 672, back contact of relay 1225, winding of relay 1226, to battery over conductor 975. In the manner previously described, the first two revertive pulses cause the operation of relays 1226, 1225, 1224 and 1223. With relay 1223 operated, the counting relay circuit is extended from the back contact of relay 1233 over the front contact of relay 1223, conductor 670, inner lower back contact of relay 1205, upper back contact of relay 1105, conductor 1126 to the winding of relay 1222. The third revertive pulse, therefore, results in the operation and locking of relays 1220, 1221, and 1222 and the termination of the selection. Since relay 1114 is operated, relay 1221 operates relay 1105 which locks through the winding of relay 1115. Relay 1105 operates relay 1207 which in turn operates relay 1208, releasing relay 1209, after which the counting relays release, permitting relay 1115 to operate, release relays 1104 and 1114, 1207 and 1208 and reestablish the fundamental circuit.

For first office group selection, the counting relay circuit is under the control of register 1030 and extends as previously traced to conductor 1248, over the inner upper front contact of relay 1115, outer lower back contact of relay 1205, conductor 1258, lower back contact of relay 1117, back contact of relay 1033, upper front contact of relay 1032, outer lower front contact of relay 1031, conductor 673, back contact of relay 1227, winding of relay 1228 to battery over conductor 975. Three revertive pulses operate relays 1228, 1227, 1226, 1225, 1224 and 1223 in succession, relays 1225 to 1228 locking under the control of relay 1234 and relays 1223 and 1224 to a contact of relay 1209. With relay 1223 operated, the counting relay circuit is extended as above to conductor 670 and thence over the inner lower back contact of relay 1205, outer upper front contact of relay 1105, outer upper back contact of relay 1107, upper front contact of relay 1034, conductor 676, winding of relay 1234 to battery on conductor 975. The next or fourth revertive pulse operates relay 1234 which locks through the winding of relay 1233 to ground at the inner lower front contact of relay 1209. Relay 1234 opens the locking circuit of relays 1225 to 1228 and these relays release. Relay 1233, which operates at the end of the pulse, transfers the counting relay circuit from the armature of relay 1223 to the armature of relay 1231 and the next four pulses operate relays 1232 to 1225 in turn. Relays 1231 and 1232 lock to the inner upper back contact of relays 1208 and relay 1232 releases relay 1235. Relays 1230 to 1225 lock over the back contact of relay 1235 to ground on conductor 220. With relay 1235 released, the operation of relay 1225 extends the counting relay circuit to relay 1222 to terminate the selection after the reception of the ninth revertive pulse.

Since relay 938 is not operated, indicating that second office selections are to be made, the operation of relay 1221 in the locking circuit of relay 1222 completes a circuit which extends as previously traced to the outer lower armature of relay 1115, over the front contact of that armature, conductor 973, back contact of relay 938, conductor 986, winding of relay 1107 to battery over conductor 975. Relay 1107 closes a locking circuit through the winding of relay 1117 to ground at inner lower front contact of relay 1107 and at its outer lower front contact connects ground over the outer upper back contact of relay 1117 to the winding of relay 1103. Relay 1103 operates and closes the previously traced locking circuit through the winding of relay 1113.

Relay 1103 closes a circuit from battery through the winding of relay 1207, lower front contact of relay 1103 to ground at the outer upper front contact of relay 1115. Relay 1207 operates relay 1208 and releases relay 1209 to further open the fundamental circuit which was first opened by relay 1220. Relay 1209 releases the counting relays permitting relays 1117 and 1113 to operate. Relay 1113 opens the locking circuit for relays 1105 and 1115 and they release. Relay 1115 releases relays 1207 and 1208 in turn operating relay 1209 and reestablishing the fundamental circuit for the second office test. Relay 1117 closes a circuit from battery through the lower winding of relay 938, inner upper front contact of relay 1117 to grounded conductor 972. At the same time, relay 1117 opens the locking circuit of relays 906 and 907 and they release.

The second office test takes place in the same manner as the first office test above described except that, since relay 907 is released, resistance 912 is not included in the fundamental circuit. As the result of this test relays 1104 and 1114 operate.

Second office brush selection takes place with relays 1104 and 1114 operated and differs from the first office brush selection only in that the counting relay circuit extends from conductor 1257 over the inner upper front contact of relay 1107 to register 1000 and thereover the back contacts of relays 1003 and 1002, upper front contact of relay 1001, conductor 671, front contact of relay 1235 to the winding of relay 1224. Therefore, two pulses satisfy the condition set up on register 1000. Relays 1105 and 1115 then operate in the manner previously described.

Similarly, second office group selection takes place with relays 1105 and 1115 operated, with

the counting relay circuit extending from conductor 1258 over the lower front contact of relay 1117 to register 1010 and thereover the upper front contact of relay 1013 to conductor 674, back contact of relay 1229 to the winding of relay 1230. For this selection, when relay 1223 operates in response to the fourth revertive pulse, the counting relay circuit is extended over conductor 676 and the inner lower back contact of relay 1205 as before, and thence over the outer upper front contact of relay 1105, outer upper front contact of relay 1107, back contact of relay 1014 to conductor 1126 and the winding of relay 1222 to complete the selection.

Since relay 938 has now been operated, the operation of relay 1221 closes a circuit from ground on conductor 1244 to the outer lower armature of relay 1115 as previously traced and thence over the front contact of that armature, conductor 973, upper front contact of relay 936, conductor 974, winding of relay 1106 to battery over conductor 975. Relay 1106 locks through the winding of relay 1116, outer lower front contact of relay 1106 to ground at the upper back contact of relay 1111. Relay 1106 closes a circuit from battery through the winding of relay 1207, inner upper front contact of relay 1106 to conductor 1122 which receives ground over the back contact of relay 1103 and the outer upper front contact of relay 1115. Relay 1207 functions in the usual manner releasing the counting relays and permitting relay 1116 to operate. Relay 1116 releases relays 1105 and 1115 removing ground at this point from conductor 1122. If at this time dialing has been completed as evidenced by the operation of relay 809 and the coin test above described has been satisfied as indicated by the operation of relay 105, the auxiliary grounds supplied by these relays are removed and relay 1207 may release to permit the closure of the fundamental circuit for trunk test.

The fundamental circuit for trunk test in the case of a call indicator call extends as previously traced from conductor 328 to conductor 1240, through the lower winding of relay 1203, inner upper back contact of relay 1206, winding of relay 1201, conductor 1255, back contact of relay 905, conductor 977, right back contact of relay 215, conductor 219, outer upper front contact of relay 924, conductor 979, inner upper front contact of relay 1116, conductor 1121, back contact of relay 904, resistance 910, front contact of relay 903, conductor 980 and back to conductor 329. Since relay 1106 is operated, the shunt through resistance 1246, closed around the winding of relay 1203 during selections, is opened. Relay 1201 operates from battery and ground at the tandem office, in turn operating relays 208 and 209 which lock under the control of relay 1209.

When relay 403 operated under the control of magnet 708 in response to the registration of the units digit, a circuit was closed from battery through the winding of relay 401, back contact of 402, conductor 417, back contact of relay 116, conductor 123, outer left front contact of relay 403, left front contact of relay 405, back contacts of timing relays 406, 407, 408 and 409 to grounded conductor 353. Relay 401 closes a locking circuit for itself which extends over the operating circuit to conductor 123 and thence over the outer right contact of relay 401 directly to grounded conductor 353. Therefore, when relay 209 operates, it closes a circuit from battery through the winding of relay 213, conductor 233, left front contact of relay 401, conductor 418, outer upper front contact of relay 922, inner lower front contact of relay 924, conductor 987, inner lower front contact of relay 1106, conductor 1123, inner right front contact of relay 209, conductor 221, back contact of relay 1203 to grounded conductor 1244. Relay 213 closes a locking circuit for itself extending over conductor 233, left contact of relay 401, conductor 418, inner left front contact of relay 213 to ground at the left back contact of relay 309. Relay 213 removes resistances 226 and 230 from the circuits of relay 200 preparing it to operate at its fast rate. Relay 213 also closes an obvious circuit for relay 214 which in turn operates relay 215. Relay 215 opens the locking circuit for relays 208 and 209 but these relays remain operated under the control of relay 1201. Relay 215 also opens the fundamental circuit as above traced but, as soon as relay 214 operated, a substitute circuit was closed extending from conductor 977 over the outer right front contact of relay 209, inner left front contact of relay 214 to conductor 1121, holding relay 1201 operated under the control of the distant tandem selector. Relay 215 also closes a shunt around the winding of relay 1203 which may be traced from the inner upper back contact of relay 1206 over the outer upper back contact of that relay, conductor 976, right front contact of relay 215, conductor 1120, outer upper front contact of relay 1106 to conductor 1240 so that relay 1203 may not respond to false pulses of current. To prevent the release of relay 209 and the start of pulsing before the proper condition has been established, a holding circuit is provided for relay 208 over the left front contact of relay 209, left back contacts of relays 207 and 202, outer left front contact of relay 214 to grounded conductor 220.

Relay 214, in operating, connected ground over its inner right contact to the armatures of relays 200 and 201 and over its middle right contact and the right back contact of relay 207 in shunt of battery through resistance 228. This connection operates relay 200 to close its front contact, operating relay 201. Since relay 207 is not operated at this time, the operation of relay 201 is ineffective to release relay 200 and relays 208 and 201 remain operated ready to start pulsing. Since relay 215 is operated, the circuit closed at the right contact of relay 201 extends from ground at that contact, conductor 231, right back contact of relay 411, conductor 416, left front contact of relay 215, left normal contact of relay 202, winding of relay 202 to battery through resistance 237. The circuit also extends to the winding of relay 203 but this winding is shunted over its back contact so that relay 202 operates alone, locking over its alternate contact to ground at the inner right contact of relay 214. With relay 200 operated and either relay 210 or 203 non-operated, a circuit is closed from ground over the front contact of relay 200, outer right back contact of either relay 210 or 203 through the winding of relay 211 to battery.

When the distant tandem selector and sender are ready to receive the wanted number, battery and ground are removed from the fundamental circuit and a dry bridge through the usual set of receiving relays is substituted therefor. Relay 1201 releases, in turn releasing relays 208 and 209. With relay 214 operated and relay 209 released, the fundamental tip conductor is extended from conductor 328, left back contact of relay 301, conductor 357, middle left contact of relay 214, inner left back contact of relay 209, left

back contact of relay 210 to conductor 235. The fundamental ring conductor extends from conductor 329, right back contact of relay 301, conductor 980, upper front contact of relay 903, resistance 910, back contact of relay 904, conductor 1121, inner left contact of relay 214, right back contact of relay 209, inner right back contact of relay 210 to conductor 236.

The release of relay 209 also closes a circuit from ground at the inner right contact of relay 214, outer left back contact of relay 209 to the winding of relay 207 and battery. Relay 207 locks to the inner right contact of relay 214. Relay 207 removes the shunt from battery through resistance 228 and connects the left front contact of relay 201 over the inner left contact of relay 207 in shunt of resistance 224, thereby starting relays 200 and 201 to pulsing as previously described. Relay 200 opens its front contact, releasing relay 201 which opens the shunt around the winding of relay 203 and that relay operates. When relay 201 next closes its right contact, it connects ground over the left front contact of relay 203 to resistance 237 in shunt of the winding of relay 202. Relay 202 releases but relay 203 is held operated over the make-before-break contact of relay 202 first to the locking ground of relay 202 and then to ground at the contact of relay 201. When relay 201 releases, relay 203 also releases. Relays 202 and 203 repeat this cycle of operations under the control of relay 201 until the designation has been completely transmitted. Each complete cycle generates four pulses to transmit one digit, as follows:

Pulse	Relay 201	Relay 202	Relay 203
1	Operated	Operated	Released
2	Released	Operated	Operated
3	Operated	Released	Operated
4	Released	Released	Released

Relay 211 operates in parallel with relay 201, being operated for the odd pulses and released for the even pulses. At each operation, relay 211 closes a circuit from battery through the winding of relay 206, left contact of relay 211, outer right contact of relay 207 to ground at the middle right contact of relay 214. Relay 211 serves to alternately connect ground to the fundamental ring conductor for the odd pulses and to the fundamental tip conductor for the even pulses. During the odd pulses, the connection of the fundamental tip conductor to the armature of relay 217 becomes effective to supply either momentary ground from the back contact of relay 206 or battery under the control of the dial register to that conductor. During the even pulses, the connection of the fundamental ring conductor to battery through high resistance 234 becomes effective by the removal of the shunting ground at the contact of relay 211. An additional connection to battery through low resistance 239 is supplied by the operation of relay 216 under the control of the dial register according to the code to be transmitted.

In general, relay 217 is operated in a circuit from battery through its winding, inner right front contact of relay 313 to the inner right armature of relay 203. With this relay released either before pulsing or in the fourth pulse period, the circuit extends over conductor 240 to contacts in the No. 1 and No. 6 levels of the dial register to operate relay 217 in readiness to send out a positive pulse in the first pulse period as called for by the code for these digits. With relay 203 operated in the second pulse period, the circuit extends over conductor 241 to contacts in the No. 4 level to operate relay 217 in readiness to send out a positive pulse in the third pulse period. Similarly, the circuit for relay 216 extends over the outer right front contact of relay 313 to the right armature of relay 202. Relay 202 being operated in the first pulse period, the circuit of relay 216 is extended over conductor 242 to contacts in the No. 2 and No. 7 levels to prepare for sending a heavy negative pulse in the second pulse period. When relay 202 releases in the third pulse period, the circuit of relay 216 extends over conductor 243 to contacts in the No. 5, No. 6, No. 7, and No. 8 levels.

To save contacts on the dial register, when a heavy negative pulse follows a positive pulse directly as in the codes for the digits three, eight and nine, relay 204 is operated over conductor 245 and contacts of levels No. 3 and No. 8 and relay 205 is operated over conductor 244 and contacts of level No. 9 to supply the circuits for operating relays 216 and 217.

It may be noted that conductors 240 to 243 also extend to contacts in levels other than those mentioned above. These contacts occur in the thousands and stations vertical which are cross-connected according to a different code arrangement as will appear from the following table, in which "*n*" represents a light negative pulse, "N" a heavy negative pulse, "*p*" a positive pulse, and "—" a blank pulse:

Regular digit	Thousands digit	Stations digit	Code
0	0	0	—n—n
1	2	1	pn—n
2	4	W(9)	—N—n
3	6	R(7)	pN—n
4	8	J(5)	—npn
5	1	M(6)	—n—N
6	3	----------	pn—N
7	5	----------	—N—N
8	7	----------	pN—N
9	9	----------	—npN

Since the first digit to be transmitted is 9, corresponding to the code letter W, no circuit is provided for operating relay 217 for the first pulse period and with relay 211 operated for that period, the fundamental ring conductor is connected to ground over the front contact of relay 211 while the tip conductor extends over the back contact of relay 217 to ground at the back contact of relay 206 until that relay operates, thereby discharging the cable conductors at the beginning of a blank pulse.

Since during the first pulse period no circuit is provided for relay 216, during the second pulse period the fundamental ring conductor extends to battery through high resistance 234 and the fundamental tip conductor extends to ground at the normal contact of relay 211, transmitting a light negative pulse to the tandem office.

When relay 214 operated, it closed a circuit from ground at its outer right contact, conductor 522, lower back contacts of relays 513 and 511, cross-point 692, conductor 244, winding of relay 205 to battery. Relay 205 operates connecting ground to conductors 241 and 243. Therefore, when relay 203 operates for the second pulse period, relay 217 operates, connecting battery through high resistance 246 to conductor 235. Since relay 211 is not operated during the second

pulse period, this battery is shunted by ground at the normal contact of relay 211 and is, therefore, ineffective at this time.

For the third pulse period, relay 211 reoperates, grounding the fundamental ring conductor, shunting the battery through resistance 234, permitting the connection of battery to the fundamental tip conductor to become effective and transmitting a positive pulse to the tandem office. During this period relay 202 releases, connecting the winding of relay 216 to conductor 243 which is grounded by relay 205. Relay 216 connects battery through low resistance 239 in parallel with battery through resistance 234 to conductor 236. Since relay 211 is operated, this battery is shunted by ground at the front contact of that relay and is ineffective. When relay 202 releases for this period, it closes a circuit from battery through the winding of relay 501, upper back contact of relay 511, upper back contact of relay 513, conductor 523, outer left front contact of relay 207, back contact of relay 202, outer left front contact of relay 214 to grounded conductor 220. Relay 501 operates and locks in a circuit through its winding and the winding of relay 511 in series, inner lower front contact of relay 501, inner lower front contact of relay 509 to ground. Relay 511 does not operate at this time being shunted by the operating circuit of relay 501. Relay 501, in operating, disconnects conductor 522 from the auxiliary A vertical of the dial register and connects it over the upper front contact of relay 501 and the upper back contact of relay 502 to the B vertical, preparing the circuits for relays 204, 216 and 217 for the first two pulse periods of the next digit.

At the fourth pulse period, relay 211 is again released, grounding the tip conductor and the battery through resistances 234 and 239 in parallel becomes effective to transmit a heavy negative pulse to the tandem office. During this period the pulse for the first period of the second digit is prepared, and at the end of the period relay 202 is reoperated to permit relay 511 to operate in the locking circuit of relay 501 and transfer the connection of conductor 522 under its control from the auxiliary A vertical to the back contact of relay 512 and the B vertical, preparing the circuits which control the third and fourth pulse periods of the second digit.

Since the second digit to be transmitted is 2 corresponding to the code letter A, no circuit is provided for operating relay 217 for the first pulse series and with relay 211 operated for that period the fundamental ring conductor is connected to ground over the front contact of relay 211, while the tip conductor extends over the back contact of relay 217 to ground at the back contact of relay 206 until that relay operates thereby discharging the cable conductors at the beginning of a blank pulse. During the first pulse period a circuit is established for relay 216 extending over the front contact of relay 202, conductor 242, the fifth contact at cross-point 716, upper back contact of relay 502, upper front contact of relay 501, upper back contact of relay 503, then to ground on conductor 522, and thus during the second pulse period the fundamental ring conductor extends to battery in parallel through high resistance 234 and low resistance 239 and the fundamental tip conductor extends to ground at the normal contact of relay 211, transmitting a heavy negative pulse. During the second pulse period there is no circuit provided for relay 217 and thus during the third pulse period when relay 211 operates, the fundamental ring conductor is grounded at its contacts in shunt of battery through resistance 234 and the fundamental tip conductor is connected to ground over the back contact of relay 217 and the back contact of relay 206 until that relay operates, thereby discharging the cable conductors at the beginning of the blank pulse.

During this period, relay 202 releases and establishes a circuit from ground over its left back contact, thence as traced to conductor 523 over the upper back contact of relay 513, the upper front contact of relay 511, the upper back contact of relay 512 through the winding of relay 502 to battery. Relay 502 operates and locks through the winding of relay 512, inner lower front contact of relay 502, lower front contact of relay 501 to ground, relay 512 not operating at this time as it is shunted by the operating circuit of relay 502. Relay 502 in operating disconnects conductor 522 from the B vertical of the dial register and connects it over the upper back contact of relay 503 and the upper front contacts of relays 501 and 502 to a C vertical, preparing the circuits which control the first and second pulse periods of the third digit.

At the fourth pulse period relay 211 is again released grounding the tip conductor and, since no circuit was made effective over the cross-point 716 for relay 216, the ring conductor is connected to battery through high resistance 234 to transmit a light negative pulse. At the end of the fourth pulse period relay 202 is reoperated thus permitting relay 512 to operate and transfer the connection of conductor 522 from a B vertical to a C vertical over the lower back contact of relay 513 and the lower front contacts of relays 511 and 512, preparing the circuits which control the third and fourth pulse periods of the third digit.

The third digit to be transmitted is 5 and since no circuit is effective over cross-point 691 for relay 217 for the first pulse period, both the tip and ring conductors of the fundamental circuit are grounded as previously described resulting in a blank pulse. Since, during the first pulse period, there is no circuit effective for relay 216 over cross-point 691 when relay 202 operates, relay 211 upon releasing during the second pulse period connects ground to the fundamental tip conductor and since the ring conductor is connected to battery through high resistance 234 a light negative impulse is transmitted. During the second pulse period, no circuit is effective over cross-point 691 for relay 217 and thus during the third period when relay 211 operates, the fundamental ring conductor is grounded at its contact in shunt of battery through resistance 234 and the tip conductor is connected to ground over the back contact of relay 217 and the back contact of relay 206 until that relay operates whereby the third pulse is blank.

During this period relay 202 releases and connects ground over its back contact to conductor 523 and thence over the upper back contact of relay 513, the upper front contacts of relays 511 and 512, through the winding of relay 503 to battery. Relay 503 operates and locks through the winding of relay 513, inner lower front contact of relay 503 and the lower front contact of relay 512 to ground, relay 513 not operating at this time as it is shunted by the operating circuit of relay 503. Relay 503 in operating disconnects conductor 522 from the C vertical of the dial register and, since the numerical designation is

less than ten thousand and relays 504 and 514 have not been previously operated, connects conductor 522 over the upper front contact of relay 503, the upper back contact of relay 504 to a stations vertical of the dial register, preparing the circuits which control the first and second pulse periods of the fourth or stations digit.

During the third pulse period with relay 202 released, a circuit is established from the winding of relay 216, thence as traced over the back contact of relay 202, conductor 243, the sixth contact of cross-point 691, thence over the lower front contacts of relays 512 and 511, the lower back contact of relay 513 to ground on conductor 522. Relay 216 operates connecting battery through low resistance 239 in parallel with battery through high resistance 234. Therefore, during the fourth pulse period when relay 211 releases, ground is connected over its normal contact to the tip conductor of the fundamental circuit and battery through resistances 234 and 239 being connected to the ring conductor, a heavy negative impulse is transmitted. At the end of the fourth pulse period relay 202 is reoperated thus permitting relay 513 to operate and transfer the connection of conductor 522 from a C vertical of the dial register to a stations vertical, over the lower front contact of relay 513 and the lower back contact of relay 514, preparing the circuits which control the third and fourth pulse periods of the fourth or stations digit.

Since no stations digit was recorded, no cross-point on the stations verticals was closed and therefore no circuits are effective for relays 204, 205, 216 and 217 during the next four pulse periods and only two light negative impulses, characteristic of the digit zero are transmitted. During the third of these pulse periods with relay 202 released, ground is connected to conductor 523 and thence over the upper front contact of relay 513 and the upper back contact of relay 514 to battery through the winding of relay 504. Relay 504 operates and locks in a circuit through the winding of relay 514, inner lower contact of relay 504 to ground on conductor 1244 and disconnects conductor 522 from a stations vertical of the dial register and connects it over the upper front contacts of relays 503 and 504 and the upper back contact of relay 505 to a thousands vertical of the dial register. At the end of the fourth pulse period relay 202 reoperates thus permitting relay 514 to operate in the locking circuit of relay 504. Relay 514 upon operating disconnects conductor 522 from a stations vertical of the dial register and connects it over the lower front contacts of relays 513 and 514 and the lower back contact of relay 515 to a thousands vertical. The circuits are now prepared which control the pulse periods of the fifth or thousands digit.

The fifth digit to be transmitted is the thousands digit 1 and since no circuit was made effective over cross-point 717 for relay 217 when relay 203 released during the previous fourth pulse period, both the tip and ring conductors are grounded during the first period through the operation of relay 211 as previously described resulting in a blank pulse. Since during the first pulse period there is no circuit effective for relay 216 over cross-point 717 when relay 202 operates, relay 211 upon releasing during the second pulse period connects ground to the fundamental tip conductor and since the ring conductor is connected to battery through high resistance 234 a light negative impulse is transmitted. During the second pulse period no circuit is effective over cross-point 717 for relay 217 and thus during the third pulse period when relay 211 operates both the tip and ring conductors are grounded resulting in a blank pulse.

During the third pulse period relay 202 releases and connects ground over conductor 523, thence over the upper front contact of relays 513 and 514 and the upper back contact of relay 515 to battery through the winding of relay 505. Relay 505 operates and locks in a circuit through the winding of relay 515, the inner lower front contact of relay 505 and the lower front contact of relay 504 to ground and disconnects conductor 522 from a thousands vertical of the dial register and connects it over the upper front contacts of relays 503, 504 and 505 and the upper back contact of relay 506 to a hundreds vertical of the dial register, preparing the circuits which control the first and second pulse periods of the sixth or hundreds digit. Relay 202 upon releasing also establishes a circuit from the winding of relay 216, thence as traced over the back contact of relay 202, conductor 243, the upper front contact of relay 509, conductor 526, sixth contact on cross-point 717, thence over the lower back contact of relay 515, the lower front contacts of relays 514 and 513 to ground on conductor 522. Relay 216 operates connecting battery through low resistance 239 in parallel with battery through high resistance 234. Therefore, during the fourth pulse period when relay 211 releases, ground is connected over its normal contact to the tip fundamental conductor and battery being connected through resistances 234 and 239 to the ring conductor, a heavy negative impulse is transmitted.

At the end of the fourth pulse period relay 202 is reoperated thus permitting relay 515 to operate in the locking circuit of relay 505 and transfer the connection of conductor 522 from a thousands vertical of the dial register to a hundreds vertical over the lower front contacts of relays 513 to 515, inclusive and the lower back contact of relay 516, preparing the circuits which control the third and fourth pulse periods of the sixth or hundreds digit.

Since the hundreds digit registered was the digit zero and the cross-point contacts 718 are operated, there are no circuits effective for the relays 204, 205, 216 and 217 during the next four pulse periods and only two light negative impulses characteristic of the digit zero are transmitted. During the third of these pulse periods with relay 202 released, ground is connected to conductor 523, thence over the upper front contacts of relays 513 to 515, inclusive, the upper back contact of relay 516 to battery through the winding of relay 506. Relay 506 operates and locks in a circuit through the winding of relay 516, the inner lower contact of relay 506, and the lower contact of relay 505 to ground and disconnects conductor 522 from a hundreds vertical of the digit register and connects it over the upper front contact of relays 503 to 506, inclusive, and the upper back contact of relay 507 to a tens vertical of the digit register. At the end of the fourth pulse period, relay 202 reoperates thus permitting relay 516 to operate in the locking circuit of relay 506. Relay 516 upon operating disconnects conductor 522 from a hundreds vertical of the digit register and connects it over the lower front contacts of relays 513 to 516 inclusive, and the lower back contact of relay 517 to a tens vertical of the dial register. The circuits are now prepared which

control the pulse periods of the seventh or tens digit.

The seventh digit to be transmitted is the tens digit 7 and since no circuit was made effective over cross-point 623 for relay 217 when relay 203 released during the previous fourth pulse period, both the tip and ring fundamental conductors are grounded, during the first period through the operation of relay 211 as previously described resulting in a blank pulse. During the first pulse period a circuit is established by the operation of relay 202 for relay 216 which extends from battery through the winding of relay 216 thence as traced over the front contacts of relay 202 to conductor 242, the fourth contact at cross-point 623, the upper back contact of relay 507, the upper front contacts of relays 506, 505, 504 and 503 to ground on conductor 522. With relay 216 operated, battery through low resistance 239 is connected to the ring conductor of the fundamental circuit in parallel with battery through high resistance 234 and thus during the second pulse period this parallel battery connection is maintained and relay 211 upon releasing connects ground to the tip fundamental conductor resulting in the transmission of a heavy negative pulse. During the second pulse period no circuit is effective over cross-point 623 for relay 217 and during the third pulse period when relay 211 operates both the tip and ring conductors of the fundamental circuit are grounded resulting in a blank pulse.

During the third pulse period relay 202 releases and connects ground over conductor 523 thence over the upper front contacts of relays 513 to 516, inclusive, the upper back contact of relay 517 to battery through the winding of relay 507. Relay 507 operates and locks in a circuit through the winding of relay 517, the inner lower contact of relay 507 and the lower contact of relay 506 to ground and disconnects conductor 522 from a tens vertical of the digit register and connects it over the upper front contacts of relays 503 to 507, inclusive, and the upper back contact of relay 508 to a units vertical thus preparing the circuits which control the first and second pulse periods of the eighth or units digit. Relay 202 upon releasing also establishes a circuit from the winding of relay 216 thence as traced over the back contact of relay 202, conductor 243, the fifth contact at cross-point 623, thence over the lower back contact of relay 517 and the lower front contacts of relays 516, 515, 514 and 513 to ground on conductor 522. Relay 216 operates connecting battery through low resistance 239 in parallel with battery through high resistance 234. Therefore, during the fourth pulse period when relay 211 releases, ground is connected over its normal contact to the tip fundamental conductor and battery being connected through resistances 234 and 239 to the ring conductor, a heavy negative impulse is transmitted.

At the end of the fourth pulse period, relay 202 is reoperated thus permitting relay 517 to operate in the locking circuit of relay 507 and transfer conductor 522 from a tens vertical of the dial register to a units vertical over the lower front contacts of relays 513 to 517, inclusive, and the lower back contact of relay 518, preparing the circuits which control the third and fourth pulse periods of the eighth or units digit.

The units digit recorded was 8 and thus the contacts at cross-point 624 are operated. Therefore, during the previous fourth pulse period a circuit is established from battery through the winding of relay 217, the back contact of relay 203 to ground at the left contact of relay 204, relay 204 having operated in a circuit over conductor 245, the third contact of cross-point 624, the upper back contact of relay 518, the upper front contacts of relays 517, 516, 515, 514 and 513 to ground on conductor 522. Therefore, during the first pulse period with relays 217 and 211 operated, ground is connected to the ring fundamental conductor in shunt of battery through resistance 234 and battery is connected through high resistance 246 over the front contact of relay 217 to the tip conductor resulting in the transmission of a light positive pulse.

During the first pulse period a circuit is established by the operation of relay 202 for relay 216 which extends from battery through the winding of relay 216, thence as traced over the front contact of relay 202 to ground at the right contact of relay 204. With relay 216 operated the pulse transmitted during the second pulse period is heavy negative. During the second pulse period no circuit is effective over cross-point 624 for relay 217 and thus during the third pulse period when relay 211 operates both the tip and ring fundamental conductors are grounded resulting in a blank pulse.

During the third pulse period relay 202 releases and connects ground over conductor 523 thence over the upper front contacts of relays 513 to 517, inclusive, the upper back contact of relay 518, to battery through the winding of relay 508. Relay 508 operates and locks in a circuit through the winding of relay 518, the lower contacts of relays 508 and 507 to ground, and disconnects conductor 522 from a units vertical of the digit register but since relay 509 is operated, conductor 522 is not further extended. Relay 202 upon releasing also establishes a circuit for relay 216 which extends as previously traced to ground at the right contact of relay 204. With relay 216 operated the pulse transmitted during the fourth pulse period is heavy negative.

At the end of the fourth pulse period, relay 202 is reoperated thus permitting relay 518 to operate in the locking circuit of relay 508 and disconnect conductor 522 from a units vertical and since relays 509 and 519 are already operated, it closes a circuit from grounded conductor 522, lower front contacts of relays 513 to 519, inclusive, conductor 524, winding of relay 210 to battery. With relay 210, operated, the fundamental tip conductor is extended over the outer left front contact of relay 210 to battery through resistance 234 and over the inner left front contact of relay 210 to battery through resistance 239 thereby preparing a heavy pulse in the positive direction. Relay 210 also connects the fundamental ring conductor to conductor 235. Since relay 211 is operated during the first pulse period, ground over the front contact of that relay shunts the battery from the fundamental tip conductor and the fundamental ring conductor receives only the momentary ground supplied by relay 206 to discharge the circuit before the open pulse. During the second pulse period, the heavy positive pulse is transmitted to the tandem office to control the two wire office selectors included in the connection. The circuit of relay 211 is carried over the back contacts of relays 203 and 210 in parallel. With relay 210 operated, relay 203, which is operated during the second and third pulse period, holds open the circuit of relay 211, prolonging the final pulse.

When relay 202 releases at the beginning of the third pulse period, it connects ground to conductor 523 as before, the circuit extending over the upper front contacts of relays 513 to 518, conductor 521, right back contact of relay 108, conductor 116, upper front contact of relay 519, conductor 1254, winding of relay 309 and battery. Relay 309 locks to grounded conductor 353 and initiates the series of operations for releasing the sender which was described under the panel type call. In addition, it opens the locking circuit of relay 213, which in turn releases relay 214. Relay 214 opens the fundamental circuit, releases relays 207 and 215, removes ground from the pulsing relays 200 and 201, releases relay 210 and opens the holding circuit for relays 202 and 203, thereby restoring the pulsing circuits to normal. When relay 315 releases in response to the operation of relay 309, the transfer relays of Fig. 5 release.

Call to local call indictor office

For this call assume that the wanted subscriber is located in a manual office reached over a single distant office selector. Therefore, only one office brush and one office group selection is made, and only the numerical part of the designation is transmitted by call indicator pulses. To further illustrate the operation of the sender, assume that the wanted number is Main 3-10,457 and that no stations digits are used. The calling line may be a non-coin line.

The seizure of the sender and the registration of the wanted number take place in the same manner as for other calls, as does the seizure of the decoder and the interchange of information therewith. The same compensating resistance relays may be operated as well as relay 1023 in office brush register 1020 and relays 1032 and 1034 in office group register 1030. Since only one distant office selector is employed, skip second office relay 938 must be operated. For this class of call the decoder operates class relays 921 and 922. Stations delay relay 934 is operated but relay 935 is not. Relay 936 is also operated but its function will be described in another connection. When relay 931 operates at the release of the decoder, these register relays are locked and relay 924 is operated as for the tandem call. Relay 931 also operates relay 105 to cancel the coin tests. In addition it closes a circuit from battery through the windings of relays 503 and 513 in series, outer lower front contact of relay 921, outer upper front contact of relay 931 to grounded conductor 1244.

Relays 1103 and 1113 operate over the back contact of relay 937 under the control of relay 301 to test the office selector and to start the office selections, which take place as described for the tandem call, except for the actual numerical values involved. During these selections relays 1104, 1114, 1105 and 1115 are operated. When relay 1221 operates at the termination of office group selection, since relay 938 is operated, relay 1106 is operated immediately, without waiting for the second office selections. Relays 1107 and 1117 are, therefore, not used in this case. Since a five-digit numerical designation is used, when the fifth digit has been recorded, a circuit is closed from battery through the windings of relays 504 and 514 in series, conductor 525, over the contact closed in the stations vertical, conductor 682, back contact of relay 935, conductor 988, over the cross-points at the No. 4 level in the tens vertical, the zero level in the hundreds vertical and the No. 1 level in the thousands vertical, conductor 681, inner left front contact of relay 403, conductor 414, outer lower front contact of relay 503, outer upper front contact of relay 931 to grounded conductor 1244. Relays 504 and 514 lock over the inner lower front contact of relay 504 to grounded conductor 1244.

Trunk test and assignment at the terminating office take place as described for the call through the tandem office. Since relays 503, 504, 513 and 514 are operated, conductor 522 is extended over the upper front contacts of relays 503 and 504, upper back contact of relay 505 to one set of contacts in the thousands vertical and over the lower front contacts of relays 513 and 514 and the lower back contact of relay 515 to another set of contacts of the thousands vertical for controlling the operation of relays 204, 205, 216 and 217. Therefore, the first digit transmitted is the ten-thousands digit which was recorded by the operation of cross-point 717. When relay 202 releases after the second pulse period of the first digit, connecting ground to conductor 523, this ground is extended over the upper front contacts of relays 513 and 514, upper back contact of relay 515 to the winding of relay 505 and battery. Relay 505 locks through the winding of relay 515, over the inner lower front contact of relay 505, outer lower front contact of relay 504 to ground, relay 515 operating at the end of the pulse. The thousands, hundreds and tens digits are transmitted in the usual manner under the control of relays 506, 516, 507, 517, 508 and 518. With relays 508 and 518 operated conductor 522 is extended by way of the back contacts of relays 509 and 519 to the stations vertical so that the units digit recorded on the stations vertical is transmitted last. Relay 518 extends conductor 523 which has been connected to its upper armature, over its upper front contact, conductor 521, right back contact of relay 108, conductor 116, upper back contact of relay 519 to the winding of relay 509 and battery. Relay 519 locks through the winding of relay 519, outer lower front contact of relay 509 to grounded conductor 1244

When relay 519 operates at the termination of the transmission of the last digit, it operates relay 210 for transmitting the final heavy positive pulse, and transfers the circuit controlled by relay 202 to the winding of relay 309 to release the sender.

From the description of these two call indicator calls, it is apparent that four-digit numbers whether or not followed by a stations letter are transmitted in the order: Stations, (a zero being sent where no letter is recorded), thousands, hundreds, tens and units, whereas, a five-digit number, which always consists of the ten-thousands digit one, recorded on the thousands register, the thousands digit zero, recorded on the hundreds register, and a hundreds digit less than five, is transmitted in the order recorded. At the manual office, the ten-thousands digit is recorded on the stations register and the remaining digits on their corresponding registers. Since, as shown in the table of codes given above, the codes for the thousands and stations digits differ from the remaining codes, an adjustment must be made in transmitting five-digit numbers. To care for the change in the stations code, one set of contacts in the stations vertical is employed when relays 509 and 519 are operated as they are for four-digit numbers, and another set when relays 504 and 514 are operated for five-digit numbers. The only thousands digit affected is the digit one, which calls for a positive pulse in the first pulse period when it represents a ten-

thousands digit and a heavy negative pulse in the fourth pulse period, when it represents a thousands digit. Therefore, the circuit of relay 217 extends over the back contact of relay 203, conductor 240 and the lower back contact of relay 509 to cross-point 717 and thence to ground while the circuit of relay 216 extends over the back contact of relay 202, conductor 243, and the upper front contact of relay 509 to cross-point 717 and thence to ground. Cross-point 717 prepares both circuits and relay 509 discriminates between them.

Call to operator through tandem office

This call is very similar to the ordinary tandem call except that only the three digits representing the operator's code are dialed. The decoder receives this code and transmits the proper information back to the sender to cause the selection of the tandem office. Class relays 922 and 923 are operated, in turn operating relay 924. When relay 931 operates at the release of the decoder, a circuit is closed from grounded conductor 1244, outer upper front contact of relay 931, outer lower back contact of relay 921, outer lower front contact of relay 923, inner lower back contact of relay 921 through the windings of relays 519 and 509 in series to battery. These relays lock as before to grounded conductor 1244 and relay 509 operates relay 809 to indicate that dialing has been completed and to permit trunk test to take place as soon as the trunk has been reached. Otherwise the call progresses in the manner described for the previous tandem call except that zeros are transmitted for the digits not dialed. If the call were originated at a substation equipped with a coin box, since an operator call is a free call, the decoder would ground conductor 132, operating relay 105, which locks to grounded conductor 972, canceling the coin tests.

Calls to local operator restricted code

Codes may be restricted either to all subscribers because unused within the direct dialing area, or to certain subscribers. When a code is dialed by a substation which does not have access thereto, the decoder selects a trunk to the proper operator and returns the corresponding information to the sender. Since a local trunk is used, the skip office relays 937 and 938 are operated, as well as class relay 921 which in turn operates relay 924. Since the decoder has no information as to the number of digits to be expected, delay relays 934 and 935 are not operated. Therefore, unless five numerical digits are actually dialed, the operation of relays 509 and 519 is delayed until after a measured time interval as above described. With relay 509 operated, relay 809 operates to permit the closure of the fundamental circuit for trunk test since the coin test would be canceled. Since relay 937 is operated, relays 1106 and 1116 operate under the control of relay 301 to prepare the sender for trunk test.

The trunk test circuit for this class of call extends from the fundamental tip conductor 328 to conductor 1240 as previously traced, lower winding of relay 1203 unshunted because relay 1106 is operated, inner upper back contact of relay 1206, winding of relay 1201, conductor 1255, back contact of relay 905, conductor 977, right back contact of relay 215, conductor 219, outer upper front contact of relay 924, conductor 979, inner upper front contact of relay 1116, conductor 1121, through the compensating resistances as determined by relays 903 and 904 to conductor 980 and thence to the fundamental ring conductor.

Relay 1201 operates from battery at the operator's position, in turn operating relays 208 and 209. Relay 209 closes a circuit from battery through the winding of relay 309, conductor 1254, upper back contact of relay 922, inner lower front contact of relay 924, conductor 987, inner lower front contact of relay 1106, conductor 1123, inner right front contact of relay 209, conductor 221, back contact of relay 1203 to grounded conductor 1244. Relay 309 releases the sender as previously described.

Official code

This type of call differs in its effect on the sender only in that class relay 923 is operated in place of relay 921. With relay 923 operated, the circuit of relays 509 and 519 is closed over the inner lower back contact of relay 921, outer lower front contact of relay 923, outer lower back contact of relay 921, outer upper front contact of relay 931 to grounded conductor 1244 as soon as the decoder is released. Therefore, trunk test may be made without delay, since the coin test is canceled on calls to operators.

Zero operator

When the digit zero is the first (and only) digit dialed, cross-points 719 and 720 are closed. At the second contact of cross-point 720, ground is connected to conductor 989 and the winding of relay 930 which receives battery over the upper normal contact of relay 932 and the lower back contact of relay 933. Relay 930 is, therefore, operated at once to summon the decoder. Otherwise, the operation is the same as for an official code.

Permanent signal

When the sender is seized and relay 315 operated, ground is connected to conductor 353, from which it is extended over the left back contact of relay 405 to conductor 419 to start the timing interrupter. This interrupter, after starting, connects ground to conductor 420, for three seconds, removes it for twenty-seven seconds and repeats this cycle until stopped by the removal of ground from conductor 419. At the first ground closure, relay 406 operates, locking to conductor 419 and extending its locking ground to the winding of relay 407. Relay 407 is shunted at its right back contact by ground from conductor 420 until the end of the three-second interval at which time it operates. With relay 407 operated a circuit is closed from battery through resistance 423, winding and normal contact of relay 408, left front contact of relay 407 to grounded conductor 419. Relay 408 locks over its left front contact to conductor 419 and connects this conductor to the winding of relay 409. However, relay 409 is shunted by ground over the left front contact of relay 407 and the left back contact of relay 409. At the end of twenty-seven seconds ground is again connected to conductor 420 and over the right front contact of relay 407 to resistance 421 in shunt of the winding of relay 406 which releases. With relay 406 released, relay 407 is held operated over the normal contact of relay 407 until the end of the three-second grounded interval, when it releases. In so doing, it permits relay 408 to operate. If no digits have been dialed at this time, a cir-

cuit is closed from battery through the winding of relay 413, inner right back contact of relay 405, right front contact of relay 409 to grounded conductor 353.

Relay 413 locks over its middle left front contact direct to conductor 353. It also connects ground from conductor 353, over its inner left front contact to conductor 989 to operate relay 930 and summon a decoder, connects ground over its inner right contacts to the first and third wires of the A vertical to transmit a permanent signal indication code to the decoder, and at its outer right contacts closes the checking circuit. At its outer left front contact it closes a shunt around the winding of relay 1203 to prevent that relay from operating from the reverse battery returned by permanent signal trunks.

Otherwise the functioning of the sender is the same as for calls to the zero operator.

Two-digit codes

Throughout the previous description three-digit codes have been used and the sender has functioned as a three-digit sender. However, it is so arranged that codes characterized by a particular first digit may include only two digits. For this purpose, cross-connecting rack 1100 is provided. This rack has eight terminals which are connected to the second contacts of the auxiliary A vertical in levels two to nine, inclusive. Any one or more of these terminals may be cross-connected to terminal 1119 which in turn is connected over conductor 1118 to the winding of relay 813 and battery. In the drawings only the terminal connected to the third level is strapped to terminal 1119. Therefore, the codes beginning with the letters D, E and F, which correspond to the digit three are two-digit codes. Assume that such a code is being recorded. In response to the first digit, cross-points 721 and 722 will be closed and the circuit of relay 813 completed to ground connected to the second wire of the auxiliary A vertical.

Relay 813 at its inner left and right contacts supplies the checking circuits for the B vertical required by the decoder. At its outer right armature relay 813 transfers the operating ground from the winding of the B magnet 703 to the winding of the C magnet 704 and at its outer left armature transfers the locking ground from the B magnet to the C magnet. Therefore, the second code digit is recorded on the C vertical and the remaining digits on the usual verticals.

Two-digit codes are transmitted to the decoder as though the second digit were zero, and are sent out to tandem offices by call indicator pulses in the same way.

Although the present disclosure shows only one digit indicative of two-digit codes, probably when first installed in an area expanding from two-digit codes to three-digit codes, all codes might be two-digit codes and all the terminals on rack 1100 cross-connected to relay 813. As growth takes place, one digit after another might be assigned to represent three-digit codes and the corresponding terminal disconnected from relay 813. In the end relay 813 might be dispensed with and the back contacts permanently connected together.

Overflow and telltale

An overflow indication is a reversed battery connected to the fundamental circuit in any position of the sender except incoming advance on a full mechanical call. It may be occasioned by an incoming or final selector at a panel type office advancing to an overflow terminal because of an all-trunks-busy condition, or to the telltale position at the top of the bank because of trouble. Likewise the decoder may cause such a signal by establishing a connection to a reverse battery trunk because it is unable to connect to a trunk over the route called for by the office code dialed.

It will be remembered that in making trunk test on call indicator or operator calls, relay 1201 and the unshunted lower winding of relay 1203 are included in the fundamental circuit. If, therefore, in hunting for such a trunk to the terminating or tandem office, the office selector goes to overflow, or the decoder establishes a connection with a reverse battery trunk, relays 1201 and 1203 are both operated in response to the reverse battery. Relay 1201 operates relays 208 and 209 as usual but these relays have no function. Relay 1203 locks in a circuit from battery through its upper winding and front contact to grounded conductor 1244. It also closes a circuit from battery through the winding of relay 1210, lower back contact of relay 1206, lower front contact of relay 1116, front contact of relay 1203 to grounded conductor 1244. With relay 1210 operated, ground from conductor 1244 is connected over the front contact of relay 1203, inner lower front contact of relay 1210, to the winding of relay 1204 and battery. The outer upper front contact of relay 1204 is ineffective at this time since relay 1202 is not operated. However, the circuit closed at its inner upper front contact from ground at the upper back contact of relay 1212, over conductor 1253, inner upper front contact of relay 924, and conductor 1243 to the windings of relays 1220, 1221 and 1222 operates these relays and they lock to ground at the outer lower front contact of relay 1209. Relay 1221 closes a circuit from grounded conductor 1244, contact of relay 1221, inner upper front contact of relay 1210, winding of relay 1207 to battery. Relay 1207 in turn operates relay 1208, releasing relay 1209 to open the fundamental circuit and open the locking circuit for relays 1220, 1221 and 1222.

Since relay 1210 is now operated, the operation of relay 1208 closes a circuit from battery on conductor 975, winding of relay 1212, lower front contact of relay 1208 to ground at the outer lower front contact of relay 1210. Relay 1212 at its lower armature, opens the circuit of relay 1213 and closes a locking circuit for itself. At its upper back contact relay 1212 opens the energizing circuit of relays 1220, 1221 and 1222 which now release. Relay 1221 opens the circuit of relay 1207 which releases in turn releasing relay 1208 and permitting relay 1209 to reoperate and reclose the fundamental circuit to simulate the trunk closure normally performed by the district junctor. Since relay 1212 is operated, the winding of relay 1201 is shunted by resistance 1260 and the inner upper front contact of relay 1212, thereby reducing the resistance in the fundamental circuit sufficiently to permit the distant apparatus to function for release. When relay 1213, which is slow to release, closes its normal contact, a circuit is completed from ground at the outer upper front contact of relay 1212, normal contact of relay 1213, conductor 1259, inner left back contact of relay 308, conductor 971, upper back contact of relay 933, winding of relay 932 to battery through resistance 990. Relay 932 operates, closing a locking circuit for itself through the upper winding of

relay 933, upper front contact of relay 932 to grounded conductor 1244. At its upper normal contact, relay 932 opens the circuit of relay 930 which releases, removing battery from conductor 975, thereby releasing the register relays of Fig. 10, the sequence relays of Fig. 11, and the counting relays of Fig. 12 as well as relays 1212 and 1209. Relay 1212 opens the energizing circuit for relay 932, permitting relay 933 to operate in the locking circuit above traced. Relay 930 also disconnects battery from the winding of relay 931 causing that relay to release.

Relay 933, when operated, locks independent of relay 932 in a circuit from battery over its outer lower front contact and lower winding to grounded conductor 1244. At its inner lower front contact it connects battery over the lower front contact of relay 932 to the winding of relay 930 causing that relay to reoperate. With relay 931 released and relay 930 operated, battery is again connected to conductor 941 to summon a decoder.

Relay 1203, being locked to the off-normal ground conductor 1244 is held operated. Relay 1210 released when relay 1116 released, but reoperates immediately thereafter over the lower back contact of relay 1116 and the front contact of relay 1203. Therefore, ground is connected over the outer upper front contact of relay 1210 to conductor 1261 notifying the decoder that it is to establish a connection with an overflow trunk and disregard the registered code. After the decoder has returned the proper information to the sender, it connects ground to conductor 970, operating relay 931 to disconnect the sender from the decoder.

During the time that relay 932 is operated and relay 933 unoperated, ground is disconnected from conductor 114, in order to release a relay in the district junctor and allow that circuit to start afresh with the new decoder.

Since an overflow trunk is one leading to an operator's position, the remaining operations in the sender are substantially the same as described for operator calls.

With relays 1103 and 1113 operated for making office test, or with relays 1106 and 1116 operated for making trunk test on a full mechanical call, high resistance 978 is included in the fundamental circuit.

The lower winding of relay 1203 and the winding of either relay 1200 or relay 1201 are also included in the fundamental circuit, but the winding of relay 1203 is shunted over the upper back contacts of relay 1206 and the outer upper front contact of relay 1103 during office test and by the upper back contacts of relay 1206, the inner upper back contact of relay 924 and the outer upper front contact of relay 1106 during full mechanical trunk test. This is for the purpose of preventing the operation of relay 1203 while the resistance of the circuit is too high to be recognized as a closure by the distant circuit. If, therefore, the trunk hunting immediately preceding one of these tests results in the connection of reversed battery to the fundamental circuit, relay 1200 or relay 1201 will operate and advance the sender to the position for making office brush selection by operating relays 1104 and 1114 or for making incoming brush selection by operating relays 1101 and 1111. When the fundamental circuit is reclosed for either of these selections, the resistance is reduced to a value which will be recognized as a closure by the distant circuit. Relays 1202 and 1203 both operate. Relay 1203 operates relay 1210 over the lower back contact of relay 1116. Relay 1210 in turn operates relay 1204 and the operations continue as described above.

If an incoming selector goes to overflow in hunting for a final selector, or if an office, incoming or final selector runs to telltale, the sender at that time will be in some selecting position with one of the sets of relays 1101 and 1111, 1102 and 1112, 1104 and 1114 or 1105 and 1115 operated. With relays 1205 and 1206 operated for controlling selections at a terminating office, relays 1103 and 1113 also mark a selecting position. For selections, relays 1203 and 1202 are included in the fundamental circuit and operate at once from the reverse battery, initiating the series of operations above described.

Abandoned calls

Where a calling subscriber hangs up his receiver at any time before the sender has completed its normal functions on a call, the sender first releases the calling line, then puts the selectors in position to restore to normal and finally releases. The procedure depends upon the class of call and the stage to which it has advanced when it is abandoned.

When the subscriber restores his receiver to the switch-hook, relay 310 releases, in turn releasing relay 814, relay 815 if still operated, relay 314 and relay 313. Until the district frame registration has been made, the release of relay 313 releases relay 315 and restores the sender to normal. Since relay 315 is held operated over the district frame vertical, following that registration, the release of relay 314 at a later time closes a circuit from ground at the inner right back contact of relay 309, back contact of relay 310, left back contact of relay 314, outer left front contact of relay 315, to the winding of relay 308 and battery.

Relay 308 closes a locking circuit over its middle left contact and conductor 353 to ground at the inner right contact of relay 315. Relay 308 connects battery through low resistance 239 over the middle right back contact of relay 309, and the right front contact of relay 308 to conductor 363 which extends over the lower back contact of relay 932 to conductor 114, thereby operating relays in the district junctor to release the line switches and in turn free the calling line. The further operations in the sender depend on the stage at which the call was abandoned.

If the call was abandoned before the sender has engaged a decoder, no connection has been made through the district and office switches and the sender may be disconnected at once. The same is true if a decoder is engaged at the moment but relay 931 has not yet operated. Even if relay 931 is momentarily normal in preparation for a second trial due to an overflow condition, the sender may be disconnected at once, since the selectors have been put in condition to return to normal as previously described. Therefore, with relay 931 normal, relay 308 closes a circuit from battery through the winding of relay 309, conductor 1254, lower back contact of relay 931, conductor 991, middle and inner left front contacts of relay 308 to grounded conductor 353. Relay 309 brings about the release of the sender as previously described.

In order not to interfere with functions of the decoder and district junctor, which follow immediately after the release of relay 301, a circuit is closed from battery through the winding of

relay 314, conductor 827 to ground at the inner right contact of relay 301. Therefore, if the call is abandoned while relay 301 is operated, relay 314 waits to release until the decoder has released relay 301. Relay 314 is slow to release and therefore delays the closure of the circuit of relay 308 until a sufficient time has elapsed for the decoder to function in connection with the district junctor.

If a full selector call is abandoned, in order to restore any distant selectors which have been seized, the sender is allowed to proceed with its regular functions until the first opportunity arrives to force an incoming or final selector to telltale. The sender completes any distant office selections which may have been called for by the routing, makes trunk test and attempts incoming brush selection, or if the sender had progressed beyond that point before the call was abandoned, it attempts the next selection in order. Neither trunk test, nor any selection is delayed for dialing or coin test, since the operation of relay 308 opens all the circuits which ordinarily delay the release of relays 1207 and 1208.

During incoming and final selections, relay 1205 is operated, and when relay 1223 operates under the control of stepping relay 1202 it extends the counting relay circuit over its front contact and the middle lower front contact of relay 1205 to conductor 1247 and the outer right back contact of relay 308. The circuits for operating the zero counting relay 1222 over the contacts of cross-points in the zero level of the numerical verticals also extend over conductor 1247. Therefore, when relay 308 is operated by the abandonment of a call, it is impossible for the selector to operate the zero counting relays and terminate the selection. It, therefore, continues its upward motion until it reaches the top of its bank and telltale. The incoming selector then sends a pulse of reverse battery which is received as described for an overflow condition and the sender makes the trunk closure described in that connection.

Normally in connection with a tell-tale condition a decoder is summoned to establish connection to an overflow trunk, but where the call has been abandoned it is not necessary. Therefore, when relay 1213 releases, following the operation of relay 1212, the circuit previously closed to relay 932 now extends from ground at the outer upper front contact of relay 1212, normal contact of relay 1213, conductor 1259, outer left front contact of relay 308 to the winding of relay 309 and battery, relay 309 releasing the sender and switches.

Where a call to a call indicator office is abandoned, in order to restore any distant office selectors which may have been seized, and to satisfy the operator who may have been signaled, the sender is allowed to proceed with its regular functions to the end. The sender completes any distant office selections required, makes trunk test, awaits assignment and then sends out the call indicator pulses and operates relay 309 in the usual manner. Trunk test is not delayed for dialing or coin test because the circuits of relays 1207 and 1208 are open at contacts of relay 308. Any digits transmitted following the release of relays 313 and 314 are sent as zeros, since relay 313 opens the circuits of relays 216 and 217. If assignment is greatly delayed so that relay 402 is operated under the control of the timing circuit as will be described hereinafter, a circuit is closed for relay 309 over the inner right front contact of relay 402, right back contact of relay 313, conductor 416, inner left front contact of relay 213, to ground at the left back contact of relay 309, thereby releasing the sender without summoning the monitor.

If a call to an operator is abandoned, the sender makes trunk test as usual, operating relay 309 and releasing the sender. Relay 308 being operated, trunk test is not delayed for either dialing or coin test.

Monitoring

The operation of the timing relays of Fig. 4 in connection with a permanent signal condition has already been described.

It will be remembered that the connection of ground to conductor 353 by relay 315 in response to the seizure of the sender, connected ground over the left back contact of relay 405 to conductor 419 to start the timing circuit.

If the subscriber starts to dial promptly, relay 405 operates from the auxiliary A register magnet 710, opening this ground and restoring the timing relays to normal. When the timing relays have released, a circuit is closed from battery through the winding of relay 404, left back contact of relay 411, inner left back contact of relay 403, left front contact of relay 405, back contacts of relays 406, 407, 408 and 409, to grounded conductor 353. Relay 404 locks over the back contact of relay 411, and the outer left front contact of relay 404 to conductor 353. With relay 404 operated, ground from conductor 353 is extended over the inner left front contact of relay 404, outer right back contact of relay 403 to conductor 419 to time the reception of the designation.

When the units digit has been dialed as indicated by the operation of magnet 708 or dialing has been completed as indicated by the operation of relay 809, either of which is followed by the operation of relay 403, ground is again disconnected from the timing relays, restoring them to normal.

When relay 403 operates, a circuit is closed from battery through the winding of relay 401, right back contact of relay 402, conductor 417, right back contact of relay 110, conductor 123, outer left front contact of relay 403, left front contact of relay 405, over the back contacts of the timing relays to conductor 353. Relay 401 locks over the back contact of relay 110 and the outer right contact of relay 401 to conductor 353. Relay 401 also connects ground from conductor 352 over its inner right contact to conductor 419 to time the release of the sender.

After the permanent signal relay 413 has been operated over the front contact of relay 409 to summon a decoder and establish a connection with a permanent signal operator, the ground maintained on conductor 419 causes the reoperation of relays 406 and 407 after about thirty seconds. Relay 407 connects ground from conductor 419, over the left front contacts of relays 407 and 409 to resistance 423 in shunt of the winding of relay 408 which now releases. Relay 409 is held operated as long as relay 407 remains operated. With relay 408 released, a circuit is closed from battery through the winding of relay 402, conductor 425, outer right contact of relay 408, right front contact of relay 409 to grounded conductor 353. Relay 402 locks directly to conductor 353. With relay 402 operated, a circuit is closed from battery through the winding of relay 411, outer left front contact of relay 402 to grounded conductor 353. Relay

411 locks over its inner left front contact, outer left back contact of relay 403 to conductor 353.

If dialing is started but not completed promptly, the operation of relay 409 closes a circuit from battery through the winding of relay 411, inner right back contact of relay 403, right front contacts of relays 405 and 409 to conductor 353. Relay 411 locks in the circuit above traced.

If release is delayed, with relays 936 and 922 normal, relay 402 operates at the end of thirty to sixty seconds over conductor 425, back contact of relay 936, lower back contact of relay 922, conductor 992, right front contact of relay 403, right front contact of relay 405, right front contact of relay 409 to grounded conductor 353. If either of these relays is operated, the operation of relay 402 is delayed an additional thirty seconds until relay 408 releases. As before, relay 402 operates relay 411 which locks. Relay 402 also opens the circuit of relay 401, in turn releasing the timing relays 406 to 409. Relay 401 also opens the circuit of relay 213, thereby releasing the call indicator impulsing relays if operated. Relay 402 also connects ground from conductor 353 over its middle left contact and the right front contact of relay 404 to conductor 429 to operate a stuck sender meter (not shown). If the sender fails to release following a permanent signal condition, this meter is not operated since relay 404 is not operated.

Relay 411, when operated and locked in any one of the ways above described, opens the locking circuit of relay 404 thereby releasing the timing relays if dialing has not been completed. At its outer left front contact it connects its locking ground to conductor 833 and the winding of relay 207. Relay 207 starts relays 200 and 201 to pulsing in the manner previously described. Since relay 213 is normal, the pulsing takes place at the slow rate. At each operation of relay 201 ground is connected over the contact of relay 201, conductor 231, outer right front contact of relay 411, conductor 124, outer right back contact of relay 104, conductor 426 to the monitor's position, where it causes the corresponding sender lamp to flash.

Upon observing the lamp signal, the operator will insert a plug in the jack (not shown) in which conductors 125, 126 and 127 terminate. Battery on the sleeve of the plug operates relay 109 which in turn operates relay 104, connecting conductors 125 and 126 to the line conductors 112 and 113, respectively, permitting the monitor to talk to the subscriber if he is still listening. Relay 104 also disconnects the intermittent ground from conductor 426 as long as the monitor is connected with the circuit. It also closes a circuit from battery through the right winding of relay 310, conductor 115, left normal contact of relay 107, and thence either through resistance 128 and the inner left front contact of relay 104 to ground at the right back contact of relay 107 or over the right front contact of relay 109, resistance 129, conductor 130, outer left front contact of relay 313, conductor 366 to ground at the right back contact of relay 107. These circuits hold relay 310 operated to prevent breaking the connection between line, district and sender, while the monitor is connected with the sender.

The monitor will ask the subscriber, if present, to release the sender by restoring his receiver to the switch-hook. If this fails, as indicated by the sender lamp flashing again when the monitor withdraws her plug, she may frequently cause a release by inserting the talking plug in the priming jack, the tip of which is connected to conductor 427 and relay 412. If relay 930 has not been operated, because only part of the code digits have been dialed, relay 412 closes a circuit from battery through the winding of permanent signal relay 413, inner left front contact of relay 412, conductor 428, to ground at the lower back contact of relay 930. A connection will then be attempted with a permanent signal trunk.

If relay 930 has been operated, ground at its lower front contact extends over conductor 993, inner right contact of relay 412, outer left back contact of relay 413, to conductor 1254 and the winding of relay 309, and from conductor 993 over the outer right contact of relay 412, inner left back contact of relay 413 to the winding of relay 308. The calling line and then the sender are released as on an abandoned call, the line seizes another sender and is connected to a permanent signal trunk. The circuits of relays 308 and 309 are carried over contacts of relay 413 to prevent their premature operation when relay 930 is operated in summoning the decoder for a permanent signal call as previously described.

Relay 412 also connects ground to the winding of relay 315 to hold the sender busy if the cord is not withdrawn to release relay 412 promptly.

Second trial with decoder

It will be remembered that under an overflow condition, ground was connected to conductor 971 and the winding of relay 932 to summon a second decoder. A second trial may also be made under other circumstances. If the decoder encounters trouble in receiving information from the sender, in decoding that information or in transmitting the information to the sender, it connects ground to conductor 971 so that the sender may release it and make a second trial.

If the decoder encounters trouble in establishing the connection through the district and office frames after disconnecting from the sender but while holding relay 301 operated through the district junctor, it connects ground to conductor 329 which extends over the outer right front contact of relay 301, to conductor 971 and the winding of relay 932.

If the decoding operation is successful on the second trial in any of these cases, relay 931 is operated as previously described but relays 932 and 933 remain locked up. If, therefore, a failure occurs again on the second trial, the connection of ground to conductor 971 closes a shunt to battery through resistance 990, releasing relay 932 which, in turn, releases relay 930 as well as the decoder connector if it is engaged at the time. Relay 933 is held operated in an independent locking circuit and the sender waits until the timing relays summon the monitor.

Coin tests

The progress of a successful coin test, and the manner in which the coin test is canceled for non-coin lines or no charge codes has already been described. The operation of the coin test circuits when failures occur will now be described.

It will be remembered that, with relay 111 operated to indicate that a coin line is calling, relays 107 and 108 operate as soon as the completion of dialing is indicated by the operation of relay 809. With these relays operated, relay 310 is held operated over the outer left front contact of relay

107; the tip conductor 112 is connected over the left normal contact of relay 104, inner left front contact of relay 108, middle winding of relay 103, right back contact of relay 102, right winding of relay 106 to ground through resistance 119; and the ring conductor 113 is connected over the right normal contact of relay 109, inner right front contact of relay 108, right winding of relay 103, outer left back contact of relay 102, left winding of relay 106, resistance 120, middle right contact of relay 108 to the source of coin collect battery. These circuits serve to test for the presence of ground at the calling substation. If a ground is present, relay 106 operates as previously described. If no ground other than the allowable 10,000 ohm leak is present on the line, relay 106 does not receive sufficient current and does not operate. Relay 103 is operated in either case.

When relay 108 operates at the beginning of coin test, it closes a circuit from battery through the winding of relay 207, conductor 833, outer left front contact of relay 108 to ground. It also connects ground over its third left contact to conductor 520 to provide a locking circuit for relays 506 and 516. Relay 207 starts pulsing by relays 200 and 201 which operate at the slow rate. Relay 201 at its first operation, connects ground over conductor 231, right back contact of relay 411, conductor 416, inner left back contact of relay 215, conductor 232, upper back contact of relay 516, winding of relay 506 to battery. Relays 506 to 508 and 516 to 518 operate under the control of relay 201 to measure off an interval of three to five seconds. When relay 518 operates it extends the circuit controlled by relay 201, over conductor 521, outer right front contact of relay 108 to the winding of relay 110. Relay 110 locks to ground at the right back contact of relay 105, opens the locking circuit of relay 401 to stop the timing relays, connects ground from the inner left back contact of relay 109 to conductor 131 to signal the monitoring operator and connects ground from the outer left contact of relay 109 to conductor 430 leading to an auxiliary signal.

The monitoring operator plugs into the jack (not shown) in which conductors 125, 126 and 127 terminate, thereby operating relay 109 which extinguishes the signal at the monitor's position as well as the auxiliary signal. Relay 109 also operates relay 104 which connects the calling line with the monitor talking conductors and holds relay 103 operated in a circuit from the coin collect battery source, middle right front contact of relay 108, resistance 120, left winding of relay 106, outer left back contact of relay 102, right winding of relay 103, inner right front contact of relay 108, resistance 128, inner left front contact of relay 104, inner left front contact of relay 108, middle winding of relay 103, right back contact of relay 102, right winding of relay 106, to ground through resistance 119. This transfer is made in such a way as to prevent ground from the monitor's cord circuit falsely operating the coin test relays.

The operator requests the deposit of a coin and disconnects, relighting the coin lamp and restoring the coin test circuits. If a coin is then deposited, relay 106 operates and the test is completed as described above and the coin lamp is extinguished to inform the operator that the tests have been satisfied.

After relay 106 operates in response to the ground test, it locks and operates relay 102 which disconnects the line conductors from relay 106 and extends the tip conductor over its outer right front contact to the left winding of relay 101 and ground at the right back contact of relay 105. It also extends the ring conductor over its inner right front contact, right winding of relay 101 to the coin collect battery over the middle right contact of relay 108.

If there is a solid ground on the line, as might be used in attempting a free call, relay 101 operates, in turn operating relay 100 in a circuit from battery at the right front contact of relay 106, winding of relay 100, front contact of relay 101 to ground at the right back contact of relay 105. Relay 100 locks over its inner right contact to ground at the back contact of relay 105, independent of relay 101. When relay 102 operates, it opens the circuit of relay 111. Relay 111 is slow to release and if relay 101 is not operated, closes its left back contact after a short interval. However, if relays 101 and 100 are operated by a solid ground, relay 101 extends its locking ground over its outer right contact to conductor 364, preventing the release of relay 111.

Since relay 111 cannot release, relay 110 is operated at the end of the time interval measured by relays 200, 201, 506 to 508 and 516 to 518 as above described, signaling the monitor. The response of the monitor releases relays 106, 102 and 100 so that the coin test may be restarted at the beginning.

If the coin test is not satisfied, as indicated by the continued illumination of the coin lamp at the monitor's position, she may release the sender by inserting the plug of her cord in the priming jack leading to relay 412 as previously described.

What is claimed is:

1. In a telephone system having selector switches for extending connections from a subscriber's line, a sending mechanism having registers for registering digits indicative of the designation of a desired line, other registers, means under the control of said first registers for operating said other registers, means for controlling the selective movements of said switches in accordance with the setting of said registers, a chain of relays and means for successively and repeatedly operating said relays to associate said controlling means sequentially with said registers.

2. In a telephone system having selector switches for extending connections from a subscriber's line, a sending mechanism having registers for registering digits indicative of the designation of a desired line, a plurality of sets of other registers, means under the control of said first registers for operating said other registers, means for controlling the selective movements of said switches in accordance with the setting of said registers, a chain of relays, means for successively operating said relays to associate said controlling means sequentially with one of said sets of registers, and means to determine whether said relays shall be reoperated to associate said controlling means with another of said sets of registers.

3. In a telephone system having selector switches for extending connections from a subscriber's line, a sending mechanism having registers for registering digits indicative of the designation of a desired line, a plurality of sets of other registers, means under the control of said first registers for operating said other registers, means for controlling the selective movements of said switches in accordance with the setting of said registers, a chain of relays, means for successively operating a portion of said relays to

associate said controlling means sequentially with one of said sets of registers, and means to determine whether said portion of said relays shall be reoperated to associate said controlling means with another of said sets of registers, or all of said relays shall be operated to associate said controlling means with said first registers.

4. In a telephone system having selector switches for extending connections from a subscriber's line, a sending mechanism having registers for registering digits indicative of the designation of a desired line, other registers, means under the control of said first registers for operating said other registers, means for controlling the selective movements of said switches in accordance with the setting of said registers, a chain of relays, means for successively and repeatedly operating said relays and means to determine whether said relays shall associate said controlling means with said first registers or with said other registers.

5. In a telephone system having selector switches for extending connections from a subscriber's line, a sending mechanism having registers for registering digits indicative of the designation of a desired line, a plurality of sets of other registers, means under the control of said first registers for operating said other registers, means for controlling the selective movements of said switches in accordance with the setting of said registers, a chain of relays, means for successively operating said relays to associate said controlling means sequentially with one of said sets of registers, a relay to determine whether said relays shall be reoperated to associate said controlling means with another of said sets of registers, and means to operate said determining relay under the control of said first registers.

6. In a telephone system having selector switches for extending connections from a subscriber's line, a sending mechanism having registers for registering digits indicative of the designation of a desired line, a plurality of sets of other registers, means under the control of said first registers for operating said other registers, means for controlling the selective movements of said switches in accordance with the setting of said registers, a chain of relays, means for successively operating said relays to associate said controlling means sequentially with one of said sets of registers, a relay to determine whether said relays shall be reoperated to associate said controlling means with another of said sets of registers, and means for operating said determining relay either under the control of said first registers or under the control of said chain of relays.

7. In a telephone system having selector switches and trunks for extending connections from a subscriber's line, a sending mechanism having registers for registering digits indicative of the designation of a desired line, means for controlling the selective movements of said switches in accordance with the setting of said registers, means for testing the operative condition of said trunks, a chain of relays, and means for successively operating said relays to render said testing means effective and to associate said controlling means sequentially with said registers.

8. In a telephone system having selector switches and trunks for extending connections from a subscriber's line, a sending mechanism having registers for registering digits indicative of the designation of a desired line, other registers, means under the control of said first registers for operating said other registers, means for controlling the selective movements of said switches in accordance with the setting of said registers, means for testing the operative condition of said trunks, a control circuit extending from said sender to said switches and to said trunks, a train of relays and means for successively operating said relays to associate said controlling means sequentially with said registers and to associate said testing means over said control circuit with said trunks.

9. In a telephone system having selector switches and trunks for extending connections from a subscriber's line, a sending mechanism having registers for registering digits indicative of the designation of a desired line, other registers, means under the control of said first registers for operating said other registers, means for controlling the selective movements of said switches in accordance with the setting of said registers, means for testing the operative condition of said trunks, a control circuit extending from said sender to said switches and to said trunks, a train of relays and means for successively and repeatedly operating said relays to associate said controlling means sequentially with said registers and to associate said testing means over said control circuit with said trunks.

10. In a telephone system, a sending mechanism for controlling the establishment of connections from subscribers' lines having coin boxes, said mechanism having registers for registering the digits of line designations dialed by a calling subscriber, a pulsing relay and a switching relay for controlling the transmission of code impulses in the establishment of connections to manual and tandem offices, means controlled by said pulsing relay and said switching relay for measuring a delay interval to enable the calling subscriber to dial and register a stations digit on one of said registers, means in said sender for testing for the deposit of a coin in the coin box of said calling line, means controlled by said pulsing relay and said switching relay for measuring a delay interval to enable the operation of said testing means, and means operable at the termination of said delay interval for operating a signal if said coin test fails.

11. In a telephone system, a sending mechanism for controlling the establishment of connections from subscribers' lines having coin boxes, said mechanism having registers for registering the digits of line designations dialed by a calling subscriber, a pulsing relay and a switching relay for controlling the transmission of code impulses in the establishment of connections to manual and tandem offices, means controlled by said pulsing relay and said switching relay for measuring a delay interval to enable the calling subscriber to dial and register a stations digit on one of said registers, means in said sender for testing for the deposit of a coin in the coin box of said calling line, means controlled by said pulsing relay and said switching relay for measuring a delay interval to enable the operation of said testing means, and means to vary the speed at which said pulsing relay operates.

12. In a telephone system, a sending mechanism for controlling the establishment of connections from subscribers' lines having coin boxes, said mechanism having registers for registering the digits of line designations dialed by a calling subscriber, a pulsing relay and a switching relay

for controlling the transmission of code impulses in the establishment of connections to manual and tandem offices, means controlled by said pulsing relay and said switching relay for measuring a delay interval to enable the calling subscriber to dial and register a stations digit on one of said registers, means in said sender for testing for the deposit of a coin in the coin box of said calling line, means controlled by said pulsing relay and said switching relay for measuring a delay interval to enable the operation of said testing means, and means to vary the speed at which said pulsing relay operates in accordance with the function to be performed.

13. In a telephone system, a sending mechanism for controlling the establishment of connections from subscribers' lines having coin boxes, said mechanism having registers for registering the digits of line designations dialed by a calling subscriber, a pulsing relay and a switching relay for controlling the transmission of code impulses in the establishment of connections to manual and tandem offices, means controlled by said pulsing relay and said switching relay for measuring a delay interval to enable the calling subscriber to dial and register a stations digit on one of said registers, means in said sender for testing for the deposit of a coin in the coin box of said calling line, means controlled by said pulsing relay and said switching relay for measuring a delay interval to enable the operation of said testing means, and means effective when said pulsing relay and switching relay are used for measuring time intervals to decrease the speed at which said pulsing relay operates.

14. In a telephone system, a sending mechanism for controlling the establishment of connections from subscribers' lines having coin boxes, said mechanism having registers for registering the digits of line designations dialed by a calling subscriber, a pulsing relay and a switching relay for controlling the transmission of code impulses in the establishment of connections to manual and tandem offices, means controlled by said pulsing relay and said switching relay for measuring a delay interval to enable the calling subscriber to dial and register a stations digit on one of said registers, means in said sender for testing for the deposit of a coin in the coin box of said calling line, means controlled by said pulsing relay and said switching relay for measuring a delay interval to enable the operation of said testing means, a circuit for said pulsing relay, resistances for insertion in said circuit, means effective when said pulsing relay and switching relay are used for measuring delay intervals to include said resistances in said circuit to cause said pulsing relay to pulse slowly, and means effective when said pulsing relay and switching relay are used to transmit code impulses to short-circuit said resistances to cause said pulsing relay to pulse at a higher speed.

15. In a telephone system, a calling subscriber's line, selector switches for extending a connection from said line, a register sender for controlling said switches, a dial associated with the calling line for setting the registers of said sender in accordance with the designation of a desired connection, and an all relay time measuring device in said sender for measuring time intervals within which dialing should be initiated, within which dialing should be completed, and during which the sender should be released.

16. In a telephone system, a calling subscriber's line, selector switches for extending a connection from said line, a register sender for controlling said switches, a dial associated with the calling line for setting the registers of said sender in accordance with the designation of a desired connection, an all relay impulse generator in said sender, an all relay time measuring device controlled by said impulse generator, a signal and means controlled by said timing device to operate said signal if said calling subscriber fails to complete dialing within a predetermined interval.

17. In a telephone system having selector switches and trunks for extending connections from a subscriber's line, a sending mechanism having a unitary registering device for registering the digits indicative of the designation of the desired line, means for recording each digit as dialed, means including a relay for successively transferring the recorded digits to said unitary registering device, a separate relay for use in transferring the digit 1 from said recording means to said registering device, and means to render said separate relay effective before and after the registration of the first code digit.

18. In a telephone system having selector switches and trunks for extending connections from a subscriber's line, a sending mechanism having a unitary registering device for registering the digits indicative of the designation of the desired line, means for recording each digit as dialed, means including a relay for successively transferring the recorded digits to said unitary registering device, a separate relay for use in transferring the digit 1 from said recording means to said registering device, and means to render said separate relay ineffective during the reception of the first code digit.

19. In a telephone system having selector switches and trunks for extending connections from a subscriber's line, a sending mechanism having a unitary registering device for registering the frame designation of one of said selector switches and the digits indicative of the designation of the desired line, means for recording each digit as dialed, means including a relay for successively transferring the recorded digits to said unitary registering device, a separate relay for use in transferring the digit 1 from said recording means to said registering device, means to render said separate relay effective to record said frame designation, to render said relay ineffective during the registration of the first code digit and to render it again effective to register the remaining digits.

20. In a telephone system having selector switches and trunks for extending connections from a subscriber's line, a sending mechanism having a unitary registering device for registering the digits indicative of the designation of the desired line, means to record the frame designation of one of said selector switches, means for recording each digit as dialed, means for successively transferring said frame designation and said recorded digits to said unitary registering device, and means to prevent the transfer of any one of said recorded digits to said unitary registering device if said frame designation has not been recorded.

21. In a telephone system having selector switches and trunks for extending connections from a subscriber's line, a sending mechanism having means for registering digits indicative of the designation of a desired line and registers for controlling said selector switches, a decoder, means for establishing a direct connection with

said decoder, means for operating said decoder under the control of said digit registering means and means for operating said selector controlling registers from said decoder, means for establishing an indirect connection with said decoder and for releasing said direct connection and means controlled over said indirect connection for releasing said selector controlling registers.

22. In a telephone system having selector switches and trunks for extending connections from a subscriber's line, a sending mechanism having means for registering digits indicative of the designation of a desired line and registers for controlling said selector switches, a decoder, means for establishing a direct connection with said decoder, means for operating said decoder under the control of said digit registering means and means for operating said selector controlling registers from said decoder, means for establishing an indirect connection with said decoder, and means controlled over said indirect connection for initiating the control of selections.

23. In a telephone system having selector switches and trunks for extending connections from a subscriber's line, a sending mechanism having means for registering digits indicative of the designation of a desired line and registers for controlling said selector switches, a decoder, means for establishing a direct connection with said decoder, means for operating said decoder under the control of said digit registering means and means for operating said selector controlling registers from said decoder, means for establishing an indirect connection with said decoder, and means responsive to one signal over said indirect connection to initiate the control of said selectors and means responsive to a different signal over said indirect connection to release said selector controlling registers.

24. In a telephone system having selector switches and trunks for extending connections from a subscriber's line, a sending mechanism having means for registering the designation of desired lines, other registers for controlling said selectors, a decoder, means for establishing connection with said decoder, means for operating said selector controlling registers from said designation register by means of said decoder, means for releasing said decoder, a control circuit for controlling said selectors, means responsive to a premature reverse battery signal over said control circuit for releasing said selector controlling registers, means for connecting with another decoder, and means for transmitting a signal to said second decoder indicating that such a reverse battery signal has been received.

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