

June 21, 1938.

F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 1

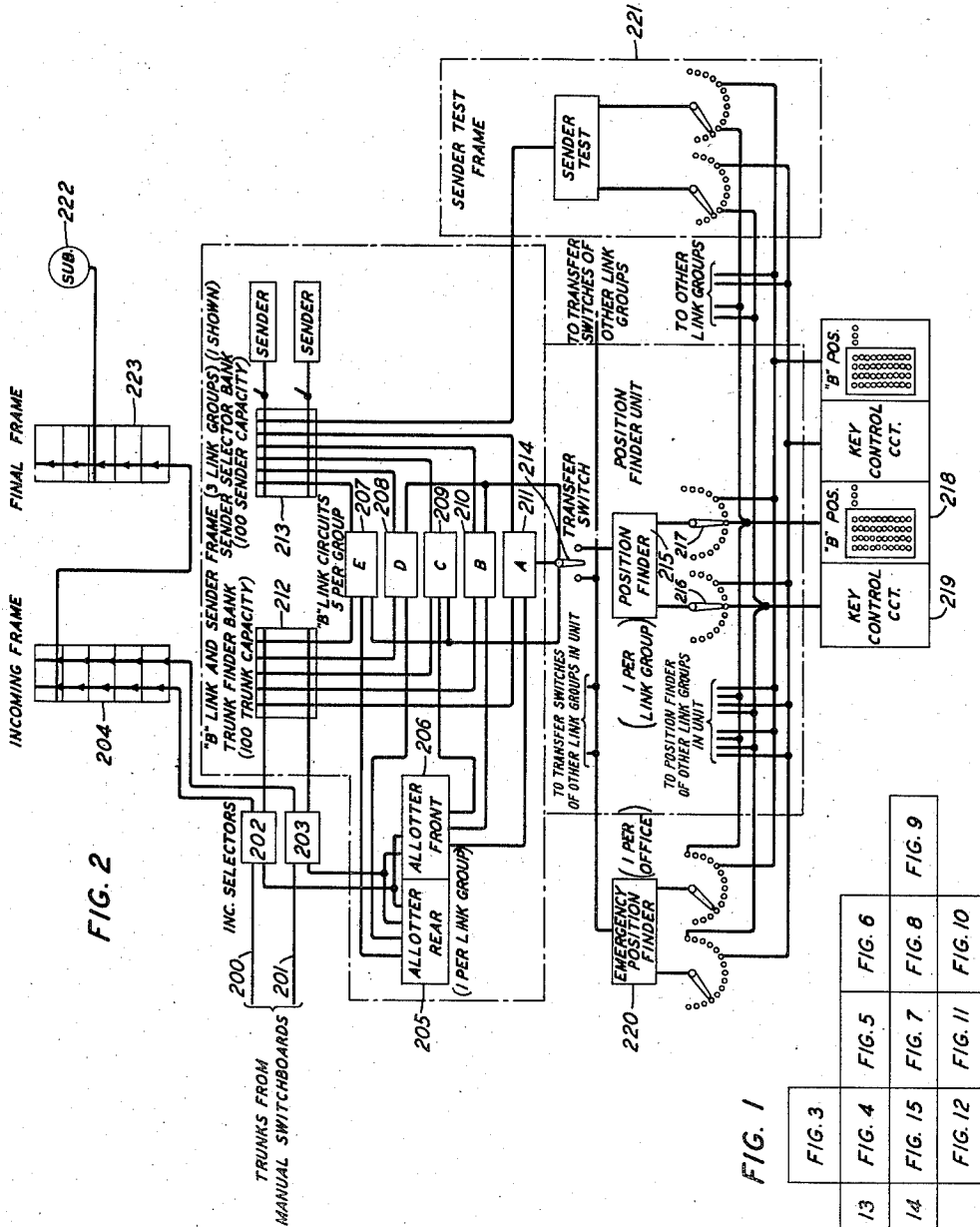


FIG. 1

FIG. 3	FIG. 4	FIG. 5	FIG. 6
FIG. 13	FIG. 14	FIG. 15	FIG. 16
FIG. 7	FIG. 8	FIG. 9	FIG. 10
FIG. 11	FIG. 12	FIG. 13	FIG. 14

INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

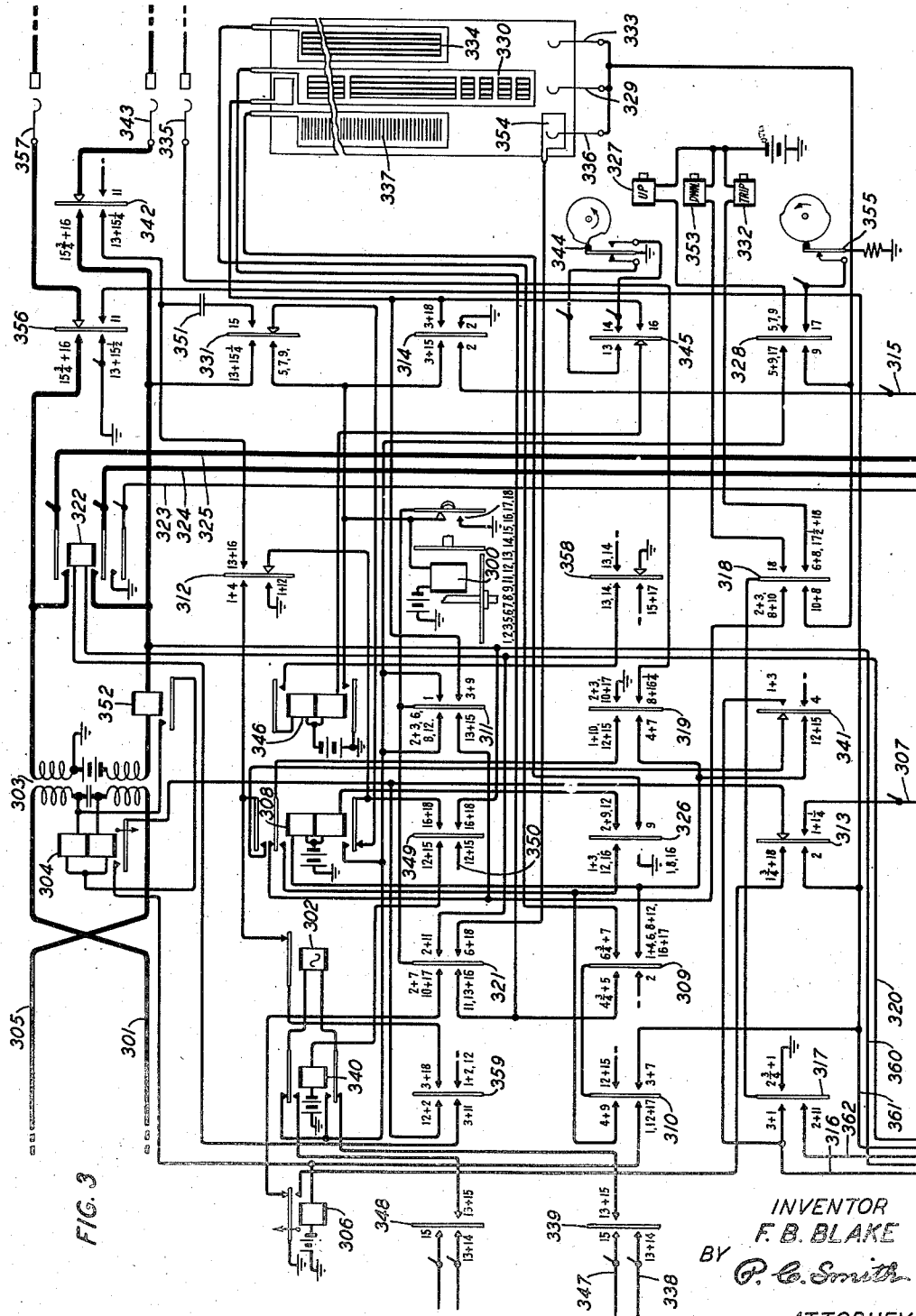
F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 2



INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

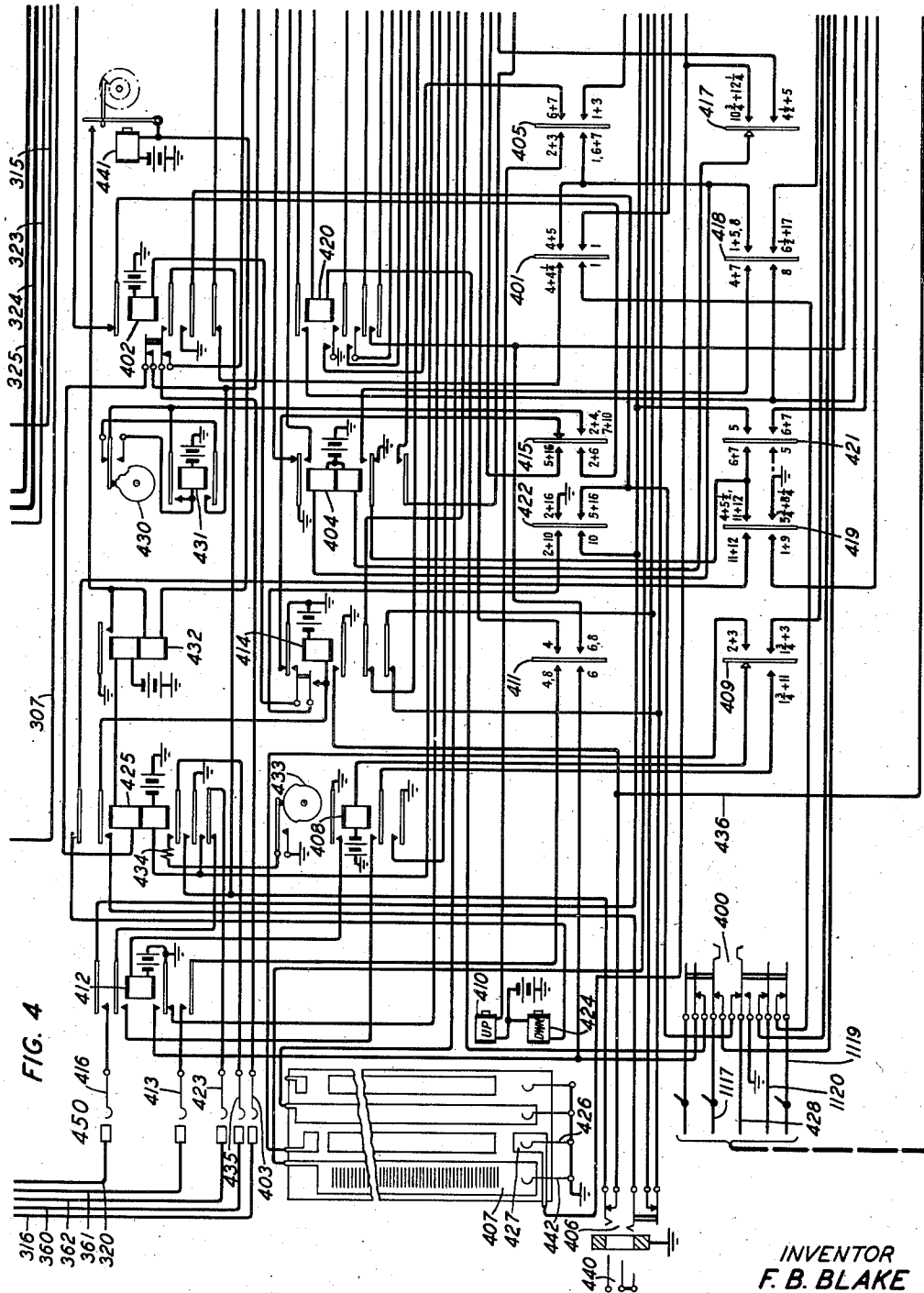
F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 3



INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

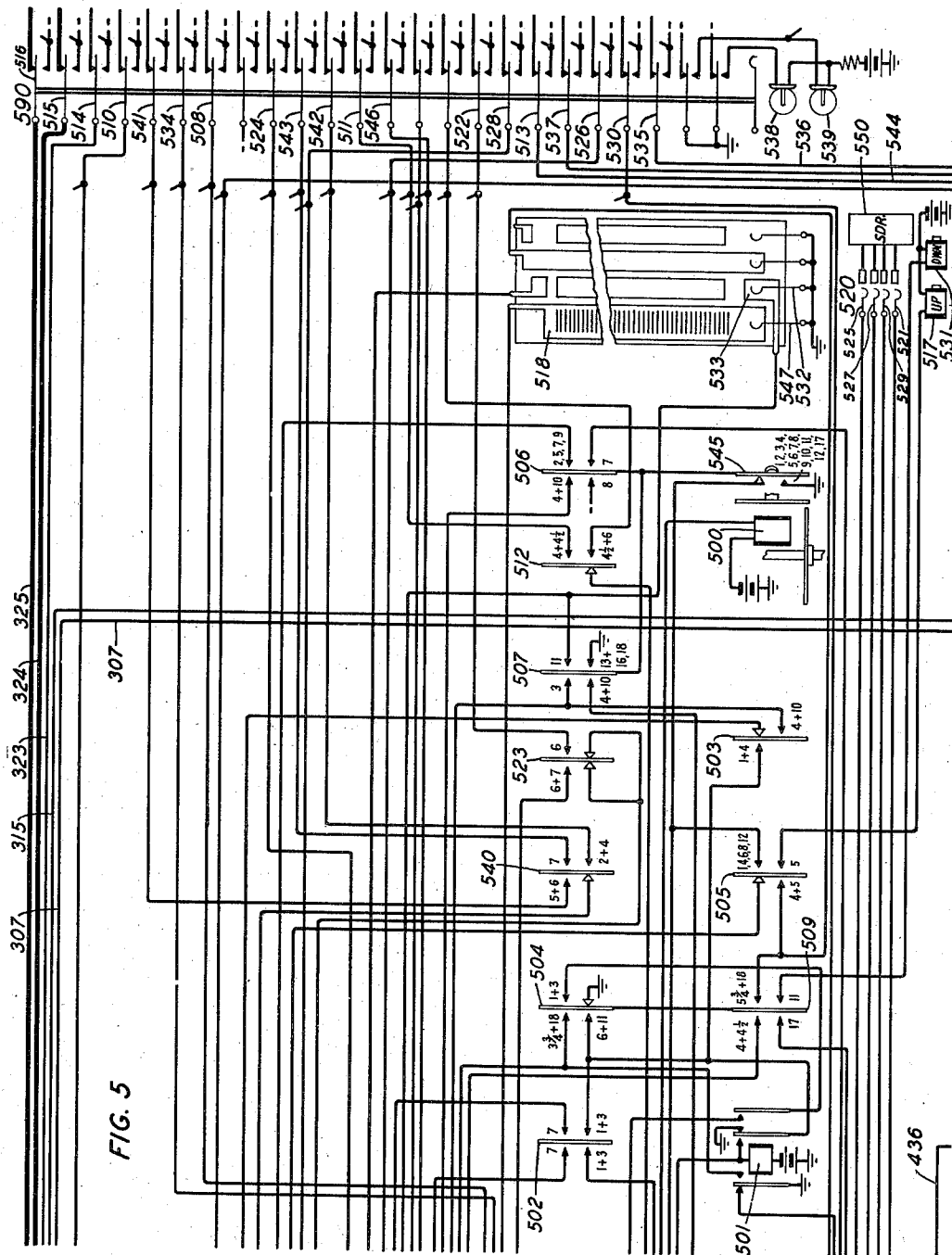
F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 4



INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

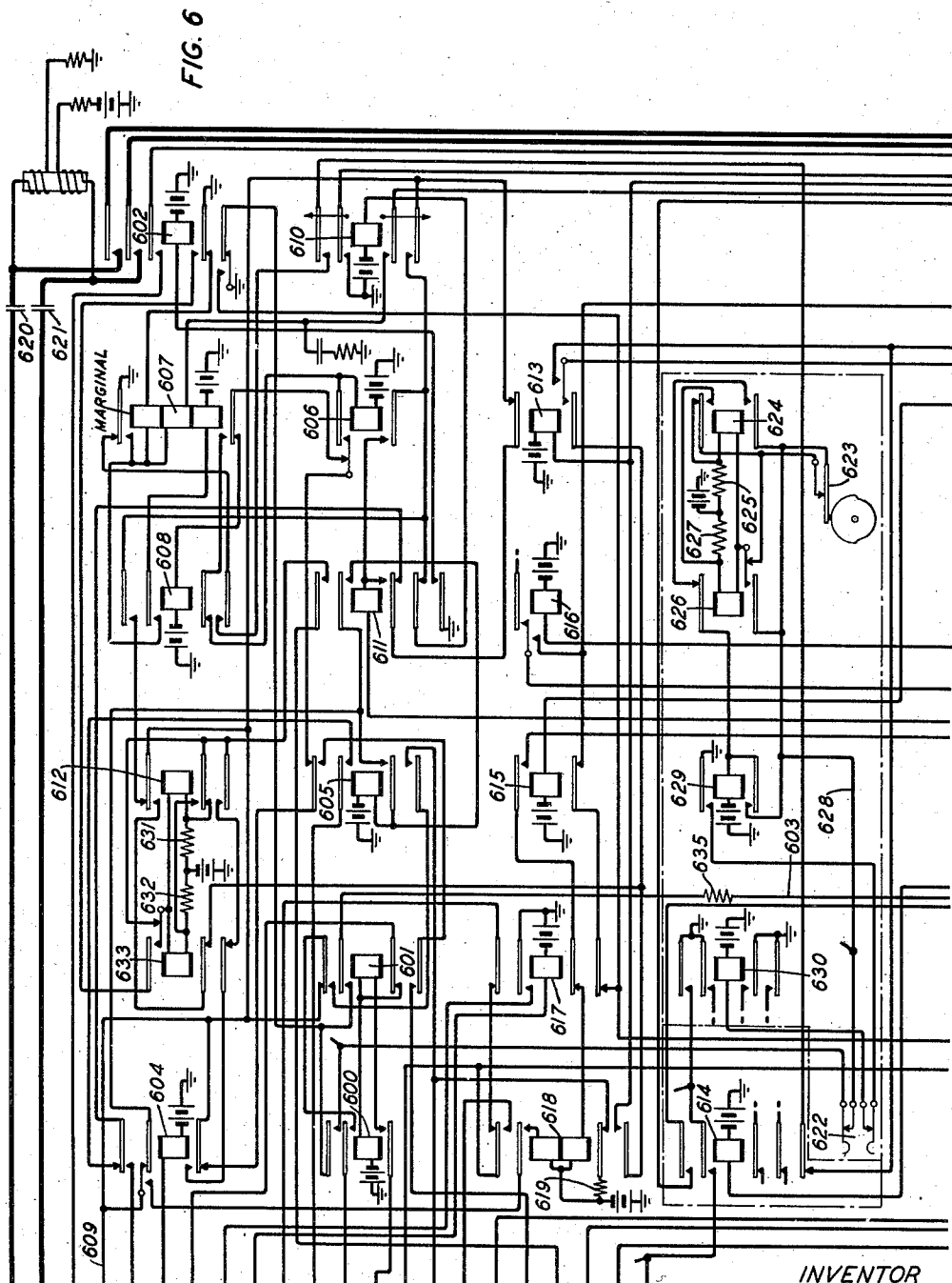
F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 5



INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 6

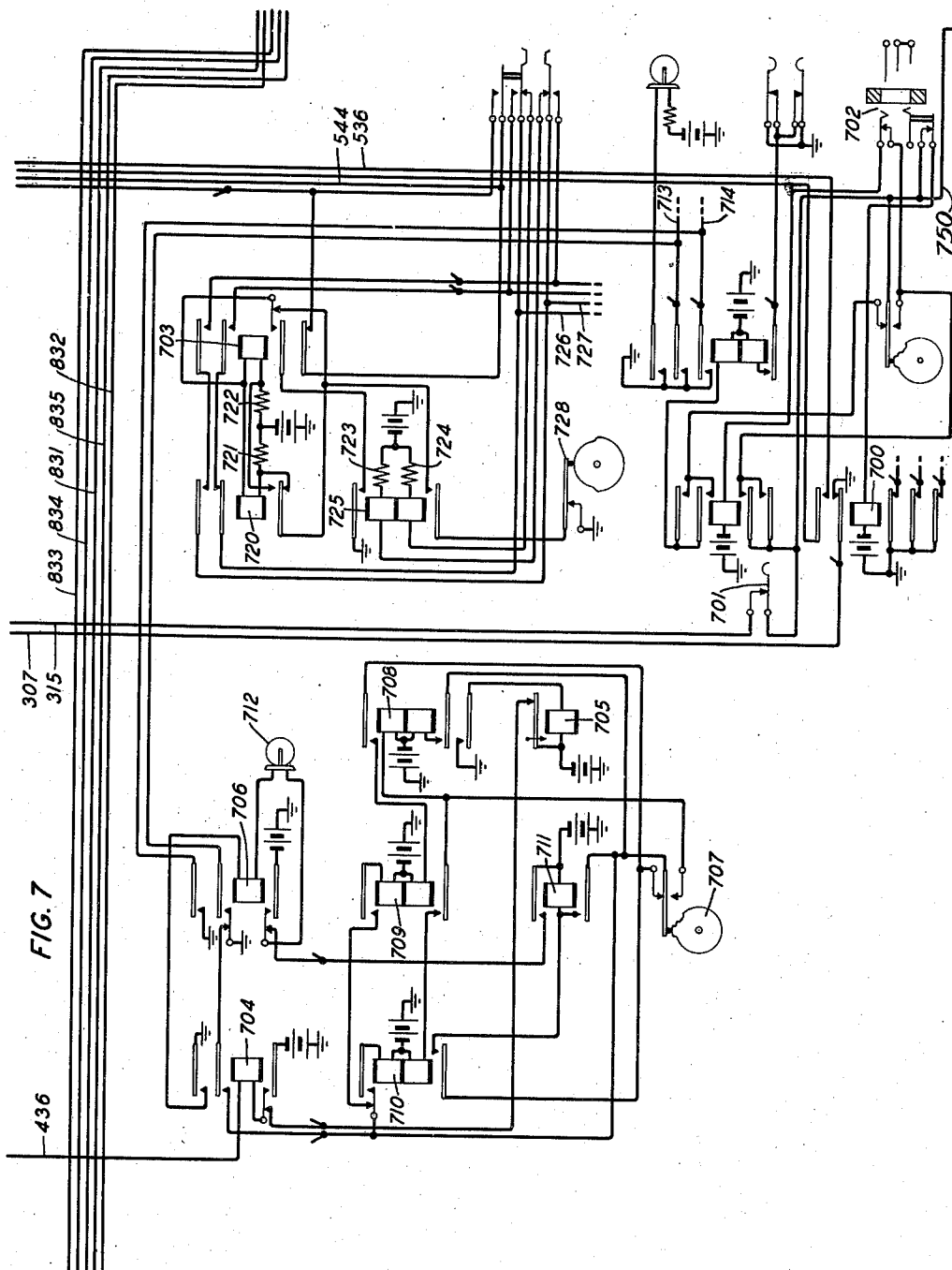


FIG. 7

INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

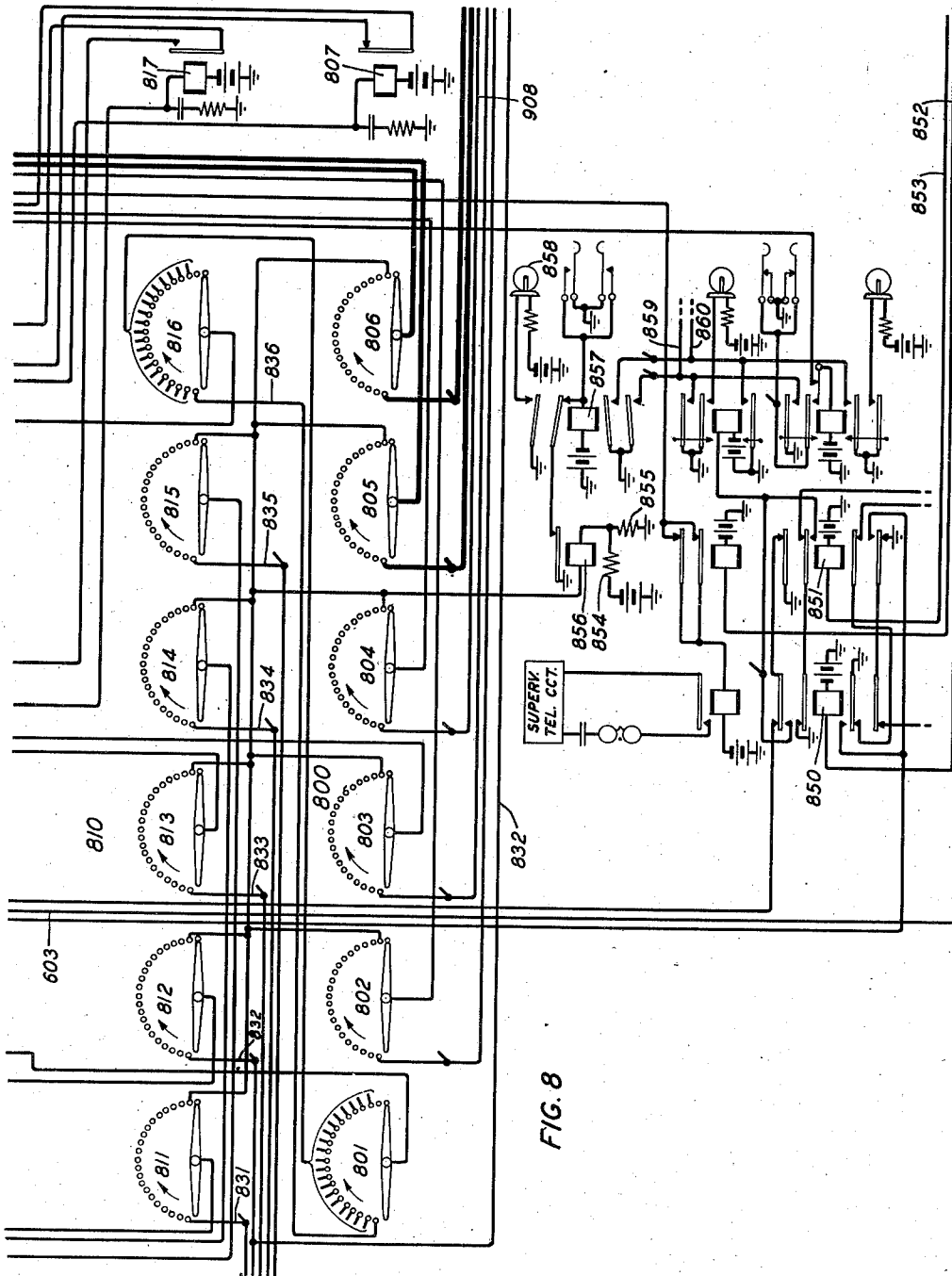
F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 7



INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

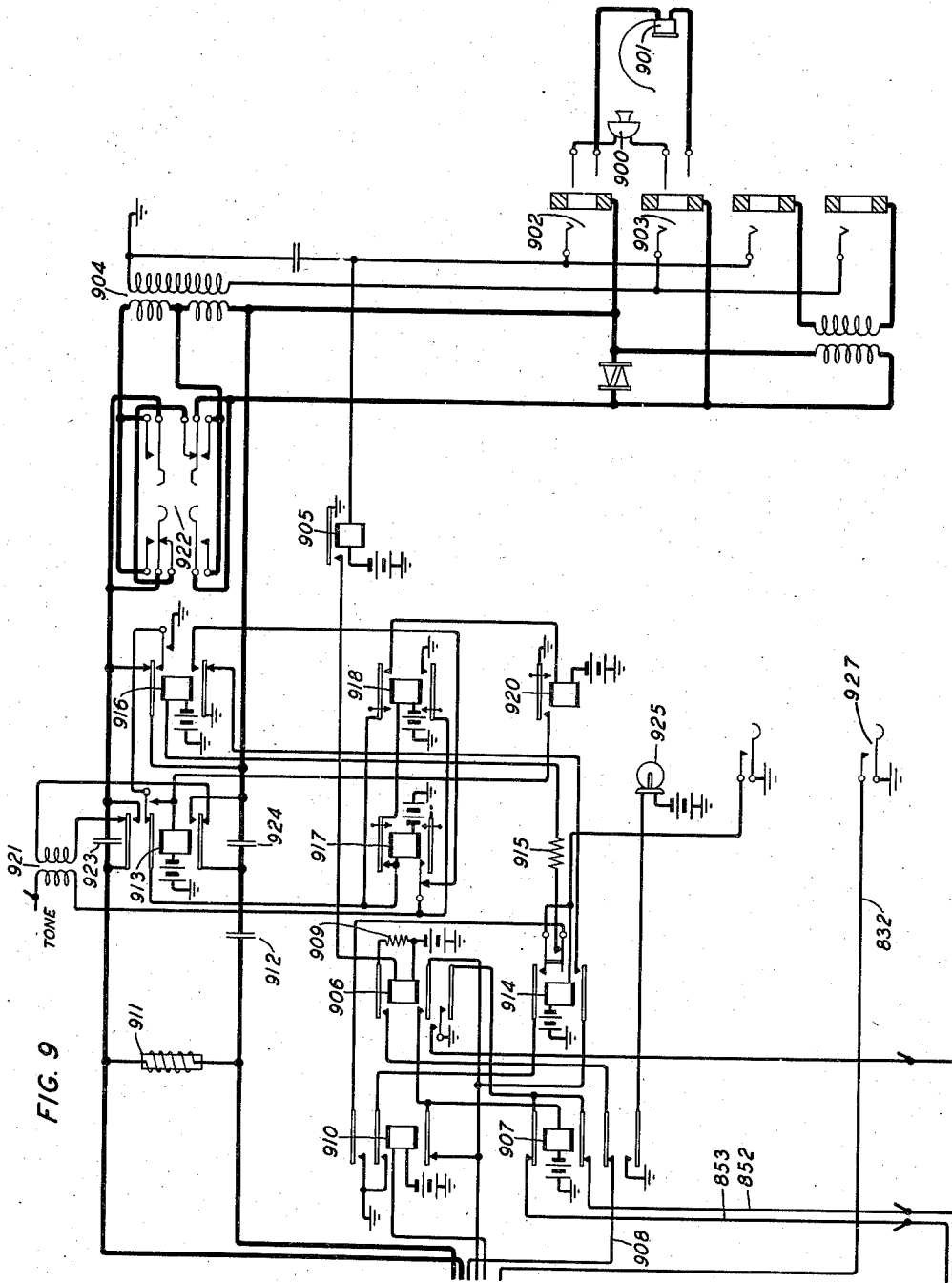
F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 8



INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

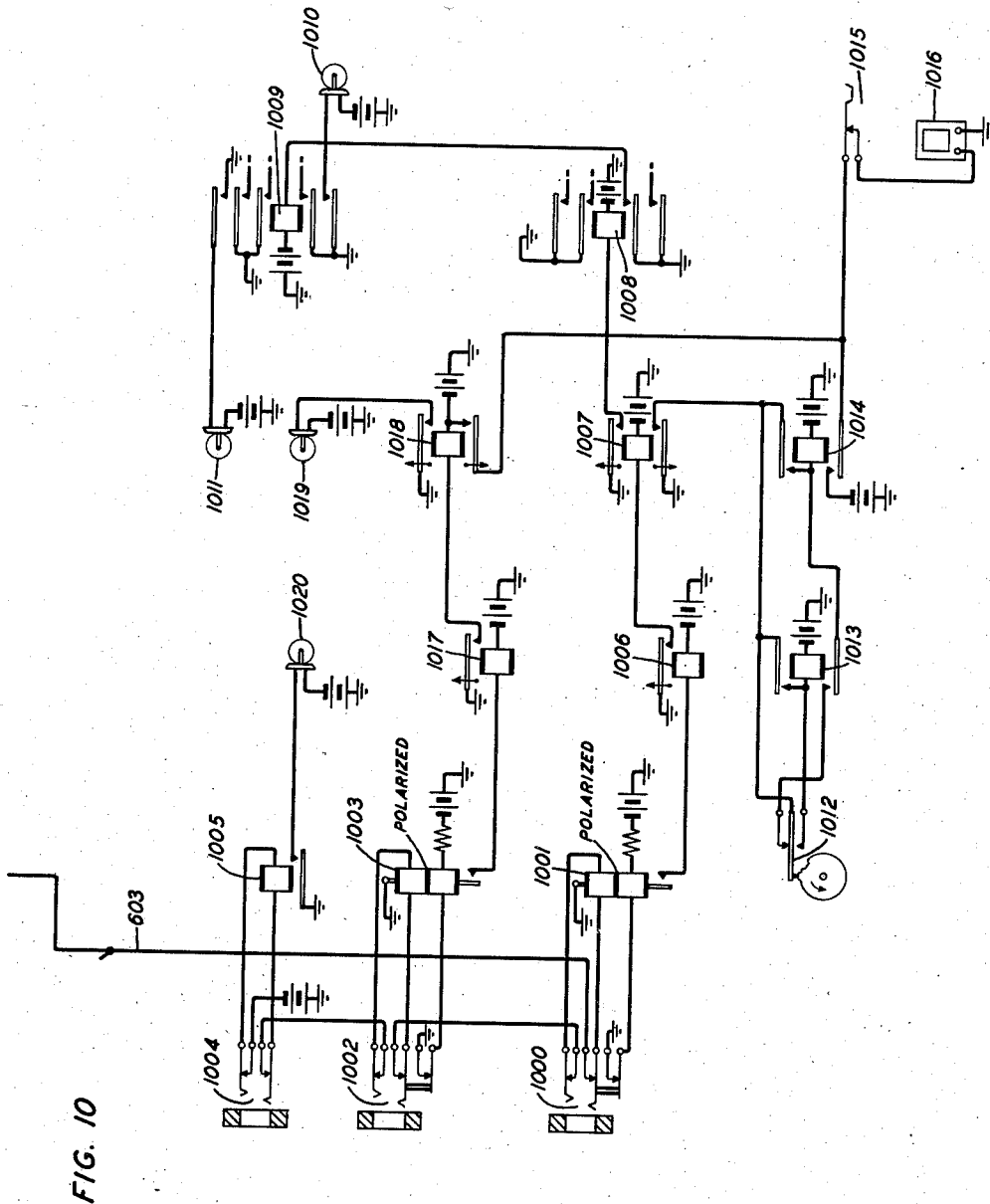
F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 9



INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

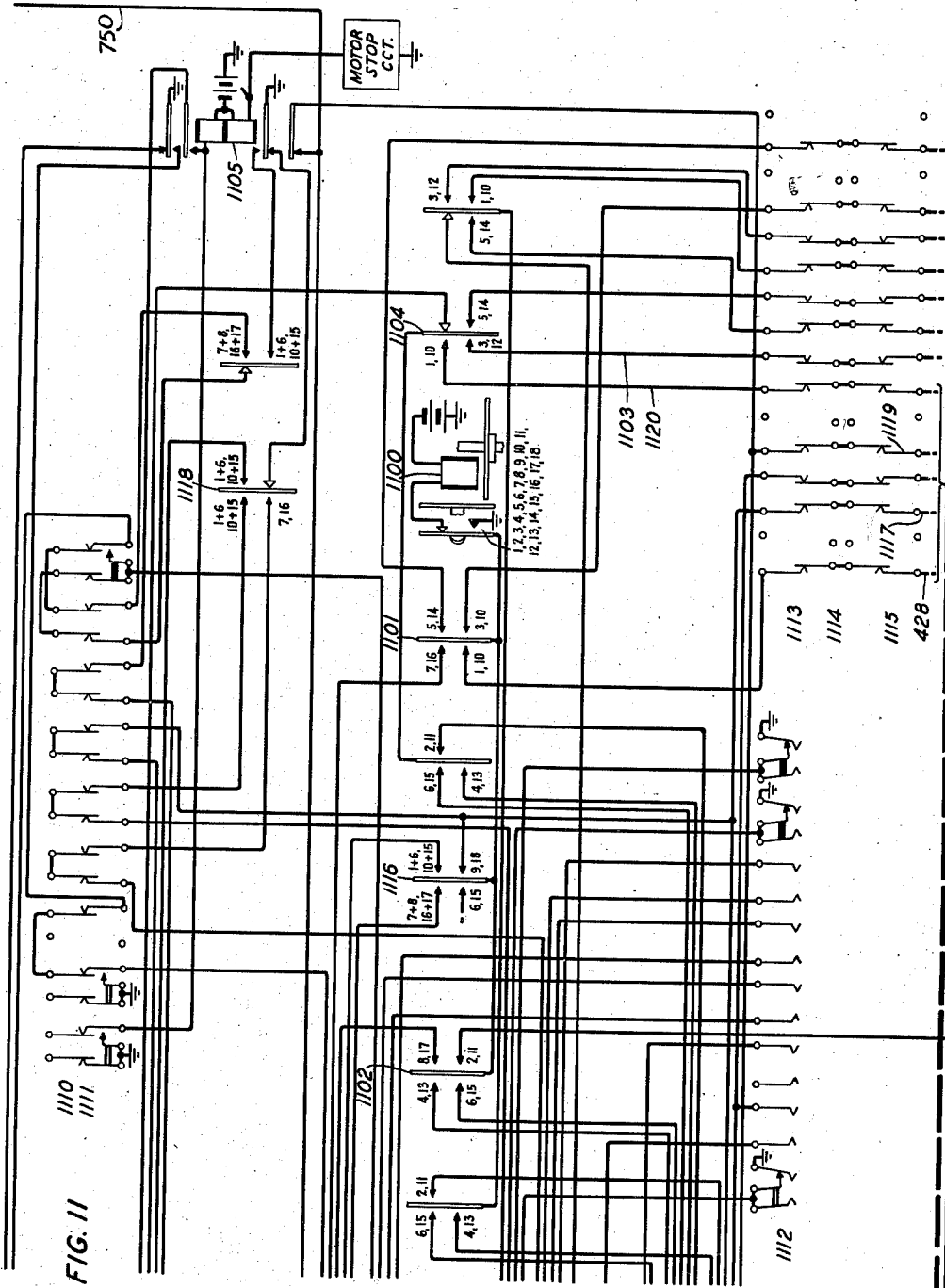
F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 10



INVENTOR
F. B. BLAKE
BY *P. C. Smith*
ATTORNEY

June 21, 1938.

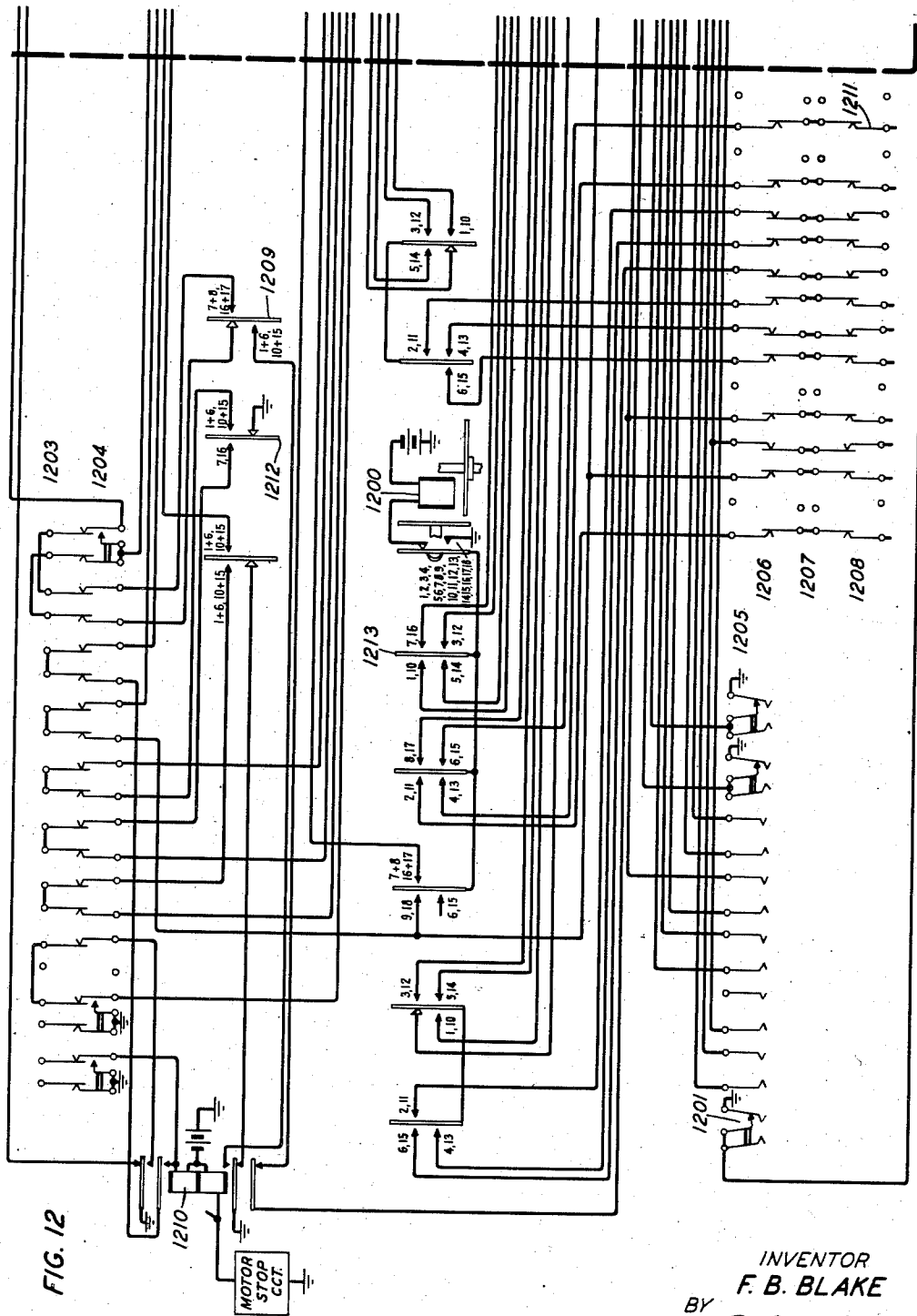
F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 11



INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

F. B. BLAKE

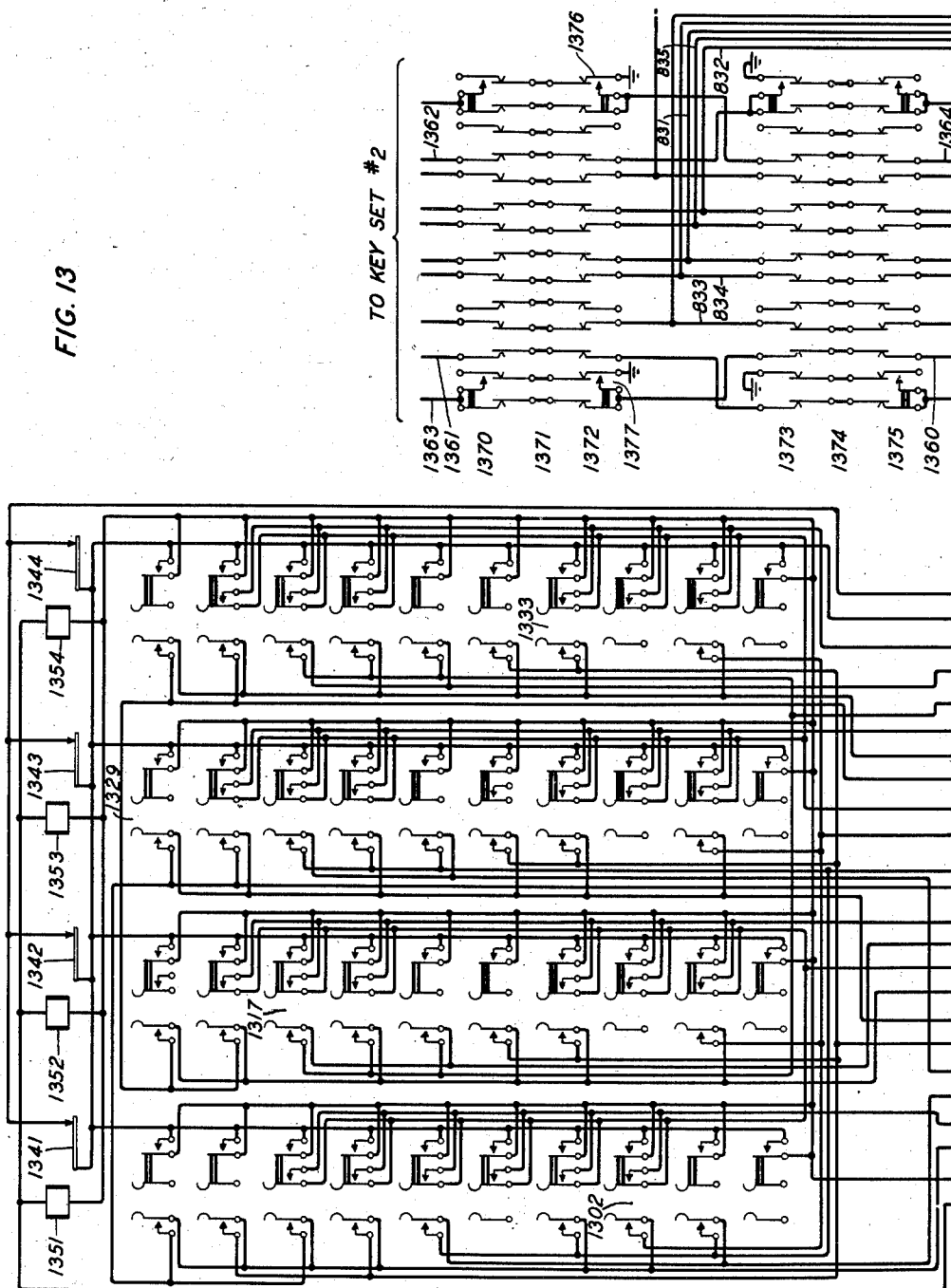
2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 12

FIG. 13



INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 13

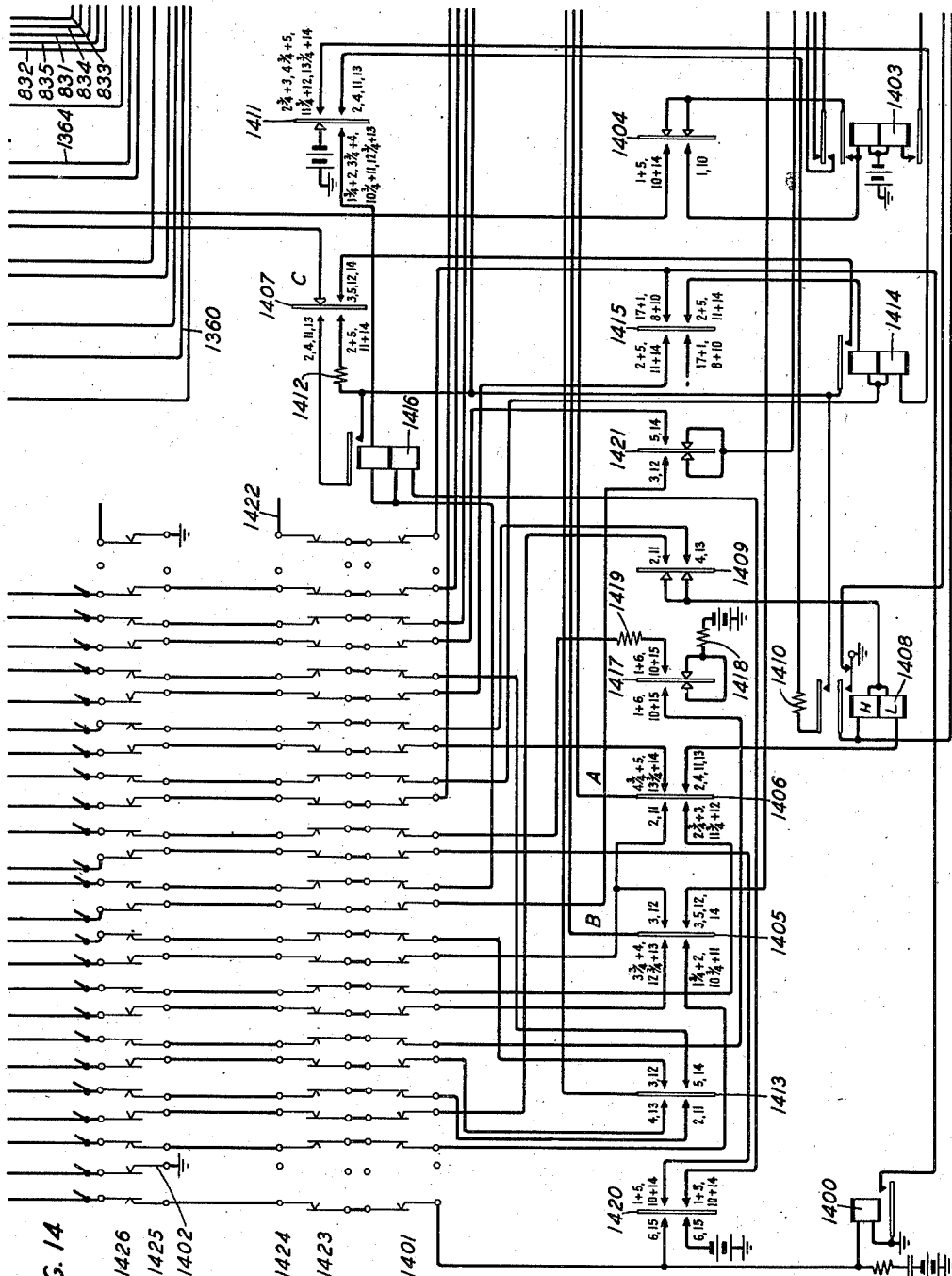


FIG. 14

INVENTOR
F. B. BLAKE
BY
P. C. Smith
ATTORNEY

June 21, 1938.

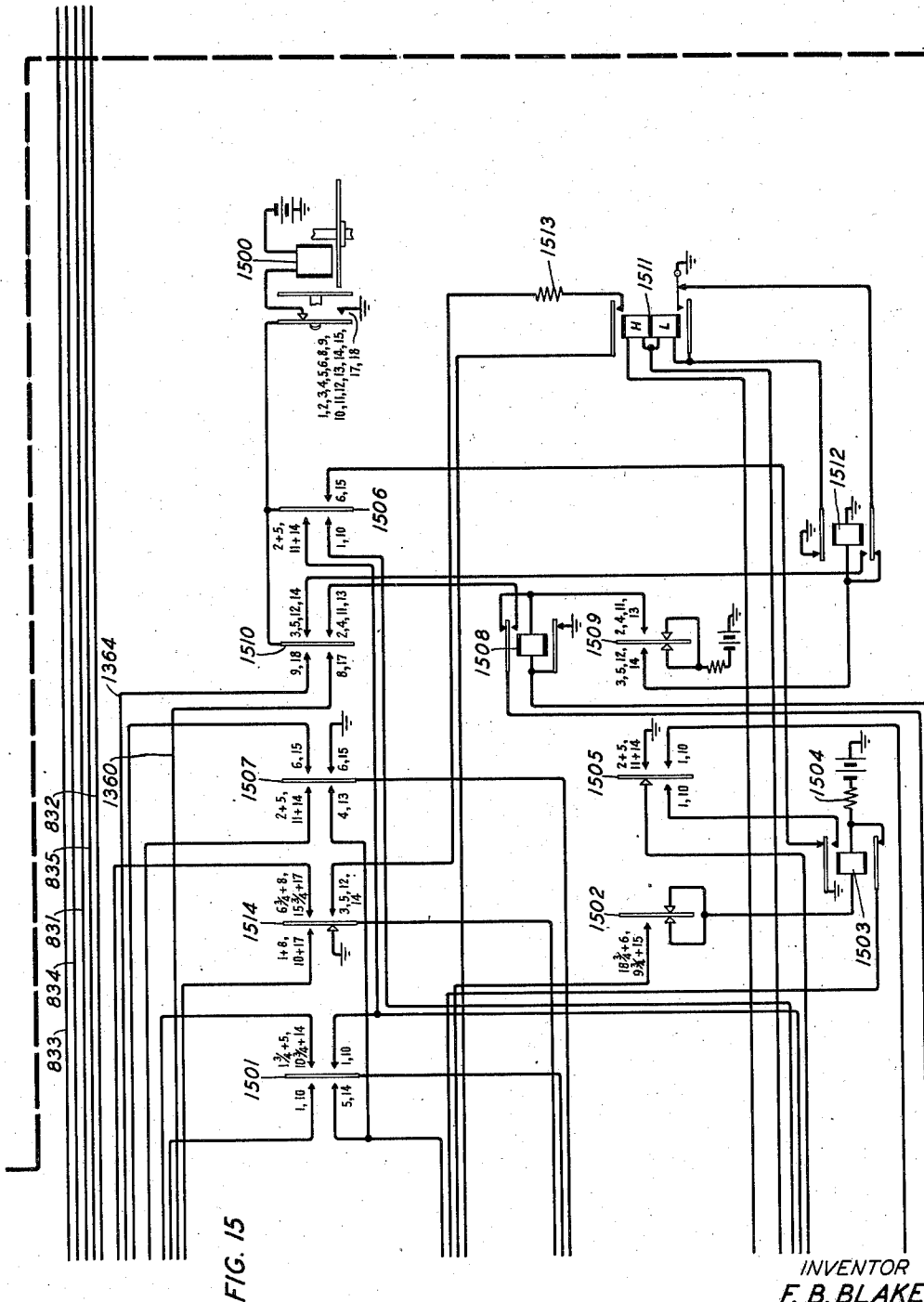
F. B. BLAKE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Filed July 27, 1937

14 Sheets-Sheet 14



INVENTOR
F. B. BLAKE
BY P. C. Smith
ATTORNEY

UNITED STATES PATENT OFFICE

2,121,419

CALL DISTRIBUTING TELEPHONE SYSTEM

Foster B. Blake, Mountain View, N. J., assignor
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

Application July 27, 1937, Serial No. 155,873

5 Claims. (Cl. 179-27)

This application relates to telephone systems and has for its object to increase the efficiency of such systems.

In systems of the type disclosed in Patent 1,517,260 granted to F. A. Stearn, December 2, 1924, calls originating in a manual office for completion in a full mechanical office are handled at the terminating office by an operator known as the B operator. A plurality of trunks appear at each B operator's position in listening keys and corresponding lamps. A call incoming on one of these trunks lights the associated lamp and the B operator connects her headset with that of the originating operator by depressing the listening key individual to the trunk.

The efficiency of this system is greatly improved by distributing the calls on a straightforward basis to operators' positions common to all trunks. This increases the efficiency of the switchboard since it tends to distribute evenly the incoming calls over the occupied positions resulting in economical operation during the most busy periods.

More specifically, the incoming trunks, arranged in groups, are served by a corresponding group of link circuits which in turn are served by a common position finder circuit. As calls reach trunks in the group, an allotted idle link circuit connects with the calling trunk and then appropriates the position finder circuit for its individual use.

Furthermore, if a second call is received in the group while the first call is being served, a second link circuit will be allotted, will hunt for and connect with the second calling trunk and will then wait until the position finder circuit is freed by the first link. When the position finder circuit is released, the presence of the second calls holds the position finder switch in its last used position and prevents the release of the operator's position.

In this arrangement if the number of operators available is less than the number of trunk groups and calls arrive with overlapping frequency it might be possible that calls in certain groups would be greatly delayed. To prevent this, an arrangement is provided in accordance with the present invention whereby, if all operators remain busy for a predetermined length of time, the position finder is automatically stepped forward when an operator has completed her handling of a call thereby freeing her position for selection by some other group of trunks.

This and other features of the present invention will be more clearly understood from a con-

sideration of the following description in connection with the drawings in which:

Fig. 1 shows the manner in which Figs. 3 to 15 should be arranged to disclose the invention;

Fig. 2 is a diagrammatic showing of the circuits serving one trunk group; and

Figs. 3 to 15 show enough detailed circuits for a clear understanding of the invention, Fig. 3 showing an incoming selector, Figs. 4 and 5 showing one link circuit, Fig. 6 showing the position finder control circuit, Fig. 7 showing certain timing and alarm circuits associated with the link circuit, Fig. 8 showing the position finder and key-set selector, Fig. 9 showing the operator's position circuit, Fig. 10 showing the calls waiting alarm circuit, Figs. 11 and 12 showing the allotter circuit, Fig. 13 showing one operator's key-set and Figs. 14 and 15 showing the key control circuit.

Referring first to Fig. 2 a group of one hundred trunks, 200, 201, etc. terminating in incoming selector circuits 202, 203, etc. and incoming selector switches 204 are served by a pair of allotter circuits 205 and 206 and by link circuits 207 to 211. With both allotters in service the allotter 206 allots links 209, 210, 211 which are located on the front of the link frame while allotter 205 allots links 207 and 208 on the rear of the frame. Each link has access to the one hundred trunks of the group over the trunk finder bank 212 and to one hundred senders over the sender selector bank 213. The five links 207 to 211 are connected in multiple over the transfer switch 214 to a position finder circuit. Normally, they are connected to position finder circuit 215 which in turn controls two switches 216 and 217, switch 217 having access to the operator's position circuit 218 and switch 216 having access to the key control circuit 219. An emergency position finder circuit 220 is provided which may be substituted for the regular position finder by means of transfer switch 214. Other groups of links are indicated which also have access to the operator's position through their position finders. The operator's position may also be seized by a sender test frame 221. The incoming selectors have access to called subscribers' lines such as line 222 through final selector frames, such as frame 223.

Briefly the operation is as follows: A call incoming on a trunk such as trunk 200 causes a preallotted link, for example link 207, to hunt for the trunk and to simultaneously hunt for an idle operator's position. When the position is found, the key control finder is advanced to the corresponding position. The B operator's posi-

tion is then connected through to the originating operator's position and the wanted number is transmitted, while at the same time the link hunts for an idle sender. As soon as the wanted number is received the B operator operates her key-set and is then disconnected from the link. When an idle sender is found the key-set is connected thereto and the number recorded in the sender. The key-set is then released, and under the control of the sender, the incoming and final selectors are operated to complete the connection with the called line after which the sender and link circuit may restore to normal.

Before describing the detailed operation of the circuits shown in Figs. 3 to 15 certain features of the equipment will be discussed. As mentioned above, two allotter are provided for the link group and they are used alternately one normally allotting the three links on the front of the frame in succession after which the other allotter successively allots the two links on the rear of the frame. However, either allotter may be removed from service and the other allotter made to assign all links. To this end each allotter is equipped with three jacks, for example, the allotter of Fig. 12 is provided with jacks 1204, 1205 and 1206, while the allotter of Fig. 11 is provided with jacks 1111, 1112 and 1113. A double plug 1207 connects jack 1206 with jack 1208 connected with the two rear links, while the double plug 1114 connects jack 1113 with the jack 1115 extending to the three front links. Under normal conditions the plug 1203 is inserted in the jack 1204 and the plug 1110 is inserted in the jack 1111 but if either allotter is to be removed from service, for example the allotter of Fig. 12, plug 1203 will be removed from jack 1204 and inserted in the jack 1205. Similarly if the allotter of Fig. 11 is to be removed from service plug 1110 will be removed from jack 1111 and inserted in jack 1112. Similar multicontact plug and jack connections are used between the key control selector and the key control circuit and also between the key-set and the key control circuit. In general, these plug and jack connections will be omitted in tracing the circuits hereinafter.

The sender indicated at 550 in Fig. 5 differs from that shown in the patent to Stearn above referred to only in that the battery and ground supply to the registration circuits is reversed between digits to minimize contact injury.

Referring now to Figs. 3 to 15, inclusive, the link circuit of Figs. 4 and 5 when idle and not allotted stands with its sequence switch 500 in position 17. The connection shown between this link and the allotter of Fig. 11 identifies it as the first link on the front of the link frame. When the last link on the rear of the frame has connected with an operator's position it connects ground to conductor 1211, advancing sequence switch 1200 of the rear allotter to position 7. Sequence switch 1100 of the front allotter has been standing in position 8, therefore the advance of switch 1200 to position 7 closes a circuit from ground over the lower right and upper left contacts of cam 1212, through jack 1204 and plug 1203, upper right contact of cam 1102 to the winding of sequence switch magnet 1100 and battery, advancing the sequence switch to position 9. It is at once advanced to position 10 in a circuit extending from battery through the winding of sequence switch magnet 1100, lower right contact of cam 1116, con-

ductor 1117 which extends in multiple to all five link circuits and may be traced in the link circuit shown over the inner upper normal contact of key 400, to ground over the lower left contact of cam 509 and the lower right contact of cam 504. When sequence switch 1100 reaches position 10 a circuit is closed from battery through the winding of sequence switch magnet 1200, upper right contact of cam 1213, through jack 1111 and plug 1110, upper left and lower right contacts of cam 1118 to ground at the inner lower back contact of relay 1105. Sequence switch 1200 is advanced to its waiting position, position 8, by this circuit.

With sequence switch 1100 in position 10 (or position 1) it closes a circuit from ground at the upper back contact of relay 1105, plug 1203 and jack 1204, upper contacts of cam 1209, jack 1204 and plug 1203, upper contacts of cam 1104 to conductor 1120 individual to the link of Figs. 4 and 5, which extends over the middle lower normal contact of key 400, lower right contact of cam 506 and cam 545 of sequence switch 500, auxiliary contact of jack 406 in parallel with the lower back contact of relay 414, winding of magnet 500 to battery. Sequence switch 500 advances to position 1 by this circuit, in which position the link is ready for use on an incoming call.

It may be noted that the contact of jack 406 and the contact of relay 414 are included in the circuit of sequence switch magnet 500 for a purpose to be explained later. Since these contacts appear in each circuit, they will, for brevity, be omitted from the circuits for magnet 500 to be traced hereinafter.

Assuming that the incoming selector circuit of Fig. 3 is seized at the originating office, a circuit is closed from battery in that office over the ring conductor 301, upper left winding of repeating coil 303, through the upper and lower windings of relay 304 in series, lower left winding of repeating coil 303, tip conductor 305 and thence to ground at the originating office. Relay 304 operates in this circuit. If no other call is waiting for service, so that relay 700 is unoperated, relay 304 closes a circuit from battery through the winding of relay 306, front contact of relay 304, right contacts of sequence switch cam 313 to conductor 307 and thence to ground at the upper back contact of relay 700. Relay 306 in operating opens one connection to the group busy circuit and prepares circuits to be used hereinafter. Relay 304 closes a circuit, in parallel with the winding of relay 306, from battery through the upper winding of relay 308, lower right contact of cam 309, lower left contact of cam 310, front contact of relay 304 and thence to ground as previously traced. Relay 308, in operating, closes a circuit from battery through the winding of sequence switch magnet 300, upper right contact of cam 311, lower front contact of relay 308 to ground over the lower contacts of cam 312. Sequence switch 300 advances to position 2 by this circuit. When the sequence switch reaches position 13/4 a locking circuit for relay 306 under the control of relay 304 is closed, which may be traced from battery through the winding of relay 306, front contact of relay 304, upper contacts of cam 313 to ground at the front contact of relay 306.

When sequence switch 300 reaches position 2 ground is connected over the lower contacts of cam 314 to start conductor 315 leading to the link allotter circuit where it extends over the

contact of key 701, to conductor 750 and over the auxiliary contact of jack 702 to the winding of relay 700 and battery. Relay 700, which is common to the group of incoming selectors, operates in this circuit opening the operating circuit for relay 306 and removing ground from similar circuits to other selectors. Relay 700, therefore, prevents any subsequent calls on trunks of the trunk group from advancing their incoming selector sequence switches to the start position until such time as all selectors which advanced before its operation have been served.

The operating circuit of relay 308 is opened in position 2 of sequence switch 300 and therefore relay 308 now releases. With relay 308 released, ground is removed from conductor 316, to mark this selector as calling.

The ground connected to conductor 750 is also applied over the lower back contact of relay 1105, to conductor 1119. This conductor is connected in multiple to all of the link circuits but since sequence switch 500 is the only switch standing in position 1, being the one allotted for use, a circuit will be completed over the lower normal contact of key 400, lower contacts of sequence switch cam 401, winding of relay 501 and battery. Relay 501 operates and closes a circuit from battery through the upper winding of relay 404, lower contacts of cam 405, outer right front contact of relay 501 to ground over the right contacts of cam 504. Relay 404 operates and in turn closes a circuit from battery through the winding of sequence switch magnet 500, upper contacts of cam 505 to ground at the upper front contact of relay 404, advancing sequence switch 500 into position 2. With sequence switch 500 in position 2, a circuit is closed from battery through the winding of up drive magnet 410 of the trunk finder 450, upper left and lower right contacts of cam 405, outer right front contact of relay 501 to ground over the right contacts of cam 504, advancing the line finder in search of the incoming trunk of Fig. 3 which has been marked by the removal of ground from conductor 316. Relay 501 is held operated over its inner right front contact, lower contacts of cam 502, commutator strip 407 and brush 442 to ground between sets of terminals and over the upper contacts of cam 503, normal contact of relay 402, brush 403 and the upper contacts of cams like cam 317 to ground as it passes trunks which are not in calling condition.

When the calling trunk of Fig. 3 is found and the brushes of trunk finder 450 are centered, relay 501 releases opening the circuit of the up drive magnet 410, and bringing the trunk finder to rest. The release of relay 501 also connects ground over its right back contact to brush 403 to mark the incoming selector as busy. In addition it closes a circuit from battery through the winding of relay 408, upper right and lower left contacts of cam 409 to ground at the left back contact of relay 501. The operation of relay 408 also closes an obvious circuit for relay 412.

The advance of sequence switch 500 from position 1 opens the operating circuit of relay 404 and that relay releases. With relay 404 released a circuit is closed from battery through the winding of sequence switch magnet 500, upper right contact of cam 506 to ground at the upper back contact of relay 404, advancing sequence switch 500 to position 3, in which it remains until the trunk is found as indicated by the operation of relay 408. The operation of relay 408 closes a circuit from ground over its outer lower front contact, upper left contact of cam 507, to the

winding of sequence switch magnet 500 and battery, advancing the sequence switch to position 4.

With relay 412 operated and sequence switch 500 in position 4, a circuit is closed from battery through the winding of relay 600, in the position finder circuit lower back contact of relay 601, contact 508 of transfer switch 590, upper contacts of cam 411, outer lower contact of relay 412, trunk finder brush 413, conductor 361, left contacts of cam 313, upper front contact of relay 306 to ground. Relay 600 operates and closes a holding circuit for itself through the winding of relay 601 over the lower front contact of relay 600, switch contact 546, inner lower back contact of relay 414, upper left contact of cam 509 and lower right contact of cam 504 to ground. Relay 601 does not operate in this circuit being shunted by the operating circuit of relay 600. Relay 600 closes a circuit from ground over the upper back contact of relay 414, upper right and lower left contacts of cam 415, upper back contact of relay 402, switch contact 510, conductor 609, back contact of relay 601, inner upper front contact of relay 600, switch contact 511, upper right and lower left contacts of cam 512, outer upper contact of relay 412, brush 416, conductor 320, upper right contact of cam 321 to the winding of sequence switch magnet 300 and battery, advancing switch 300 to position 3. The advance of sequence switch 300 from position 2 releases relay 307, restoring ground to conductor 307 and permitting other incoming selectors to advance to the calling position.

The advance of sequence switch 500 to position 2 as previously described seizes the position finder circuit, if free, by connecting ground to conductor 609 thereby closing a circuit from ground over the back contact of relay 414, upper right and lower left contacts of cam 415, upper back contact of relay 402, transfer switch contact 510, conductor 609, lower back contact of relay 604, upper back contact of relay 605, upper normal contact of relay 606, lower back contact of relay 607 to the winding of relay 608 and battery. Relay 608 operates and closes a circuit from battery through the winding of relay 610, outer lower back contact of relay 611, outer upper front contact of relay 608, upper back contact of relay 612, to conductor 609 and thence as previously traced to ground. Relay 608 also prepares the double test relay 607 for testing for an idle operator's position. It closes a circuit from battery through the lower winding of relay 607, inner upper front contact of relay 608, upper winding of relay 607, inner lower back contact of relay 602 and ground to prepare the relay for operation. A branch of this circuit extends from ground through the upper and middle windings of relay 607, inner lower front contact of relay 610 to brush 804 of position finder 800. Relays 608 and 610 close a circuit for relay 613 which may be traced from battery through the winding of that relay over the back contact of stepping magnet 807, lower back contact of all-positions-busy relay 614, upper front contact of relay 610, lower front contact of relay 608 to ground at the upper back contact of relay 607. Relay 613 in turn operates and closes a circuit from battery through the winding of stepping magnet 807, lower front contact of relay 613, lower back contact of relay 614 and thence as traced for the circuit of relay 613 to ground at the back contact of relay 607. Magnet 807 in operating opens the previously traced circuit of relay 613 which in releasing opens the circuit

of magnet 807 and this magnet and relay co-operate until an idle operator's position is found.

Such a position is indicated by the presence of battery on a terminal to which brush 804 has access, which is brought about as follows: When an operator occupies her position, she inserts the plugs of her headset, made up of transmitter 900 and receiver 901, into telephone jacks 902 and 903 thereby closing a circuit from ground through the right winding of repeating coil 904, tip contact of jack 903, transmitter 900, tip contact of jack 902, winding of relay 905 to battery. Relay 905 operates and in turn closes an obvious circuit for relay 906 which operates and extends battery through resistance 909 over its upper front contact and the outer lower back contact of relay 907 to conductor 908 to mark the position occupied. Conductor 908 terminates in the arc served by brush 804 of position finder 800, thereby completing the test circuit through the middle winding 607 which now operates.

Relay 607 in operating opens the circuit of both relay 613 and magnet 807, bringing the position finder 800 to rest. Relay 607 closes a locking circuit for itself from battery in the operator's position as traced through brush 804, inner lower front contact of relay 610, middle winding of relay 607 to ground at the upper front contact of relay 607. The operation of relay 607 also opens the operating circuit of relay 608 which now releases, and when it closes its lower back contact completes a circuit from battery through the winding of relay 606, lower back contact of relay 608, lower front contact of relay 607, normal contact of relay 606, upper back contact of relay 605, lower back contact of relay 604 to grounded conductor 609. Relay 606 locks over its upper alternate contact to conductor 609 over a part of its operating circuit independent of relays 608 and 607. With relay 606 operated, grounded conductor 609 is extended over the lower front contact of relay 610, lower front contact of relay 606, winding of relay 611, brush 803 of the position finder, lower back contact of relay 910 or inner lower front contact of relay 906 to the winding of relay 907 and battery. Relay 907 operates in this circuit disconnecting battery from conductor 908 to mark the position busy, lights lamp 925 to warn the operator of an incoming call and disconnects ground from conductors 852 and 853 leading to the positions busy circuit.

Relay 611 also operates in this circuit, locking over its inner lower front contact, the upper back contact of relay 613 to grounded conductor 609. Relay 611 closes a circuit from battery through the winding of relay 605, inner upper front contact of relay 611, inner upper back contact of relay 604 to conductor 609. Relay 605 operates, opening the locking circuit of relay 606 and that relay releases. Relay 611 in operating also closes an obvious circuit for relay 602.

With relay 602 operated, ground is connected to brush 801 of the position finder, and through a terminal engaged by that brush to a corresponding terminal accessible to brush 816 belonging to the key-set finder 810 to which the winding of relay 615 is connected. Relay 602 also closes a circuit from ground at its outer lower front contact, lower back contact of relay 617, back contact of relay 615, if the key control circuit has completed its operation on the last previous call, back contact of stepping magnet 817 of the key-set finder, winding of relay 616 and battery. As in the case of relay 613, relay 616 operates and

closes a circuit for the corresponding stepping magnet 817 which extends from battery through the winding of magnet 817, upper contacts of relay 616, lower back contact of relay 615 and thence over the operating circuit of relay 616. Relay 616 and magnet 817 cooperate as in the case of relay 613 and magnet 807 to advance the key-set finder 810 until brush 816 engages the terminal marked by position finder 800 at which time the circuit of relay 615 is closed and that relay operates, opening the circuit of relay 616 and magnet 817 and stopping the advance of the key-set finder 810.

The advance of sequence switch 300 from position 2 opens the operating circuit of relay 600 and permits relay 601 to operate in the locking circuit of relay 600. Relay 601 further opens the operating circuit of relay 600. It also closes ground on the outer lower back contact of relay 602 over the inner upper front contact of relay 601 to conductor 603 leading to the calls waiting signal circuit which will be described hereinafter. The operation of relay 602 in response to the engagement of the operator's position removes this ground from conductor 603.

With relays 600, 601 and 605 operated a signal is transmitted to the incoming trunk to connect the A and B positions together. A circuit is closed from battery through resistance 619, lower back contact of relay 618, lower front contact of relay 605, outer upper front contact of relay 601, inner upper front contact of relay 600, contact 511, upper right and lower left contacts of cam 512, upper front contact of relay 412, brush 416, conductor 320, winding of relay 322, lower left and upper right contacts of cam 359, upper back contact of relay 302, left contacts of cam 312 to ground. Relay 322 operates in this circuit, connecting the tip and ring conductors of the trunk circuit over conductors 325 and 324, switch contacts 516 and 515 of switch 590 to condensers 620 and 621 and thence over the upper front contacts of relay 602, brushes 805 and 806 of the position finder, to the terminals of choke coil 911, the armatures of relay 913 and over the back contacts thereof to the secondary winding of tone coil 921. Relay 322 also closes a circuit from ground over its outer lower front contact, conductor 323, switch contact 514, inner upper front contact of relay 602, brush 802, winding of relay 910 and battery.

Relay 910 in operating initiates the operations which result in the transmission of two "zip" tones to the A operator and the connection of the two operators' headsets in talking relation. Relay 910 closes a circuit from ground over its outer upper front contact, normal contact of relay 914, resistance 915, winding of relay 916 and battery. Relay 916 operates and closes a circuit from the tone source through the primary winding of tone coil 921, lower normal contact of relay 917 to ground the lower front contact of relay 916. At the same time it closes a circuit from ground over its upper front contact, upper back contact of relay 913, winding of relay 917 to battery. The closure of the primary circuit of tone coil 921 transmits an impulse of tone current to the originating operator's position over the talking conductors as previously traced and thence through the repeating coil 303 out over tip and ring conductors 305 and 301, respectively. The operation of relay 917 opens the primary circuit of the tone coil thereby terminating the first tone impulse. Relay 917 extends its operating ground to the winding of relay 918 which oper-

ates after an interval to reclose the primary circuit of tone coil 921 and to extend the operating ground of relay 917 to the winding of relay 920. Relay 920 after an interval closes a circuit for relay 913 which disconnects the secondary of the tone coil from the talking conductors thereby terminating the second impulse of tone. Relay 913 also locks over its inner upper contact to ground at the upper front contact of relay 916.

With relay 913 operated the talking circuit extends over the outer upper front contact of relay 913, normal contacts of key 922, ring of jack 903, the operator's headset receiver 901, ring of jack 902 and the lower front contact of relay 913 thereby permitting the A operator to transmit the wanted number to the B operator. The tones transmitted to the A operator are also heard by the B operator through condensers 923 and 924 preparing her to receive the wanted number.

As soon as the number has been passed the B operator writes it up on her key-set shown in Fig. 13. Assuming that the wanted number is 2793 she will depress key 1392 in the thousands row, key 1317 in the hundreds row, 1329 in the tens row and 1333 in the units row. When the first key is operated, a circuit is closed from ground through the winding of relay 1400, through the windings of the release magnets 1351, 1352, 1353 and 1354 in parallel, right contact of key 1302, contacts of sequence switch cam 1502, winding of relay 1503, resistance 1504 and battery. None of these release magnets and relays operate in this circuit, there being insufficient current to operate relay 1400 or any of the release magnets and relay 1503 being shunted by a circuit extending from battery through resistance 1504, over the back contact of relay 1503 and in parallel over the normal contacts 1341, 1342, 1343 and 1344 of each of the key strips until a key in each of the strips has been operated. When this occurs, the shunt is removed from relay 1503 and that relay operates, closing a circuit from ground over its upper front contact, left contacts of cam 1505, upper back contact of relay 1403, lower right and upper left contacts of cam 1501, conductor 333, brush 813 of switch 810, upper front contact of relay 615, lower back contact of relay 617, to the lower winding of relay 618 and battery. Relay 618 operates in this circuit, opening the operating circuit of relay 322 which in turn releases relay 910. Relay 910 opens the holding circuit of relays 916 and 913, restoring the tone relays and the operator's talking circuit to normal.

In the meantime the operation of relay 605 following the connection with the operator's position circuit started the hunt for an idle sender by completing a circuit from grounded conductor 609 over the lower back contact of relay 604, upper front contact of relay 605, lower front contact of relay 601, switch contact 513, lower back contact of relay 703, lower back contact of relay 402, upper contacts of cam 401, upper winding of relay 404 to battery. Relay 404 operates and closes a circuit from ground over its upper front contact, upper contacts of cam 505, to the winding of sequence switch magnet 500 and battery advancing the sequence switch to position 5. The advance of sequence switch 500 is signaled to the position finder circuit by a circuit extending from the upper back contact of relay 414, upper contacts of cam 415, switch contact 534, winding of relay 604 and battery. Relay 604 operates, opens the locking circuit of relay 605 and prepares a locking circuit for relay 618.

With sequence switch 500 in position 5 relay 404 closes a circuit from ground over its upper front contact, upper left and lower right contacts of cam 505, through the winding of the up drive magnet 517 of sender finder 520 for advancing the finder in search of an idle sender. In position 5 the operating circuit of relay 404 is opened, but this relay remains operated in a circuit through its lower winding, upper left and lower right contacts of cam 417 to the centering commutator strip 518, brush 547 and ground. It also is held operated in a circuit from battery through its upper winding, upper contacts of cam 418, lower front contact of relay 404, upper right and lower left contacts of cam 419 and finder brush 521 as it passes over busy senders. When an idle sender is found and the brushes are properly centered, both holding circuits for relay 404 are opened and that relay releases and closes a circuit from ground over its upper back contact, upper right contact of cam 505 to the winding of sequence switch 500 and battery, advancing the sequence switch to position 6.

With relay 618 operated to indicate that the number has been completely set up on the key-set and sequence switch 500 in position 6 to indicate that an idle sender has been found, a circuit is closed from battery through the upper winding of relay 1403, left contacts of cam 1404, conductor 332, brush 812, upper front contact of relay 618, switch contact 522, right contacts of cam 523, winding of relay 420, outer upper normal contact of key 400 to ground at the inner lower contact of relay 412. Relay 1403 operates and locks to its operating circuit through its upper winding and inner upper front contact and the upper contacts of cam 1404. With relay 1403 operated, sequence switch 1500 is advanced from position 1 in a circuit from battery, through the winding of magnet 1500, lower left contact of cam 1506, outer upper front contact of relay 1403 to ground over the left contacts of cam 1505 and the upper front contact of relay 1503. At the same time, relay 420 operates closing a circuit from battery through the upper winding of relay 404, lower left and upper right contacts of cam 405 to ground at the innermost front contact of relay 420. Relay 404 operates and closes a circuit from ground over its upper front contact, upper contacts of cam 505 to the winding of sequence switch magnet 500, advancing the sequence switch to position 7. When sequence switch 500 leaves position 6 it disconnects ground from conductor 609, thereby releasing relays 618, 611 and 907 and freeing the operator's position unless another call is waiting in the group. Relay 420 also closes a circuit from ground at its second lower front contact over switch contact 524 to the winding of relay 617 and battery. In addition relay 420 prepares the sender recording circuits by connecting brush 525 of the sender finder over the outer lower front contact of relay 420, switch contact 526, key-set finder brush 814, conductor 334, upper right contact of cam 1501 to cam 1405; brush 527 of the sender finder over the upper front contact of relay 420, switch contact 528, key-set finder brush 811, conductor 331, upper left contact of cam 1507 to cam 1406. Furthermore, with sequence switch 500 in position 7 brush 529 is connected over the lower right and upper left contacts of cam 421, lower front contact of relay 404, upper left and lower right contacts of cam 418, switch contact 530, key-set finder brush 815, conductor 335, to cam 1407.

Registration in the sender is controlled by certain circuit conditions set up on these circuits as determined by the operated keys of the key-set of Fig. 13. As the sequence switch 1500 passes through positions 2, 3, 4, and 5 battery and ground through various resistances are connected to these circuits. The register relays of the sender which are not shown are marginal and non-marginal, the marginal relays responding to low resistance conditions, while the non-marginal relays operate under all conditions. The sender and its operation is disclosed in the above-identified patent to Stearn. Assuming as before that keys 1302, 1317, 1329 and 1333 are operated with sequence switch 1500 in position 2, the thousands digit is transmitted to the sender. The circuit extending to cam 1406, which will be called circuit A, extends in two branches, one over the lower right contact of cam 1406, through both of windings of relay 1408 to ground at the back contact of relay 1508. The other branch of this circuit extends over the upper left contact of cam 1406, inner right contact of key 1302, upper contacts of cam 1409 to the lower winding of relay 1408, thereby shunting the high resistance upper winding of that relay and creating a low resistance ground condition on circuit A. Relay 1408 operates in this circuit and locks to ground at its own upper front contact. The circuit closed to cam 1405, which will be identified hereinafter as circuit B, extends over the lower left contact of that cam to the left contact of key 1302, resistance 1419, right contacts of cam 1417, resistance 1418 to battery creating a high resistance battery condition on circuit B. With relay 1408 operated the circuit closed through cam 1407, which will be identified as circuit C, is extended over the upper right and lower left contacts of cam 1407, resistance 1412, upper front contact of relay 1408, resistance 1410, lower right and upper left contacts of cam 1411 to battery, producing a high resistance battery condition on circuit C.

Relay 1408 also closes a circuit from ground over its inner upper front contact through the winding of relay 1508, right contacts of cam 1509 to battery. When relay 1408 starts to operate relay 1508 is shunted by a circuit over the right contacts of cam 1509, upper back contact of relay 1508 to ground at the upper normal contact of relay 1408 but this circuit is immediately opened, permitting relay 1508 to operate and open the operating circuit of relay 1408. When the registration of the thousands digit has been accomplished at the sender, all three registration circuits are opened and relay 1408 releases, connecting ground over its normal contact and the upper front contact of relay 1508, lower right contact of cam 1510 to the winding of sequence switch magnet 1500 and battery, advancing the sequence switch to position 3 and releasing relay 1508.

When the sequence switch 1500 reaches position 3 the key-set is ready to transmit the hundreds digit to the sender. In this position circuit A is open at the contacts of key 1317. Circuit B is extended over the lower right contact of cam 1405 through the windings of relay 1511 to ground at the upper back contact of relay 1512. A branch of this circuit extends over the upper right contact of cam 1405, inner right contact of key 1317, left contacts of cam 1421 to the lower winding of relay 1511 in shunt of the upper high resistance winding thereby creating a low resistance ground condition on circuit B. When the sender is ready to receive this digit

and completes circuits A, B and C, relay 1511 operates and locks to ground at its own lower front contact. Circuit C extends through resistance 1412, upper front contact of relay 1511, resistance 1513 to ground over the lower contacts of cam 1514. With sequence switch 1500 in position 3 a circuit is closed from battery over the upper contacts of cam 1411, windings of relay 1414, lower right and upper left contacts of cam 1415, left contact of key 1317, upper right contact of cam 1413 to ground over the lower left contact of cam 1514. Relay 1414 operates in this circuit and closes a shunt over its contact and the lower right contact of cam 1407 around resistance 1412, thereby transmitting low resistance ground over circuit C.

With sequence switch 1500 in position 3 a circuit is prepared from battery over the left contacts of cam 1509, through the winding of relay 1512 to ground but relay 1512 is prevented from operating by means of a shunt over its lower back contact and the normal contact of relay 1511. When relay 1511 operates in circuit B, as previously described, it opens this shunt and relay 1512 operates. As before, the registration of the hundreds digit in the sender causes the temporary opening of all three registering circuits and relay 1511 releases, closing a circuit from ground over its normal contact and the front contact of relay 1512 to the upper right contact of cam 1510 and the winding of sequence switch magnet 1500, advancing the sequence switch to position 4.

In position 4 circuit A extends over the lower right contact of cam 1406, through the two windings of relay 1408 to ground at the back contact of relay 1508 creating a high resistance ground on circuit A. Circuit B extends over the upper left contact of cam 1405, left contact of key 1329, upper winding of relay 1416, left contacts of cam 1411 to battery. With relays 1408 and 1416 operated circuit C extends over the upper contacts of cam 1407, front contact of relay 1416, upper contact of relay 1408, resistance 1410 to battery over the lower right and upper left contacts of cam 1411, thereby creating a low resistance battery condition on circuit C. As before relay 1408 operates relay 1508 and, when the sender has completed the registration, is released to advance sequence switch 1500 to position 5.

When the sender is ready for the next registration the three registering conductors are extended to the units register in the sender. In the key control circuit, registering circuit A is extended over the upper right contact of cam 1406, left contact of key 1333 to battery over the left contacts of cam 1417 and low resistance 1418. Circuit B may be traced over the lower left contact of cam 1501, inner right contact of key 1333, right contacts of cam 1421, lower winding of relay 1511 to ground at the back contact of relay 1512. The normal circuit over the lower right contact of cam 1405 to the two windings of relay 1511 is also closed. With relay 1511 operated, a circuit is closed from ground over the lower contacts of cam 1514, resistance 1513, upper front contact of relay 1511 through resistance 1412 and the lower right contact of cam 1407 to connect a high resistance ground to registering circuit C.

Relay 1511 permits the operation of relay 1512 as previously described and after the completion of the registration releases to advance sequence switch 1500 to position 6.

When sequence switch 1500 reaches position 6, a circuit is closed from battery over the left contacts of sequence switch cam 1420, through the windings of the release magnets 1351 to 1354 to ground over the plug contact 1402. At the same time a circuit is closed from ground through the winding of relay 1400 to battery over the left contacts of cam 1420. Relay 1400 in operating, connects ground over its front contact to conductor 1422 to operate a peg count meter. When the last of the keys has been released the shunt around the winding of relay 1503 is restored and that relay releases, closing a circuit from ground over its upper back contact, lower right contact of cam 1506 to the winding of sequence switch magnet 1500 and battery, advancing the sequence switch to position 8.

The operator's position is provided with two key-sets and corresponding key control circuits which are used alternately, the second set being represented by the group of conductors extending vertically in Fig. 13. The key control circuit sequence switch is advanced to position 8 after use, as above described. With sequence switch 1500 in any position from 1 to 8, a circuit is closed over the left contacts of cam 1514 and the plug and jack connection to conductor 1361 leading to the second key control circuit which corresponds to conductor 1360 leading to the one shown in Figs. 14 and 15. This conductor extends to the contact corresponding to the lower right contact of cam 1510 in the other key control circuit and advances that sequence switch to position 9. When sequence switch 1500 reaches position 6¾ it connects ground over the upper right contact of cam 1514 to conductor 1362 leading to the second key control circuit advancing that sequence switch to position 10 which is a second normal position. When the No. 2 key-set reaches position 1 or 10 it connects ground to conductor 1363 extending to conductor 1360 and advances sequence switch 1500 to position 9 in which position it remains until the second key-set has completed its operation and advances out of position 6.

If because of trouble or any other reason it is desired to use only one key-set, the plug 1371 or 1374 may be removed. In this case, assuming that the plug 1371 has been removed, ground will be connected to conductor 1360 over the jack contact 1377 to automatically advance sequence switch 1500 out of position 8 and over jack contact 1376 to conductor 1364 to advance it out of position 9.

The advance of sequence switch 1500 from position 5 opens the circuit of relay 420 thereby releasing relay 404 which closes a circuit from ground over its upper back contact, upper right contact of cam 506 to the winding of sequence switch magnet 500 advancing the sequence switch to position 8. When sequence switch 500 reaches position 8 the sender is connected with the incoming selector to control incoming and final selections. In this position the fundamental circuit is closed, extending from brush 525 of the sender finder over the lower right and upper left contacts of cam 411, lower front contact of relay 412, brush 413, conductor 361, lower right contact of cam 310, lower right contact of cam 309 to the upper winding of relay 308 and battery. When relay 308 operates, a circuit is closed from battery through the winding of sequence switch magnet 300 upper left contact of cam 311, lower front contact of relay 308, to ground over the lower contacts of cam 312, advancing

the sequence switch to position 4. As the switch enters position 4 a locking circuit is closed for relay 308 from battery through the upper winding of relay 308, left contacts of cam 319, inner upper front contact of relay 308, upper left and lower right contacts of cam 310 and thence to the operating circuit of relay 308.

Position 4 is a pass-by position and sequence switch 300 comes to rest at position 5. In position 5 a circuit is closed for up drive magnet 327 over the upper contacts of cam 328, lower front contact of relay 308 to ground over the lower contacts of cam 312, advancing the incoming selector in its brush selecting movement. As the selector moves up, carrying the commutator brushes over the commutator segments, a circuit is intermittently closed from ground over the upper right contact of cam 317, lower left contact of cam 318, brush 329, commutator strip 330, upper left contact of cam 309 to the locking circuit of relay 308, holding that relay operated and shunting the stepping relay of the sender in the well-known manner. When sufficient impulses have been sent back to satisfy the sender the fundamental circuit is opened and relay 308 releases. The release of relay 308 opens the circuit of the up drive magnet 327, stopping the upward movement of the selector and closing a circuit from ground over the lower contacts of cam 312, lower back contact of relay 308, lower contacts of cam 331 to the winding of sequence switch magnet 300 and battery, advancing the sequence switch to position 6.

With sequence switch 300 in position 6 a circuit is closed from battery through the winding of trip magnet 332, lower right contact of cam 318, right contact of cam 317 to ground, to prepare the selector brushes for tripping on the next upward movement of the brush rod. The fundamental circuit is reclosed as previously traced in position 6, relay 308 again locking and advancing sequence switch 300 to position 7. In position 7 the up drive magnet 327 is again energized. In this position, ground over the right contact of cam 317 and the lower left contact of cam 318 is connected over brush 333, commutator strip 334, and the upper right contact of cam 309 to the fundamental circuit to control group selection. As before, when the sender has been satisfied, ground is removed from the fundamental circuit and relay 308 releases, advancing sequence switch 300 to position 8 and bringing the selector to rest at the beginning of the desired group of trunks. With sequence switch 300 in position 8, a circuit is closed from battery through the lower winding of relay 308, upper right and lower left contacts of cam 326 to ground. Relay 308 prepares a holding circuit for itself from battery through its upper winding, lower right contact of cam 309, upper left contact of cam 310, inner upper front contact of relay 308, upper left and lower right contacts of cam 319 to sleeve brush 335 of the incoming selector. If the first outgoing trunk is busy, ground on the busy terminal renders this locking circuit effective. With relay 308 operated, sequence switch 300 is advanced to position 9. In position 9 the up drive magnet 327 is again operated. A centering circuit is also prepared from ground over the lower contacts of cam 312, lower front contact of relay 308, left contacts of cam 328, brush 336, commutator strip 337, right contacts of cam 326 to the lower winding of relay 308 and battery to hold this relay operated until the brushes are properly centered. When an idle trunk has been found and the

brushes are positioned, relay 308 releases, disconnecting ground from commutator brush 336 and from the winding of the up drive magnet 327. The incoming selector then drops into place, centering the brushes on the trunk terminals.

As soon as relay 308 releases it connects ground to brush 335 over a circuit which may be traced from the brush, lower right and upper left contacts of cam 319, upper back contact of relay 308 to ground over the upper left contact of cam 318 and the right contact of cam 317. The release of relay 308 also closes a circuit from battery through the winding of sequence switch magnet 300, lower contacts of cam 331, lower back contact of relay 308, lower contacts of cam 312 to ground advancing the sequence switch out of position 9 and into position 11. As soon as it reaches position 10 direct ground is connected to brush 335 over the right contacts of cam 319 to hold the outgoing trunk busy.

With sequence switch 300 in position 11, the fundamental circuit is extended from conductor 351 over the right contacts of cam 356 to brush 357 and the tip conductor of the final selector, for controlling the operation of that selector in completing the connection.

At the end of final selections, ground is connected by the sender to brush 527 completing a circuit over the lower left and upper right contacts of cam 418 through the upper winding of relay 404 to battery. Relay 404 in operating closes ground over its upper front contact and the upper contacts of cam 505 to operate sequence switch magnet 500, advancing the sequence switch to position 9, in which position relay 404 releases, closing ground over its upper back contact and the upper right contact of cam 505 for advancing sequence switch 500 to position 10. In position 10, ground is connected over the upper right and lower left contacts of cam 422, outer upper front contact of relay 412, brush 416, conductor 320, upper right contact of cam 321, winding of sequence switch magnet 300 to battery, advancing this sequence switch to position 12.

The advance of sequence switch 300 from position 11 disconnects ground from brush 423, releasing relay 408 and in turn relay 412. Relay 412, in releasing, connects ground over its lower back contact, upper left contact of cam 506 to the winding of sequence switch magnet 500 and battery, advancing the sequence switch to position 11. With sequence switch 500 in position 11, the down drive magnet 424 of the trunk finder 450 is operated over the upper back contact of relay 425, upper contacts of cam 419, lower back contact of relay 404 and ground, while the down drive magnet 531 of the sender finder 520 is operated over the lower right contacts of cams 509 and 504 and ground. When the trunk finder reaches normal, a circuit is closed from ground over commutator brush 426, commutator segment 427, upper contacts of cam 417 to the lower winding of relay 404 and battery. When the sender finder reaches normal a circuit is closed from ground over brush 532, commutator segment 533, upper right contact of cam 507 to the winding of sequence switch magnet 500 and battery, advancing the sequence switch to position 12. With relay 404 operated, a circuit is closed from ground over the upper front contact of relay 404, upper contacts of cam 505 to the winding of sequence switch magnet 500 and battery, advancing the sequence switch to position 17, positions 13 to 16 being pass-by positions. The link sequence

switch remains in position 17 until the link is again allotted for service.

When sequence switch 300 reaches position 12, if relay 304 is still operated, showing that the call has not been abandoned, a circuit is closed from battery through the upper winding of relay 308, lower right contact of cam 309, lower left contact of cam 310, front contact of relay 304, upper contacts of cam 313 to ground at the front contact of relay 305. Relay 308 locks in a circuit from battery through its lower winding, upper contacts of cam 326, inner upper front contact of relay 308 to ground over the upper contacts of cam 319. It also closes a circuit from battery through the winding of sequence switch magnet 300, upper left contact of cam 311, lower front contact of relay 308 to ground over the lower contacts of cam 312 advancing sequence switch 300 into position 13. Relay 308 closes a locking circuit for itself from battery through its upper winding, left contacts of cam 341, outer upper front contact of relay 308, back contact of relay 302, upper contacts of cam 359 and thence to ground over the upper contacts of cam 313 and the front contact of relay 306. This locking circuit is effective in position 13.

In this position continuous ringing current on conductor 338 is connected over the lower left and upper right contacts of cam 339, lower back contact of relay 340, winding of relay 302, upper back contact of relay 340, lower front contact of relay 308, right contacts of cam 312, lower left and upper right contacts of cam 342, brush 343, to the ring conductor leading to the final selector and to the subscriber's line. Ringing ground is also connected over the lower left and upper right contacts of cam 355 and brush 357 to the tip conductor of the final selector and to the subscriber's line, signaling the wanted subscriber. A circuit is also closed in position 13 from ground over the left contact of interrupter 344, left contacts of cam 345, lower winding of relay 346 and battery. Relay 346 closes an obvious circuit for sequence switch magnet 300 advancing the sequence switch to position 14. Relay 346 locks through its upper winding and upper front contact to ground over the upper left and lower right contacts of cam 358 to insure its continued operation until the sequence switch leaves position 13. In position 14 interrupter 344 connects ground over its right contact and the upper right and lower left contacts of cam 345 to the lower winding of relay 346, reoperating that relay which again locks over cam 358 and advances sequence switch 300 to position 15. In this position intermittent machine ringing is connected from conductor 347 over the upper contacts of cam 339 to the ring conductor of the subscriber's line and this continues until the called subscriber answers at which time relay 302 operates, opening the locking circuit of relay 308 and causing that relay to release.

In the case of a party line where negative ringing is desired, the ringing is applied over cam 348 and the front contacts of relay 340 which is operated over conductor 350 from special commutator segments in the well-known manner. Stations which are rung with negative ringing current are assigned numbers which are reached through final trunks terminating in either the 0 or the 2 groups in the incoming frame while stations which are rung with positive current are assigned numbers which are reached through final trunks terminating in either the 1 or 3 groups in the incoming frame and the special

commutator segments are correspondingly arranged. The ringing of the stations on the tip side of the line is cared for by cross-connecting and reversing arrangements at the distributing frame.

In position 15, a branch of the ringing circuit is closed for transmitting an audible tone to the calling party extending over the lower left contact of cam 342, through condenser 351 and the upper contacts of cam 331, winding of relay 352 to battery through the lower right winding of repeating coil 303, where the tone is repeated to the calling line.

The release of relay 308 in response to the calling subscriber's answer disconnects ringing current from the line and closes a circuit from battery through the winding of sequence switch magnet 300, lower left contact of cam 311, upper back contact of relay 308 to ground over the upper contacts of cam 319 advancing sequence switch 300 to position 16. When the sequence switch reaches position 16 relay 308 reoperates in a circuit from battery through its upper winding, lower right contact of cam 309, lower left contact of cam 310, contact of relay 304, upper contacts of cam 313 to ground at the front contact of relay 306, but without effect at this time. With sequence switch 300 in position 16 battery through the lower right winding of repeating coil 303 and the winding of relay 352 is connected over the upper contacts of cam 342 to brush 343, and ground through the upper right winding of repeating coil 303 and the upper contacts of cam 356 is connected to brush 357 to supply talking battery to the called subscriber. Relay 352 operates in series with the called subscriber's line and closes a shunt around the upper, high resistance, winding of relay 304 to control a signal at the originating operator's position indicating that the called subscriber has answered.

At the termination of conversation when the called subscriber restores his receiver to the switchhook, relay 352 releases, opening the shunt around the upper winding of relay 304 as a disconnect signal to the originating operator. When the plug is removed from the jack at the originating manual office, relay 304 releases, in turn releasing relays 306 and 308. The release of relay 306 closes a circuit from ground over its upper back contact, upper left contact of cam 321, winding of sequence switch magnet 300 to battery, advancing sequence switch 300 to position 18. When the sequence switch leaves position 16 $\frac{1}{4}$, ground is removed from brush 335 permitting the final selector to return to normal. In position 18 a circuit is closed from battery through the winding of the down drive magnet 353, upper right contacts of cams 318 and 317 to ground, restoring the selector to normal. It may be noted that in positions 17 $\frac{1}{2}$ to 18 the trip magnet 332 is operated over the lower right contact of cam 318 and the upper right contact of cam 317 to prevent damage to the brushes in the restoring operation. When the selector reaches its normal position, a circuit is closed from ground over the upper right contact of cam 317, lower left contact of cam 313, brush 336, normal commutator segment 354, lower right contact of cam 321 to the winding of sequence switch magnet 300 and battery, advancing the sequence switch to position 1, or normal.

If the calling operator disconnects prematurely, for example, with sequence switch 300 in positions 2 to 7, in which positions incoming selections take place, relay 304 is released, in turn releasing

relay 306 and closing a circuit from ground over the back contact of relay 306, upper left contact of cam 321 to the winding of sequence switch magnet 300 and battery, advancing the sequence switch to position 8. In this position relay 308 operates in a local circuit as previously described and advances the sequence switch to position 9. If the selector has not been moved from normal, relay 308 will release when the sequence switch leaves position 8 and the sequence switch 300 is advanced to position 11 in a circuit from battery through the winding of sequence magnet 300, lower contacts of cam 331, lower back contact of relay 308 to ground over the lower contacts of relay 312. If the selector switch has been moved off-normal, trunk hunting will take place as previously described and the release of relay 308 will advance the sequence switch to position 11. As soon as sequence switch 300 reaches position 10, the circuit over the back contact of relay 306 becomes effective to advance it to position 18 where the down drive magnet is operated if the selector is off-normal and the normal segment of commutator segment advances the sequence switch to position 1.

If all of the trunks of a group are busy, the incoming selector in position 9 moves to the top of the group and comes to rest on the overflow terminals. Commutator strip 337 is open at the overflow positions, therefore the holding circuit of relay 308 is open and that relay is released, advancing the sequence switch to position 11, where it is immediately advanced to position 12 over a circuit from battery through its magnet winding, lower left contact of cam 321, commutator strip 330, brush 329, lower left contact of cam 318 to ground at the right contact of cam 317. In position 12, relay 308 is again operated and advances sequence switch 300 to position 13. With commutator brush 329 on a conducting segment of strip 330, a circuit is closed from ground over the upper right contact of cam 317, lower left contact of cam 318, brush 329, commutator strip 330, lower left contact of cam 321, winding of sequence switch magnet 300 to battery, advancing the sequence switch to position 17. With the sequence switch in positions 16 and 17 relay 308 operates in a circuit from battery through its upper winding, lower right contact of cam 309, lower left contact of cam 310, contact of relay 304, upper contacts of cam 313 to ground at the front contact of relay 306. When the sequence switch reaches position 17 with relay 308 operated a circuit is intermittently closed from ground over interrupter 355, lower right and upper left contacts of cam 328, lower front contact of relay 308, right contacts of cam 349, winding of relay 352, lower right winding of repeating coil 303 to battery. Relay 352 operates under the control of the interrupter 355, closing the shunt around the upper winding of relay 304 to give an intermittent signal to the originating operator. When the originating operator disconnects, relay 304 will release to cause the circuit to restore to normal as described above.

If, when the final selector connects with the called line, the line is busy, sequence switch 300 will be in position 13. In this case the busy back interrupter associated with the final selector will intermittently connect a low resistance ground to brush 343 thereby operating relay 302 which will release relay 308 and advance the sequence switch to position 16. When this position is reached, the intermittent ground connected

to brush 343 will extend over the upper contacts of cam 342 to the winding of relay 352, lower right winding of repeating coil 303 and battery, operating relay 352 intermittently to shunt the high resistance winding of relay 304 and transmit a busy back signal to the originating operator and a busy tone to the calling subscriber. Disconnection is then controlled as previously described.

It will be remembered that the circuits of Fig. 6 are common to a plurality of link circuits such as shown in Figs. 4 and 5. As soon as sequence switch 500 reaches position 5, the allotter circuit of Fig. 11 is advanced, by a circuit closed from ground over the right contacts of cam 422, inner lower normal contact of key 400, conductor 428, lower left contact of sequence switch cam 1101, winding of sequence switch magnet 1100 to battery, advancing the front allotter switch to position 2, from which it is immediately advanced by ground over the normally closed contact 1201 of jack 1205, lower right contact of cam 1102 to the winding of sequence switch magnet 1100 and battery. With sequence switch 1100 in position 3, ground is connected over the upper back contact of relay 1105 over plug and jack connections 1203 and 1204, upper contacts of cam 1209, plug and jack connection 1203 and 1204, upper right and lower left contacts of cam 1104 to conductor 1103 leading to the second of the link circuits served by this front allotter circuit. This conductor corresponds to conductor 1120 of the link circuit shown, which extends over the middle lower contact of key 400, lower right contact of cam 506 to the winding of sequence switch magnet 500 when the sequence switch stands in position 17. Therefore, it advances the second link circuit sequence switch into position 1 ready to serve the next call. If another incoming selector in the group reached position 2 before relay 700 operated, so that it now has ground connected to a circuit corresponding to the one which may be traced over the lower contacts of cam 314 and conductor 315, it causes the advance of the newly allotted second link circuit to position 2 before the first link circuit has advanced from position 6. The advance of the second link circuit connects ground to conductor 609 in the manner described for the first link as soon as it advances to position 2. Therefore, the locking circuit of relay 611 in the common equipment is established in the second link circuit before it is opened in the first link circuit. The battery for relay 611 is maintained over brush 803 and the winding of relay 907 in the operator's position circuit, relay 907 holding lamp 925 lighted, and holding the idle battery indication disconnected from conductor 908. When sequence switch 500 of the first link advances from position 16 relay 604 releases and since relay 611 is held operated by the second link, a circuit is immediately closed from battery through the winding of relay 605, inner upper front contact of relay 611, upper back contact of relay 604 to grounded conductor 609, relay 605 locking to conductor 609 independent of relay 611. With relay 611 held operated, relay 610 cannot operate and the position finder 800 does not advance and consequently neither does the key-set finder 810.

Ordinarily, all overlapping calls in one group will be satisfied before the operator's position is again marked free. However, if traffic is heavy, so that calls accumulate in a group, but there is no operator available because there are more trunk groups than there are operators on duty

and all operators are busy, a "kick-off" arrangement is provided that will advance the position finder from the position to which it has just been connected as soon as the last simultaneous call in a group has been answered. This is arranged as follows: As soon as a link has been connected with an incoming trunk, relay 600 is operated and a circuit is closed from ground over the lower back contact of relay 602, outer upper front contact of relay 600, upper normal contact of key 622 to conductor 628 and interrupter 623. When the interrupter, which is common to all links in the office, closes its contact it completes a circuit over the normal contact and through the winding of relay 626, resistance 627 and battery. Relay 626 locks over its lower contact to conductor 628 and closes a circuit from battery through resistance 625, winding of relay 624, the front contact of relay 626 to grounded conductor 628, but relay 624 cannot operate being shunted by the operating circuit of relay 626. After an interval, interrupter 623 opens and relay 624 operates. On the next closure of interrupter 623 it shunts the winding of relay 626 and causes that relay to release, relay 624 being held operated until the interrupter again opens its contact. Normally the operation of relay 602 in connecting the A and B positions together, disconnects ground from conductor 628 before this condition is reached. With relay 624 operated and relay 626 released, a circuit is closed from battery through the winding of relay 629, upper back contact of relay 626, lower front contact of relay 624 to grounded conductor 628. Relay 629 locks to conductor 628 and closes a circuit over the lower contact of key 622 to the winding of relay 630 and battery.

As each position is occupied, the corresponding relay 906 is operated as previously described, connecting ground over the upper back contact of relay 907 to conductor 853 and over the inner lower back contact of relay 907 to conductor 852 holding relays 850 and 851 operated. When relay 907 operates, when the position becomes busy, ground is disconnected from these two conductors. Therefore if all the operators become busy or all positions vacant, no ground will be connected to either one of these conductors and relays 850 and 851 will be released, completing a circuit from ground over the upper back contact of relay 851, upper back contact of relay 850, to the winding of the common all-positions-busy relay 614 and battery. Relay 614 opens the circuit of relay 613 to prevent the position finder from hunting.

When relay 630 operates as above described, ground is connected over the contacts of relay 630, and the contacts of relay 614 to all link circuits, extending, in groups where an operator's position is held by overlapping calls, over switch contact 535, conductor 536, upper front contact of relay 700, switch contact 537, upper front contact of relay 611, upper normal contact of relay 633, winding of relay 633, resistance 632 to battery. Relay 633 operates in this circuit and locks to the front contact of relay 602 which is held operated. When relay 700 releases as the last of a group of simultaneous calls is extended to the operator's position, relay 612 is allowed to operate in the locking circuit of relay 633. When the next call comes into this group, and relay 700 reoperates, the circuit previously traced to the normal contact of relay 633 is now extended over the inner lower front contact of relay 612 to resistance 632 in shunt of the winding of

relay 633 causing that relay to release. A circuit is then closed from battery through the winding of relay 613, lower front contact of relay 618, when the operator finishes setting up the number on her key-set, inner lower back contact of relay 633, upper front contact of relay 612 to ground on conductor 609. Relay 613 operates in this circuit, closing a circuit for magnet 807. When sequence switch 500 advances out of position 16, relay 604 releases, relay 612 releases and in turn releases relay 613 and magnet 807 to advance switch 800 from the position which has just been used, making the position idle so that it may be selected by some other link group. As soon as the position becomes free, relay 614 releases, rendering the timing circuit ineffective until another group has seized the position.

When emergency switch 590 is operated, the emergency position finder is substituted for the regular position finder and calls from all trunk groups are handled by the emergency position finder circuit. With the switch operated, lamps 538 and 539 are lighted to indicate that the emergency circuit is in use with some link.

While the position finder 800 is hunting for an idle position, if by any chance one of the windings of relay 607 has become grounded, this may be detected as the position finder passes its position 21. In this position relay 856 is connected across a Wheatstone bridge having for two arms the resistances 854 and 855 and for its opposite arms two windings of relay 607, the bridge being fed by the battery and ground through the windings of relay 607 and those connected to resistances 854 and 855, respectively. If false ground appears relay 856 operates, removing ground from the locking circuit of relay 857, which releases lighting lamp 858, and operating alarms over conductors 859 and 860. A similar arrangement permits the testing for false ground on other brushes of the position finder and key-set finder. All of these brushes are connected to relay 856 in position 21 of the switch.

If for any reason a link does not advance within sixty seconds, a reorder signal is given. Ground from the back contact of relay 414 is connected over the right contacts of cam 415 to interrupter 430, which when it closes its lower contact operates relay 431 which locks to ground over cam 415. When, thirty to sixty seconds later, interrupter 430 closes its upper contact it completes a circuit from ground on its movable contact over its upper contact, lower front contact of relay 431, normal contact of relay 402 to the upper windings of relay 425 and relay 432 and battery. Relay 425 locks over its lower winding and outer lower front contact, brush 423 and conductor 362 to ground over the lower left and upper right contacts of cam 317. It also connects ground over interrupter 433, resistance 434, inner lower front contact of relay 425, brush 435, conductor 369, winding of relay 352, lower right winding of repeating coil 303 to battery, causing this relay to operate intermittently and to transmit a reorder signal to the originating operator. Relay 425 opens the circuit of the down drive magnet 424, disconnects relay 408 from brush 423 thereby releasing relays 408 and 412 and connects ground over its middle lower front contact and the upper normal contact of jack 406 to conductor 436 leading to the time alarm circuit of Fig. 7 where it extends through the winding and normal contact of relay 704, back contact of relay 705 to battery. Relay 704 locks over its lower front contact to battery and 75 also closes a circuit from ground over the normal

contact of relay 706, inner upper front contact of relay 704 to interrupter 707. When the interrupter closes its lower contact it operates relay 708 which is locked under the control of relays 704 and 706 and closes an obvious circuit for relay 705 opening the operating circuit of relay 704. When interrupter 707 closes its upper contact it completes a circuit over the upper front contact of relay 708 to the lower winding of relay 709 and battery. Relay 709 operates and locks through its upper winding and upper front contact, upper normal contact of relay 710, under the control of relays 704 and 706. When interrupter 707 again closes its lower contact it completes a circuit over the lower front contact of relay 709 through the lower winding of relay 710 and battery. Relay 710 locks over its upper winding and upper contact under the control of relays 704 and 706. It also closes a circuit from battery through the winding of relay 711, lower front contact of relay 710 through the upper contacts of interrupter 707. Therefore, when interrupter 707 again closes its upper contact it operates relay 711 which locks in turn under the control of relays 704 and 706. It also connects battery over its upper front contact over the normal contact of relay 706, lamp 712, winding of relay 706, to ground at the upper front contact of relay 704. Relay 706 operates in this circuit locking to battery at its lower front contact and connecting ground over two conductors 713 and 714 to sound an alarm. It also opens the ground supplied to the interrupter 707 and releases the timing relays 708 to 711, inclusive.

If a link circuit is suspected of being in trouble, a plug 440 is inserted in jack 406 and, if trouble does occur, so that relay 425 is operated, a circuit is closed from ground over the sleeve of jack 406, sleeve and ring contacts of plug 440, ring contact of jack 406, inner upper front contact of relay 425 to the winding of relay 414 and battery. Relay 414 locks over its inner upper front contact to ground over the upper contacts of cam 422. It also closes an obvious circuit for relay 402. It will be remembered that the circuit of sequence switch magnet 500 as originally traced extended over the auxiliary contact of jack 406 or in parallel therewith over the lower back contact of relay 414. With plug 440 in jack 406 one of these branches is held open and therefore, when trouble occurs causing the operation of relay 414, the circuit of sequence switch magnet 500 is opened at the contact of relay 414 and the link cannot advance beyond the position in which the trouble occurred. The operation of relay 402 removes ground from conductor 609 so that the position finder circuit cannot be operated by this link. Relay 414 also disconnects ground from cam 415 thereby preventing the functioning of the time-out interrupter 430. Relay 402 connects ground over the middle lower front contact of relay 425, inner lower front contact of relay 402 to brush 403 and conductor 316 of the trunk circuit to mark the trunk busy. It also connects ground over its outer lower front contact and the inner lower contact of key 400 to conductor 428 to cause the allotter to advance and to pass this link in subsequent cycles.

If for any reason relay 611 releases before relay 605 releases, a circuit is closed from battery through the upper windings of relays 432 and 425, 70 normal contact of relay 402, lower contacts of cam 540, switch contact 542, upper front contact of relay 605, upper back contact of relay 604, inner lower back contact of relay 611, back contact of relay 613 to grounded conductor 609. Relay 432 75

in operating closes a circuit from ground over its upper front contact, and lower winding, to the winding of trouble release meter 441 which locks under the control of relay 432 but closes a shunt around the lower winding of that relay so as to release immediately that the trouble ground is removed.

Relay 432 is also operated if relay 604 operates while relay 611 is released. The circuit in this case extends as previously traced to the lower right contact of cam 540 and thence over the upper left contact of cam 540, switch contact 541, upper front contact of relay 604, inner lower back contact of relay 611, back contact of relay 613 to grounded conductor 609. In addition, if the relay 618 does not operate in response to the operator completing her key-setting operation, she may release her position by operating key 927, grounding conductor 832 and completing a circuit for relay 432 from battery through the upper windings of relays 432 and 425, normal contacts of relay 402, over the lower left and upper right contacts of cam 540, switch contact 543, back contacts of relays 617 and 618, brush 812 and conductor 832.

It will be remembered that in position 4 of sequence switch 500, a circuit was closed over the front contacts of relays 601 and 605, to conductor 544 and over the lower back contact of relay 703 to the winding of relay 404 as above traced. Assuming that there are three groups of link circuits, each having a common position finder circuit, a similar circuit is closed by the relays corresponding to relays 601 and 605 of the second position finder circuit to conductor 726 and by the corresponding relays of the third position finder circuit to conductor 727. The grounding of either one of these conductors operates relay 725 which renders the interrupter 728 effective. The first closure of interrupter 728, following the operation of relay 725, operates relay 703 and this relay in operating opens the circuit over conductor 544 closed by the present position finder circuit, and extends conductor 726 over the back contact of relay 720 and the front contact of relay 703 to the allotted link in the second group. The operation of relay 703 also prepares a circuit for relay 720 which becomes effective when the interrupter opens its contacts. With interrupter 728 opened and relays 720 and 703 both operated conductor 727 is extended over the front contacts of relays 720 and 703 to the third link group. When the interrupter 728 closes a second time it completes a shunt around the winding of relay 703, causing that relay to release. With relay 703 released, conductor 544 is extended through to the first link group. Therefore, as long as calls exist in the second and third group circuits, relay 725 remains operated and the calls will be assigned for service in each of the groups in rotation. This arrangement prevents interference between links of different groups in hunting for idle senders.

When ground is connected to conductor 603, a circuit is completed over ring contact of jack 1000, upper winding of relay 1001, tip contact of jack 1000, ring contact of jack 1002, upper winding of relay 1003, tip contact of jack 1002, ring contact of jack 1004, winding of relay 1005, tip contact of jack 1004 and battery. Relay 1005 operates, lighting green lamp 1020. Relays 1003 and 1001 are electrically polarized by circuits through lower windings and contacts of their corresponding jacks so that relay 1001 will respond only when four or more position circuits

have closed ground through the resistance like resistance 635 to conductor 603, while relay 1003 will respond only after six such parallel circuits are closed.

When relay 1001 operates, relays 1006, 1007 and 1008 are operated in turn. Relay 1007 grounds interrupter 1012 which operates relays 1013 and 1014 to control audible alarm 1016 if the condition continues unduly. Relay 1008 operates a plurality of relays, including relay 1009 which lights white lamps 1010, 1011 etc. at each pair of operators' positions.

Relay 1003 in operating operates relays 1017 and 1018, relay 1018 lighting red lamp 1019 and immediately sounding the audible alarm.

What is claimed is:

1. In a telephone system, a plurality of groups of link circuits, a position finder individual to each group of link circuits, a lesser plurality of operators' positions, means responsive to the seizure of a link circuit to associate said link circuit with an operator's position by means of the position finder of the corresponding group, means responsive to the overlapping seizure of a second link circuit in said group to prevent the release of said position, and means effective if a group of link circuits is not connected with an operator's position within a predetermined length of time to forcibly release an operator's position.

2. In a telephone system, a plurality of groups of link circuits, a position finder individual to each group of link circuits, a lesser plurality of operators' positions, means responsive to the seizure of a link circuit to associate said link circuit with an operator's position by means of the position finder of the corresponding group, means responsive to the overlapping seizure of a second link circuit in said group to prevent the release of said position, means to indicate when all of said operators' positions are busy, timing means operated by said link circuits while waiting for an operator's position, and means under the control of said position busy means and said timing means to force the release of one of said operators' positions.

3. In a telephone system, a plurality of groups of link circuits, a position finder individual to each group of link circuits, a lesser plurality of operators' positions, means responsive to the seizure of a link circuit to associate said link circuit with an operator's position by means of the position finder of the corresponding group, means responsive to the overlapping seizure of a second link circuit in said group to prevent the release of said position, and means effective if a group of link circuits is not connected with an operator's position within a predetermined length of time to advance one of said position finders.

4. In a telephone system, a plurality of groups of link circuits, a position finder individual to each group of link circuits, a lesser plurality of operators' positions, means responsive to the seizure of a link circuit to associate said link circuit with an operator's position by means of the position finder of the corresponding group, means responsive to the overlapping seizure of a second link circuit in said group to prevent the release of said position, means to indicate when all of said operators' positions are busy, timing means operated by said link circuits while waiting for an operator's position, and means under the control of said position busy means and said timing means to force the advance of one of said position finders.

5. In a telephone system, a plurality of groups

of trunk circuits, a plurality of groups of link
circuits, each group of link circuits serving one
group of trunk circuits, a plurality of operators'
positions, a position finder individual to each
5 group of link circuits, means in each of said link
circuits responsive to its seizure by a trunk cir-
cuit for seizing said position finder to connect
with an idle operator's position, means for seiz-
ing a second link circuit in the same group, means
10 effective upon the release of said first link circuit

for associating said second link circuit with said
position finder without releasing the attached
position and means effective when the number
of operators' positions available is less than the
number of groups of link circuits and all avail- 5
able positions are associated with busy links to
advance the position finder associated with such
link circuits to permit a link circuit in another
group to seize said operator's position.

FOSTER B. BLAKE. 10