

June 30, 1931.

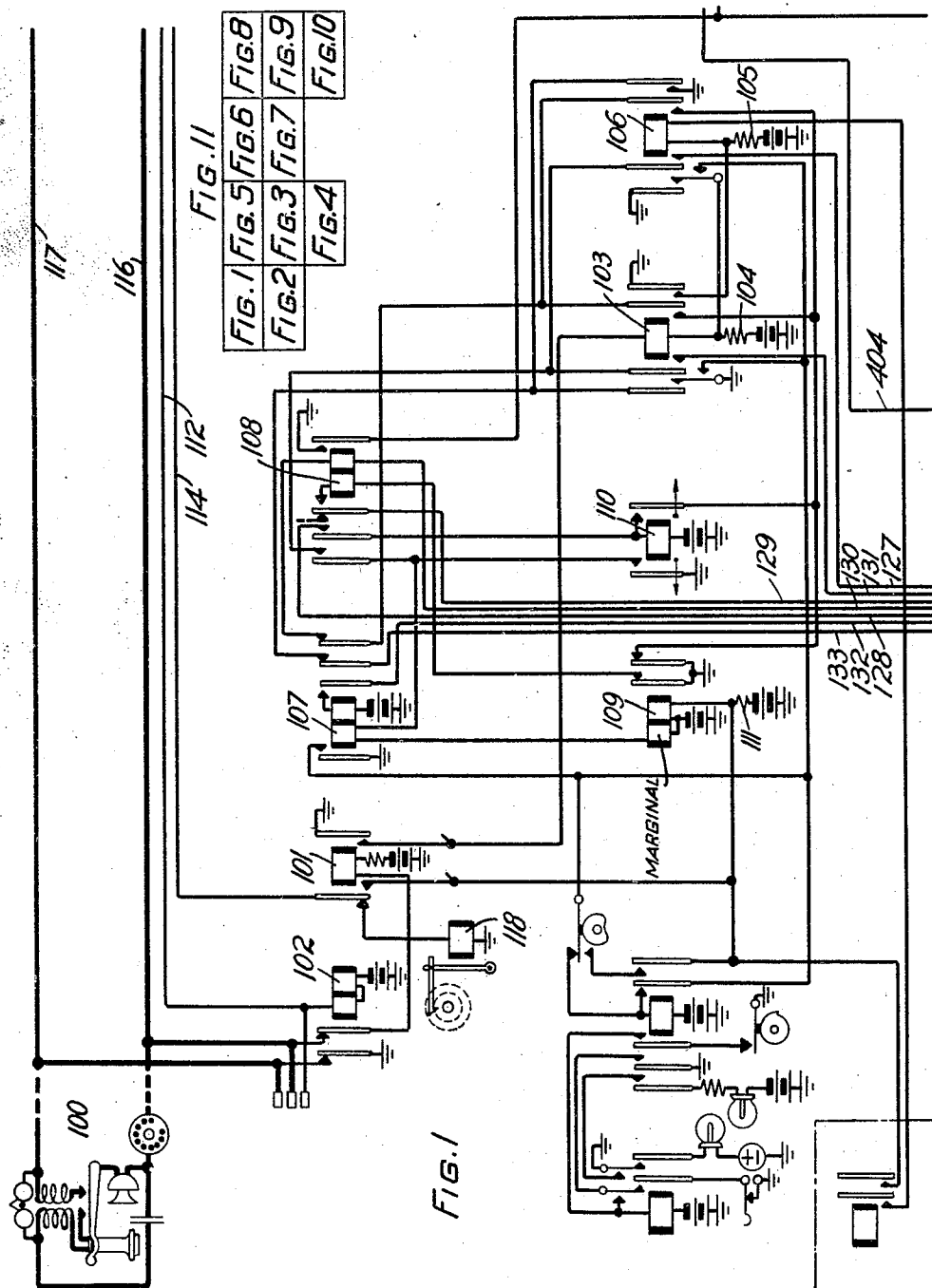
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1,811,844

AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed Jan. 6, 1930

11 Sheets-Sheet 1



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11 Sheets-Sheet 2

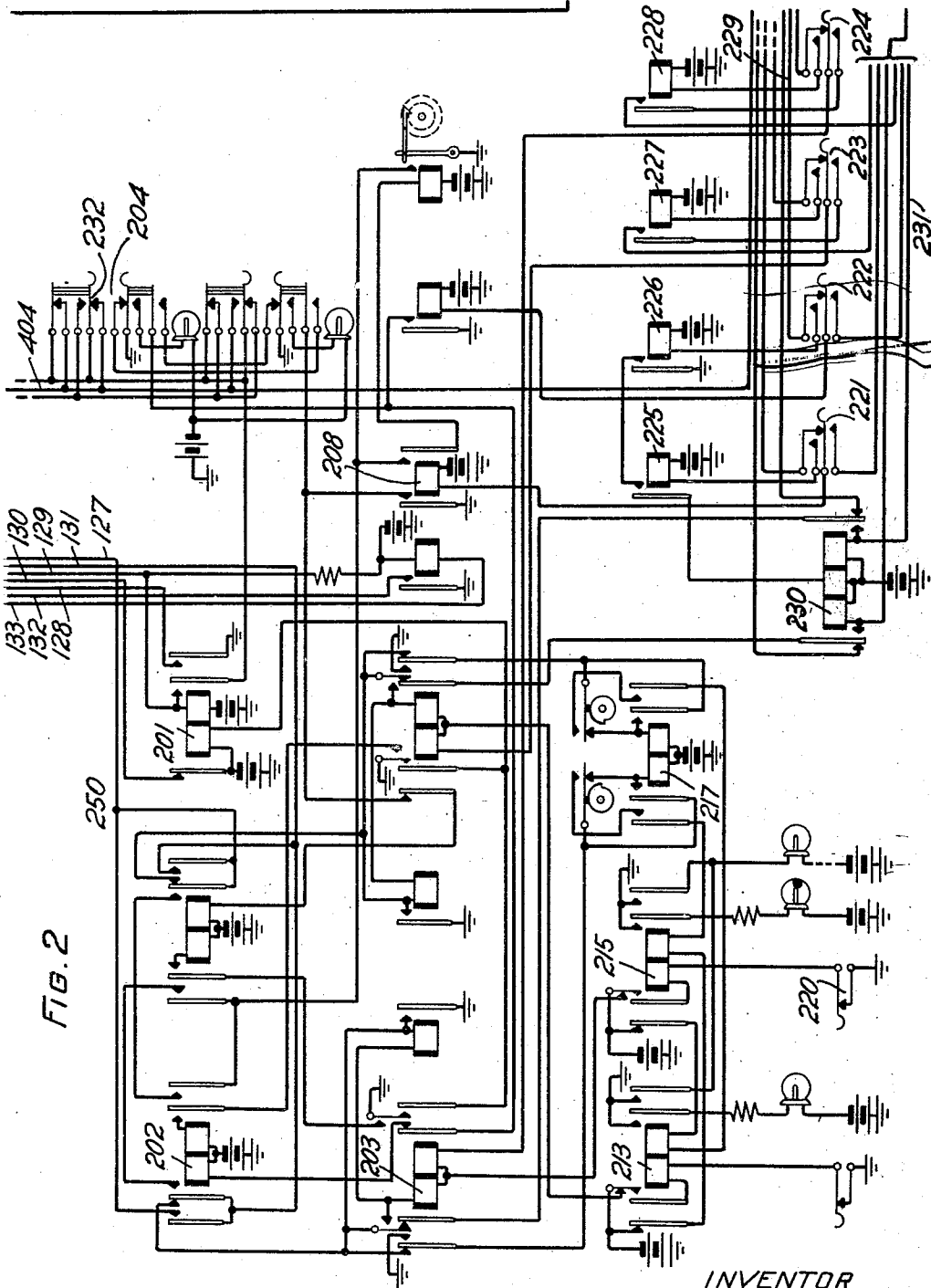


FIG. 2

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11 Sheets-Sheet 3

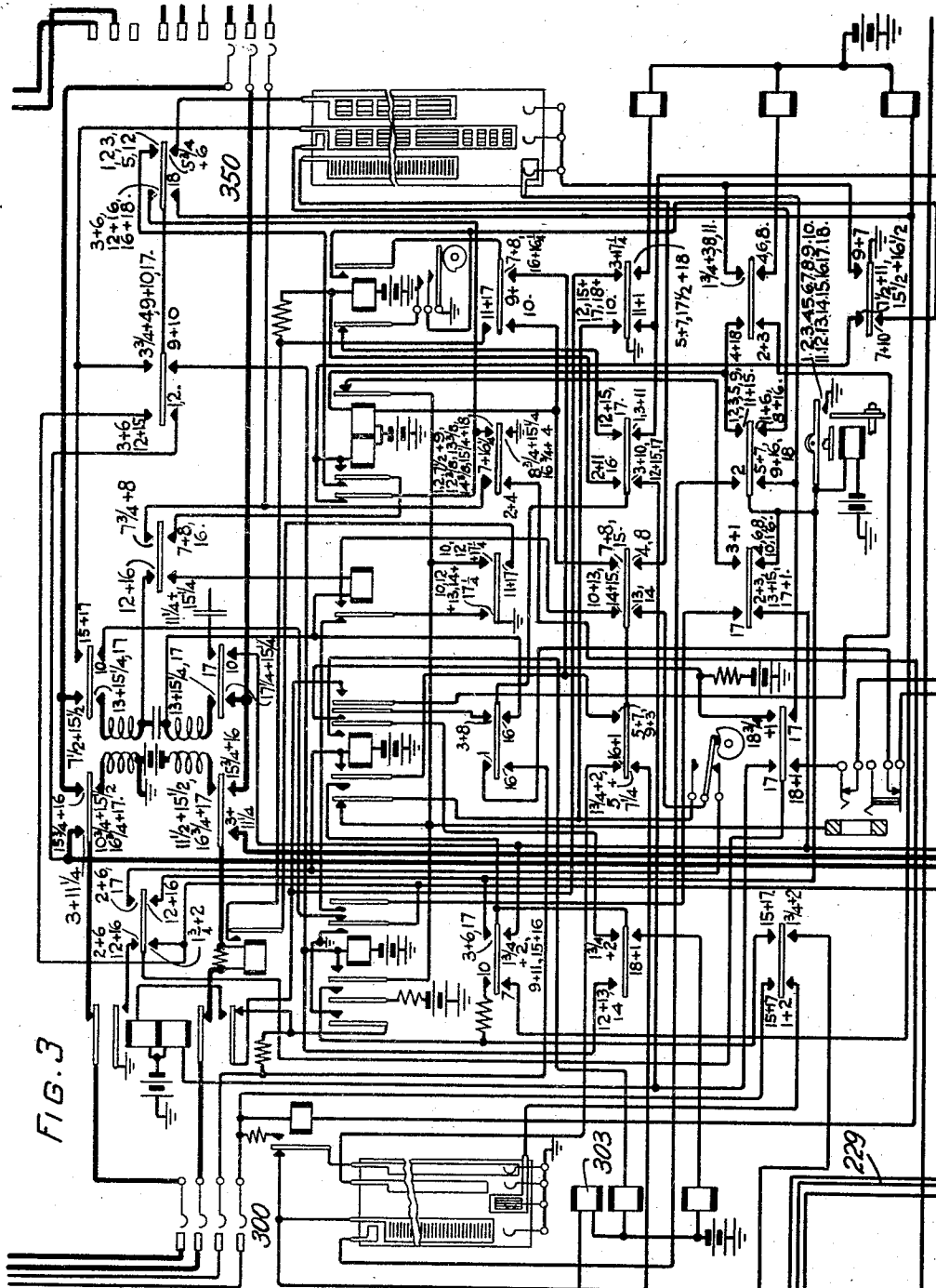


FIG. 3

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11 Sheets-Sheet 4

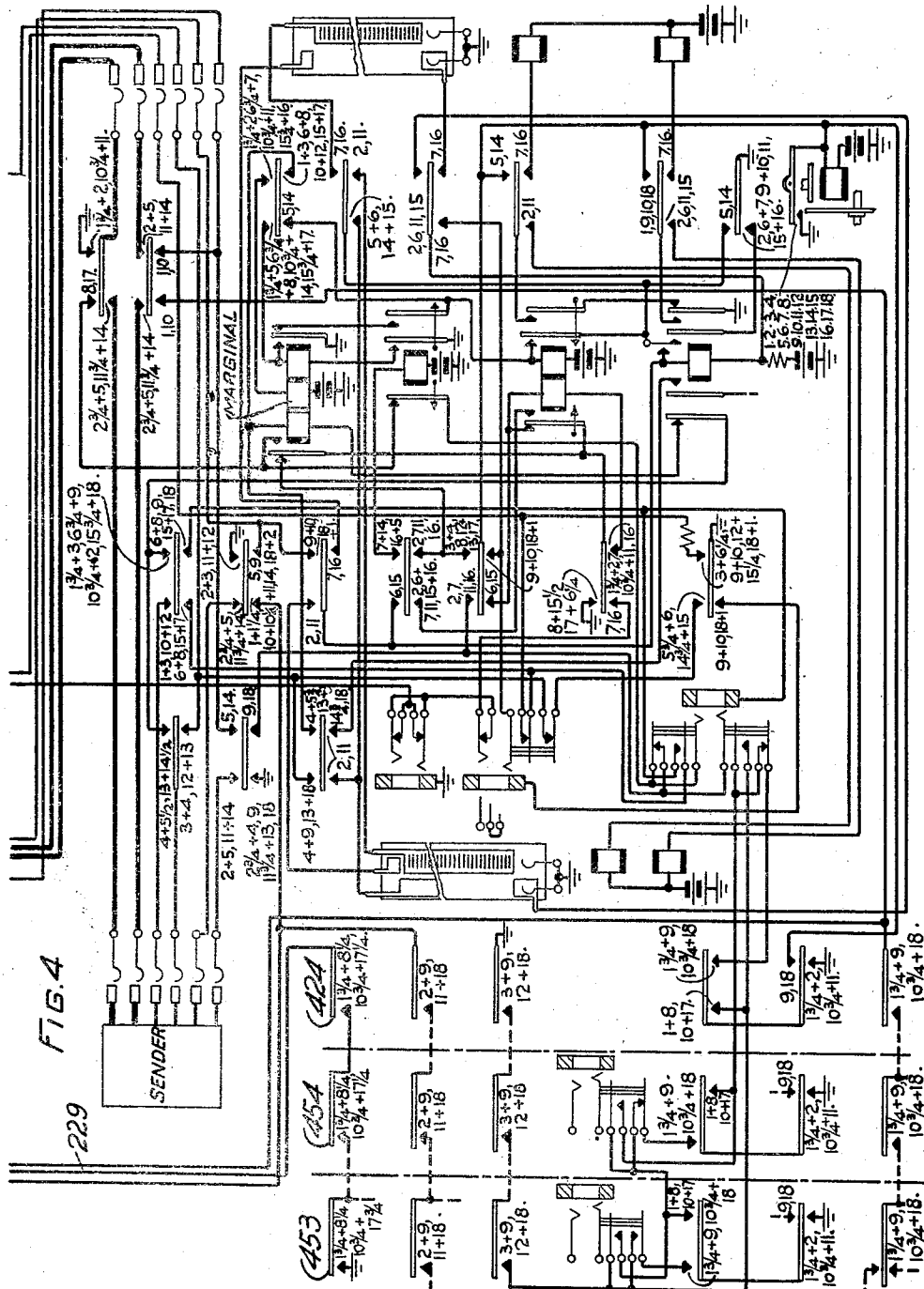


FIG. 4

229

SENDER

(453)

(454)

(424)

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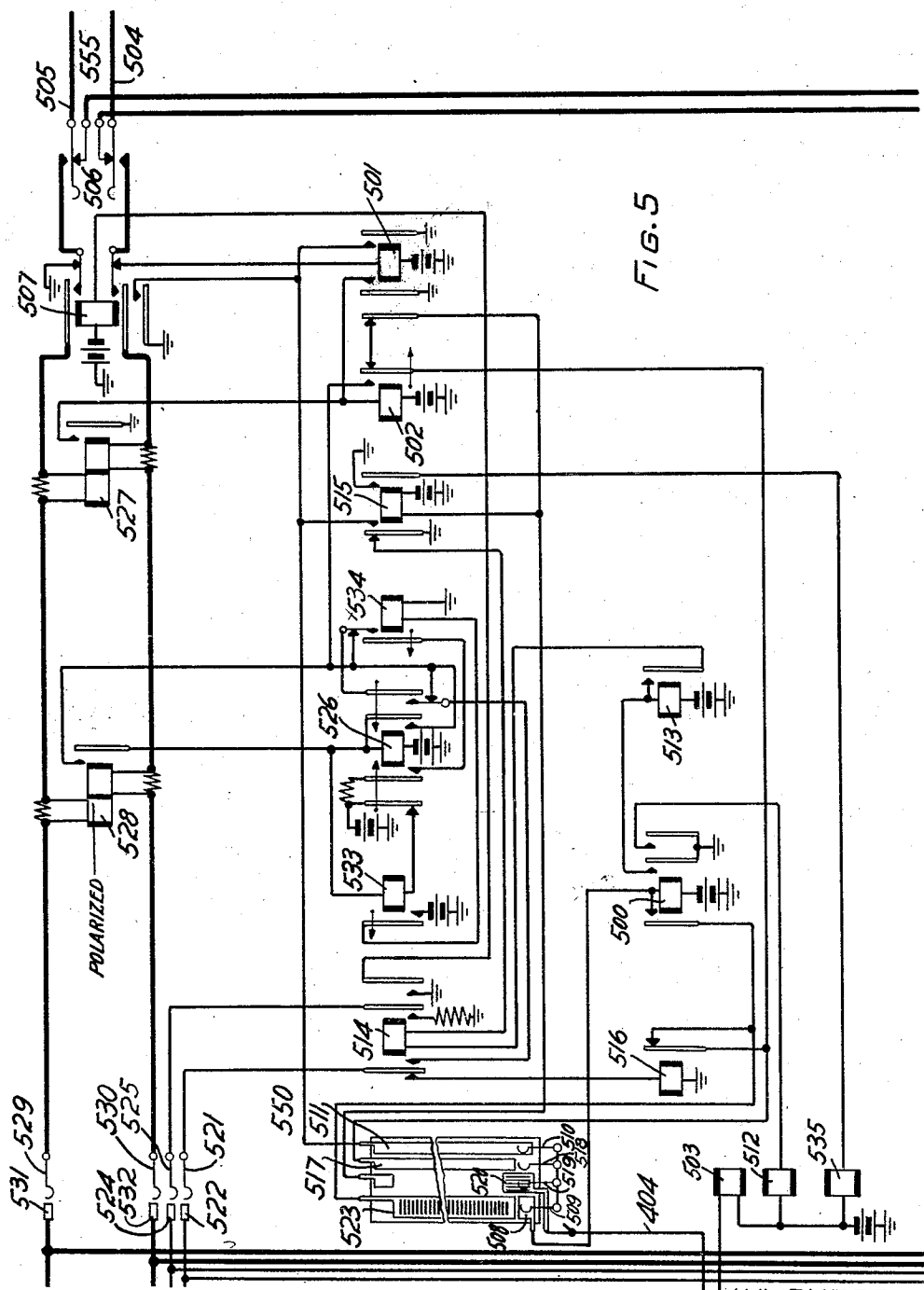
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11 Sheets-Sheet 5



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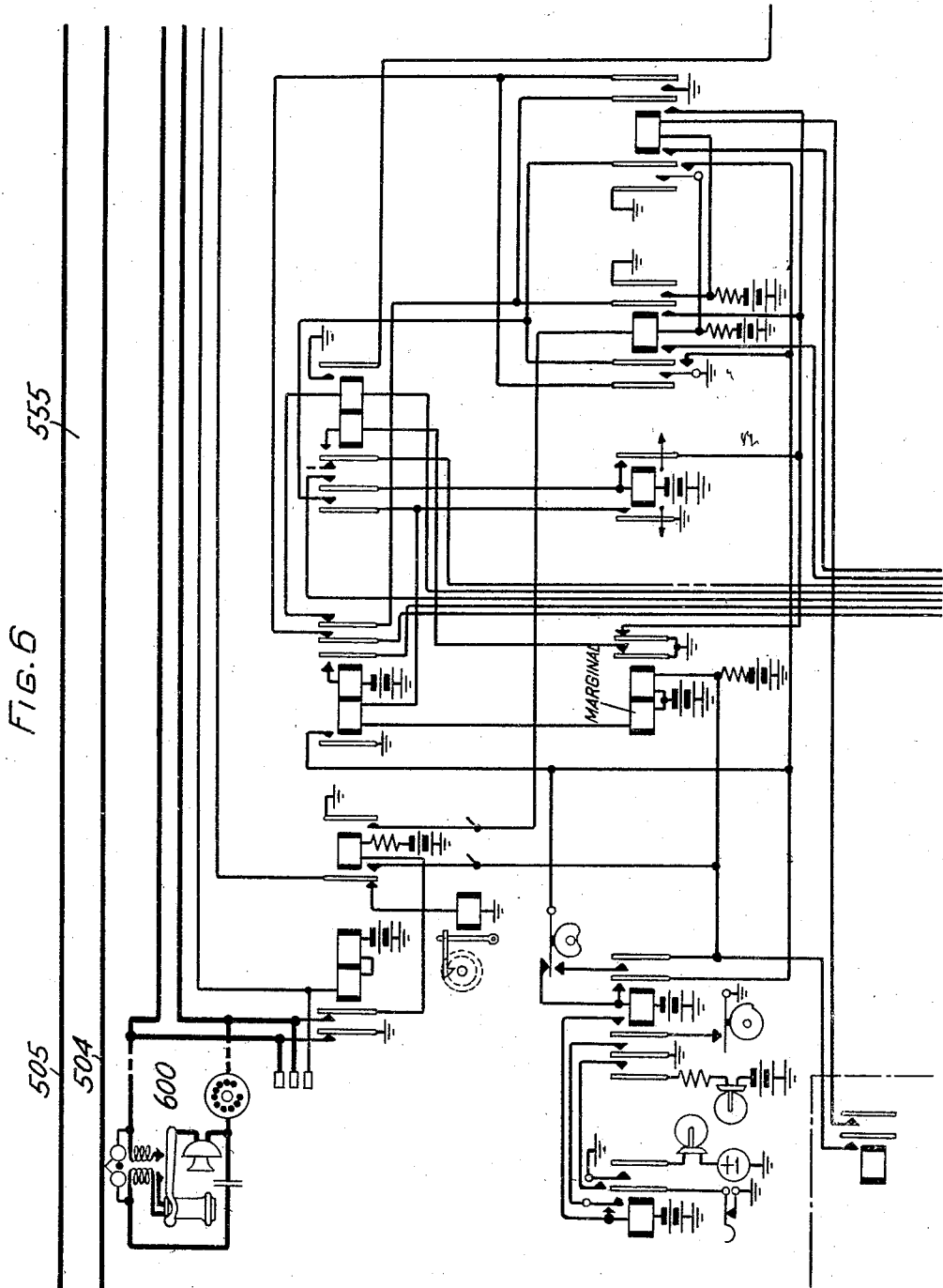
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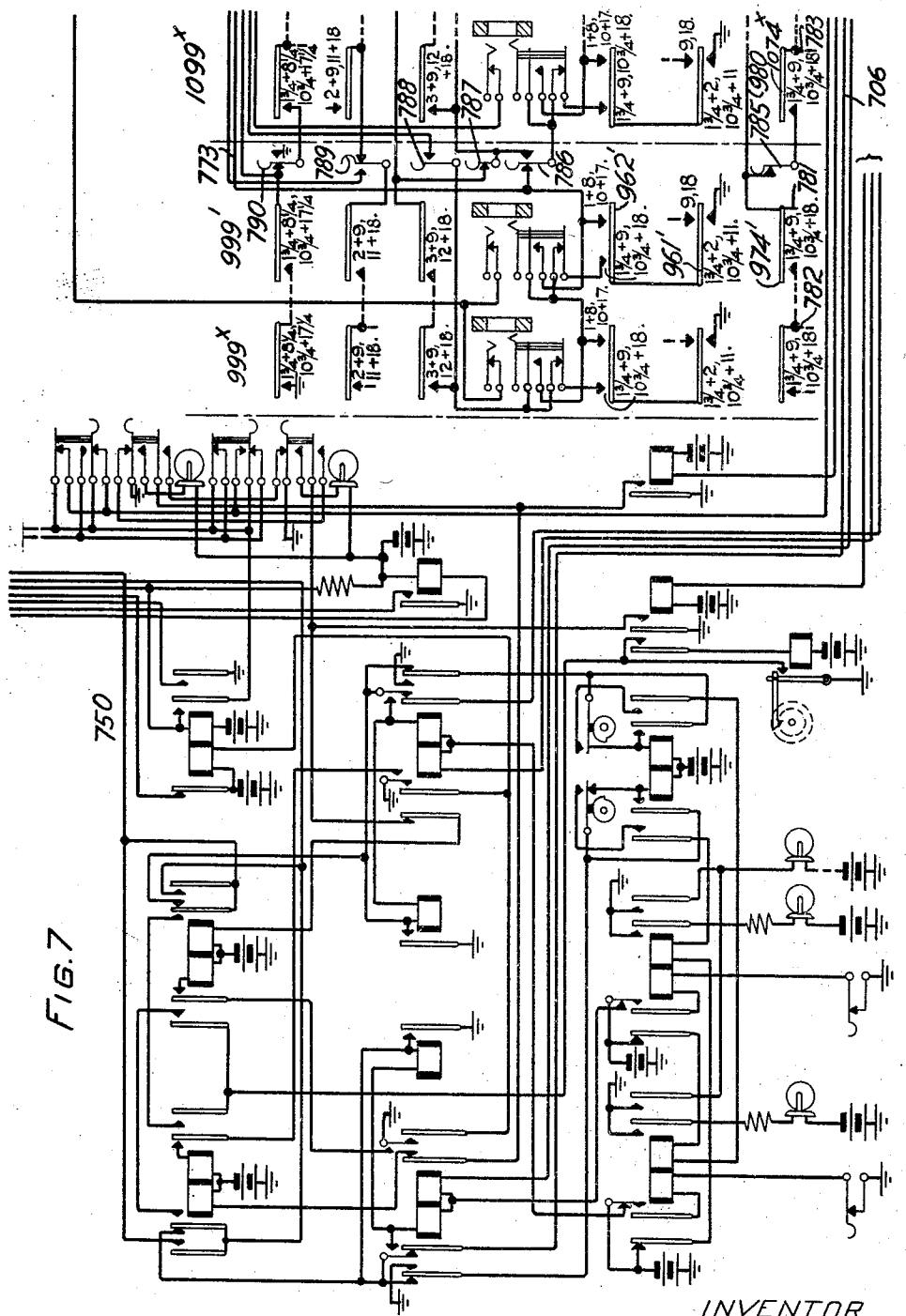


FIG. 7

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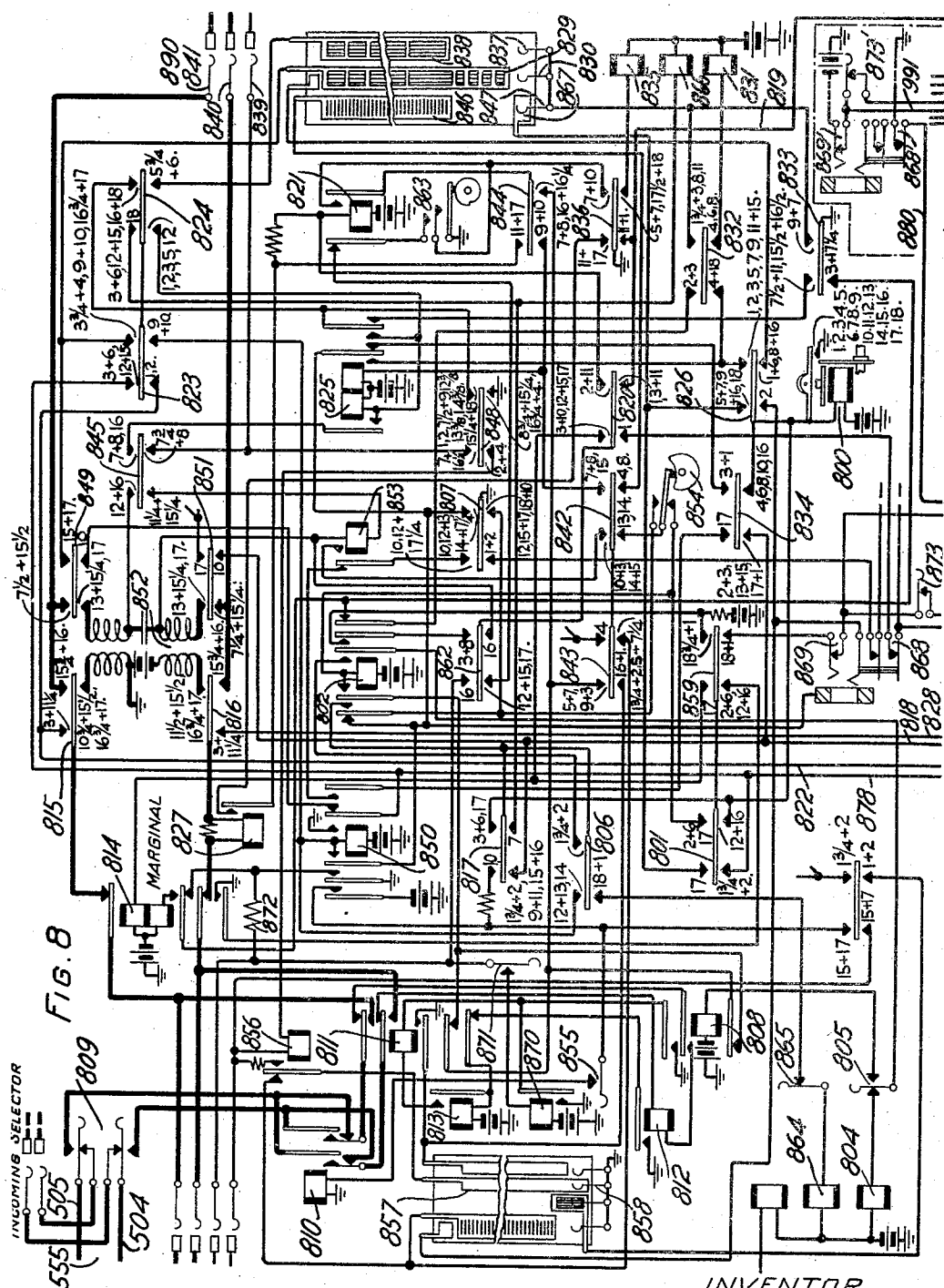
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11 Sheets-Sheet 8



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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

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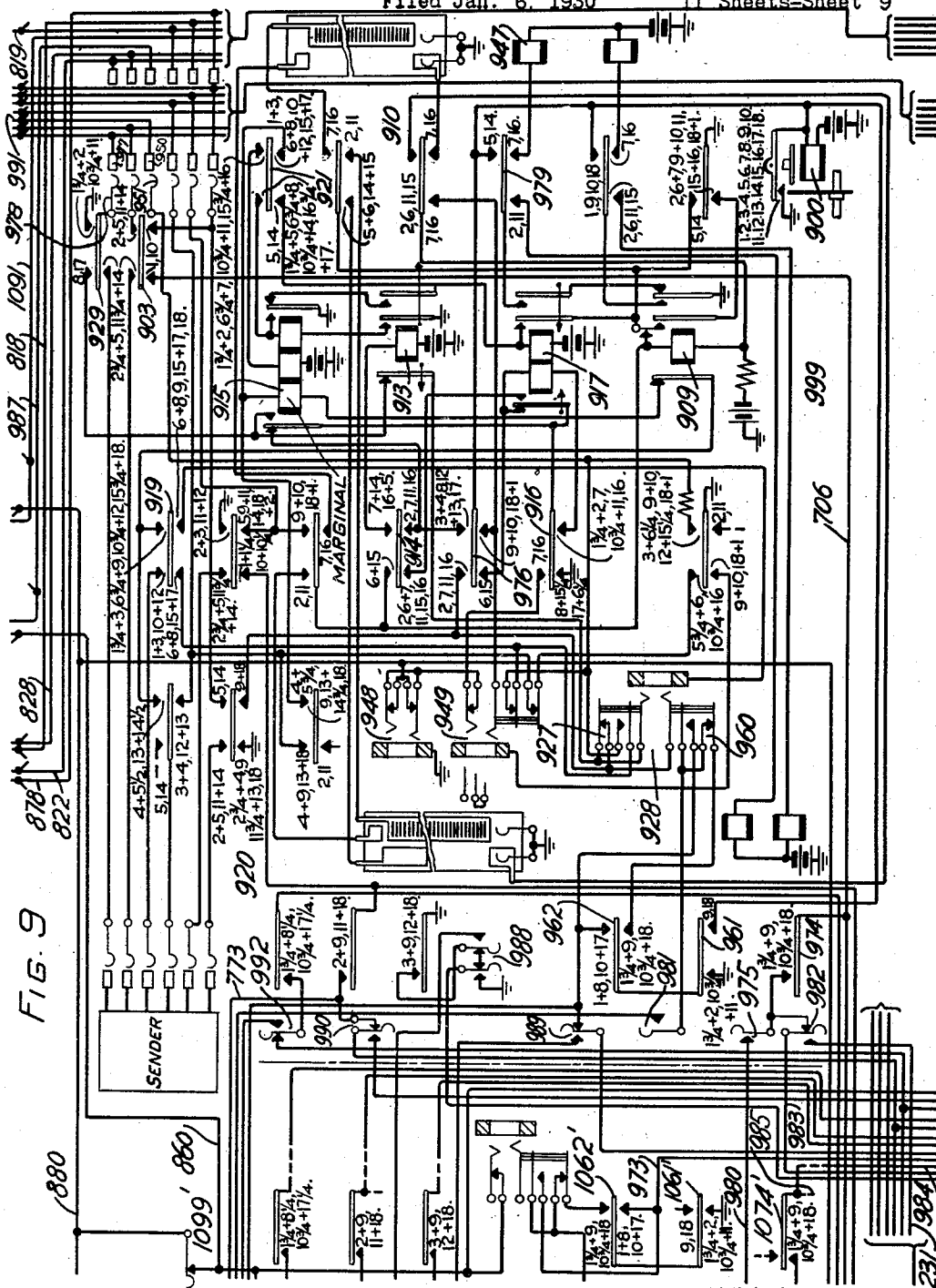


FIG. 9

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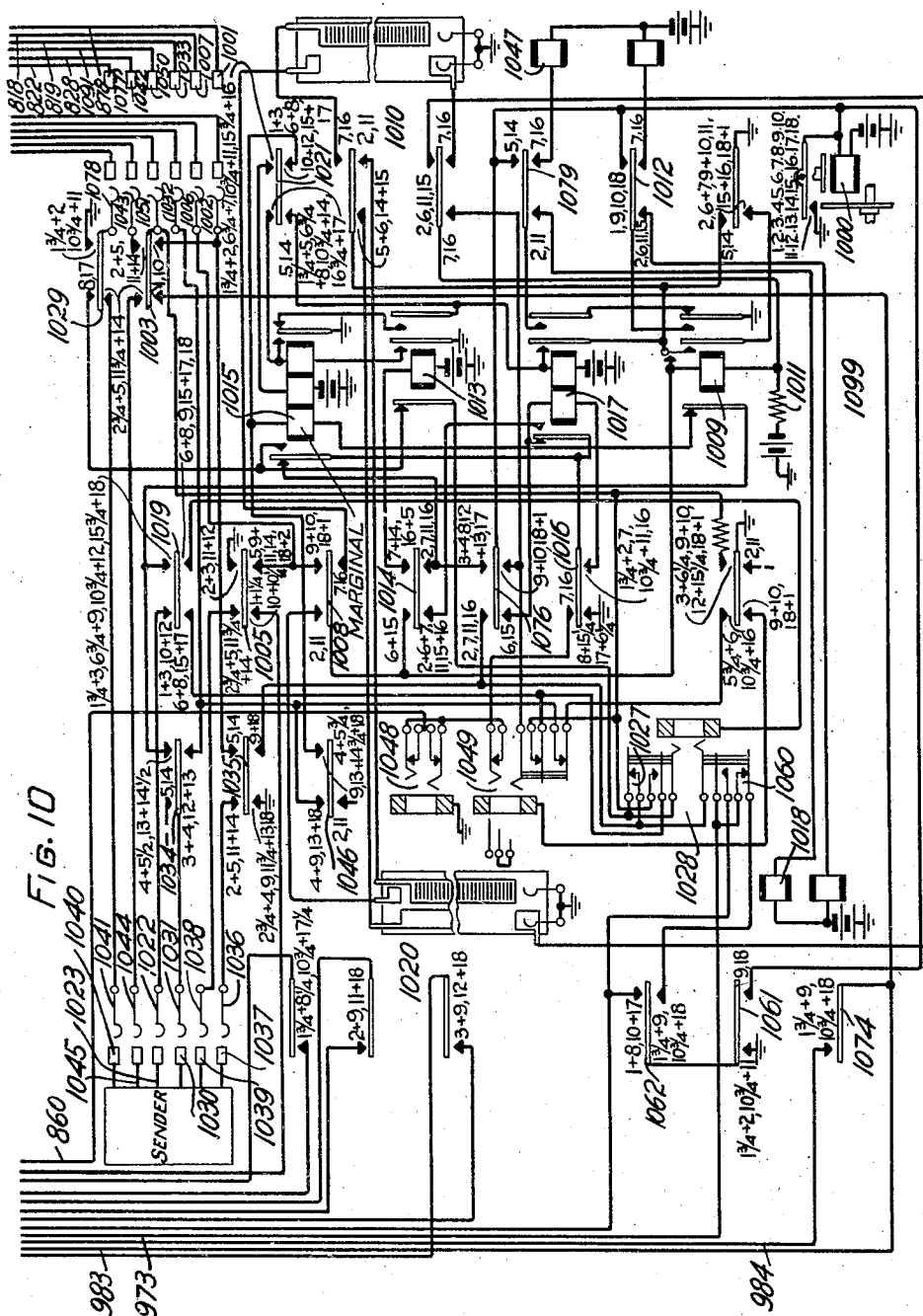
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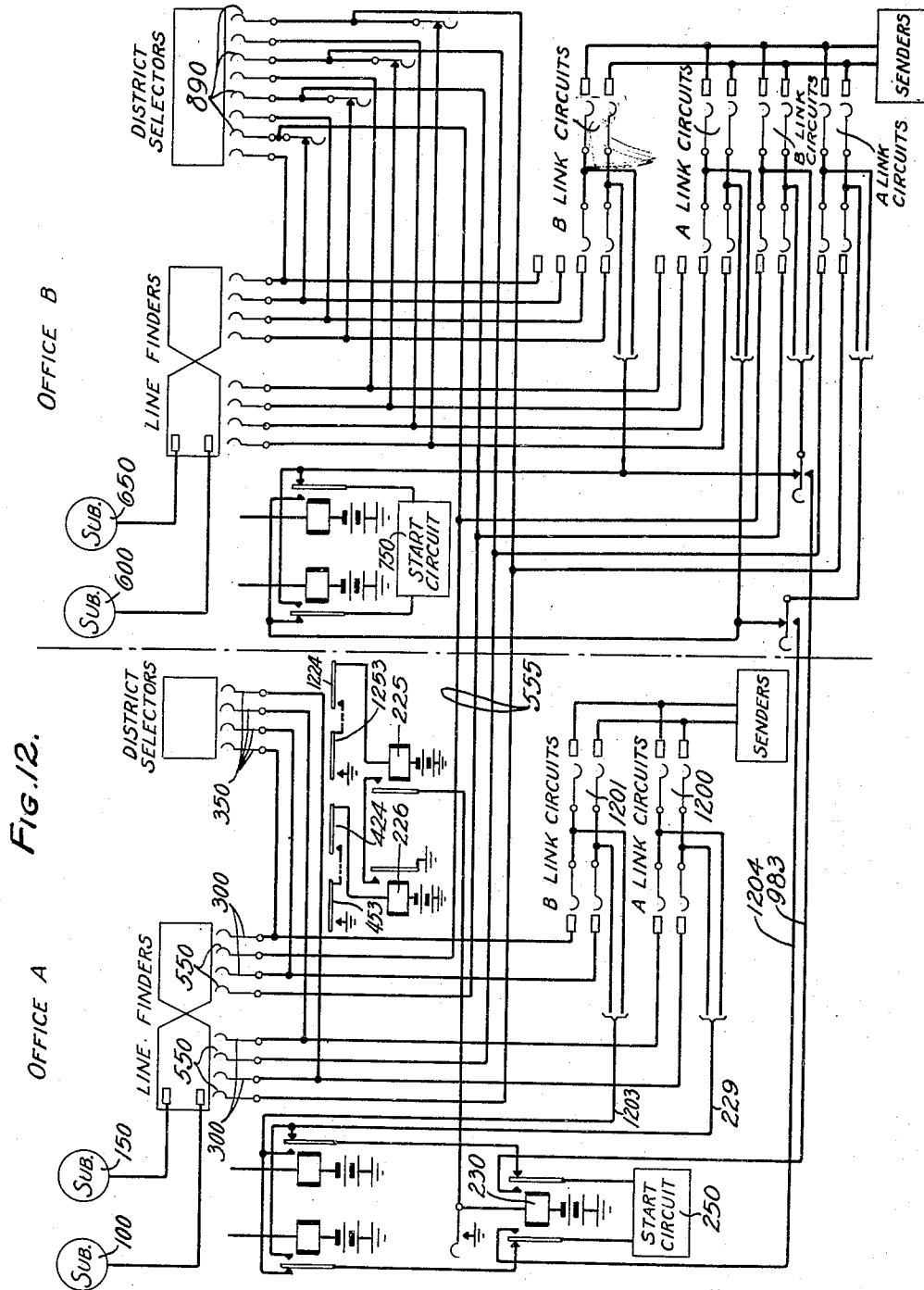
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11 Sheets-Sheet 11



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UNITED STATES PATENT OFFICE

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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Application filed January 6, 1930. Serial No. 418,861.

The invention relates to an automatic telephone system and more particularly to a novel method and system of circuits for utilizing equipment located in one exchange in a large exchange area as overflow or auxiliary equipment for another exchange in the same area.

Where there is a large number of telephone lines to be served as is the case in most cities, these lines are divided among a number of exchanges or offices which together form what is known as an exchange area. The number of offices, of course, is determined by the geographical distribution of the subscribers to be served and by the density of the telephone development in a given section.

It generally occurs that certain of these offices will serve lines which are used almost exclusively for business purposes and others will serve lines which are used for a variety of purposes other than those classed as strictly business. In offices where business lines predominate, the peak load is during ordinary business hours and after business hours the load may drop off to practically nothing, whereas in the residential districts the peak load is often after business hours. There may be other local conditions which would cause the peak load in the various offices to occur at different times during the day. For example, reference may be made to the situation in New York city where offices serving the financial district in the lower part of the city are practically without load after five o'clock, whereas the peak load in an office serving the hotel and theatrical district comes on between seven and eight in the evening.

It is the usual practice in offices which are worked on an automatic basis to provide sufficient equipment in the way of line finders, selectors and control equipment to take care of the peak load. A certain percentage of this equipment is idle when the load is at its minimum. Apparatus which is idle is not worked at a maximum efficiency and fixed charges and depreciation are present whether the equipment is operating or not.

In accordance with the present invention, advantage is taken of the fact that the peak

loads in one or more offices are at different hours of the day and makes equipment in certain offices during their period of light load available for handling calls incoming to an office operating at a peak load. As a result, it is not necessary to install in the office which is to be assisted, equipment necessary to handle its peak load. These economies are effected both in the initial amount of equipment installed and in the more efficient use of the equipment that is installed.

More specifically, in accordance with the invention it is proposed to connect line finders in one office or exchange with the selector switches and control apparatus of another office by means of trunk conductors normally used for handling the calls between the offices. For a specific example reference may be made to the Hanover and Pennsylvania offices of New York city wherein the Hanover office serves the financial district and the Pennsylvania office serves the hotel and theater district. In accordance with the invention the line finders at the Pennsylvania office serving incoming calls at that office are not all connected to the selector switches at the Pennsylvania office. A certain number of these line finders at the Pennsylvania office are connected by interoffice trunks to the selector switches at the Hanover office. Those calls incoming at Pennsylvania which normally would be handled by the line finders and selector switches of the Pennsylvania office are routed to Hanover and handled through the equivalent equipment at the Hanover office. The arrangement is such that this routing may be made effective only during the hours of peak load at the Pennsylvania office and the hours of light load at the Hanover office. By utilizing selector switches and control apparatus at the Hanover office, an equivalent amount of control equipment and selector switches is released at the Pennsylvania office for other use or a corresponding amount of equipment may be omitted from the Pennsylvania office.

In accordance with a feature of this invention a switching arrangement is provided whereby certain of the line finders in one office may be switched into association with

the selector switches at another office. This switching means may be either manually controlled or automatically controlled in accordance with the amount of traffic. In one case, the second office would take care of a certain portion of the incoming traffic at the first office when the switching apparatus has been operated, whereas in the other case a variable amount of the traffic would be handled at the second office depending upon the busy or idle condition of the apparatus at the first office.

It is apparent that in accordance with the present invention the capacity for incoming calls at a given office may be materially increased without increasing the equipment other than adding the necessary number of line finders. The rest of the equipment is operative from another office during the period of peak load.

A clearer conception of the scope and purpose of the invention may be obtained from a consideration of the following description in connection with the attached drawings in which Figs. 1 to 5 show apparatus at an office A of an exchange system and

Figs. 6 to 10 show apparatus at an office B of the same exchange;

Fig. 1 shows a calling subscriber's line together with relay equipment common to a group of lines;

Fig. 2 shows a start circuit;

Fig. 3 shows a line finder and district selector;

Fig. 4 shows a link circuit for associating a sender, diagrammatically illustrated, with the district selector of Fig. 3;

Fig. 5 shows a line finder having access to the calling line for serving such calling line during periods of peak load and associable with a district selector, Fig. 8, of office B;

Fig. 6 shows a calling subscriber's line together with common relay equipment terminating in office B;

Fig. 7 shows a start circuit;

Fig. 8 shows a line finder and district selector, the district selector being arranged to be paired with the line finder of Fig. 5, and in the lower right portion a representation of a linefinder-district which may be used only for calls locally originated;

Figs. 9 and 10 show link circuits for associating senders, diagrammatically illustrated, with the district selectors of Fig. 8;

Fig. 11 is a diagram showing how the several figures should be arranged to illustrate the complete circuits of the invention; and

Fig. 12 is a schematic drawing illustrating the principles of the invention.

The invention has been embodied in a disclosure which is substantially like that of Patent No. 1,690,206 granted to A. Raynsford, November 6, 1928. The senders diagrammatically indicated by the small rec-

tangles in the upper left corner of Figs. 4, 9 and 10 are of the character disclosed in the Patent No. 1,589,402 granted to O. H. Kopp, June 22, 1926 and reference to the Kopp patent is made for operations not completely described herein.

As in the disclosures of the above mentioned patents, a plurality of link circuits is provided at each exchange office arranged to serve a group of calling lines and are taken into service in rotation. When a link circuit completes its function it hunts for and associates itself with a district selector which is ready for use and the link and district remain in a suballotted condition until the next link in the series has been put into service. The link circuit is then put into an allotted position from which it will be advanced by the initiation of a call and the action of the associated start circuit. For example, the trip circuit of Fig. 1 and start circuit of Fig. 2 are so arranged that only one line of a group of lines may be served at a time and so that there may be cooperation between two subgroups of lines to each of which the group of link circuits of Fig. 4 is individual. The details of these functions form no particular part of the present invention and are fully described in Patent No. 1,567,072 granted to W. H. Matthies, December 29, 1925.

The start circuit of Fig. 2, however, differs from the start circuits of the above mentioned patents in that provision is made for starting a link circuit of an office B in which at the time traffic is light, in the event that at the time when a call is initiated in either of the line sub-groups of Fig. 1 the traffic is so heavy that there are no links and senders available in office A for serving the call. At such periods of peak load the keys shown in the lower right portion of the start circuit of Fig. 2 will be operated to their alternate positions and the key shown in the upper right portion of Fig. 5 will be operated to associate the line finder of Fig. 5 with an inter-office trunk extending to a district selector in office B. When such a condition arises a call is transferred to the start circuit of Fig. 7, and a preallotted link, Fig. 10, of office B is started to select a sender and to associate it with a district selector of office B for serving the call.

In addition, the start, link and district selectors of office B shown in Figs. 7, 9 and 8 are modified by the addition of keys which enable this apparatus to be made available for serving calls originating in office A during periods of light load in office B. The keys associated with the district selector of Fig. 8 are applied only to a portion of the district selectors of the frame and when operated disassociate such selectors from their normal association with line finders of office B and associate them with special line finders such as shown in Fig. 5 in the same frame as

the line finder of Fig. 3 serving the group of calling lines shown in Fig. 1 of office A.

Referring particularly to Fig. 12 in which apparatus of two offices A and B of an exchange system have been schematically illustrated, it will be assumed that office A is an office in which a peak load may occur at a time when the load in office B is light. In office A the line finders 300 serving the group of subscribers' lines are shown paired with district selectors 350, the line finders in the left half of the line finder frame being arranged to be started through the start circuit 250 and a preallotted link of the A group of link circuits 1200, and the line finders in the right half of the frame being arranged to be started by a link in the B group 1201 in accordance with the practice set forth in the above mentioned patents. In accordance with this invention each half of the line finder frame is also equipped with certain line finders which are linked over interoffice trunks of the trunk group 555 with certain district selectors 890 in the district selector frame of office B.

At the office B all of the line finders in both halves of the line finder frame are paired with selectors of the district selector frame during periods of normal load. The line finders of the left half of the line finder frame are arranged to be started through the start circuit 750 and a preallotted link of the A group of link circuits, and the line finders of the right half of the frame are arranged to be started through the start circuit 750 and a preallotted link of the B group of link circuits. During such normal load periods with the keys illustrated in their normal positions, all of the apparatus of office B is effective only for handling calls originating in such office.

When, however, a period of light load occurs in the office B and a period of peak load occurs at the same time in the A office, the attendant at office B by operating the keys indicated may render the district selectors 890 available for pairing with the line finders 550 of office A over trunks 555 and may transfer the start leads of half of the link circuits of both A and B groups from their normal connection with the start circuit 750 to the start circuit of office A over trunks 983 and 1204. If then all of the apparatus of office A available for serving the group of lines illustrated becomes busy, the transfer relay 230 operates transferring the start conductors extending from start circuit 250 from the link start conductors 229 and 1203 extending to the A and B groups of links in office A to conductors 983 and 1204 extending to the A and B groups of links in office B. Thus on such peak load calls initiated in office A the links of office B will function to select an idle sender and associate it with an allotted district selector in office B to serve such calls.

Calls originating in office A and served by apparatus in office B

Since under conditions of normal load the apparatus of office A functions in the well-known manner, fully set forth in the patents referred to, it will not be necessary to describe herein in detail the manner in which a call is extended under those conditions. It will therefore be assumed that at the time the subscriber of calling station 100 initiates a call the links and senders which would ordinarily be available for use are busy because of a peak load condition and that during the existence of that condition the keys 221, 222, 223 and 224 are operated. With these keys operated and all of the link circuits of both the A and B groups busy, circuits are established for the relays 225 and 226. The circuit of relay 226 may be traced from battery, through the winding of relay 226, the upper alternate contacts of key 222, conductor 229, sequence switch contacts 424, 454 and 453 of busy link circuits of the A group to ground. A similar circuit will also be effective for relay 225 over sequence switch contacts of the busy link circuits of the B group.

When the subscriber at substation 100 removes his receiver from the switchhook a circuit is closed from battery, through the winding of line relay 101, inner back contact of relay 102, over the subscriber's line to ground at the outer contact of relay 102. Relay 101 in operating closes a circuit from battery, through resistance 104, winding of relay 103 to ground at the right contact of relay 101. It also prepares a circuit from battery, through resistance 111 and the right winding of relay 109 in parallel, left front contact of relay 101 to conductor 114 to identify the calling line to the line finders having access to that line. Relay 103 in operating closes a circuit from battery, over the back contact of relay 201, conductor 130, right winding of relay 108, outer right back contact of relay 107, inner right contact of relay 103 to ground at the outer right contact of relay 109.

Relay 108 operates in this circuit and closes a locking circuit for itself from battery, through the right winding of relay 201, conductor 129, over back contacts of relays similar to relay 108 individual to other subgroups of lines appearing before the same line finder, inner left front contact and left winding of relay 108 to ground at the inner right back contact of relay 109. Relay 108 closes a circuit from ground at its outer right front contact, through the winding of trip magnets 303 and 503 of the line finders of the frame serving the sub-group of lines in which the substation 100 is located to battery in preparation for tripping the proper set of brushes of the line finder. In actual practice but one trip magnet such as 303 would

be used for a single brush group of all line finders of the same frame. However, for the sake of clarity a separate trip magnet has been illustrated for each line finder. Relay 201 operates in the locking circuit of relay 108 and in combination therewith closes a circuit from ground, over its outer right contact, conductor 128, left middle contact of relay 108, winding of relay 110 to battery. Relay 110 locks over its right contact to ground at the outer back contact of relay 109 and closes a circuit for starting an allotted line finder.

It has been assumed that there are no idle link circuits available in office A and that an idle link circuit, for example, link circuit 1099 of Fig. 10, office B is to be used. The sequence switch 1000 of this link circuit will therefore be standing in position 1 and the sequence switch 800 of the district selector, Fig. 8, preallotted by the link circuit of Fig. 10 will be standing in position 2. At this time since all of the links of office A normally available for serving the group of lines in which the calling line is located are busy, relays 225 and 226, are operated thereby establishing an obvious circuit for relay 230. The operation of relay 110 will therefore close a circuit from ground at its left contact, the outer left contact of relay 108, the inner left contact of relay 103, conductor 131, left back contact of relay 202, inner left back contact of relay 203, the right front contact of relay 230, conductor 231, alternate contact of key 982, conductor 983 lower contacts of cam 1003, brush 1002, terminal 1001, conductor 878, the lower left and upper right contacts of cam 801, winding of relay 802 to battery. Relay 230 locks over its right winding and right contact in this circuit to prevent the opening of the start circuit should a link in office A become available at this time and release either relay 225 or 226.

Relay 802 in operating closes a circuit from battery through the winding of relay 808, alternate contact of key 805, inner right contact of relay 802, right contact of cam 806, outer left front contact of relay 802 to ground at the lower right contact of cam 807. It has been assumed that the keys of all linefinder-district circuits of the frame on which the linefinder-districts shown in Fig. 3 are located have all been operated to their alternate positions for handling peak load calls originating in office A. Relay 808 upon operating establishes a circuit extending over the conductors 504 and 505 of the interoffice trunk, normally used for extending calls from the bank of a district selector in office A to an incoming selector in office B, but set apart for peak load calls through the operation of key 809 at office B and key 506 at office B, for operating relay 501 associated with the line finder, Fig. 5,

This circuit may be traced from battery, through the winding of relay 501, the lower normal contact of relay 507, the lower alternate contacts of key 506, conductor 504, the lower alternate contacts of key 809, the inner normal contacts of relay 810, the upper back contact of relay 811, winding of relay 812, the inner upper contact of relay 808, the upper back contact of relay 811, the outer normal contacts of relay 810, the upper alternate contacts of key 809, conductor 505, the upper alternate contacts of key 506 to ground at the upper normal contacts of relay 507. Relays 501 and 812 operate in this circuit, relay 501 closing an obvious circuit for relay 502 and at its right contact establishing a circuit for relay 500 extending from battery, through the winding of relay 500, commutator segment 508, brush 509, brush 510, commutator segment 511 to ground at the right contact of relay 501. Relay 500 upon operating closes obvious circuits for the updrive magnet 512 and for relay 513. Relay 513 at its front contact closes a locking circuit for itself extending through the winding of relay 514 to ground at the left back contact of relay 515. Relay 514 being shunted by ground at the contact of relay 500 does not operate in this locking circuit as long as relay 500 remains energized. The line finder of Fig. 5 moves upwardly under control of magnet 512 and since trip magnet 503 is operated the proper set of brushes is tripped.

As soon as the line finder leaves normal, a locking circuit is provided for relay 500 extending from battery through the left contact of relay 500, the back contact of relay 516, commutator strip 517, brush 518 to ground over brush 510, strip 511 and the right contact of relay 501 which holds relay 500 operated. As soon as the commutator brush 519 engages segment 520 a circuit is closed from ground over brushes 510 and 519, segment 520, conductor 404, contact 232 of key 204, inner front contact of relay 201 to conductor 129 and the right winding of relay 201. This circuit shunts the left winding of relay 108 and causes that relay to release in turn releasing the trip magnet 503. When brush 519 leaves segment 520 the circuit of relay 201 is opened and that relay releases freeing the start circuit of Fig. 2 and releasing relay 802 in the district selector of Fig. 8. When the line finder brush 521 makes contact with terminal 522 which is connected to conductor 114 and therefore to battery through the right winding of relay 109, a circuit is completed from this battery, through the winding of relay 516 to ground. Relays 109 and 516 operate, relay 516 opening the holding circuit previously traced for relay 500. As soon as the brushes of the line finder become accurately centered on the terminals of the calling line, a second holding

circuit extending from battery, through the winding and left contact of relay 500, over centering strip 523, brushes 509 and 510 to ground, is opened at an insulating segment of strip 523 and relay 500 releases opening the circuit of updrive magnet 512 and removing the shunt ground from the winding of relay 514 which now operates in the locking circuit of relay 513. Relay 514 upon operating opens the circuit of relays 516 and 109, at its outer right contact establishes an obvious circuit for relay 507, at its inner right contact establishes a circuit for the cut-off relay 102 of the calling line extending from battery, through the windings of relay 102, conductor 112, terminal 524 and brush 525 to ground, and at its left front contact connects direct ground to brush 521 over the right normal contacts of relay 526, the right front contact of relay 502, commutator strip 517, brushes 518 and 510, strip 511 to ground at the right front contact of relay 501 and after relay 507 operates, to ground at the lower front contact of relay 507. Relay 109 which operated in series with relay 516 opens the holding circuit of relay 110 thereby restoring the relay equipment of Fig. 1 so that another calling line in the same line group may have access to the common start circuit for starting another call. Relay 507 upon operating disconnects ground and the winding of relay 501 from the trunk conductors 505 and 504 and extends these trunk conductors through the windings of relays 527 and 528 over brushes 529 and 530 and terminals 531 and 532 to the conductors of the calling line. Relay 812 in the district circuit of Fig. 8 is maintained energized over the calling line loop due to the transfer contacts of relay 507 and relay 527 operates in series therewith. Relay 528 being polarized does not receive current in the right direction through its windings to operate at this time. Relay 527 upon operating closes at its contacts a new operating circuit for relay 502 for replacing the original circuit opened at the contacts of relay 501 upon the release of that relay.

At the district selector of Fig. 8 upon the operation of relay 812 a circuit is closed extending from ground at the contacts of relay 812, over the lower back contact of relay 811 to battery through the winding of relay 813. Relay 813 operates locking over its front contact, through the winding of relay 811 to ground at the upper front contact of relay 808, but relay 811 being shunted as long as relay 812 remains operated does not operate at this time. As soon as relay 802 releases following the finding of the calling line as previously described, a circuit is established for relay 870 extending from battery winding of relay 870, contacts of key 871, resistance 872, innermost lower back contact of relay 814, right back contact of relay 802, upper

contacts of cam 832 to ground at the right contact of cam 833 and opens the circuit of relay 808. Relay 808 releases in turn releasing relay 812 and relay 870 supplies an operating ground for the circuit of relay 811. Relay 811 thereupon operates opening the initial operating circuit of relay 813 and transferring the trunk conductors 505 and 504 from their connection with the winding of relay 812, over back contacts of relay 814 to cams 815 and 816.

At the time relay 802 operated it closed a circuit from ground at the lower right contact of cam 807, over the left front contact of relay 802, lower left contact of cam 817, conductor 818, terminal 1007, brush 1006 of the link district finder 1010, upper right contact of cam 1008, winding of relay 1009, resistance 1011 to battery. Relay 1009 operates and closes a circuit from battery, through the winding of sequence switch magnet 1000, upper contact of cam 1012 to ground at the outer right front contact of relay 1009 advancing link sequence switch 1000 to position 2. When sequence switch 1000 leaves position 1 relay 1009 releases. In position 2 a circuit is closed from battery, through the winding of relay 1013, right contacts of cam 1014, left back contact of relay 1015 to ground at the lower left contact of cam 1016. Relay 1013 operates closing a circuit from battery, through the right winding of relay 1017, the outer right contact of relay 1013 to ground at the right back contact of relay 1015. Relay 1017 in operating closes a circuit from battery, through the winding of updrive magnet 1018 of the sender finder 1020, left contact of cam 1079, outer right contact of relay 1017 to ground at the right back contact of relay 1009. The sender finder moves upwardly under the control of magnet 1018 in search of an idle sender.

Relay 1013 also closes a circuit from battery through the middle winding of relay 1015, upper contacts of cam 1021, right winding of relay 1015 to ground at the inner right contact of relay 1013. The current in this circuit, however, is not sufficient to operate relay 1015 but does create a flux in the windings of that relay so that it becomes quick to operate when the test circuit is closed. The test circuit extends from brush 1022, upper contacts of cam 1019, left back contact of relay 1009, left winding of relay 1015, lower right and upper left contacts of cam 1021, right winding of relay 1015 to ground at the inner right contact of relay 1013. An idle sender is characterized by battery potential on terminal 1023 and therefore when brush 1022 engages terminal 1023 the above traced circuit is completed and relay 1015 operates quickly closing a locking circuit for itself from battery, through its middle winding, the upper contacts of cam 1021, its right front contact to ground. It also opens the

circuit of relay 1017 which releases to in turn release magnet 1018 and bring the sender finder 1020 to rest on the terminals of the idle sender. The release of relay 1017 in turn releases relay 1013. With relay 1013 released and relay 1015 operated a circuit is closed from battery, through the winding of sequence switch magnet 1000, upper left contact of cam 1076, contacts 1027 of jack 1023, left back contact of relay 1013, left front contact of relay 1015 to ground at the left lower contact of cam 1016 thus advancing sequence switch 1000 to position 3.

As soon as sequence switch 1000 reached position $1\frac{3}{4}$ a circuit was established from ground, over the right contact of cam 1029, brush 1078, terminal 1077, conductor 822, the lower left contact of cam 823, the lower left contact of cam 824, to battery through the left winding of relay 825. Relay 825 upon operating with relay 802 released, closes a circuit for advancing sequence switch 800 into position 3. This circuit extends from battery, through the winding of sequence switch magnet 800, the upper right contact of cam 826, the inner right contact of relay 825, the outer left back contact of relay 822 to ground at the lower right contact of cam 807. With sequence switch 800 in position 3, relay 870 is held operated over key 871, resistance 872, the innermost lower back contact of relay 814 to ground at the lower contact of cam 833.

When sequence switch 1000 reaches position 3 a circuit is closed from ground at the sender over terminal 1030, brush 1031, the lower contact of cam 1034, brush 1032, terminal 1033, conductor 819, lower right and upper left contacts of cam 820 to battery through the upper winding of relay 814 and in parallel therewith over the upper right contact of cam 820, through the winding of relay 821 to battery. Relay 814 is marginal and does not operate, but relay 821 operates although ineffective at this time.

As soon as sequence switch 1000 arrived in position $2\frac{3}{4}$ it prepared the pulsing circuit for receiving dialing impulses. This circuit may be traced from the sender, over terminal 1040, brush 1041, the lower contact of cam 1029, brush 1078, terminal 1077, conductor 822, the upper left contact of cam 815, the upper contact of relay 814, thence as traced over the calling subscriber's line loop returning over the intermediate lower back contact of relay 814, the winding of supervisory relay 827, the left contact of cam 816, conductor 828, terminal 1042, brush 1043, the upper contacts of cam 1003, brush 1044, terminal 1045 to the sender. Upon the establishment of the pulsing circuit a dialing tone is transmitted to the calling line in the well-known manner to inform the calling subscriber that the sender is ready to receive impulses which he may then send out by manipulating his dial.

Upon the seizure of the sender, battery is removed from terminal 1023, thus releasing relay 1015, which closes a circuit for advancing sequence switch 1000 into position 5. This circuit may be traced from battery through the winding of magnet 1000, the upper right contact of cam 1076, the left back contact of relay 1015 to ground at the lower left contact of cam 1016. Sequence switch 1000 remains in position 5 throughout the further operation of the sender. As soon as the calling subscriber has dialed the office code digits, the sender establishes a fundamental circuit for controlling the district selector of Fig. 8 which may be traced from battery through the left winding of relay 825, the lower left contact of cam 824, upper left contact of cam 823, conductor 878, terminal 1001, brush 1002, the upper contacts of cam 1035, brush 1036, terminal 1037, through the winding of the stepping relay (not shown) of the sender to ground. Relay 825 energizes in this circuit and locks over its outer right front contact and the upper right contact of cam 824 to the fundamental circuit and also closes a circuit from battery through the winding of sequence switch magnet 800, upper right contact of cam 826, inner right front contact of relay 825, outer left back contact of relay 802 to ground at the lower right contact of cam 807. Magnet 800 operates to advance the sequence switch to position 4.

In position 4 relay 825 closes a circuit from battery through the winding of updrive magnet 831, the lower contacts of cam 832, the inner right front contact of relay 825, thence to ground at the lower right contact of cam 807. The updrive magnet operates and causes the district selector switch shaft to move upwardly in a brush selecting movement. Each time the commutator brush 830 makes contact with a conducting segment of strip 829, a shunt circuit is established from ground at the right contact of cam 833, over brush 830 and strip 829, the upper right contact of cam 823, the upper right contact of cam 824, the outer right front contact of relay 825 to the winding of relay 825 for holding this relay operated, but shunting down the sender stepping relay. In the well-known manner the operation of the sender stepping relay operates counting relays of the sender until the sender is satisfied as to the district brush selection coded by the office code registers, when the fundamental circuit is opened at the sender thereby permitting relay 825 to release as soon as brush 830 leaves the conducting segment of strip 829 upon which it last rested. The release of relay 825 opens the circuit of the updrive magnet 831 and closes a circuit from battery through the winding of sequence switch magnet 800, the right contacts of cam 834, the inner right back contact of relay 825

to ground as previously traced for advancing the sequence switch into position 5.

With sequence switch 800 in position 5, the fundamental circuit is again closed as previously traced, whereupon the stepping relay of the sender and relay 825 again operate, relay 825 locking to the fundamental circuit over the circuit previously traced and closing the previously traced circuit for advancing sequence switch 800 into position 6. As soon as the sequence switch reaches position 5 a circuit is established for the trip magnet 835 extending from battery through the winding of magnet 835 to ground at the lower right contact of cam 836. With sequence switch 800 in position 6, the circuit for the updrive magnet 831 is again closed over the circuit previously traced and magnet 831 causes the switch shaft to move upwardly in its group-selection movement. During the initial portion of this movement due to the energization of the trip magnet 835, a set of brushes is tripped for engagement with the terminal bank. As the shaft continues upwardly a shunt circuit is intermittently established from ground at the right contact of cam 833, over brush 837, commutator strip 838, the lower right and upper right contacts of cam 824, the outer right front contact and left winding of relay 825 to battery for holding relay 825 operated and for shunting down the sender stepping relay.

At the sender in response to the intermittent operation of the stepping relay, counting relays are operated in the well-known manner until the sender is satisfied with respect to the district group selection coded by the office code registers when the fundamental circuit will be opened at the sender, permitting the release of relay 825 as soon as brush 837 engages the next insulating portion of strip 838. Relay 825 upon releasing opens the circuit of updrive magnet 831 to arrest the upward movement of the switch shaft with the tripped set of brushes 839, 840 and 841 in engagement with the lowermost set of bank terminals in the selected trunk group. Relay 825 in releasing also establishes the previously traced circuit for advancing sequence switch 800 into position 7.

In position 7 of sequence switch 800, relay 825 is operated in a circuit extending from battery through its right winding, the upper right contact of cam 842, lower right contact of cam 843, back contact of relay 856, commutator strip 857, brush 858 to ground. Relay 825 energizes in this circuit closing a circuit for advancing sequence switch 800 into position 8. This circuit may be traced from battery through the winding of magnet 800, upper right contact of cam 826, inner right front contact of relay 825, the outer left back contact of relay 802, to ground at the lower right contact of cam 807. In positions 7 $\frac{3}{4}$ to 8, relay 825 locks over its left contact,

the right contacts of cam 845 to the test brush 839 and ground over the sleeve terminal of the trunk provided that trunk is busy. The original energizing circuit of relay 825 is opened when the sequence switch leaves position 7 $\frac{1}{4}$. If the first trunk of the group is busy, however, relay 825 is held energized in position 8 and a circuit is completed for the updrive magnet 831 from battery through the winding of magnet 831, lower contacts of cam 832, the inner right front contact of relay 825 to ground as traced. The updrive magnet is energized and causes the selector shaft to move upwardly in search of an idle outgoing trunk. Relay 825 is held energized as the test brush 839 passes from terminal to terminal over a circuit extending from battery through the right winding of relay 825, the right contacts of cam 842, commutator strip 846, brush 847, the upper right and lower left contacts of cam 832, the inner right front contact of relay 825, thence to ground as traced. As soon as an idle trunk is reached characterized by the absence of ground on its sleeve terminal, the locking circuit of relay 825 is opened and that relay releases, in turn, releasing the updrive magnet 831 to bring the district selector to rest with its brushes 839, 840 and 841 on the terminals of the selected idle trunk. The release of relay 825 closes a circuit from battery through the winding of sequence switch magnet 800, the right contacts of cam 834, the inner right back contact of relay 825 to ground as traced for advancing sequence switch 800 into position 9.

As soon as relay 825 releases ground is connected to sleeve brush 839, over the upper contacts of cam 848, the outer right back contact of relay 825 to ground at the upper left contact of cam 833. As soon as the sequence switch arrives in position 8 $\frac{3}{4}$ ground is connected over the lower right and upper left contacts of cam 848 to sleeve brush 839 independent of relay 825 which ground is maintained until the sequence switch leaves position 15 $\frac{1}{4}$.

With sequence switch 800 in position 9, a circuit is completed from battery through the right winding of relay 825, the lower left contact of cam 844, the right front contact of relay 821 to ground at the upper right contact of cam 836. Relay 825 operates and closes a circuit from battery through the winding of sequence switch magnet 800, upper right contact of cam 826, inner right front contact of relay 825 to ground as traced for advancing sequence switch 800 into position 10, in which position it remains until all subsequent selections are completed. In this position the fundamental circuit over which subsequent selections are controlled extends from brush 841, over the upper left and lower right contacts of cam 849, the right back contact of relay 850, thence as traced over conductor 878 to the sender returning over ter-

minal 1039, brush 1038, the upper left and lower right contacts of cam 1005, brush 1006, terminal 1007, conductor 818, the lower contacts of cam 851 to brush 840.

5 Following the completion of units selection and the advance of the incoming selector, current over the fundamental circuit is reversed and the sender is prepared for making talking selection. At this time the sender increases the resistance in the circuit of relay 821 to such an extent that it releases, opening the circuit of relay 825 which in turn releases, closing a circuit from battery through the winding of sequence switch magnet 800, over the right contacts of cam 834, the inner right back contact of relay 825 to ground as traced for advancing sequence switch 800 out of position 10 into position 11. As soon as sequence switch 800 reaches position 11 a circuit is closed for magnet 800 over the upper right contact of cam 826, the lower left and upper right contacts of cam 832, to ground at the right contact of cam 833 for advancing sequence switch 800 into position 12.

20 With sequence switch 800 in position 11, a local circuit is established for relay 821 extending from battery through the winding of relay 821, the right contacts of cam 820 to ground at the lower left contact of cam 836, and ground is connected to the sender over the lower left contact of cam 836, conductor 819, terminal 1033, brush 1032, upper contacts of cam 1046, left winding of relay 1015, left back contact of relay 1009, the upper right contact of cam 1034, brush 1031, terminal 1030 to battery in the sender for advancing the sender for making talking selection. Relay 1015 does not, however, operate in this circuit. At this time the calling line is connected over the lower contact of cam 815, through the left windings of repeating coil 852, the upper contact of cam 816, through the winding of supervisory relay 827, thereby operating relay 827 which establishes a holding circuit for relay 821 extending from battery through the winding of relay 821, the front contact of relay 827 to ground at the upper left contact of cam 836. Thus, relay 821 is maintained operated until the calling subscriber releases the connection.

50 In position 12 a circuit is established for relay 825 extending from battery through the left winding thereof, the lower left contact of cam 824, the upper left contact of cam 823, conductor 878, thence as traced through the winding of the stepping relay of the sender to ground. Relay 825 and the stepping relay of the sender operate in this circuit, relay 825 closing the previously traced circuit for advancing sequence switch 800 out of position 12 and locking itself to the fundamental circuit over its outer right front contact and the upper right contact of cam 824. Switch 800 now advances under the control of relay

825 and in positions 12 $\frac{3}{8}$, 13 $\frac{3}{8}$ and 14 $\frac{3}{8}$ connects ground over the right contacts of cam 848 in shunt of the winding of the sender stepping relay. The position in which sequence switch 800 comes to rest is determined by the counting relays of the sender in accordance with the talking selection registration set up by the sender code registers. When the sender is satisfied for this selection the fundamental circuit is opened thereby releasing relay 825 and stopping the sequence switch 800 in the next stopping position. For the purposes of this description it will be assumed that sequence switch 800 stops in position 14. In this position the right windings of repeating coil 852 are connected over the left contacts of cam 849 and left contacts of cam 851 to the brushes 841 and 840, respectively, in series over the left contacts of cam 845 and the winding of polarized relay 853, and thence to the repeating coil in the incoming selector.

The called line is tested by the final selector and if found idle, ringing current is applied from the incoming selector in the usual manner. When the called subscriber answers relay 853 operates and as soon as interrupter 854 closes its lower contact it establishes a circuit for relay 802 extending from battery through the winding of relay 802, the lower contact of interrupter 854, left contacts of cam 842, front contact of relay 853 to ground at the upper left contact of cam 807. Relay 802 operates and locks over its inner left front contact, the lower contact of relay 808, the upper left contact of cam 843, the upper left contact of cam 842, front contact of relay 853 to ground at the upper left contact of cam 807. The operation of relay 802 prepares a circuit for relay 850 which may be traced from battery through the winding of relay 850, upper left contact of cam 806, outer left front contact of relay 802, upper contact of interrupter 854 as soon as the interrupter advances to close its upper contact, the left contacts of cam 842, the front contact of relay 853 to ground at the upper left contact of cam 807. Relay 850, upon operating, locks over its inner left front contact to ground at the upper right contact of cam 807, closes a circuit from battery over its outer left contact, the contact of key 855, to ground through the winding of relay 810 and at its intermediate left contact establishes a new holding circuit for relay 870.

Relay 810, upon operating, reverses the connection of trunk conductors 504 and 505 to battery and ground through the left windings of repeating coil 852, thereby causing current to flow over the interoffice trunk through the windings of polarized relay 528 in such a direction as to operate this relay. Relay 528, upon operating, closes circuits in parallel for relays 526 and 533. The circuit of relay 533 which is quick operating but slow

to release extending from battery, over the left back contact of relay 526, winding of relay 533, front contact of relay 528, front contact of relay 502, commutator strip 517, brushes 518 and 510, strip 511 to ground at the lower front contact of relay 507. The circuit of relay 526 extends from battery through the winding of this relay to the contacts of relay 528, thence to ground as just traced. Relay 526 being slow to operate does not operate as quickly as relay 533, thereby allowing relay 533 to operate and establish the obvious circuit for slow-to-release relay 534. Relay 534, upon operating, opens at its normal contacts the circuit hereinbefore traced from ground at the lower contact of relay 507, through the winding of the calling line message register 118 to ground. As soon as relay 526 operates it opens at its left back contact the circuit of relay 533, at its inner right front contact closes a locking circuit for itself extending over the front contact of relay 502 to ground at the lower contact of relay 507 and establishes an operating circuit for the message register 118 extending from battery at its left front contact, over the alternate contacts of relay 534, the outer right alternate contacts of relay 526, the left front contact of relay 514, brush 521, terminal 522, the left back contact of relay 101 to ground through the winding of register magnet 118. This circuit is maintained only for the period required for slow-releasing relays 533 and 534 to release. As soon as relay 534 releases battery potential is removed from the operating circuit of magnet 118 and ground over the normal contacts of relay 534, the front contact of relay 502, over the circuit previously traced to the lower contact of relay 507 is substituted therefor, thus insuring that the message register will be operated but once.

After talking selection is completed the current in the circuit previously traced through the left winding of relay 1015 is increased to such an extent that relay 1015 operates and closes a circuit from battery through the right winding of relay 1017, the left contacts of cam 1021 to ground at the right front contact of relay 1015. Relay 1017 closes a circuit from battery through the winding of sequence switch magnet 1000, upper contact of cam 1079, outer right contact of relay 1017 to ground at the right back contact of relay 1009, advancing sequence switch 1000 into position 6. In this position all the conductors extending to the sender are opened and the sender is completely released.

As soon as sequence switch 1000 leaves position 5, relay 1015 releases and in turn releases relay 1017. With relay 1017 released in position 6, a circuit is closed from battery through the winding of sequence switch magnet 1000, lower left contact of cam 1076, left back contact of relay 1017 to ground at the lower left contact of cam 1016 advancing sequence switch 1000 into position 7. If another district is standing in position 1 awaiting association with a link, a circuit will be closed from ground over the lower left contact of cam 836, the lower contacts of cam 820, jack contacts 868, conductor 860, contacts of jacks 1048 and 1049 upper contact of cam 1016, left back contact of relay 1015, right contacts of cam 1014 to battery through the winding of relay 1013. Relay 1013 closes a circuit from battery, through the right winding of relay 1017, right front contact of relay 1013 to ground at the right back contact of relay 1015. Relay 1017 in operating closes a circuit for updrive magnet 1047 of the district finder 1010, lower right contact of cams 1079, outer right contact of relay 1017 to ground at the right back contact of relay 1009. The district finder moves upwardly under the control of magnet 1047 in search of a district which is in condition to be seized. Such a district is identified by battery connected over the right contacts of cam 859, jack contacts 869, conductor 1091 to terminal 1050. Relay 1013, in operating, closes the same circuit through the right and middle windings of relay 1015 as it closed in position 2. At this time the test circuit extends to ground at the inner right front contact of relay 1013, through the right winding of relay 1015, upper left and lower right contacts of cam 1021, left winding of relay 1015, left back contact of relay 1009, upper right and lower left contacts of cam 1019, contact of jack 1049 to brush 1051. Relay 1015 thereupon quickly operates locking through its middle winding, the upper contacts of cam 1021 to ground at the right front contact of relay 1015, opening the circuit of relay 1017 to release magnet 1047 and bring the district finder to rest on the terminals of the district, and at its left back contact opening the circuit of relay 1013 which also releases. Since key 873 of each district of the frame which is not arranged for use with a line finder of office A is operated, the link 1099 and all other links of the same group 1099'—1099* will not be able to select such districts since the test terminals corresponding to terminal 1050 will thus be disconnected. With relay 1015 operated and relays 1013 and 1017 released, a circuit is closed from battery, through the winding of sequence switch magnet 1000, upper left contact of cam 1076, contact 1027 of jack 1028, left back contact of relay 1013, left front contact of relay 1015, upper contact of cam 1016, contacts of jacks 1049 and 1048, conductor 860, jack contacts 868, the lower left contact of cam 820 to ground at the lower left contact of cam 836. Sequence switch 1000 advances to position 8 in this circuit.

Relay 1015 is held operated in position 8 from battery at the district selector over con-

ductor 1091 terminal 1050, brush 1051, contact of jack 1049, lower left and upper right contacts of cam 1019, back contact of relay 1009, left winding of relay 1015, lower right and upper left contacts of cam 1021 to ground at the right front contact of relay 1015. With relay 1015 operated a circuit is closed from ground at the lower left contact of cam 1016, left front contact of relay 1015, upper left contact of cam 1029, brush 1078, terminal 1077, conductor 822, lower right contact of cam 823, lower right contact of cam 824 to battery through the left winding of relay 825. Relay 825 operates and closes a circuit through the winding of sequence switch magnet 800, upper right contact of cam 826, inner right front contact of relay 825, outer left back contact of relay 802 to ground at the lower right contact of cam 807. Sequence switch 800 advances to position 2 in this circuit, releasing relay 825. The advance to position 2 removes battery from conductor 1091 and ground from conductor 860. The removal of battery from conductor 1091 opens the circuit of relay 1015 and that relay releases, closing a circuit from battery through the winding of sequence switch magnet 1000, upper right contact of cam 1076, left back contact of relay 1015 to ground at the lower left contact of cam 1016. Sequence switch 1000 now advances to position 9.

The link circuit 1099 remains in this position until the link standing next to it in series is advanced from position 1 for the purpose of selecting a sender. Link circuit 1099' occupying that relationship to the link circuit 1099 of Fig. 10 a circuit may be traced from ground over the lower contact of cam 1061', the lower contact of cam 1062', conductor 973, contact 1060 of jack 1028, lower contact of cam 1062, right contact of cam 1061 to battery through the winding of sequence switch magnet 1000, advancing the sequence switch of link circuit 1099 to position 10, which is the equivalent of position 1, so that the link circuit is ready to operate in response to the next call. It is to be noted that the link circuit 1099' will be used for a call incoming to office B from office A next succeeding the call just described and that succeeding calls will use other links interposed between link 1099 and link 1099*, link 1099* being the last link in the group available for handling calls incoming from office A.

At the end of the conversation the calling subscriber hangs his receiver upon the switchhook, thereby opening the circuit through the windings of relays 527, 528 and 827. The release of relay 528 has no effect, but relay 527, upon releasing opens the circuit of relay 502 which at its back contact establishes a circuit for relay 515 extending from battery through the winding of relay 515, left back contact of relay 501, back contact of relay 502, commutator strip 517,

brushes 518 and 510, strip 511 to ground at the lower contact of relay 507, and opens the locking circuit of relay 526. Relay 515, upon operating, opens the holding circuit of relays 514 and 513, relay 514, in turn, releasing the cutoff relay 102 of the calling line. At its left front contact relay 515 establishes a holding circuit for itself extending from ground at its left front contact to replace the operating ground supplied from the lower contact of relay 507 since the relay 507 releases following the release of relay 514. At its right contact relay 515 establishes a circuit for the downdrive magnet 535 for driving the line finder shaft downwardly into its normal position. Just before the shaft reaches normal, the brush 518 leaves the commutator strip 517, opening the circuit of relay 515, which thereupon releases, opening the circuit of magnet 535 to arrest the switch shaft in its normal position.

At the district selector upon the release of relay 827, the circuit of relay 821 is opened and relay 821 releases, establishing a circuit for relay 814 extending from battery through the upper winding of relay 814, the upper left contact of cam 820, the lower left contact of cam 862, the back contact of relay 821 to ground as soon as interrupter 863 closes its upper contact. Relay 814, upon operating, locks over its lower winding and innermost lower contact to ground at the lower contact of cam 833 and closes a circuit from battery, through the winding of sequence switch magnet 800, the lower right contact of cam 801, the lower left contact of cam 859 to ground at the lower front contact of relay 814, advancing sequence switch 800 into position 17. As the sequence switch reaches position 17 a circuit is closed for relay 802 extending from battery through the winding of relay 802, upper right contact of cam 801, upper left contact of cam 859, upper left contact of cam 820, lower left contact of cam 862, back contact of relay 821 to ground at interrupter 863. Relay 802 operates and locks over its inner left front contact, back contact of relay 808, left contacts of cam 843, to ground at the inner lower front contact of relay 811, and establishes a circuit for advancing sequence switch 800 into position 18.

This circuit may be traced from battery through the winding of magnet 800, the upper right contact of cam 817, the outer left front contact of relay 802 to ground at the lower right contact of cam 807. When the sequence switch leaves position 17½ cam 833 opens the holding circuits of relays 814 and 850, in turn releasing relays 870, 811 and 813. In position 18 the usual circuit for operating the downdrive magnet 864 of the line finder of Fig. 8 is not closed because key 865 is in its alternate position. Since the finder is already normal when sequence switch 800 leaves position 17, relay 802 releases. In

position 18 a circuit is established for the downdrive magnet 866 of the district selector extending from battery through the winding of magnet 866, upper contacts of cam 824 to ground at the right contacts of cam 848. As soon as the district selector reaches normal, ground over the right contact of cam 833, brush 847, normal segment 867, upper left contact of cam 826 to battery, through the winding of magnet 800, advances sequence switch 800 into normal position. When the sequence switch left position 15 $\frac{1}{4}$, ground was removed from the test brush 839 at the lower contact of cam 848 for releasing succeeding selector switches. All apparatus employed in the establishment of the connection has now been restored to normal.

Calls originated in office B while apparatus of office B is set aside for serving calls originated in office A

Should a call be initiated from substation 600 in office B during the period that apparatus of office B has been assigned for the use of office A, through the operation of keys of Figs. 7, 8 and 9, the start circuit of Fig. 7 will function under the control of the calling line to connect ground to start lead 706 through the preallotted link of Fig. 9 to start a line finder of the line finder frame of office B which has been selected by the link. This line finder, for example that shown schematically in the lower right portion of Fig. 8, will not, however, be equipped with keys, such as 805, 809, 855, 865, 871 but will be equipped with a key 873' similar to key 873 and therefore will function in the well-known manner to hunt for the calling line and associate it with the district selector with which it is paired. After the calling line has been found, the link 999 of Fig. 9 will function in the same manner as previously described in connection with the link 1099 of Fig. 10 to associate an idle sender with the calling line and to control the district selector paired with the line finder for controlling the establishment of the desired connection under the control of the dial of the calling substation 600.

After the sender seized by the link circuit of Fig. 9 has completed talking selection, the current in the circuit through the left winding of relay 915 is increased to such an extent that relay 915 operates and closes a circuit from battery through the right winding of relay 917, the left contacts of cam 921 to ground at the right front contact of relay 915. Relay 917 closes a circuit from battery through the winding of sequence switch magnet 900, upper contact of cam 979, outer right contact of relay 917 to ground at the right back contact of relay 909, advancing sequence switch 900 to position 6. In this position all the conductors extending to the sender are opened and the sender is completely re-

leased. As soon as the sequence switch 900 leaves position 5, relay 915 releases and in turn releases relay 917. With relay 917 released in position 6, a circuit is closed from battery through the winding of sequence switch magnet 900, lower left contact of cam 976, left back contact of relay 917, left back contact of relay 915, right contacts of cam 914 to battery through the winding of relay 913. Relay 913 closes a circuit from battery through the right winding of relay 917, outer right front contact of relay 913 to ground at the right back contact of relay 915. Relay 917, in operating, closes a circuit for updrive magnet 947 of the district finder 910, lower right contact of cam 979, outer right contact of relay 917 to ground at the right back contact of relay 909. The district finder moves upwardly under the control of magnet 947 in search of a district selector which is in condition to be seized. Since it has been assumed that the keys associated with certain district selectors of office B have been operated so that the district selectors may be used with line finders of office A, the test conductors 987 of such line finder-district links normally extending in multiple to test contacts such as 950 of all the links then segregated for use on calls incoming from office A are opened at key 873 of each such line finder to prevent the selection of such line finders by links 999, 999'—999*. Each district that is available to be seized by the link 999 is identified by battery connected over the right contacts of a cam similar to cam 859, jack contacts 869' similar to contacts 869, a conductor 991 similar to 1091 to a terminal similar to terminal 950. Relay 913, in operating, closes the same circuit through the right and middle windings of relay 915 as it closed when sequence switch 900 was in position 2 and the sender finder 920 of the link was searching for an idle sender. At this time the test circuit extends to ground at the inner front contact of relay 913, through the right winding of relay 915, upper left and lower right contacts of cam 921, left winding of relay 915, left back contact of relay 909, upper right and lower left contacts of cam 919, contact of jack 949 to brush 951. Relay 915 thereupon operates quickly and locks through its middle winding, the upper contacts of cam 921 to ground at the right front contact of relay 915, opening the circuit of relay 917 to release magnet 947 and bring the finder to rest on the terminals of the district and opening the circuit of relay 913. With relay 915 operated and relays 917 and 913 released, a circuit is closed from battery, through the winding of sequence switch magnet 900, upper left contact of cam 976, contact 927 of jack 928, left back contact of relay 913, left front contact of relay 915, upper contact of cam 916, contacts of jacks 948 and 949 to conductor 880, extending thence over jack con-

tact 868' similar to contact 868, cams similar to cams 820 and 836 to ground at the selected district. Sequence switch 900 now advances to position 8.

5 Relay 915 is held operated in position 8 from battery at the district over a conductor 991 similar to conductor 1091 terminal 950 and brush 951, contact of jack 949, lower left and upper right contacts of cam 919, back
10 contact of relay 909, left winding of relay 915 lower right and upper left contacts of cam 921 to ground at the right front contact of relay 915. With relay 915 operated a circuit is closed from ground at the lower left
15 contact of cam 916, left front contact of relay 915, upper left contact of cam 929, brush 978, terminal 977, conductor 822 of the selected district, lower right contact of cam 823, lower
20 right contact of cam 824 to battery through the left winding of relay 825 of the selected district. Relay 825 closes a circuit as previously traced to advance the district sequence switch into position 2 for allotting the district and releasing relay 825. The sequence
25 switch in advancing to position 2 removes battery from conductor 991 and ground from conductor 880. The removal of battery from conductor 991 opens the circuit of relay 915 and that relay releases, closing a circuit from
30 battery through the winding of sequence switch magnet 900, upper right contact of cam 976, left back contact of relay 915 to ground at the lower left contact of cam 916. Sequence switch 900 advances to position 9.

35 The link circuit 999 remains in this position until the link standing next to it in series is advanced from position 1 for the purpose of selecting a sender. Link circuit 999' occupying that relationship to the link 999 of
40 Fig. 9, a circuit may be traced from ground through the lower contact of cam 961', the upper right contact of cam 962', conductor 773, alternate contact of key 981, contact 960 of jack 928, lower contact of cam 962, right
45 contact of cam 961 to battery through the winding of sequence switch magnet 900, advancing the link circuit sequence switch into position 10, which is equivalent to position 1, so that the link circuit 999 is ready to operate
50 in response to the next call. It is to be noted that the link circuit 999' will be used for the next call initiated at office B, the start conductor 706 being extended over the contact
55 of cam 974 during the time that the link circuit 999 of Fig. 9 is engaged in a call, the contact of key 975, conductor 980 to start conductor 781 corresponding to start conductor 706. When this link 999' is taken into
60 service and its sequence switch is standing in some position between $1\frac{3}{4}$ to 9 or $10\frac{3}{4}$ to 18, the start conductor 706 will be extended to the start conductor of the next succeeding link over the contact of cam 974'. In this manner
65 the links are taken for use until the start

conductor 706 is extended to the start conductor 782 of the last link 999*.

Calls originated in office B when traffic conditions are normal in offices A and B

70 As hereinbefore stated during periods of normal load at both offices A and B, the keys at both offices will be in their normal positions and therefore the apparatus at each office will function in the usual manner to control the extension of calls in each office, respectively. With the keys of Fig. 8 normal, the line finder and district are paired together.
75 With the keys of Fig. 2 normal, the start conductor cannot be extended to office B from office A for starting a link in office B in case all available links in office A are busy.

80 With the keys of Figs. 7 and 9 in normal position all of the links of the group disclosed function as a single group rather than as two groups as previously described and serve only calls originated in office B. Thus on the first call initiated in the group of lines in which
85 substation 600 is located, the start circuit is established over conductor 706 which is extended through the link circuit 999 of Fig. 9 for starting a line finder preallotted for use. As soon as the line finder finds the calling line, the link circuit of Fig. 9 advances as
90 previously described out of its normal position 1 or 10, thus extending the start conductor 706 over the contact of cam 974, normal contacts of key 982, conductor 983, through the link 1099 of Fig. 10 for starting a line finder preallotted by such link. When
95 the line finder thus started advances, the link 1099 of Fig. 10 advances out of position 1 or 10 closing cam contact 1074 for extending the start circuit over conductor 984 to start lead 985 for starting the line finder then associated with the link circuit 1099'. When
100 the link circuit 1099' advances to close cam contact 1074', the start circuit is extended to the start conductor of the next succeeding link. In a similar manner the start conductor 706 is extended successively to all links of the sub-group until it is extended to start conductor 783 of the last link 1099* of the sub-group. When the link 1099* advances the
105 start conductor is further extended over the contact of cam 1074* thereof to contact of key 785 to start lead 781 of link 999'. In the similar manner the start conductor is further extended to successive links until it becomes extended to the last link 999*.

110 With the keys 988 to 990 and 992, and 786 to 790 inclusive, normal, the six cams of each of the link circuits 999' to 999* and 1099' to 1099* indicated at the right of Fig. 7 and left
115 of Fig. 9 are connected in series relation with each other and with the corresponding cams of link circuit 1099 of Fig. 10 and link circuit 999' of Fig. 9, whereby all of these link circuits are employed as a single group and are
120 taken into service in succession.

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With the keys 805, 809, 855, 865, 871 and 873 of all district selector circuits such as Fig. 8 which are arranged for service with line finders of office A in their normal positions and the keys 873' of all district selector circuits which are arranged to be used only on locally originated calls in their normal position, any of these district circuits may be selected by any one of the link circuits of Figs. 7, 9 and 10 for use in extending calls originated locally. When the keys 809 and 506 are in their normal positions the interoffice trunk 504 or 505 is available for extending a call from the district selector terminal banks of office A to an incoming selector in which the interoffice trunk terminates in office B.

What is claimed is:

1. A telephone exchange system comprising a plurality of offices, call distributing and call extending equipment at each office, trunks connecting said offices, means including said trunks for associating call distributing equipment at one office with the call extending equipment of another office independently of the call extending equipment of the first office, and means for thereupon completing any call originated in said first office over the call extending equipment of said other office.

2. A telephone exchange system comprising a plurality of offices, call extending equipment at each office, interoffice trunks over which calls may be extended from one office to another, means including said trunks for extending any calls originating at one office to the call extending equipment at another office independent of the call extending equipment at the originating office, and means for thereupon completing all such calls over the call extending equipment of said other office.

3. In a telephone exchange system, non-numerical switches for associating calling lines terminating in offices of said exchange system with numerical switches local to such offices respectively, other non-numerical switches in certain of said offices, means for connecting said other non-numerical switches of such offices with numerical switches at other offices without operating or utilizing the numerical switches at the originating offices, and means for completing any calls originated in said certain offices over the numerical switches of said other office.

4. A telephone exchange system comprising a plurality of offices, line finders and call extending equipment at each office, trunks connecting said offices, means including said trunks for associating line finders at one office with the call extending equipment at another office independent of the call extending equipment of the first office, and means for thereupon completing any call originated

in said first office over the call extending equipment of said other office.

5. A telephone exchange system comprising a first office and a second office, call distributing and call extending equipment at each office, trunks connecting said offices, means operative when a peak load occurs at said first office at a time when a light load occurs at said second office for associating call distributing equipment of said first office over said trunks with the call extending equipment of said second office independently of the call extending equipment of said first office, and means for thereupon completing any call originated in said first office over the call extending equipment of said second office.

6. A telephone exchange system comprising a first office and a second office, call extending equipment at each office, trunks over which calls may be extended from said first office to said second office, means operative when a peak load occurs at said first office at a time when a light load occurs at said second office for extending calls originating at said first office over said trunks to the call extending equipment of said second office independent of the call extending equipment of said first office, and means for thereupon completing any call originated in said first office over the call extending equipment of said second office.

7. A telephone exchange system comprising a first office and a second office, non-numerical switches at each office for associating calling lines terminating therein with numerical switches local to such offices respectively, other non-numerical switches in said first office, means operative when a peak load occurs at said first office at a time when a light load occurs at said second office for connecting said other non-numerical switches at said first office with numerical switches of said second office without operating or utilizing the numerical switches at said first office, and means for thereupon completing any call originating in said first office over the numerical switches at said second office.

8. A telephone exchange system comprising a first office and a second office, line finders and call extending equipment at each office, auxiliary line finders at said first office, trunks over which calls may be extended from said first office to said second office, means operative when a peak load occurs at said first office at a time when a light load occurs at said second office for associating certain of the line finders of said first office with the call extending equipment of said second office independent of the call extending equipment of said first office, and means for thereupon completing any call originating in said first office over the call extending equipment at said second office.

9. A telephone system comprising a plurality of offices, call distributing and call extending equipment at each office, trunks connecting said offices, auxiliary call distributing equipment at one of said offices, and means including said trunks operative only when there is a peak load in said one office for associating said auxiliary call distributing equipment with the call extending equipment of another of said offices.

10. A telephone exchange system comprising a plurality of offices, call distributing and call extending equipment at each office for establishing connections on calls originated therein, auxiliary call distributing equipment in certain of said offices, trunks terminating in said auxiliary call distributing equipment of said certain offices, and extending to one of said plurality of offices and terminating therein in call extending equipment, and means including said trunks and associated auxiliary call distributing and call extending equipment for completing any calls originated in said certain offices.

11. A telephone exchange system comprising a plurality of offices, line finders and directionally controlled selectors at each office for establishing connections on calls originated therein, auxiliary line finders in certain of said offices, trunks terminating in said auxiliary line finders of said certain offices and extending to one of said plurality of offices and terminating in directionally controlled selectors therein, and means including said trunks and associated line finders and selectors for completing any calls originated in said certain offices.

In witness whereof, I hereunto subscribe my name this 3rd day of January, 1929.

AMOS F. DIXON.