

Nov. 17, 1931.

W. W. CARPENTER

1,832,447

TELEPHONE SYSTEM

Filed Jan. 25, 1930

9 Sheets-Sheet 1

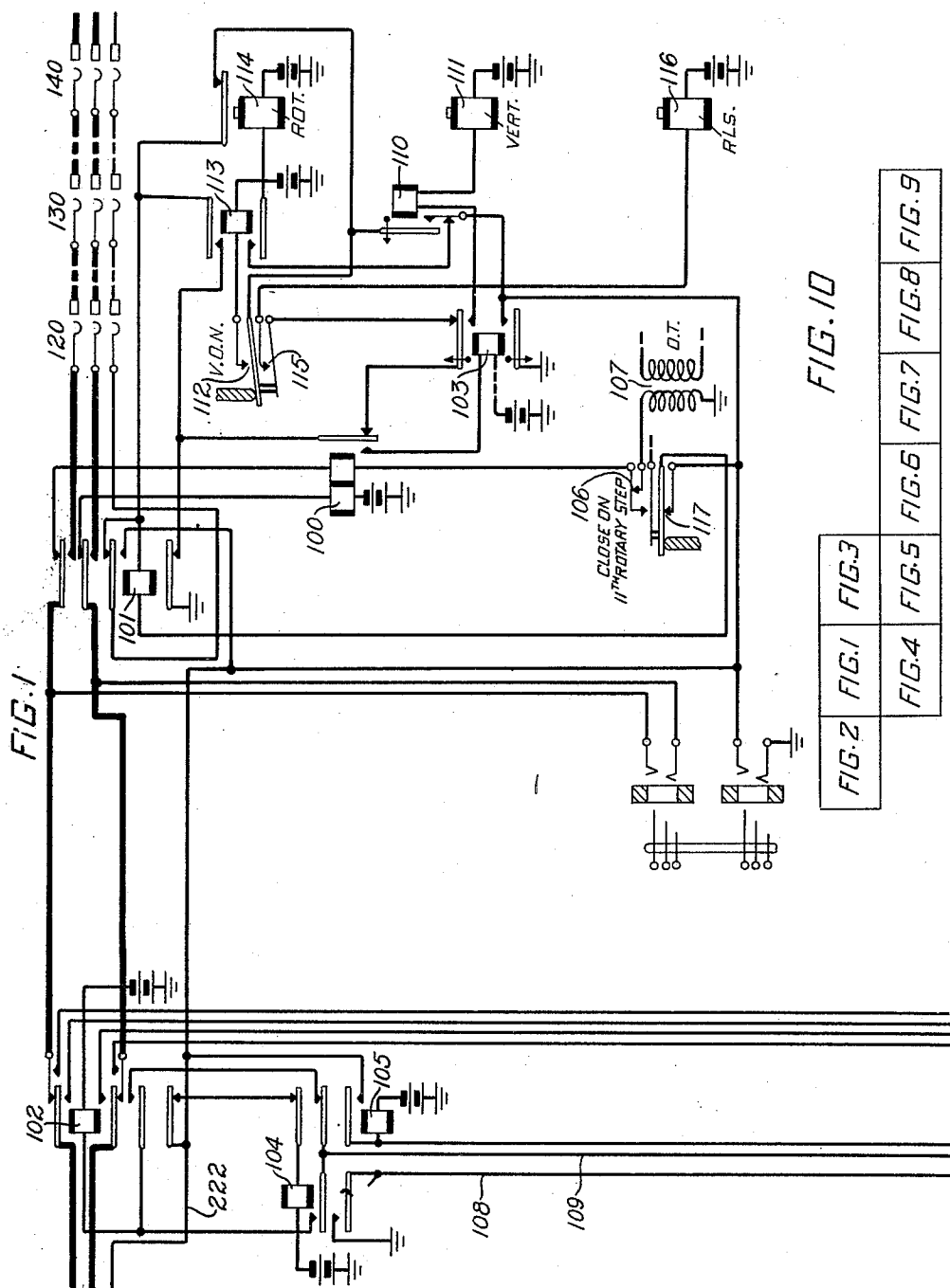


FIG. 10

FIG. 2	FIG. 1	FIG. 3
FIG. 4	FIG. 5	FIG. 6
FIG. 7	FIG. 8	FIG. 9

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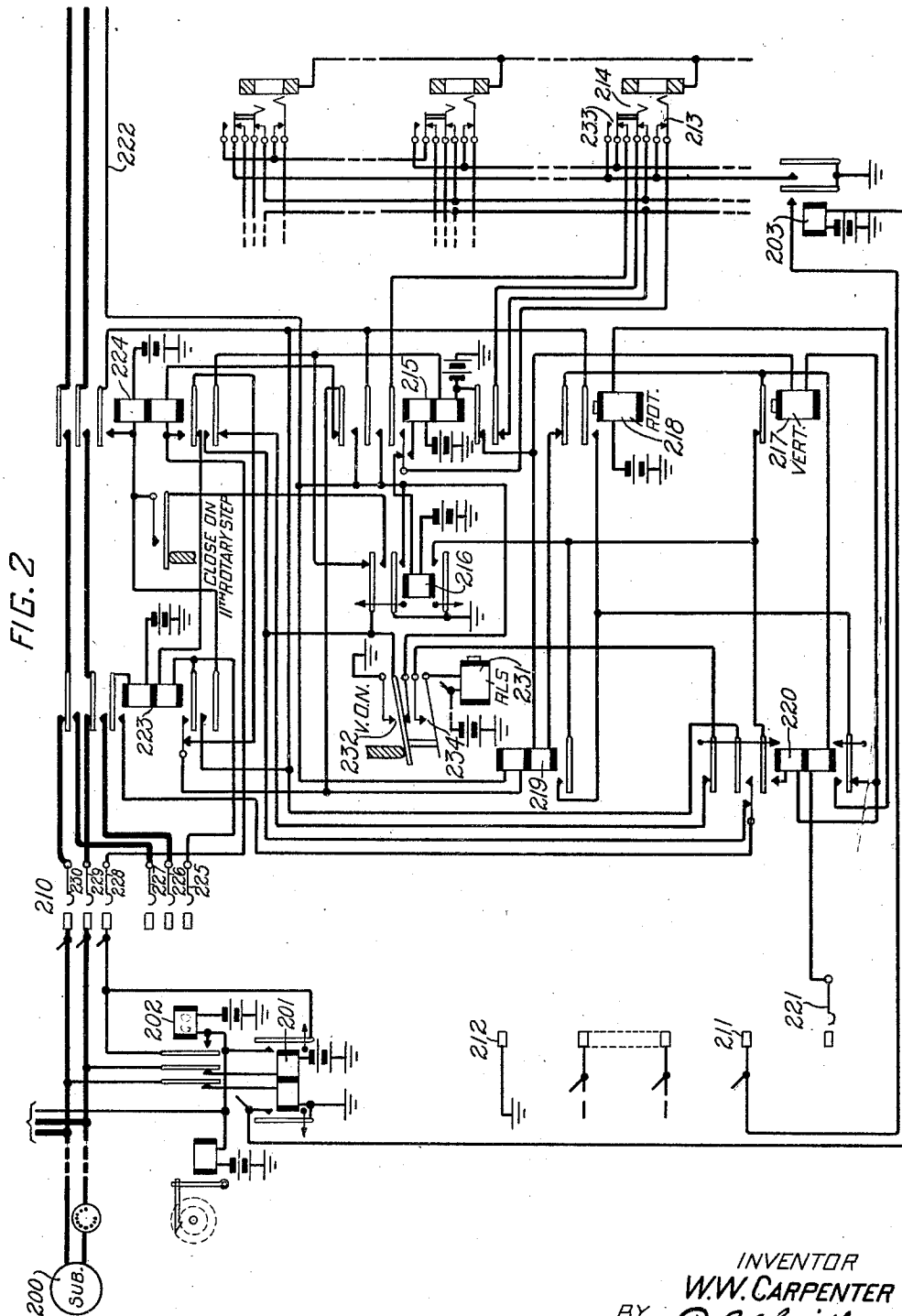
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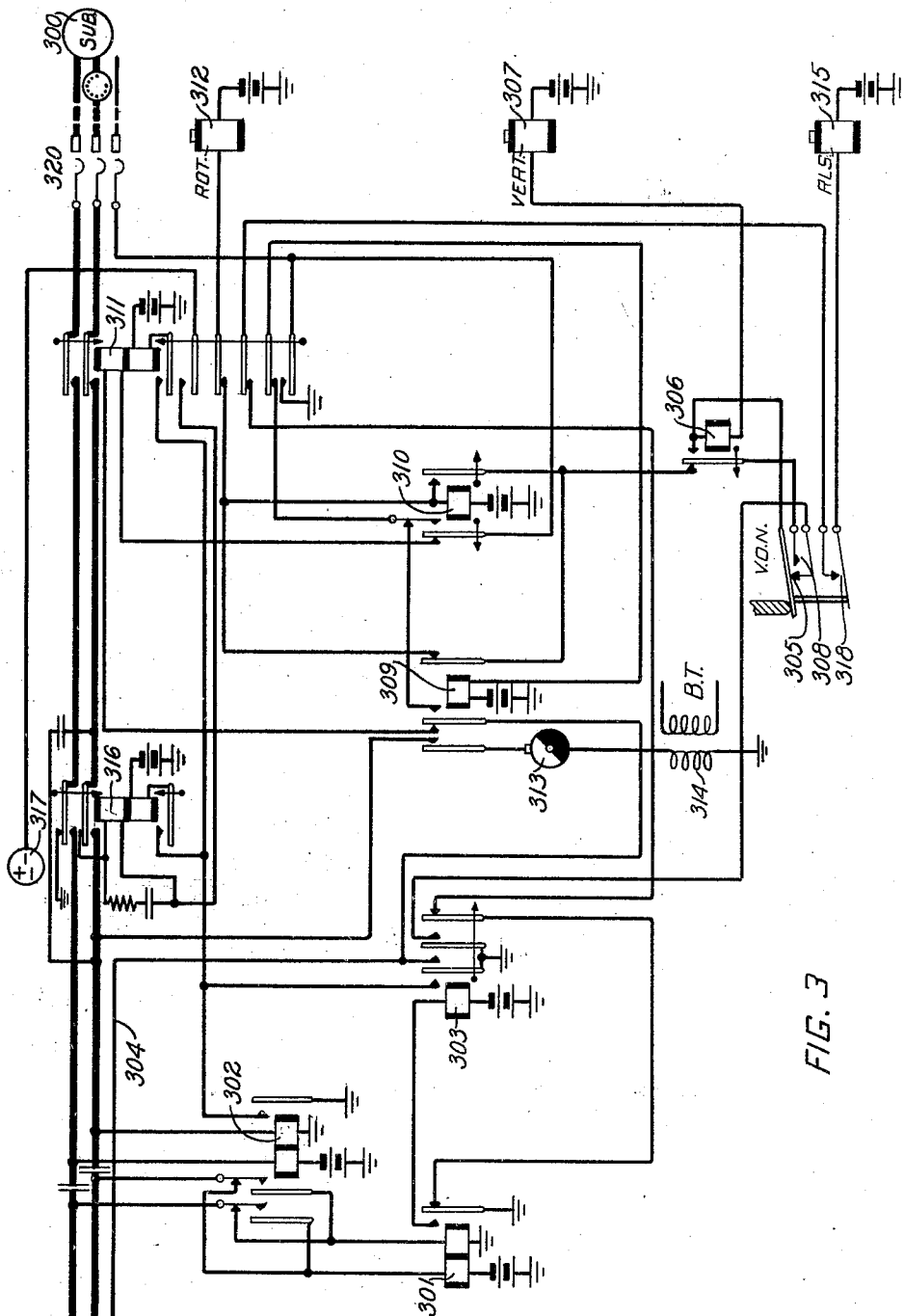
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9 Sheets-Sheet 4

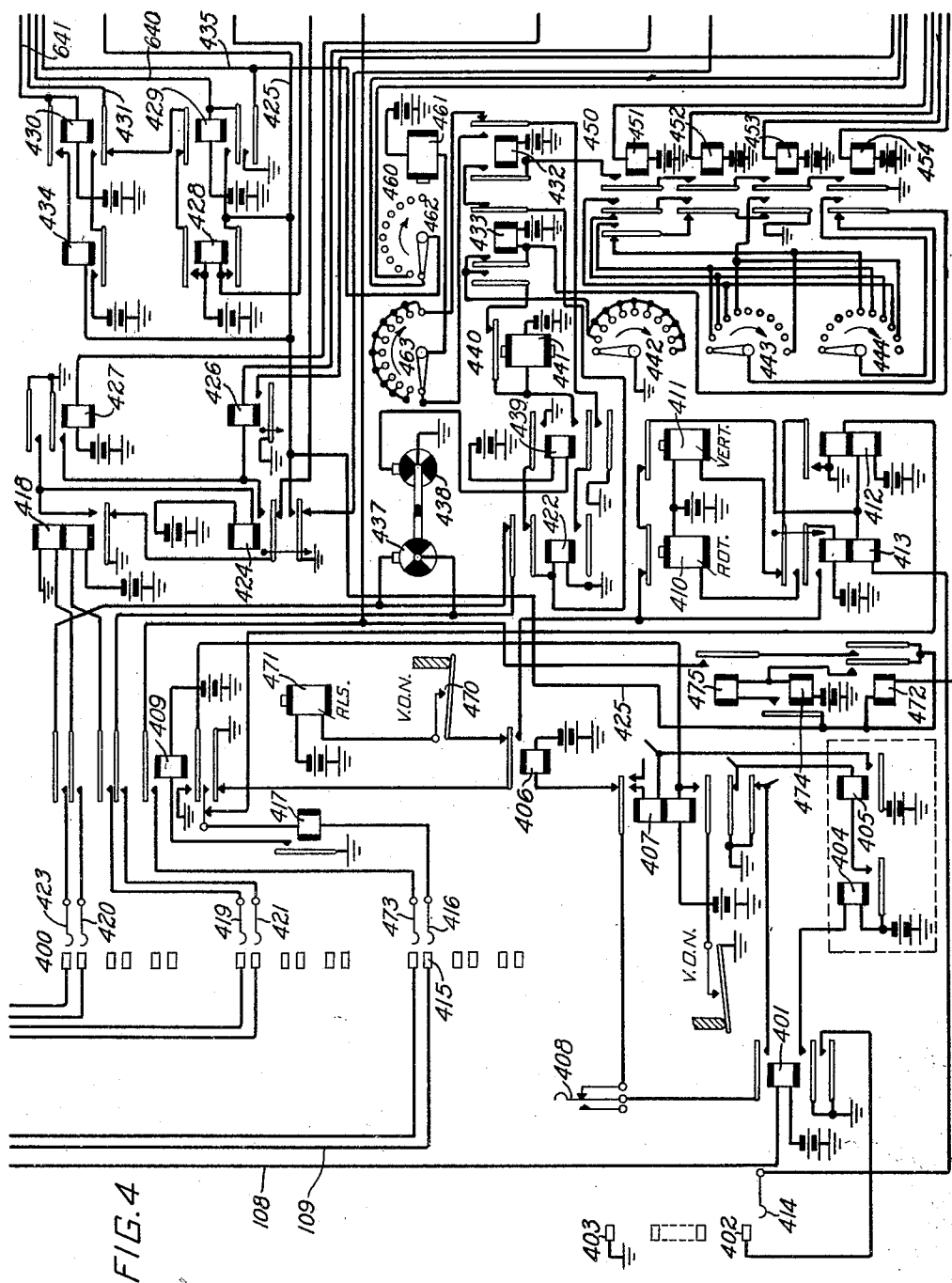


FIG. 4

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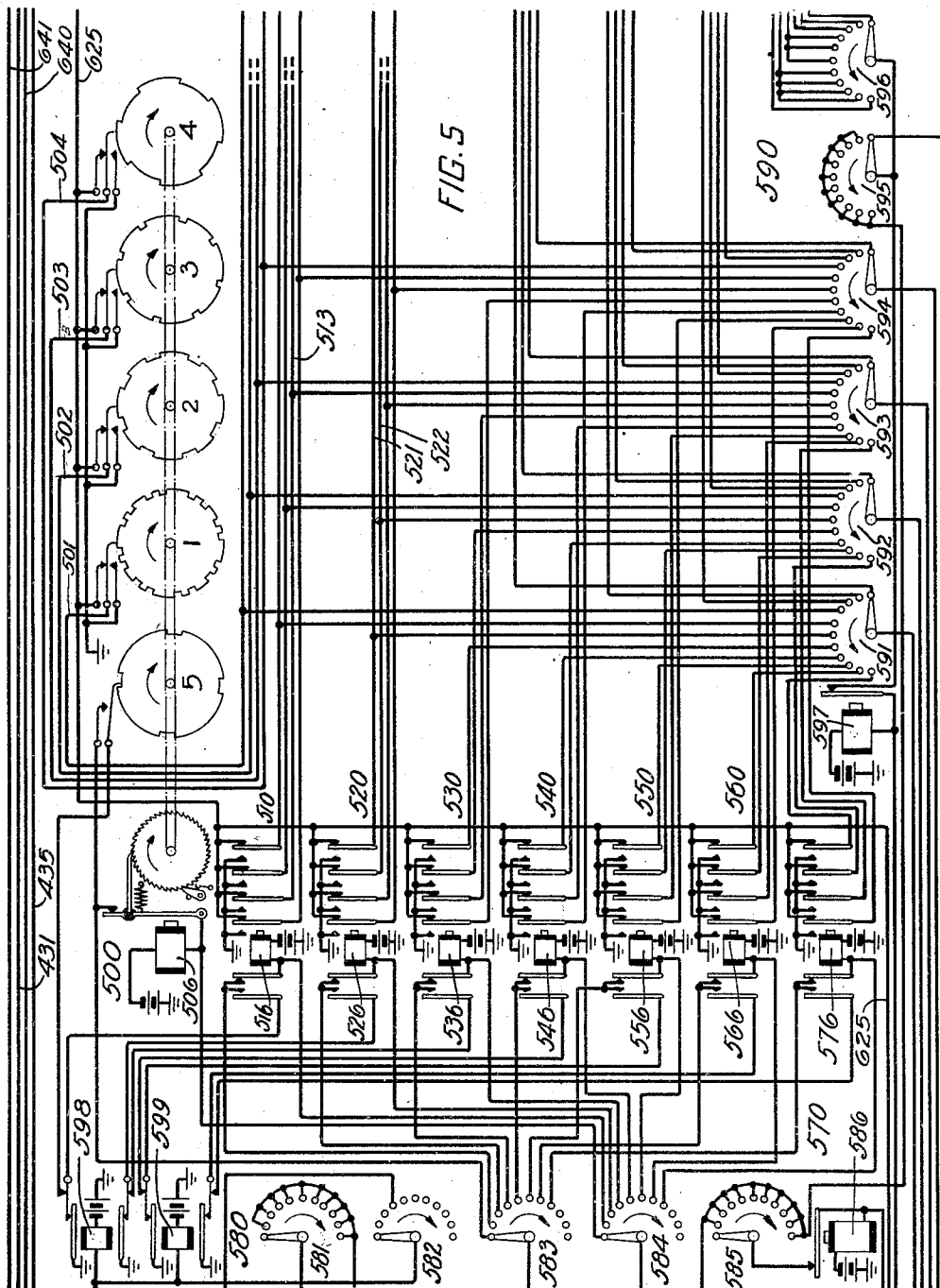
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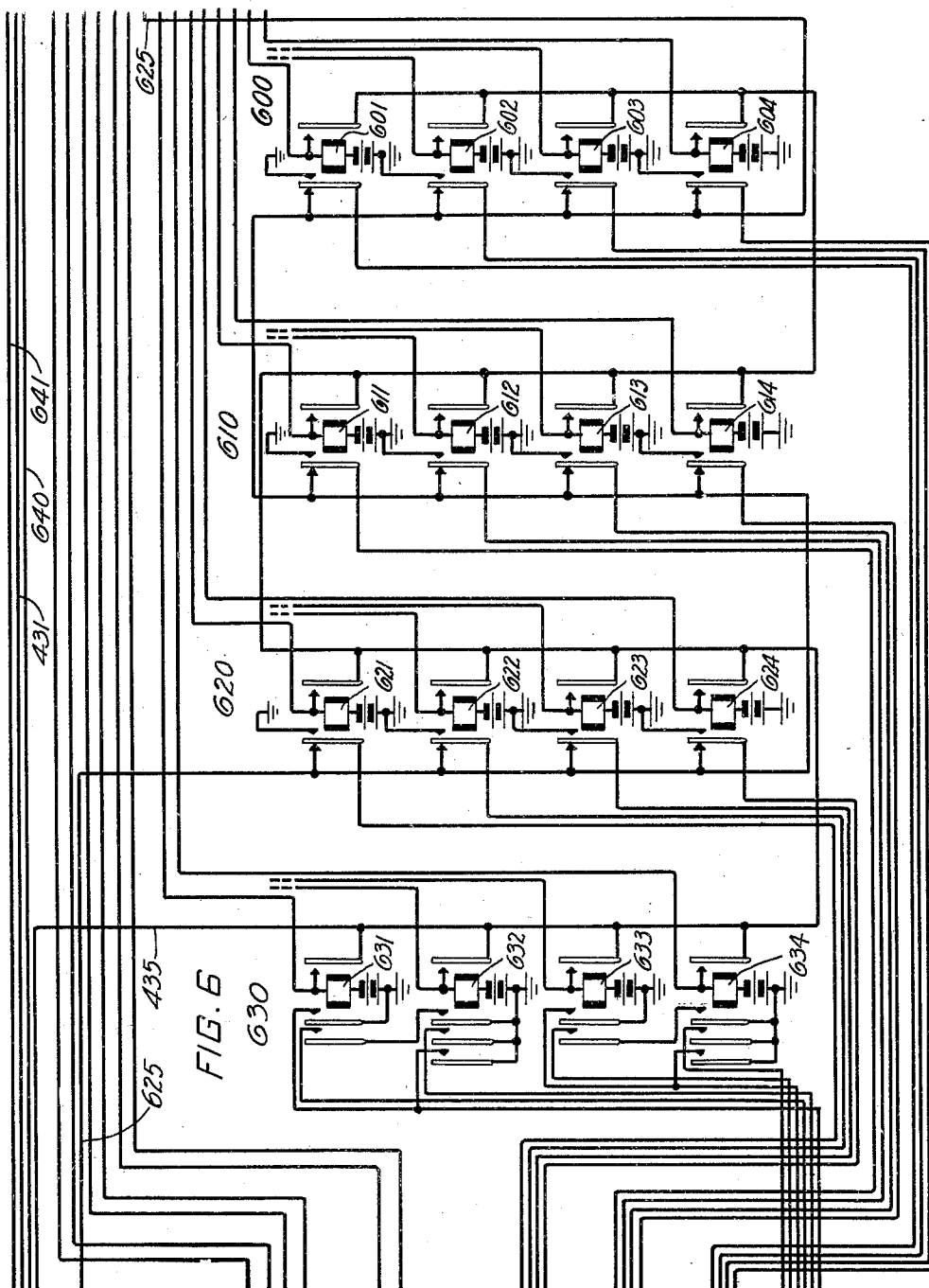
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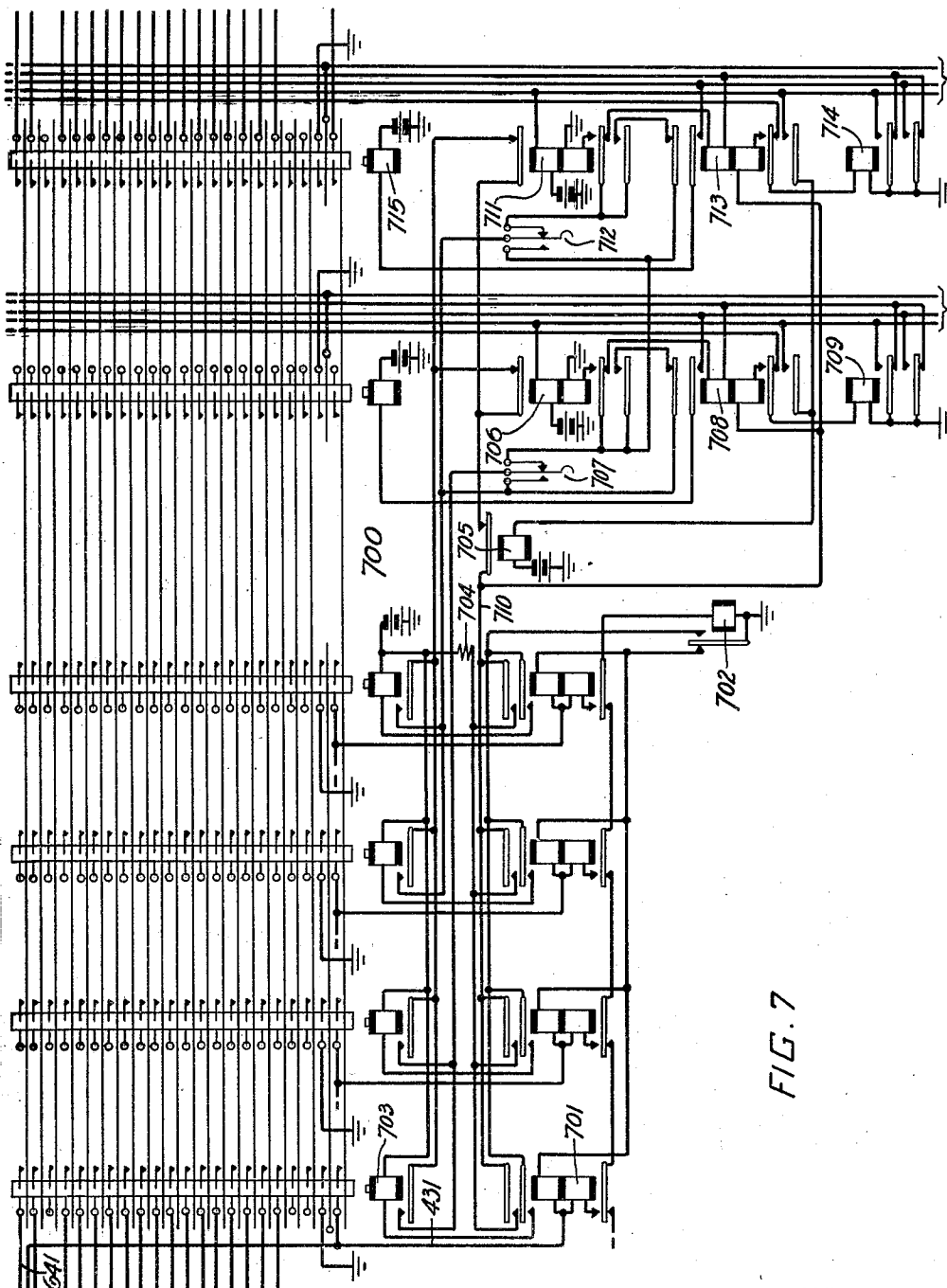


FIG. 7

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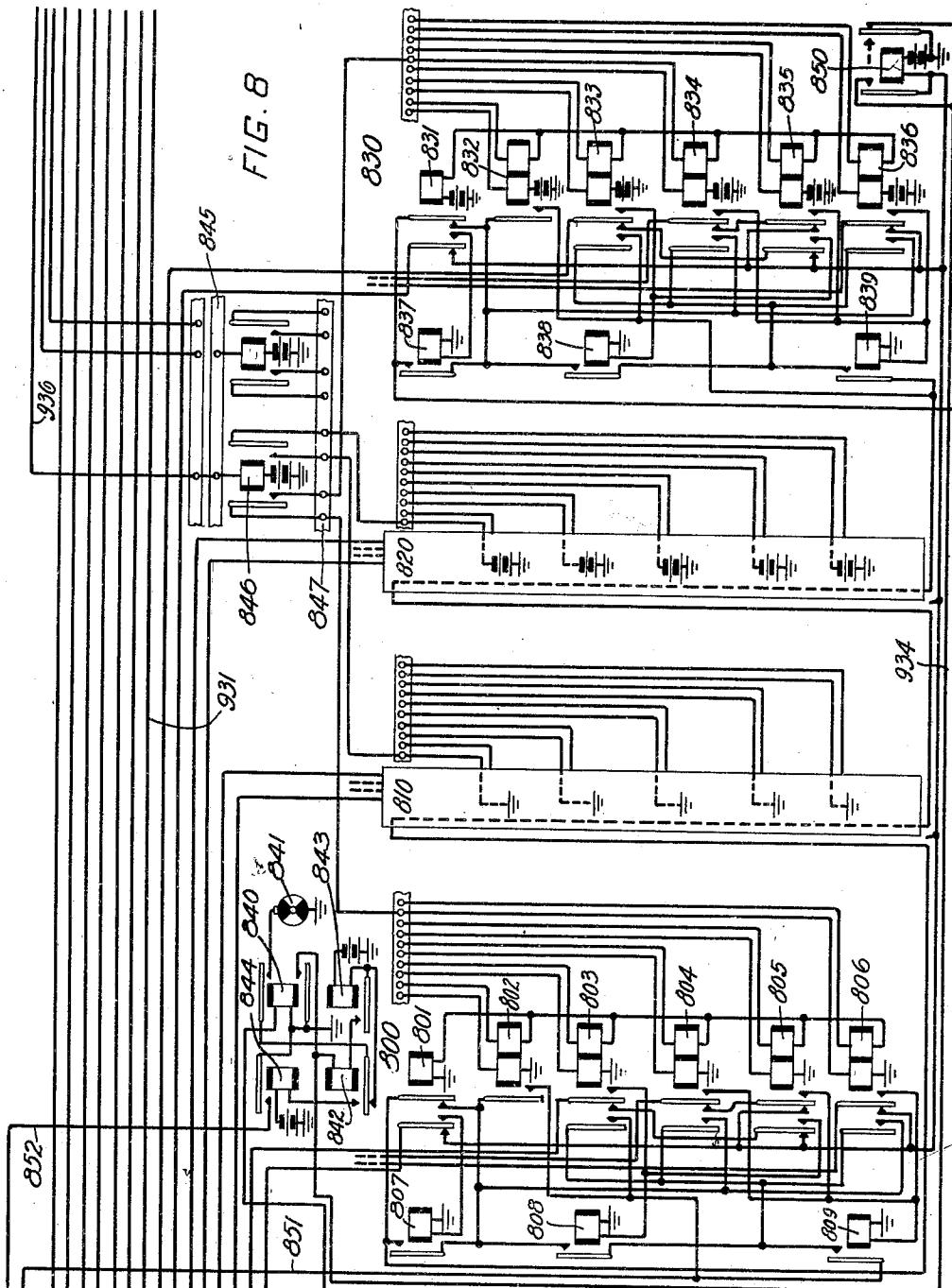
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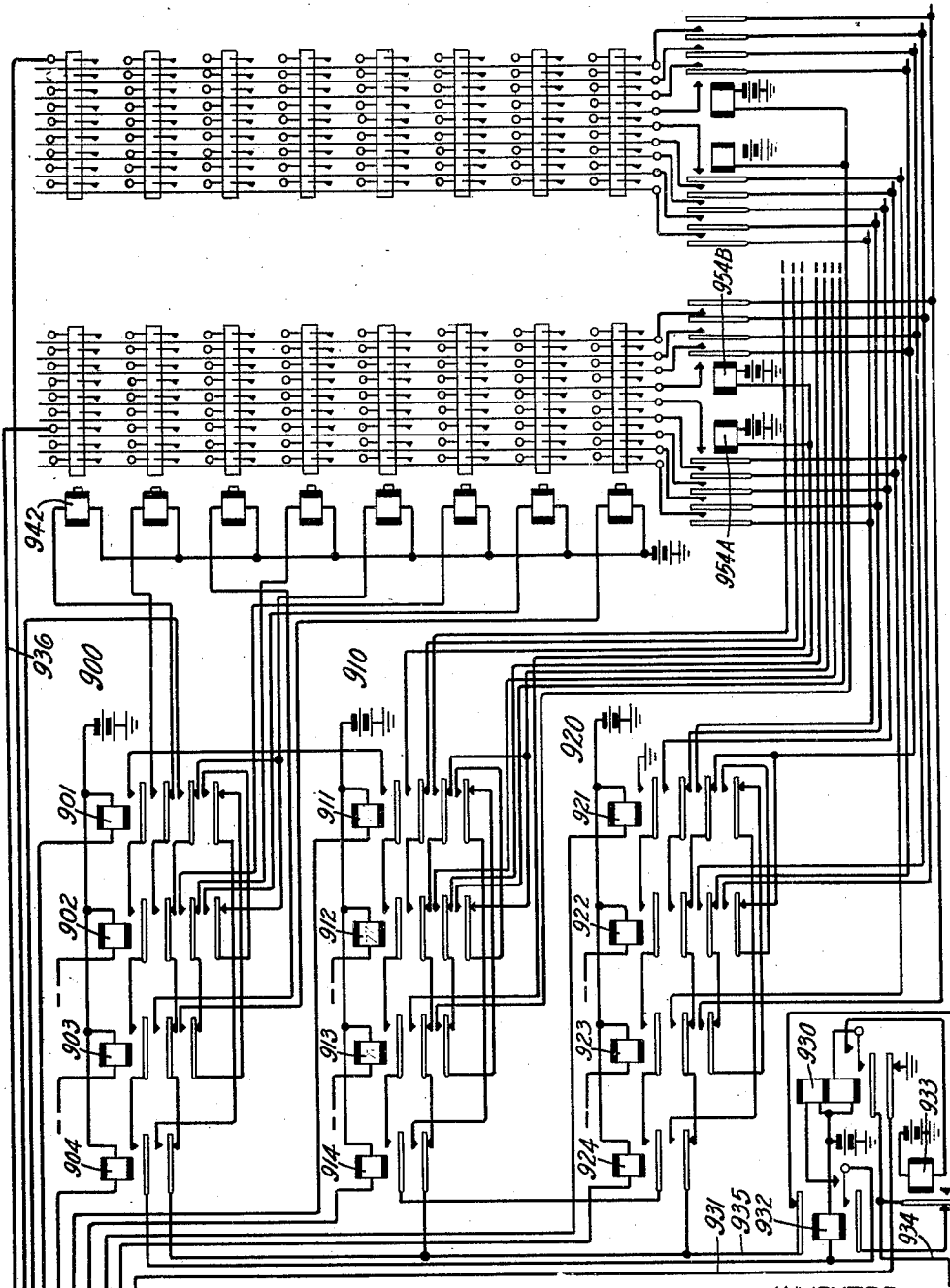


FIG. 9

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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Application filed January 25, 1930. Serial No. 423,313.

This invention relates to a telephone exchange system in which connections are established by means of automatic step-by-step switching apparatus operated under control of central office register senders of the director type.

According to the present invention, a number of decoding devices are provided common to a number of director senders; with means for associating simultaneously a plurality of said devices with respective senders for decoding registrations established in said senders, and for thereupon setting the switch controlling registers of said senders in accordance with decoded registrations to directly set step-by-step switches for telephone station interconnections.

According to another aspect of the invention, means is provided for testing the progressive operation of the sender apparatus as the dial impulses are recorded and decoded in order to detect faults or errors if such should be present to prevent incorrect operation of the directive control apparatus in setting the step-by-step switches.

The advantages of the sender and decoder combination are the same as described in Patent 1,700,456 to F. A. Stearn and my Patents 1,600,399, 1,600,398 and 1,623,777. The inventions of the foregoing patents relate to panel and coordinate types of switching systems. The efficiency of the sender and decoder combination is very high as compared to the senders of the type which include individual translators and much economy can be effected by the use of this type of sender. In the present invention, registers in the sender are set by a decoder after the dial impulses have been translated. An impulsing device is included in the sender for directly setting step-by-step switches in accordance with the aforementioned register settings. The impulsing device comprises a switching arrangement for permitting separate series of impulses to be transmitted for each switch setting in addition to control relays and an impulsing interrupter.

The invention will be more clearly understood from a consideration of the following

description taken in connection with the drawings, in which:

Fig. 1 shows a first selector and two secondary selectors.

Fig. 2 shows a subscriber's line and a line finder.

Fig. 3 shows a connector circuit and called subscriber's line.

Figs. 4, 5 and 6 show a sender for controlling the selectors of Figs. 1 and 3.

Fig. 7 shows a connector switch for connecting the sender of Figs. 4 to 6 with a decoder.

Figs. 8 and 9 show a decoder circuit.

The line finder of Fig. 2 is a switch of the step-by-step type, hunting in the vertical direction being controlled by a commutator and in the horizontal direction by the sleeve terminals of subscribers' lines. The switch has access to 200 calling lines and is provided with two brush sets together with a test relay which discriminates between the two brush sets. The selectors and connector switches of Figs. 1 and 3 are of the well known 100 point step-by-step type.

The decoder of Figs. 8 and 9 and the decoder connector of Fig. 7 are similar to those disclosed in U. S. Patent 1,700,456 to F. A. Stearn, issued January 29, 1929. The decoder comprises a set of registers positioned in accordance with the code of the wanted office which registers cause the operation of a single route relay which in turn operates another set of registers in accordance with the selector switch operation necessary to reach the wanted office. Fig. 7 shows one of a plurality of similar channels making up the connector switch by which any sender may be connected with any decoder. Each channel is made up of a plurality of multi-contact relays connected by a series of cross-wires. There is one such relay for each decoder in each channel and a similar relay for each of the senders which appear in any channel. Due to the large number of senders, a number of channels are necessary. When a decoder is taken for use in any one channel, it is marked busy to all of the channels.

The registers shown in Fig. 5 are some-

what different from those usually employed in senders. They resemble the sequence switches employed in Patent 1,009,020 to F. R. McBerty, granted November 21, 1911, but are operated by a stepping mechanism similar to that employed in Patent 1,472,465 to Forsberg-de Vignier, October 30, 1923. Five discs of insulating material are mounted on the shaft, each of which controls a movable contact member. The perimeters of discs 1, 2, 3 and 4 are notched according to a code and the movable contact members have two contacts, one of which is closed when the member encounters a notch on the controlling disc and the other of which is closed at all other times. Since the notches differ on each disc, different combinations of circuits are closed in each position of the register. The contact controlled by disc 5 is opened when the register is normal and closed at all other times, thus serving as a means for returning the register to normal. Each register has four normal positions so that the notched pattern is repeated four times. Register 500 has been shown in full, but registers 510 and 570 have their contacts indicated schematically to save space. Similarly the first and last of each set of four conductors connecting the sender with the decoder are shown and the two middle conductors omitted.

The operation of the system in general is as follows: When a subscriber initiates a call, the line finder 210 hunts for the level in which the line appears and then for the line itself which is extended through to the first selector 120. While the line finder is hunting, the operation of trunk finder 400 is initiated and the sender of Figs. 4 to 6 connected with the trunk of Fig. 1. At this time the subscriber's line is extended through to a pulsing relay in the sender, and the line relay of the first selector is connected through to a pulsing contact controlled by interrupter 437 and relay 422 also in the sender, the trunk being opened at the contacts of relay 102. The digits are then recorded on registers 500 to 570 inclusive, control switch 580 serving to direct the various digits to the proper registers. When switch 580 has reached position 4 following registration of the office code, the decoder connector of Fig. 7 is operated to associate a decoder with the sender. The registration set up on registers 500, 510 and 520 is then transferred to registers 900, 910 and 920 in the decoder which combine to operate relay 846 which is individual to the route by which the wanted office is to be reached. Under the control of relay 846, registers 800, 810, 820 and 830 are operated. These registers in turn establish circuits for operating registers 600, 610, 620 and 630 in the sender. When these registers have been positioned, the decoder is disconnected from the sender. Register

630 is a class register and determines how many sets of pulse must be sent out to reach the wanted subscriber. Switch 590 then controls the association of the registers 600, 610 and 620 with the stop register 450. This register marks a terminal on the bank of switch 440. When register 450 is operated, relay 422 removes the shunt from around the interrupter 437 and simulated dial pulses are sent out to the line relay 100 of the first selector. Interrupter 438 operates in synchronism with interrupter 437 and controls switch 440. When switch 440 reaches the marked terminal the shunt is reclosed around the interrupter 437 and switch 460 is operated to count-off a time interval during which the first selector may hunt. Similarly the other selectors are operated under the control of registers 620, 630, 530 to 560. Register 570 is a stations register and a corresponding digit is transmitted only in case the call is extended to a manual office in which a call indicator is located. When the selection control switch 590 is restored to normal either by the transmission of the stations digit or by the class register, relay 105 associated with the first selector and line finder is operated. The operation of this relay disconnects the sender from the trunk, establishes the connection between the calling subscriber and the called subscriber and prevents the association of another sender with the trunk.

The release by the calling subscriber at any time prior to the completion of a connection restores the selectors and sender to normal. The release of a completed connection is under the joint control of the calling and called subscriber.

Detailed description

A detailed description will now be given of the operation of the circuit. In this description the relay contacts will be described as though numbered starting at the top or at the left, and counting consecutively.

When the subscriber at sub-station 200 initiates a call, he completes a circuit from battery through the right winding of his line relay 201, contact 2 of cut-off relay 202, over the sub-station circuit, contact 1 of relay 202, left winding of relay 201 to ground. Relay 201 operates, connecting battery through the winding of the relay 202 to the sleeve terminal of the subscriber's line and connecting ground to the winding of relay 203 to initiate the operation of the line finder. Relay 203, which is individual to the group of twenty lines including line 200, connects ground to commutator segment 211 to identify the level in which the calling line may be found. It also closes a circuit from ground over contact 213, of test jack 214, contact 4 of relay 215, winding of relay 216 to battery. Relay 216 operates, closing a circuit over its 4th contact, contact of vertical magnet 217, contact 1 of rotary

magnet 218, lower winding of relay 219, contact 7 of relay 215 to battery. Relay 219 closes a circuit for vertical magnet 217 from battery over contact 7 of relay 215, winding of vertical magnet 217, contact 6 of relay 220, contact of relay 219 to ground at contact 4 of relay 216. Relay 216 also connects ground over contact 3 to conductor 222 to initiate the association of a sender with the trunk. Vertical magnet 217 operates in the circuit above traced, opening the circuit of relay 219. Relay 219 then releases in turn releasing magnet 217 and the relay and magnet thus cooperate to advance the line finder in search of the level marked. When commutator brush 221 encounters segment 211, a branch of the circuit of relay 219 is extended through the lower winding of relay 220, brush 221, segment 211 to ground at contact 1 of relay 203. Relay 220 locks in series with magnet 217, upper winding of relay 220, contact 4 of relay 220 to ground at contact 4 of relay 216. The vertical magnet can not operate in the series with relay 220.

With relay 220 operated, the circuit controlled by relay 219 is extended over contact 5 of relay 220, to the winding of rotary magnet 218 and battery. The line finder is now rotated in search of the calling line. Two testing circuits are prepared. One circuit extends from ground over contact 3 of relay 216, upper winding of relay 219, contact 1 of relay 215, lower winding of relay 224, to brush 228 of the upper brush set. The other circuit extends as above traced through the winding of relay 219, contact 6 of relay 223, contact 5 of relay 224, lower winding of relay 223, to brush 225 of the lower brush set. Assuming that line 200 appears before the upper brush set as shown, when the line is found the circuit of cut-off relay 202 is extended to ground through the windings of relays 224 and 219, as above traced. Relay 219 is held operated, holding the rotary magnet 218 operated. Relay 202 locks over its contact 3 to its energizing circuit independent of the line relay which is now released as soon as its circuit is opened at contacts 1 and 2 of relay 202. The line relay is made slow-to-release to permit relay 202 to lock before this circuit is opened.

Relay 224 is sufficiently energized through its lower winding to close its 3d contact, when its upper winding is energized over the 2nd contact of magnet 218, contact of relay 219 to ground at contact 4 of relay 216. Relay 224 extends the circuit of relay 202 over contact 4 of relay 224, contact 6 of relay 223, upper winding of relay 219 to grounded conductor 222. It extends the tip and ring conductors through to the armatures of relay 102. Relay 224 also closes a circuit from battery through the lower winding of relay 215, contact 6 of relay 224, to ground at off-normal contact 232. Relay 215 extends the circuit

of cut-off relay 202 over contact 2 of relay 215 to conductor 222 independent of the winding of relay 219. Relay 215 also closes a substitute locking circuit for relay 224 over contact 3 of relay 224, contact 3 of relay 215, to grounded conductor 222. With relay 215 operated, the start lead controlled by relay 203 is extended to the next line finder over contact 5 of relay 215 and contact 233 of the test jack. The operation of relay 215 also releases relay 216 which is slow-to-release and does not open its contacts until sufficient time has elapsed for the grounding of conductor 222 at the first selector. The operation of relay 215 disconnects battery at contact 7 from the lower winding of relay 219 and from both windings of relay 220 and these relays release in turn releasing magnet 218.

When conductor 222 was grounded by the operation of relay 216 as previously described, a circuit was completed over contact 8 of relay 102, contact 1 of relay 105, through the winding of relay 104 to battery. Relay 104 in operating connected ground to conductor 108 and prepared a circuit from battery through the winding of relay 102 to conductor 109. Grounded conductor 108 extends to the winding of relay 401 and battery. Relay 401 connects ground over contact 3 to commutator segment 402 to identify the level in which the trunk appears before trunk finder 400. It also operates in turn relays 404 and 405 to prepare a holding circuit for relay 407. In addition it closes a circuit from battery through the winding of relay 406, contact 1 of relay 407, contact of key 408, contact 1 of relay 401, contact 6 of relay 407 to ground. This circuit is completed only if there is an idle trunk finder and sender and extends to the winding of a relay such as relay 406 in the first idle trunk finder. Relay 406 operates in this circuit and closes a circuit from ground over contact 9 of relay 409, contact 2 of relay 406, interrupter contacts of rotary magnet 410 and vertical magnet 411, lower winding of relay 412 to battery. Relay 412 operates and connects ground over its contact and contact 1 of relay 413 to the winding of vertical magnet 411. The trunk finder is therefore advanced in search of the level marked by segment 402. When this segment is found, a circuit is closed from ground over contact 3 of relay 401, segment 402, brush 414, lower winding of relay 413, lower winding of relay 412, to battery. Relay 413 operates and relay 412 is held operated. Relay 413 locks from battery through its upper winding and contact 3, contact 2 of relay 406 to ground at contact 9 of relay 409. Relay 413 closes a circuit from battery through rotary magnet 410, contact 2 of relay 413, to ground at the contact of relay 412 causing the trunk finder to hunt for the trunk, which is identified by battery through relay 102 connected to conductor 109 and terminal 415. When this ter-

minal is found, the circuit of relay 102 is extended over brush 416 through the winding of relay 417, contact 8 of relay 409, upper winding of relay 412 to ground holding relay 412 operated and operating relays 417 and 102. Relay 417 operates relay 409. Relay 409 connects ground over contact 7 to the windings of relays 417 and 102 holding them operated and releasing relays 412 and 143. It also connects ground to the lower winding of relay 407 and battery thus extending the start circuit controlled by relay 401 to the next sender and releasing relay 406. In addition, relay 409 extends the control conductors of the sender to the trunk.

Relay 102 in operating locks over its 7th contact, contact 2 of relay 105, to conductor 109 and the winding of relay 417, thus rendering itself independent of relay 104. It opens the circuit of relay 104 causing that relay to release and release relay 401 and remove the calling condition. Relay 102 also splits the trunk. That is, it connects the subscriber's line over contacts 3 and 4 of relay 102, brushes 419 and 420 in the trunk finder, and contacts 2 and 3 of relay 409 to the windings of relay 418 which operates over the subscriber's loop. In addition, it completes a circuit from battery through the left winding of relay 100, contact 3 of relay 101, contact 5 of relay 102, brush 421, contact 4 of relay 409, contact 1 of relay 422, which is in shunt around the interrupter 437, contact 1 of relay 409, brush 423, contact 2 of relay 102, contact 1 of relay 101, right winding of relay 100, normal contact 106 of the first selector, left winding of dial tone coil 107 to ground. Relay 100 operates in this circuit and closes a circuit from ground over contact 7 of relay 101, contact 1 of relay 100, to the winding of relay 103 and battery. Relay 103 connects ground over contact 3 to conductor 222.

If the trunk finder operates quickly, these functions may take place in the order described. However, if the finder has to hunt over a considerable number of terminals in finding the trunk, the subscriber's line may be connected through to the windings of relay 100, and relay 103 operated to ground conductor 222 before the sender is associated with the trunk. However the contacts of relay 102 are so arranged that, in that case, the circuit of relay 100 will be maintained and no false pulse received. Relay 418 in operating closes a circuit from battery through the winding of relay 424 to ground at contact 1 of relay 418. Relay 424 connects ground to conductor 425 for locking certain relays to be operated hereinafter and also operates relays 598 and 599 to hold open the restoring circuits of the registers. The grounding of conductor 425 also closes a circuit from battery through the winding of magnet 597 and its back contact, normal contact of brush 595, winding of relay 472 to

conductor 425. Relay 472 has a very high resistance so that magnet 597 is not affected. The operation of relay 472 completes a circuit from conductor 425, contact 1 of relay 472, winding of relay 474 to battery. Relay 474 locks to conductor 425 through the winding of relay 475, but relay 475 remains inert as long as the operating circuit of relay 474 is held closed. When the subscriber dials, relay 418 responds and closes a circuit over contact 2, contact 1 of relay 424, winding of relay 426, brush 584 of the register control switch 580 to the winding of magnet 506 of the first register and battery. Magnet 506 advances its discs one step at each release of the relay 418, and the register comes to rest in a position corresponding to the digit dialed. Relay 426 operates in series with magnet 506 and being slow to release holds its armature attracted to the end of the digit. It closes a circuit from ground over its contact to the winding of magnet 586 and battery. Magnet 586 attracts its armature and when relay 426 releases at the end of the digit advances the brushes of control switch 580 to their second position. At this time the circuit controlled by relay 418 extends to the winding of magnet 516 which controls the second register and the second digit is recorded on that register. Similarly the remaining digits are recorded on the remaining registers.

When brush 582 reaches position 4 a circuit is closed from battery through the winding of relay 428, brush 582 to grounded conductor 425. Relay 428 locks over its contact 2 to grounded conductor 425 and connects battery over its first contact, contact 1 of relay 429, contact 3 of relay 430, conductor 431, upper winding of relay 701 to ground at contact 1 of relay 702. Relay 701 locks over its 3d contact and the back contacts of the relays individual to other senders in this channel, through the winding of relay 702 to ground. Relay 702 opens the energizing circuit of relay 701 and also that of the other relays individual to other senders. Relays 701 and 702 close a circuit from battery through the winding of multi-contact relay 703, contact 2 of relay 701, contact 2 of relay 702 to ground, connecting the conductors from the sender to the cross wires of the channel. Relay 701 also closes a circuit from battery through resistance 704, contact 1 of relay 701, conductor 710 contact of relay 705 and thence in parallel over the armatures of all the decoder relays such as relays 706 and 711, corresponding to idle decoders, contact of relay 703, to the contact of key 707. Assuming that the first decoder is busy, relay 706 will be operated and the circuit will extend over contact 4 of relay 706, contact 1 of relay 708, to the contact of key 712, contact 3 of relay 711, upper winding of relay 713, to ground at contacts 2 and 4 of relay 714. Relay 713

operates and closes a holding circuit for itself from ground through the winding of relay 714, contact 3 and lower winding of relay 713, conductor 710, contact 1 of relay 701, resistance 704 and battery. Relay 714 opens the energizing circuit of relay 713 and closes a circuit for relay 711 and similar relays individual to this decoder in each channel. Relay 714 also closes a circuit from ground over its first contact, contact 5 of relay 713, to the winding of relay 705 and battery. Relay 705 opens the operating circuit of relay 713. In addition relay 714 closes a circuit from battery through the winding of relay 715, contact 2 of relay 713, contact 3 of relay 714 to ground. Relay 715 extends the cross wires to the conductors of the decoder.

With both relays 703 and 715 operated the start conductor 431 is extended over contacts of these relays to the winding of relay 840 and ground. Relay 840 connects interrupter 841 over its first contact and contact 2 of relay 842 to the winding of relay 843 and battery. Relay 843 operates when the interrupter closes its contact and locks through the winding of relay 842 to ground at contact 2 of relay 840. However, relay 842 does not operate until the interrupter 841 disconnects ground from the operating circuit of relay 843. With relay 842 operated interrupter 841 is connected to the winding of relay 844 so that on the next closure of the contact, relay 844 operates to send a signal back to the sender. These relays and the interrupter serve to time the operation of the decoder and if it is not completed within the time limit set up, initiate the release of the decoder as will be described hereinafter.

As soon as the decoder and sender have been connected, circuits will be established for setting the decoder registers from the sender registers. Assume that the called line number is CHElsea 6789. The first three digits corresponding to the office name will be 2-4-3 and registers 500, 510 and 520 will have been positioned in their second, fourth and third positions, respectively. Registers 530 to 560 will have been advanced to positions 6, 7, 8 and 9 and register 570 will not have been operated. Four conductors, of which only two are shown in full, connect each of the registers 500, 510 and 520 through the decoder connector 700 to registers 900, 910 and 920 in the decoder. With register 500 in position 2, ground is connected to conductor 502 over cam 2; with register 510 in position 4 ground is connected to conductor 513 over cam 3 and with register 520 in position 3 ground is connected to conductors 521 and 522 over cams 1 and 2, respectively. Therefore, relays 902, 913, 921 and 922 are operated in the decoder because of the positions occupied by the code registers. At the same time a circuit is closed from ground over contact 3 of relay 930, conductor 931 through the decoder connector 700, conductor 625 over the normal contacts of discs 1, 3 and 4 of register 500 to the windings of relays 901, 903 and 904. This circuit also extends over the normal contacts of discs 1, 2 and 4 of register 510 to the windings of relays 911, 912 and 914 in the decoder and similarly over the normal contacts of discs 3 and 4 of register 520 to relays 923 and 924 of the decoder. Therefore, all of the relays of registers 900, 910 and 920 should be operated provided the connection through the decoder connector is properly established and is not interrupted by poor contact or actual breaks.

With all of the register relays operated, a circuit is completed from ground over the first contacts of relays 921, 922, 923, 924, 914, 913, 912, 911, 901, 902, 903 and 904 to the winding of relay 932 and battery. Therefore the operation of relay 932 is a check on the fact that the register relays have been properly operated. With relay 932 operated, a circuit is closed from battery through the upper winding of relay 930, contacts 2 and 3 of relay 932, contact 1 of relay 933, conductor 934 to ground at contact 2 of relay 840. Relay 932 also closes a holding circuit for itself to conductor 934. Relay 930 locks over its second contact to conductor 934 independent of relay 933 and then closes a circuit for relay 933. The operation of relay 930 disconnects ground from conductor 931 permitting the relays which were operated over the normal contacts of the sender registers to release. The release of these relays opens the operating circuit for relay 932. Relay 933 in operating opens the holding circuit of relay 932 and that relay releases. With relay 932 released, ground is connected from the conductor 934, over contact 2 of relay 933, contact 1 of relay 932 to conductor 935 and the contacts of registers 900, 910 and 920. Since relay 902 of register 900 was operated, this ground is connected over contacts 3 of relays 904 and 903, contact 2 of relay 902, contact 3 of relay 901 to the winding of relay 942 and battery, operating relay 942 which controls a plurality of cross wire contacts. At register 910 ground from conductor 935 is connected over contact 3 of relay 914, contact 2 of relay 913 to windings of relays 954-A and 954-B which together extend the contacts of register 920 to the cross wires controlled by relay 942. At register 920 ground on conductor 935 is connected over contact 3 of relays 924 and 923, contacts 2 of relays 922 and 921 over contact 3 of relay 954-A, contact 3 of relay 942 to conductor 936, winding of route relay 846 to battery. Thus the setting of the three code registers has been translated into a single designation. Relay 846 closes circuits for controlling the settings of outgoing registers 800, 810, 820 and 840. Registers 800 and 830 have been shown in full but registers 810 and 820 have

been shown diagrammatically. Connecting racks 845, 847, etc. permit the ready association of any routing relay with any office name, and the control by a route relay of any combination of settings of the relay registers. Assuming that the office CHELSEA is reached by trunks appearing in the fourth level of the first selector, the cross-connections will be as shown, and the operation of relay 846 closes a circuit from ground through the left winding of relay 806, contact 1 of relay 846, right winding of relay 834, winding of relay 831 to battery. In registers 810 and 820 the relays corresponding to relay 802 will be operated in each case. With these relays operated, circuits are closed for setting class register 630 and selection control registers 600, 610 and 620 in the sender. In order to insure that the sender has been properly positioned, circuits are provided for testing the completion of the circuits actually employed in setting the sender registers and other circuits provided for testing for false grounds or cross connections on the conductors not employed in setting the sender. With relay 806 operated the following circuit is closed from ground through the winding of relay 809, contact 3 of relay 806, through the decoder connector, winding of relay 603 to battery. The relays of registers 810 and 820 do not operate any sender relays but close links in a checking circuit to be traced hereinafter. With relays 831 and 834 operated, circuits will be closed through the winding of relay 837 to the winding of relay 634 and from ground through the winding of relay 839 to the winding of relay 632. With these relays operated a checking circuit is closed from ground over contact 3 of relay 850, contact of relay 837, contact 1 of relay 834, contact of relay 839, over contacts in both registers 820 and 810 similar to contact 3 of relay 831 and the contact of relay 832, contact 3 of relay 801, contact 1 of relay 806, contact of relay 809, conductor 851 through the decoder connector to conductor 640, winding of relay 429 to battery. The completion of this circuit sends a signal to the sender that the decoder has completed its operation and may be released.

It will be apparent that this circuit can be completed only if relay 850 is unoperated. An inspection of Fig. 8 will show that relay 850 is connected by way of the back contacts of unoperated relays to those conductors not employed in setting the sender registers. If a false ground is connected to any one of these conductors, or it is crossed with any of the conductors used in setting the sender, in which case it will also be grounded through a relay, relay 850 is operated and removes ground from the checking circuit thus preventing the transmission of a release signal to the sender.

Relay 429 when operated in the above

traced circuit locks over its second contact to grounded conductor 425. It also opens the start conductor and applies a ground to conductor 435 to lock the relays of registers 600, 610, 620 and 630. The opening of the start conductor releases relay 701, in turn releasing relay 703 and disconnecting the sender from decoder. It also opens the circuit for relay 840 to stop the counting operation. In addition relays 705, 714, 713, 711 and 715 are released together with relays corresponding to relays 711 in the other channels of the decoder connector. With relay 840 released, relays 933 and 930 release. The relays of registers 900, 910 and 920 are released by the disconnection of the decoder from the sender in turn releasing relays 942, 954A, 954B and 846 and the relays of registers 800, 810, 820 and 830. The sender is now ready to control selections.

If these operations are not completed in the time provided by the operation of the interrupter 841, or the release signal cannot be sent because the checking circuit is incomplete or because relay 850 is operated from ground over one of the unused conductors, the operation of relay 844 connects ground to conductor 852 and thence through the decoder connector to conductor 641, winding of relay 430 and battery. Relay 430 opens the start lead to permit the decoder and decoder connector to release. It closes a holding circuit for itself through the winding of relay 434 to ground at conductor 425 but relay 434 cannot be operated until the decoder has been disconnected, since the trouble release ground is in shunt of its winding. When relay 434 operates, it connects battery over its contact and contact 2 of relay 430 to start conductor 431 initiating the connection of another decoder with the sender. It is, of course, possible that the same decoder might be used, although this is not likely. The operation of the decoder is the same as above described.

Class register 630 determines which digits shall be transmitted by establishing circuits for passing the selection control switch through those positions corresponding to digits not to be sent out. Relays 631 and 632 are operated in accordance with the number of selections necessary to select an outgoing trunk. With neither of these relays operated three selections are made. With relay 631 alone operated two selections, with relay 632 operated one selection. With both operated, these selections can all be skipped. In positions 4, 5 and 6 the selection control register 590 causes the transmission of the code digits as in the case of a tandem call indicator call. These digits are skipped with either relay 633 or 634 operated. The stations digit which is used only for call indicator calls is skipped with relay 634 operated, while the numerical digits which are not used in a call to an oper-

tor are skipped if both relays 633 and 634 are operated.

With selection control switch 590 in its normal position circuits are prepared for the relays of stop register 450 to the right armatures of the relays of register 620. However, with relays 632 and 634 of class register 630 operated, a circuit is closed from ground over contact 1 of relay 632, brush 596 in position 1, interrupter contact and winding of magnet 597 to battery, so that the register control switch is immediately advanced one step. As soon as switch 590 leaves position 1 the circuit of relay 472 is opened in turn opening the operating circuit of relay 474 and permitting relay 475 to operate. A similar circuit is closed over contact 2 of relay 632, and brush 596 in position 2, advancing switch 590 to position 3 in which position register 600 is connected to the stop register.

With relay 603 operated, ground is connected over contact 2 of relay 603 and thence over brush 593 to the winding of relay 453. Since relays 601, 602 and 604 were not operated, circuits are closed for relays 451, 452 and 454 over brushes 591, 592 and 594 back contacts of relays 601, 602 and 604 to conductor 625, normal contact or brush 462 of the timing switch 460 to ground at contact 3 of relay 429. With these relays operated, a circuit is closed from ground over contact 3 of relays 454, 453 and 452, contact 5 of relay 451 to winding of relay 432 and battery. Relay 432 closes a locking circuit for itself over its first contact, contact 3 of relay 433, winding of relay 422 to ground, but relay 422 cannot operate as long as it is shunted by ground over the chain circuit. Relay 432 also closes a circuit from ground at contact 3 of relay 439, contact 2 of relay 432, brush 463 in position 1 to the winding of magnet 461 and battery. Relay 439 is controlled from the contact of interrupter 438 and therefore closes its contact intermittently. The first operation of relay 439, following the establishment of the above circuit, operates magnet 461 and then releases it to advance the timing switch to its second position. In this position ground from the front contact of relay 429 is connected to the winding of magnet 597 of the selection control switch to operate the magnet. However, the switch does not advance its brushes until the magnet releases.

The advance of the timing switch opens the operating circuit of relay 432 and permits relay 422 to operate, provided relay 439 is not operated at the same time. Interrupters 437 and 438 are mounted in the same shaft and rotate in synchronism. However the contact of interrupter 438 is closed at the time that the contact of interrupter 437 is opened. Therefore, relay 439 is operated at the same time that interrupter 437 opens its contact. If the circuit for relay 422 becomes

effective at the time the interrupter contact is opened, a shunt is closed over contact 2 of relay 422 and contact 1 of relay 439 which prevents the operation of relay 422 and the consequent mutilation of the first digit.

When relay 439 releases relay 422 can operate and in so doing opens the shunt around its own winding as well as the shunt around interrupter 437. It also prepares a circuit over its third contact, contact 2 of relay 439 to the winding of magnet 441 which controls the counting switch 440. The next opening of the interrupter contact 437 is transmitted as an open pulse to the winding of relay 100 which releases to control the setting of the first selector. The advance of the timing switch releases relays 451, 452 and 454. With relay 453 operated, a circuit is closed from battery through the winding of relay 433, contact 1 of relay 454 to brush 443. The counting switch is advanced one step for each pulse sent to the first selector and as soon as it takes the fourth step, the circuit of relay 433 is extended over contact 2 of relay 453 to ground.

Relay 433 in operating opens the holding circuit for relay 432 and the circuit of relay 422, thus reclosing the shunt around interrupter 437 and stopping the counting switch. Relay 433 also closes a circuit from ground at brush 442 of the counting switch 440 and strapped off-normal terminals, contact 1 of relay 433, interrupter contact and winding of magnet 441 to battery which restores the counting switch 440 to normal. The release of relay 432 closes a circuit from battery through the winding of magnet 461 of the timing switch 460, brush 463 and the strapped off-normal terminals, contact 3 of relay 432 to contact 3 of relay 439 and ground. Relay 439, which continues to operate and release under control of interrupter 438 thus steps the timing switch back to normal. When brush 462 leaves its second position, it opens the circuit of magnet 597 and advances the selection control switch 590 to position 4.

At the first selector, the release of relay 100 at each opening of the interrupter contact closes a circuit from ground over contact 7 of relay 101, contact 2 of relay 100, contact 2 of relay 103, winding of relay 110, winding of vertical magnet 111 to battery. Magnet 111 steps the first selector to the level indicated by the setting of the stop register 450. Relay 110 also operates in this circuit and, being slow to release, it remains operated throughout the reception of pulses. As soon as the switch steps off-normal with relay 110 operated, a circuit is closed from ground over contact 3 of relay 103, contact 2 of relay 110, off-normal contact 112 to the winding of relay 113 and battery. Relay 113 closes a holding circuit for itself over the contact of the rotary magnet 114, contact 1 of relay 113 to ground on contact 7 of relay 101. Relay

110 releases, following the completion of the first digit and a circuit is closed from ground over contact 3 of relay 103, contact 1 of relay 110, contact 2 of relay 113 for the rotary magnet 114. Magnet 114 opens the holding circuit of relay 113 which releases in turn releasing the rotary magnet to step the first selector to the first set of terminals in the level. When magnet 114 recloses its contact, it closes a circuit for relay 113 extending from battery through the winding of that relay, vertical off-normal contact 112, back contact to magnet 114, winding of relay 101, normal rotary contact 117 to ground at contact 3 of relay 103. If the trunk on which the brushes of the first selector are now standing, is busy, ground on the sleeve terminal of that trunk will be extended over contact 5 of relay 101 to the winding of relay 113, holding relay 113 operated and shunting relay 101. Relay 113 reoperates the rotary magnet which again releases relay 113 and in this manner the first selector is rotated until an idle trunk is found. At this time no shunt exists for relay 101 and that relay operates in the circuit above traced. With relay 101 operated the tip and ring conductors are extended through to the second selector and the release conductor 222 is also extended to the control of the second selector. The operation of relay 101 opens the circuit of relay 100 which releases in turn releasing relay 103 but these functions take place slowly enough to permit the holding of the connection by the second selector. Relay 101 is held operated in the circuit above traced in series with relay 113 to ground at the second selector.

Returning to the sender, when selection control switch reached position 4 a circuit was closed from ground, contact 1 of relay 634, brush 596 in positions 4, 5 and 6, interrupter contact and winding of magnet 597 to battery. Switch 590 is therefore stepped immediately to position 7. As soon as the selection control switch 590 is advanced to position 7, relays 451 and 454 of register 450 are operated under the control of thousands register 530 which was set in position 6. When the timing switch returns to normal, ground from contact 3 of relay 429 is extended to the normal contacts of register 530 and thence to the stop relays 452 and 453, to initiate the transmission of the thousands digit which effects the setting of the second selector 130. In position 8 the stop register is placed under the control of hundreds register 540 and third selector 140 is operated in accordance therewith.

When the third selector selects a connector, such as the one shown in Fig. 3, a circuit is closed from battery through the left winding of relay 301, contact 3 of relay 302 thence through the third, second and first selectors, contact 4 of relay 101, contact 5

of relay 102 to the back contact of relay 422 and the interrupter 437, back over contact 2 of relay 102, contact 2 of relay 101 through the selector switches to contact 1 of relay 302, left winding of relay 301 to ground. Relay 301 operates, in turn operating relay 303 which connects ground to conductor 304. This ground is extended back over the release conductor through the selectors to conductor 222 to maintain the connection. The connector is now operated vertically under the control of the tens register 550 which was set in position 8. With the register in position 8, ground is connected over cams 1, 2 and 4 to relays 451, 452 and 454 of the stop register. The counting switch is advanced in the manner previously described until it reaches its 8th terminal, at which time the stop circuit is extended from battery through the winding of relay 433, contact 2 of relay 454, brush 444, terminal 8, contact 4 of relay 451, contact 2 of relay 452 to ground at contact 1 of relay 453. The units digit is transmitted in a similar manner under the control of register 560. It will be remembered that this register was set in position 9 and therefore ground is connected over cams 3 and 4 of the register to relays 453 and 454 and the stopping circuit extends from ground over contact 2 of relay 453, brush 444 and its 9th terminal, contact 2 of relay 454 to the winding of relay 433.

At the connector switch the release of relay 301 in response to each pulse of the tens digit closes a circuit from ground at its second contact, contact 3 of relay 303, normal vertical contact 305, winding of relay 306, winding of vertical magnet 307 to battery. At the first vertical step, normal contact 305 is opened and off-normal contact 308 is closed. Relay 306 operates in series with vertical magnet 307 and closes a holding circuit for itself which may be traced from ground over contact 2 of relay 301, contact 3 of relay 303, off-normal contact 308, contact 2 of relay 306, winding of relay 308, winding of magnet 307 to battery. This circuit is maintained by the slow to release nature of relay 306 throughout the tens digit. In the interval between the tens and units digit, relay 306 releases and the circuit controlled by the release of relay 301 is extended over contact 1 of relay 306, contact 4 of relay 309 to the winding of relay 310 and battery and in parallel therewith over contact 5 of relay 311 to the winding of rotary magnet 312 and battery. Relay 310 closes a holding circuit for itself over its fourth contact to contact 2 of relay 301 and remains operated because of its slow to release character throughout the units digit. Rotary magnet 312 responds to the units digit to rotate the connector to the wanted subscriber's line. When relay 301 remains operated following the units digit, relay 310 releases and during its re-

lease time, closes a testing circuit for the subscriber's line which may be traced from battery through the winding of relay 309, contact 7 of relay 311, contact 3 of relay 310 to the sleeve brush of the connector. If the wanted subscriber's line is busy ground will be connected to this terminal and relay 309 operated. Relay 309 closes a locking circuit for itself over contact 7 of relay 311, contact 2 of relay 310, as soon as relay 310 releases, contact 3 of relay 309 to ground at contact 2 of relay 303. Relay 309 opens the circuit of relay 310 and closes a circuit from battery through busy tone coil 314, interrupter 313, contact 1 of relay 309 to ground through the right winding of relay 302. Relay 302 operates intermittently in this circuit and reverses the connection of relay 301 to the tip and ring conductors, thus reversing the polarity of current flow over the line to give a busy tone to the calling subscriber.

If the wanted subscriber's line is idle, relay 309 will not operate and a circuit will be closed as soon as relay 310 releases from ground over contact 2 of relay 303, contact 2 of relay 309, upper winding of relay 311, contact 1 of relay 310, sleeve brush of the connector 300 to battery through the cut-off relay of the wanted subscriber's line. Relay 311 closes a holding circuit for itself over its third contact to contact 1 of relay 303. It also connects direct ground over its eighth contact to the sleeve brush to hold the subscriber's line busy. Relay 311 in operating causes the application of ringing current to the line in a circuit which may be traced from ground through ringing current generator 317, contact 4 of relay 318, upper winding of relay 316, which is shunted by a condenser and resistance, contact 3 of relay 316, contact 2 of relay 311 over the ring brush to the called line and back over the tip brush, contact 1 of relay 311, contact 1 of relay 316 to ground. The subscriber's bell rings in this circuit and when he answers, relay 316 operates in the direct current circuit completed thereby and locks over its lower winding and fifth contact to ground through contact 1 of relay 303. The operation of relay 316 removes ringing current from the line and connects the calling line through to the windings of relay 302 which now operates, reversing the connection of relay 301 to the tip and ring conductors. It also supplies substitute ground for holding relays 311 and 316 operated, placing these relays of the connector under the joint control of the calling and called subscribers.

Following the transmission of the units digit selection control switch 590 was advanced to position 11 in which a station's digit might be sent. However, with class register relay 634 operated the switch 590 is immediately advanced to position 1. The circuit previously traced for relay 472 is again closed

and that relay now closes a circuit from grounded conductor 425, contact 2 of relay 472, contact of relay 475, contact 5 of relay 409, brush 473, winding of relay 105 to battery. Relay 105 opens the locking circuit of relay 102. With this relay released, the calling subscriber's line is connected through to the windings of relay 301 in the connector. The contacts of relay 102 are so arranged that relay 301 is held operated continuously. Relay 105 locks to grounded conductor 222. The release of relay 102 opens the circuit of relay 418, in turn opening the circuit of relay 424. Relay 424 remove locking ground from the relay registers and also opens the circuit of relays 598 and 599. With these relays released, ground is connected to the off-normal contact of each register and the registers are restored to normal. Ground is also supplied to restore the register control switch 580 and the selection control switch 590 to normal over contact 4 of relay 424. The sender is therefore ready for use in connection with another call.

The operation of relay 105 also opens the circuit of relay 417 which in turn releases relay 409. With relay 409 released a circuit is closed from battery through release magnet 471, off-normal contact 470, contact 1 of relay 406 to ground at contact 9 of relay 409. The trunk finder switch is then restored to normal. The release of relay 409 also opens the circuit of relay 407 but a separate holding circuit is provided which is effective if a trunk is seeking an idle sender at the moment that relay 407 would release. This circuit is extended from battery at the front contact of relay 405 through the upper winding of relay 407 and its second contact, contact of key 408, contact 1 of relay 401 to ground at the back contact of relay 407 of any idle trunk finder. As soon as a sender has been associated with the trunk relay 405 is released permitting relay 407 to release and return the trunk finder to service.

When the calling subscriber hangs up his receiver, relay 301 releases in turn releasing relay 303. The release of relay 303 disconnects ground from conductor 304 and in turn from conductor 222, releasing all of the selectors but not the connector. The release circuit for selector 120, for example, may be traced from battery through release magnet 116, off-normal contact 115, contact 1 of relay 103, contact 2 of relay 100 to ground at contact 7 of relay 101, which contact is closed when relay 101 releases due to the removal of ground from conductor 222. The removal of ground from conductor 222 permits the release of relay 224. With relay 224 released a circuit is closed from battery through the winding of release magnet 231, off-normal contact 234, contact 1 of relay 220, contact 7 of relay 224, contact 1 of relay 216 to ground

on off-normal contact 232. The release of the line finder opens the circuit of the release magnet. Relay 215 is held operated until off-normal contact 232 is opened. It is also held operated over its fifth and sixth contacts to the start conductor if a call is being extended in the group of the calling subscriber at the time the line finder returns to normal. When the called subscriber restores his receiver relay 302 also releases and relays 316 and 311 are no longer held operated. A circuit is thereupon closed from battery through the winding of release magnet 315, off-normal contact 318, contact 6 of relay 311, contact 4 of relay 303, contact 2 of relay 301 to ground restoring the connector to normal.

What is claimed is:

1. In a telephone exchange system, a plurality of senders, means in each sender for recording dial impulses, a group of decoders common to said senders, means in each sender to cause the association of an idle decoder therewith, step-by-step switches, controlling registers in each sender, means in said decoder to designate a setting for said controlling registers, means to set said registers in accordance with said designation, and means to transmit directive impulses for setting up a train of said switches for a telephone connection in accordance with said register settings.

2. In a telephone exchange system, a plurality of senders, means in each sender for recording dial impulses, a group of decoders common to said senders, means in each sender to cause the association of an idle decoder therewith, step-by-step switches, controlling registers in each sender, means in said decoder to designate a setting for said controlling registers, means to set said registers in accordance with said designation, and an impulsing device operable in response to the action of said decoder for transmitting a plurality of trains of directive impulses under the guidance of said registers for setting a plurality of said switches.

3. The combination in a telephone system, of step-by-step switches, means for extending connections to said switches, a number of senders having registers for recording dial impulses and registers for controlling directive impulses for setting said step-by-step switches, a number of decoders commonly available to said senders, means for connecting a sender with any one of said decoders, cooperating means in the sender and decoders responsive to such connection for operating the decoder for deciphering impulses recorded in the sender, means in the decoder responsive to said operation for setting the impulse controlling registers, and means responsive to the action of said decoder for transmitting trains of impulses for setting a plurality of said switches in accordance with the setting of said impulse controlling registers.

4. The combination in a telephone system, of step-by-step switches, means for extending connections to said switches, a number of senders having registers for recording impulses and registers for controlling directive impulses for setting said switches, a number of decoders commonly available to said senders, means to connect a plurality of senders indiscriminately with an equal plurality of said decoders, cooperating means in the senders and decoders responsive to such connections for operating the decoders for deciphering the impulses recorded in the respective senders and for setting respective impulse controlling registers accordingly, and means in said senders for transmitting trains of directive impulses in accordance with the latter register settings for setting a plurality of trains of switches.

5. In a telephone system, a first register, a second register, a plurality of conductors interconnecting said registers, means to position said first register, means under control of said first register and including certain of said conductors for positioning said second register correspondingly, and means to indicate whether each of said certain conductors are unbroken.

6. In a telephone system, a first register, a second register, a plurality of conductors interconnecting said registers, means to position said first register in accordance with any one of a plurality of designations, means under the control of said first register and including different combinations of said conductors for positioning said second register correspondingly and means to indicate whether each of the conductors in said combinations are unbroken.

7. In a telephone system, a first register, a second register, a connector switch for connecting said registers, a plurality of circuits extending between said registers through said switch, means to position said first register, means under the control of said first register and including certain of said circuits, for positioning said second register correspondingly, and means to indicate whether each of said circuits are completed.

8. In a telephone system, a first relay register, a second relay register, a connector switch for connecting said registers, a plurality of circuits extending between said registers through said switch, means to operate the relays of said first register in accordance with a particular designation, said relays being effective to close said circuits in combination to operate the relays of said second register correspondingly, other relays included in said circuits by the operation of the relays of said first register, and means controlled by said other relays for initiating a further operation.

9. In a telephone system, a first relay register, a second relay register, a connector

- switch for connecting said registers, a plurality of circuits extending between said registers through said switch, means to operate the relays of said first register in accordance with a particular designation, said relays being effective to close said circuits in combinations to operate the relays of said second register correspondingly, other relays equal in number to the maximum number of said circuits closed at any one time and included in said circuits by the operation of the relays of said first register, a chain circuit over the contacts of said other relays for initiating a further operation, and contacts controlled by the relays of said first register for completing said chain circuit in substitute of the contacts of said other relays not employed in a particular setting.
10. In a telephone system, a first relay register, a second relay register, a connector switch for connecting said registers, a plurality of circuits extending between said registers through said switch, means to operate the relays of said first register in accordance with a particular designation, said relays being effective to close said circuits in combination to operate the relays of said second register correspondingly, other relays, said other relays being included in said circuits by the operation of the relays of said first register, and means controlled by said other relays and by relays of said first register jointly for initiating a further operation.
11. In a telephone system, a first relay register, a second relay register, a connector switch for connecting said registers, a plurality of circuits extending between said registers through said switch, means to operate the relays of said first register in accordance with a particular designation, said relays being effective to close said circuits in combination to operate the relays of said second register correspondingly, other relays, said other relays being included in said circuits by the operation of the relays of said first register, means controlled by said other relays for initiating a further operation, an additional relay, a circuit for said additional relay extending to each of the circuits not closed by the relays of said first register and means controlled by said additional relay for preventing the initiation of said further operation.
12. In a telephone system, a first relay register, a second relay register, a connector switch for connecting said registers, a plurality of circuits extending between said registers through said switch, means to operate the relays of said first register in accordance with a particular designation, said relays being effective to close said circuits in combination to operate the relays of said second register correspondingly, other relays equal in number to the maximum number of said circuits closed at any one time and included in said circuits by the operation of the relays of said first register, a chain circuit over the contacts of said other relays for initiating a further operation, contacts controlled by the relays of said first register for completing said chain circuit in substitute of the contacts of said other relays not employed in a particular setting, an additional relay, a circuit for said additional relay extending to each of the circuits not closed by the relays of said first register and means controlled by said additional relay for preventing the initiation of said further operation.
13. In a telephone system, a first relay register, a second relay register, a connector switch for connecting said registers, a plurality of circuits extending between said registers through said switch, means to operate the relays of said first register in accordance with a particular designation, said relays being effective to close said circuits in combination to operate the relays of said second register correspondingly, other relays, said other relays being included in said circuit by the operation of the relays of said first register, means controlled by said other relays and by relays of said first register jointly for initiating a further operation, and means for preventing the initiation of said further operation.
14. In a telephone system, a first register, a second register, a connector switch for connecting said registers, a plurality of circuits extending between said registers through said switch, means under the control of said first register for closing certain of said circuits to position said second registers correspondingly, means to indicate whether said circuits are completed, an additional relay, a circuit for said relay extending in parallel to each of said plurality of circuits not closed by said first register, and means controlled by said additional relay for rendering said indication ineffective.
15. In a telephone system, a first set of registers, a second set of registers, a plurality of conductors interconnecting said sets of registers, means to position said first set of registers, means under the control of said first set of registers and including certain of said conductors for positioning said second set of registers correspondingly and means to indicate whether each of said certain conductors are unbroken.
16. In a telephone system, a first set of registers, a second set of registers, a connector switch for connecting said sets of registers, a plurality of circuits extending between said registers through said switch, means to position said first set of registers, means under the control of said first set of registers and including certain of said circuits for positioning said second set of registers correspondingly and means to indicate

whether each of said certain circuits are completed.

17. In a telephone system, a first plurality of relay registers, a second plurality of relay registers, a connector switch for connecting said registers, a plurality of circuits extending between said registers through said switch, means to operate the relays of said first registers in accordance with a particular designation, said relays being effective to close said circuits in combination to operate the relays of said second registers correspondingly, other relays, said other relays being included in said circuits by the operation of the relays of said first registers, and means controlled by said other relays for initiating a further operation.

18. In a telephone system, a first plurality of relay registers, a second plurality of relay registers, a connector switch for connecting said registers, a plurality of circuits extending between said registers through said switch, means to operate the relays of said first registers in accordance with a particular designation, said relays being effective to close said circuits in combination to operate the relays of said second registers correspondingly, other relays, said other relays being included in said circuits by the operation of the relays of said first registers, means controlled by said other relays for initiating a further operation, an additional relay, a circuit for said additional relay extending to each of the circuits not closed by the relays of said first registers, and means controlled by said additional relay for preventing the initiation of said further operation.

19. In a telephone system, a first set of registers, a second set of registers, a connector switch for connecting said sets of registers, a plurality of circuits extending between said sets of registers through said switch, means under the control of said first set of registers for closing certain of said circuits to position said second set of registers correspondingly, means to indicate whether said circuits are completed, an additional relay, a circuit for said relay extending in parallel to each of said plurality of circuits not closed by said first set of registers, and means controlled by said additional relay for rendering said indication ineffective.

20. In a telephone exchange system, a sender, a decoder, a plurality of registers in said sender, a plurality of registers in said decoder, means responsive to the setting of the registers in said sender to associate said decoder with said sender, a plurality of conductors connecting the registers in said sender with the registers in said decoder, means responsive to the association of said decoder with said sender to establish testing circuits for all of said conductors, means responsive to the successful establishment of

said testing circuits for initiating the further operation of said decoder and the disassociation of said decoder from said sender, and other means effective if said testing circuits are not successfully established to cause the disassociation of said decoder from said sender and to prevent the further operation of said decoder.

21. In a telephone exchange system, a sender, a plurality of decoders, a plurality of registers in said sender, a plurality of registers in said decoder, means responsive to the setting of the registers in said sender to associate any one of said decoders with said sender, a plurality of conductors connecting the registers in said sender with the registers in said decoder, means responsive to the association of said decoder with said sender to establish testing circuits for all of said conductors, means responsive to the successful establishment of said testing circuits for initiating the further operation of said decoder and the disassociation of said decoder from said sender, other means effective if said testing circuits are not successfully established to cause the disassociation of said decoder from said sender and to prevent the further operation of said decoder, means in said sender responsive to said other means to cause the reassociation of said sender with a decoder.

22. In a telephone exchange system, a sender, a decoder, pulse recording registers and selection controlling registers in said sender, incoming and outgoing registers in said decoder, means to associate said sender with said decoder, a first set of conductors for associating said recording registers with said incoming registers, a second set of conductors for associating said selection controlling registers with said outgoing registers, means to establish a first circuit to test the continuity of all of said first set of conductors, means to establish a second circuit to test certain of said second sets of conductors for continuity, means to establish a third circuit to test the remaining conductors of said second set for false grounds, and means responsive to the successful completion of said first and second circuits and the non-completion of said third circuit for disassociating the said decoder from said sender.

23. In a telephone exchange system, a sender, a decoder, pulse recording registers and selection controlling registers in said sender, incoming and outgoing registers in said decoder, means to associate said sender and said decoder, a first set of conductors for associating said recording registers with said incoming registers, a second set of conductors for associating said selection controlling registers with said outgoing registers, means to establish a first circuit to test the continuity of all of said first set of conductors, means to establish a second circuit to test certain of

said second sets of conductors for continuity, means to establish a third circuit to test the remaining conductors of said second set for false grounds, means responsive to the successful completion of said first and second circuits and the non-completion of said third circuit for disassociating the said decoder from said sender, and the other means effective if said testing circuits are not successfully established to cause the disassociation of said decoder from said sender and to prevent the further operation of said decoder.

24. In a telephone system, a first office, a second office, a selection control device in said first office including a switch, means effective in the various positions of said switch to control the transmission of a corresponding series of directive impulses to directly control the establishment of a connection to a subscriber at said second office, and means operated in accordance with the nature of said second office to determine which of said series of impulses shall be transmitted.

25. In a telephone system, a first office, a second office, a selection control device in said first office including a switch, means effective in the various positions of said switch to control the transmission of a corresponding series of directive impulses to control the establishment of a connection to a subscriber at said second office, means to advance said switch following each series of impulses and means operated in accordance with the nature of said second office to automatically advance said switch through certain positions to prevent the transmission of the corresponding series of impulses.

26. In a telephone system, a first office, a second office, a selection control device in said first office including a switch, a means effective in the various positions of said switch to control the transmission of a corresponding series of directive impulses to control the establishment of a connection to a subscriber at said second office, means to advance said switch following each series of impulses, a class register, means to position said register in accordance with the nature of said office, and means controlled by said class register to automatically advance said switch through certain positions to prevent the transmission of the corresponding series of impulses.

In witness whereof, I hereunto subscribe my name this 22 day of January, 1930.

WARREN W. CARPENTER.