

Jan. 12, 1932.

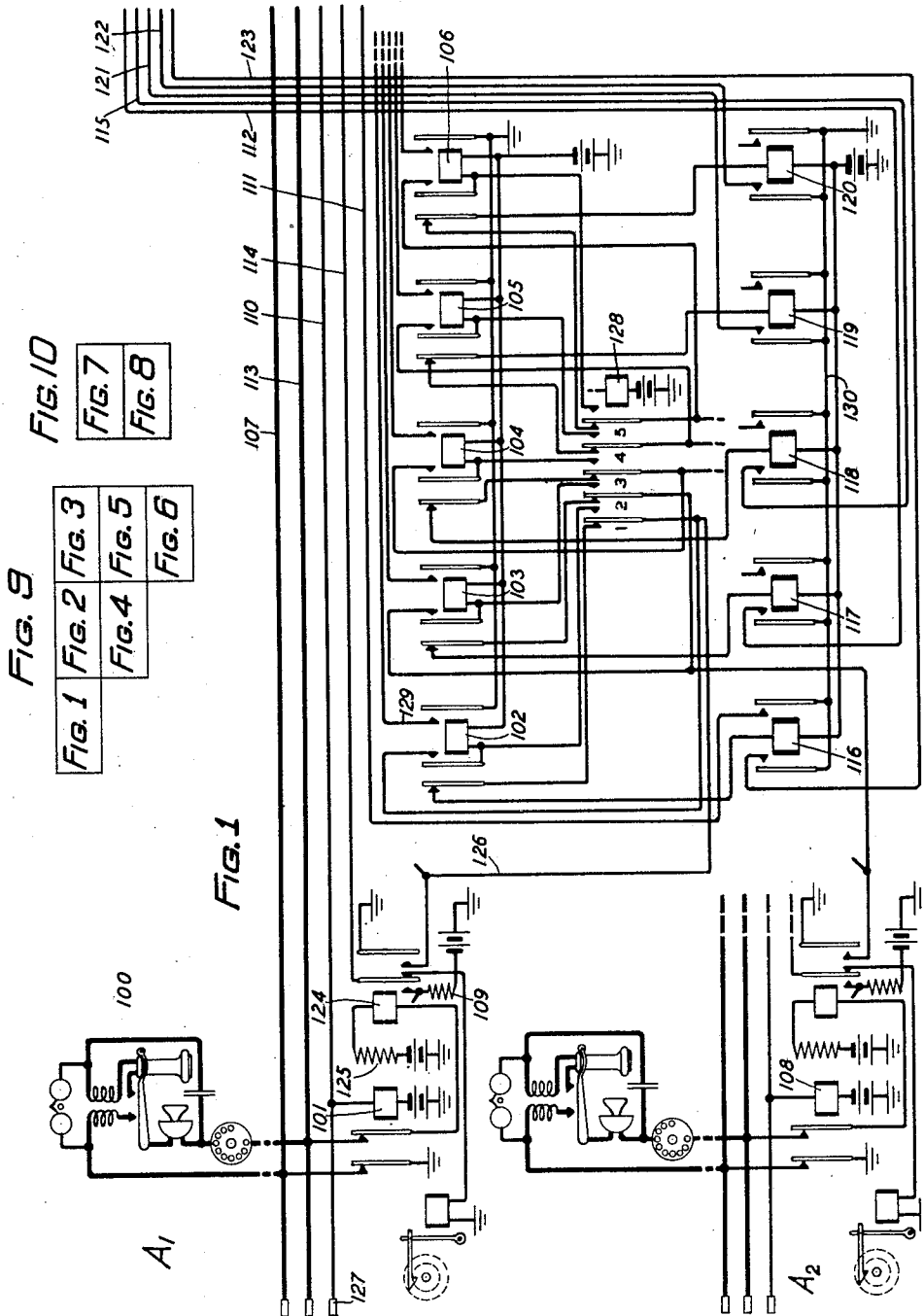
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1,840,356

AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed July 7, 1930

8 Sheets-Sheet 1



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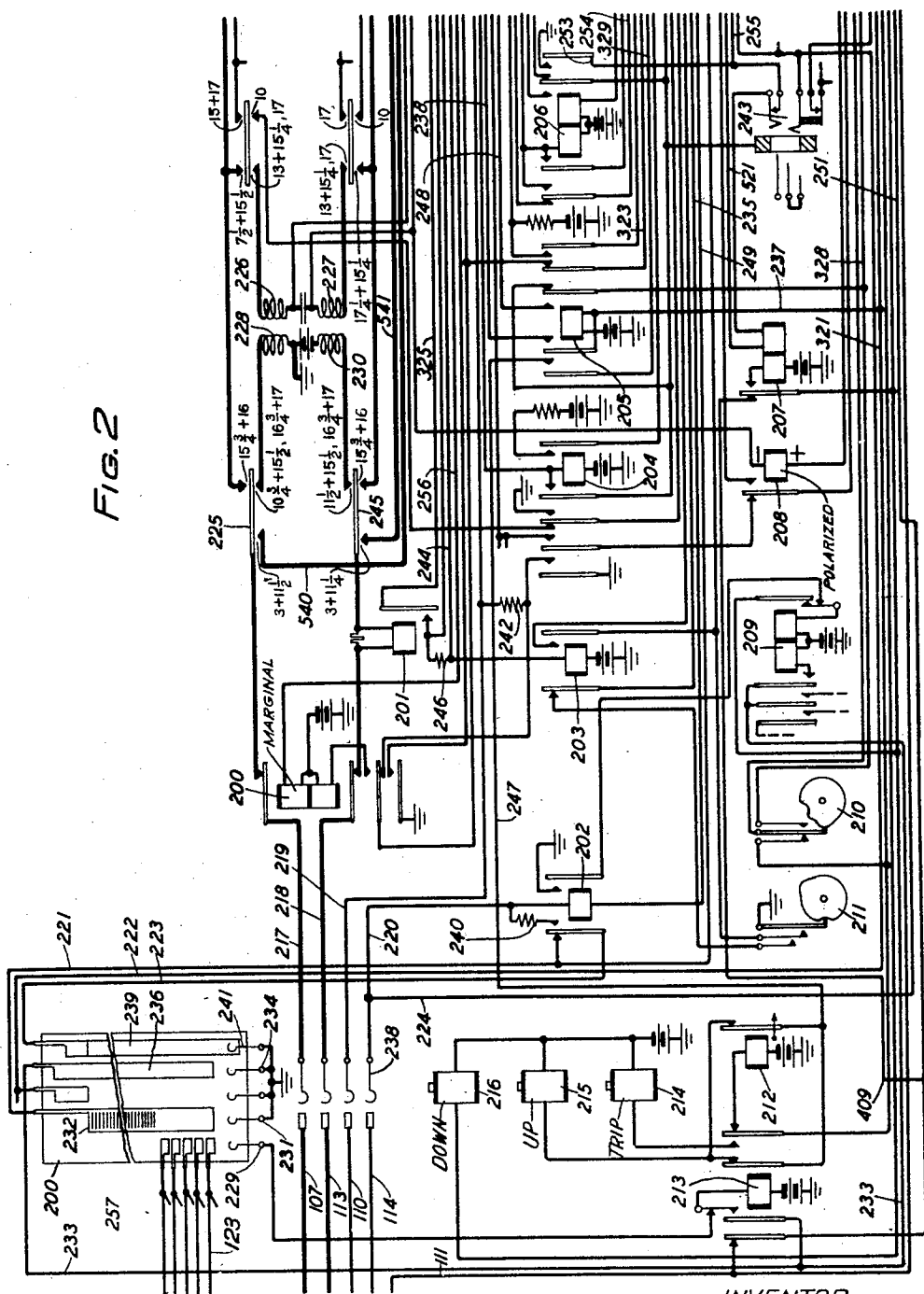
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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

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8 Sheets-Sheet 2

FIG. 2



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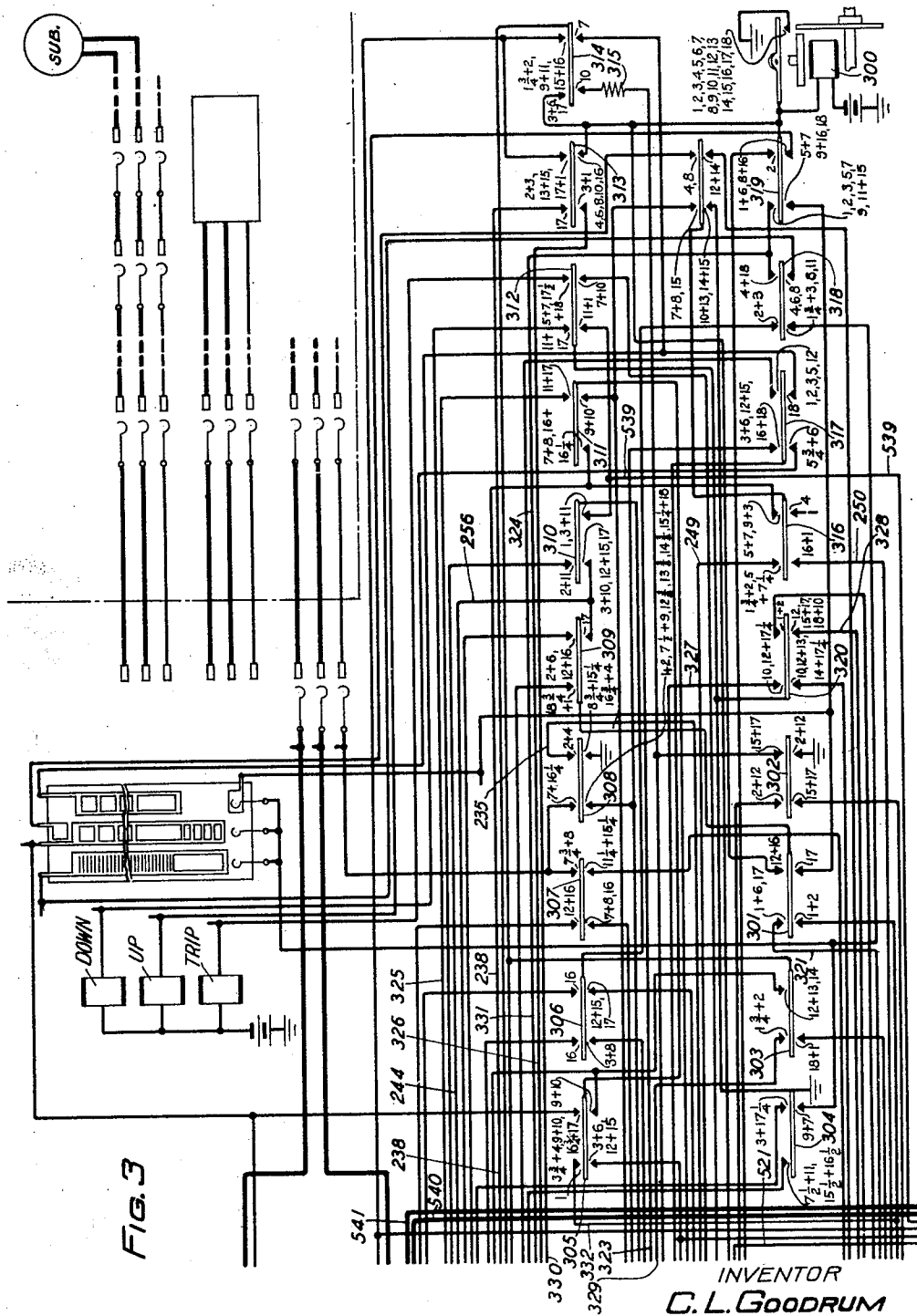
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8 Sheets-Sheet 3



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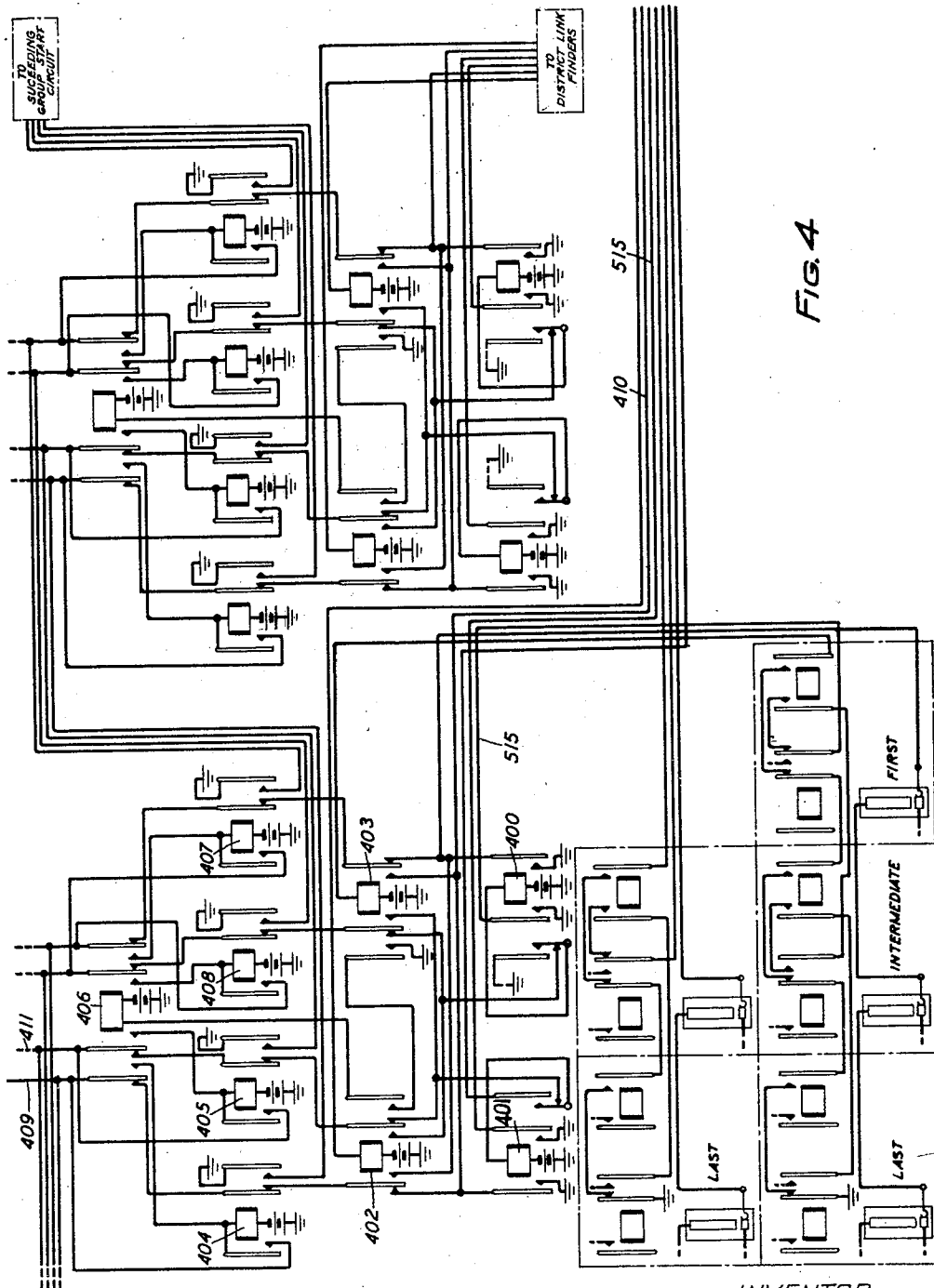
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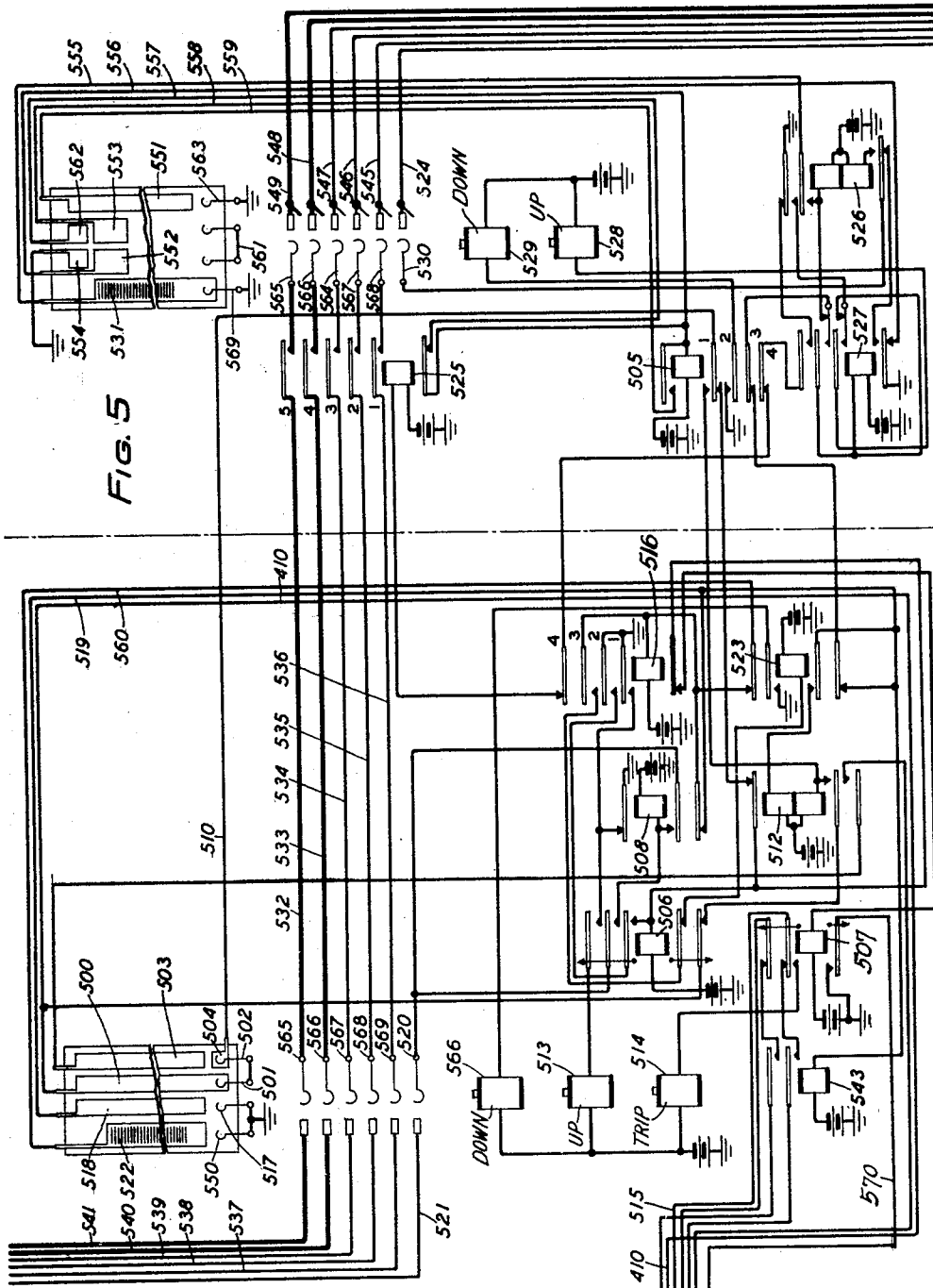


FIG. 5

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Filed July 7, 1930

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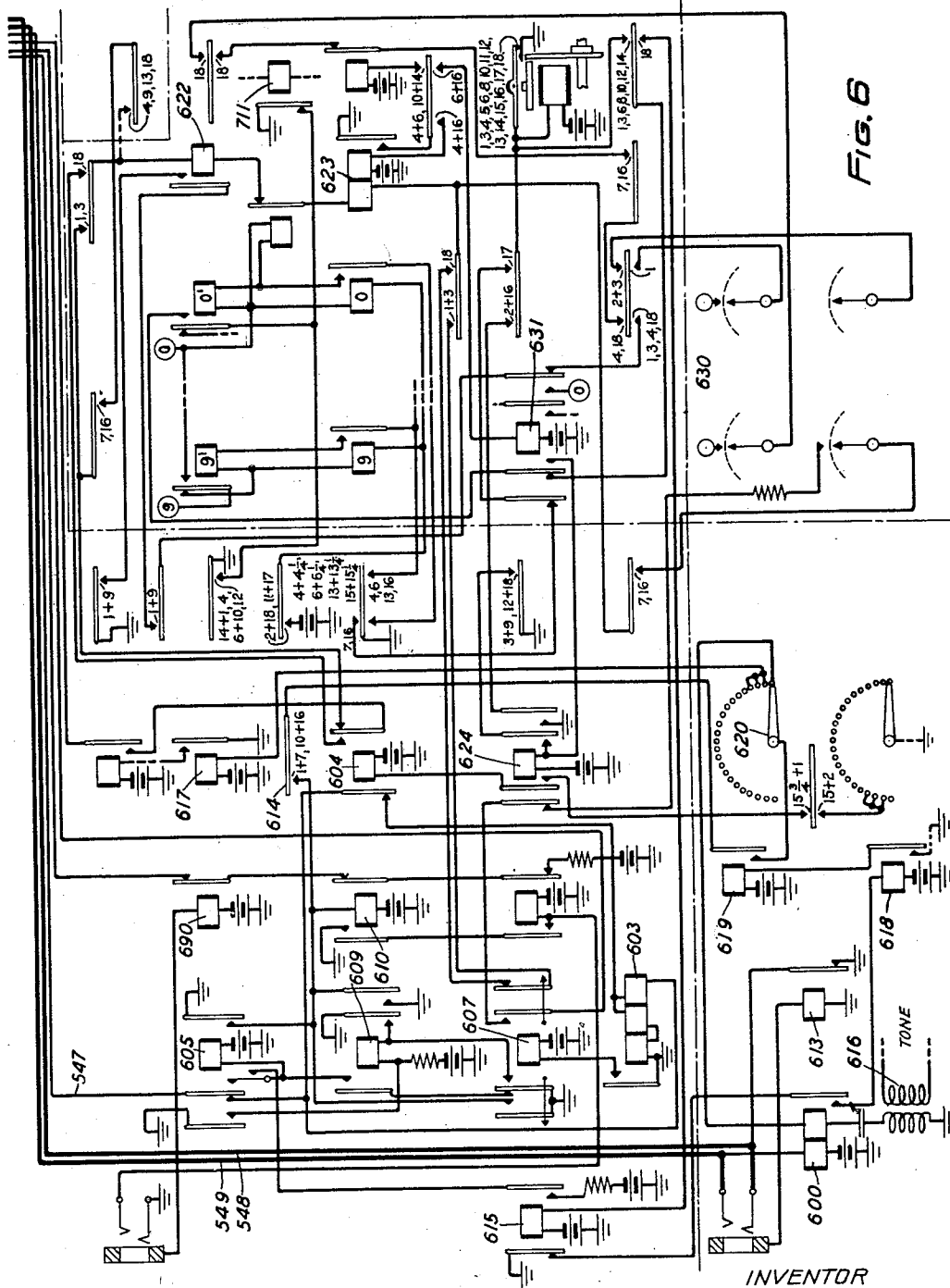


FIG. 6

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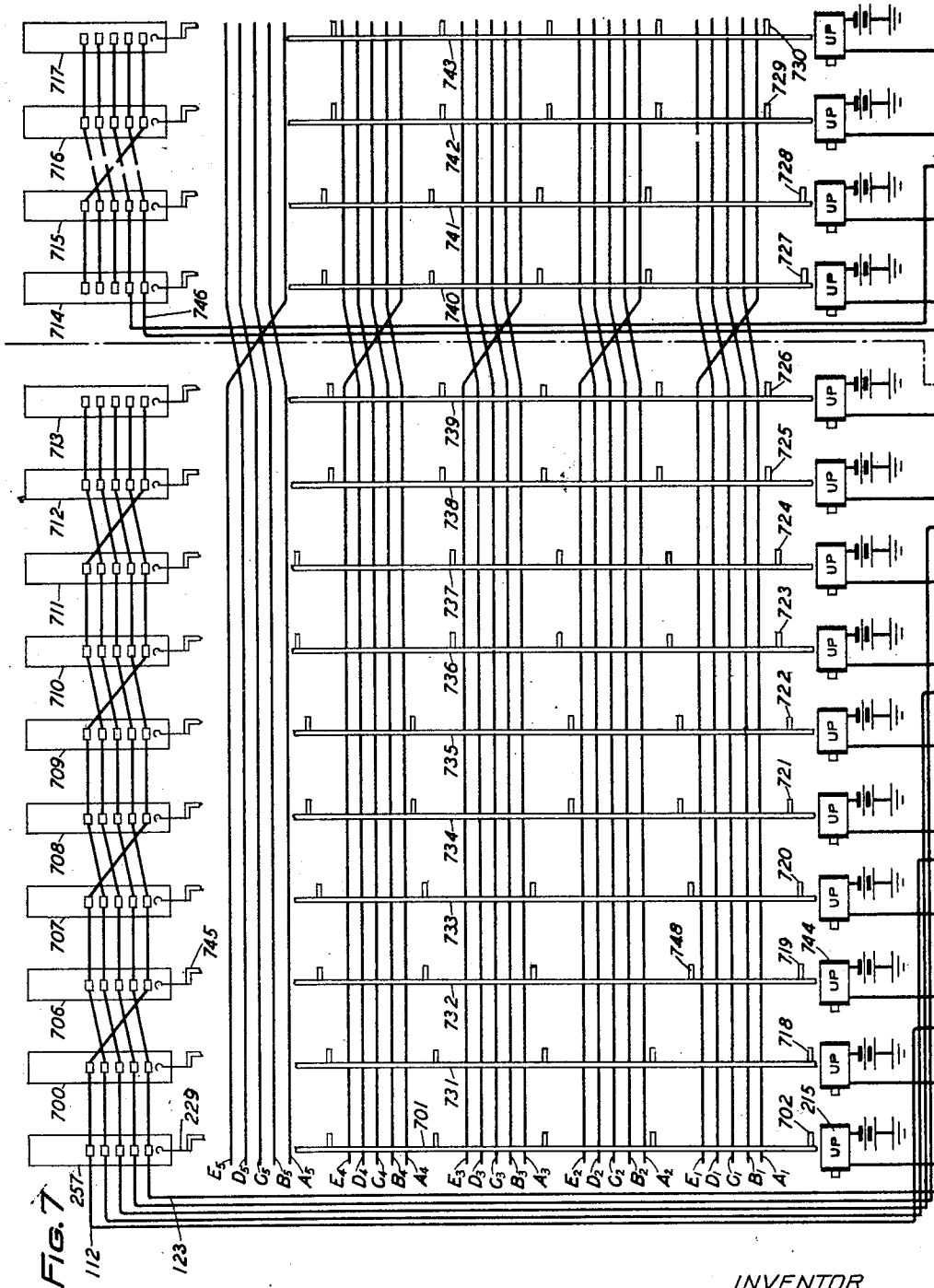
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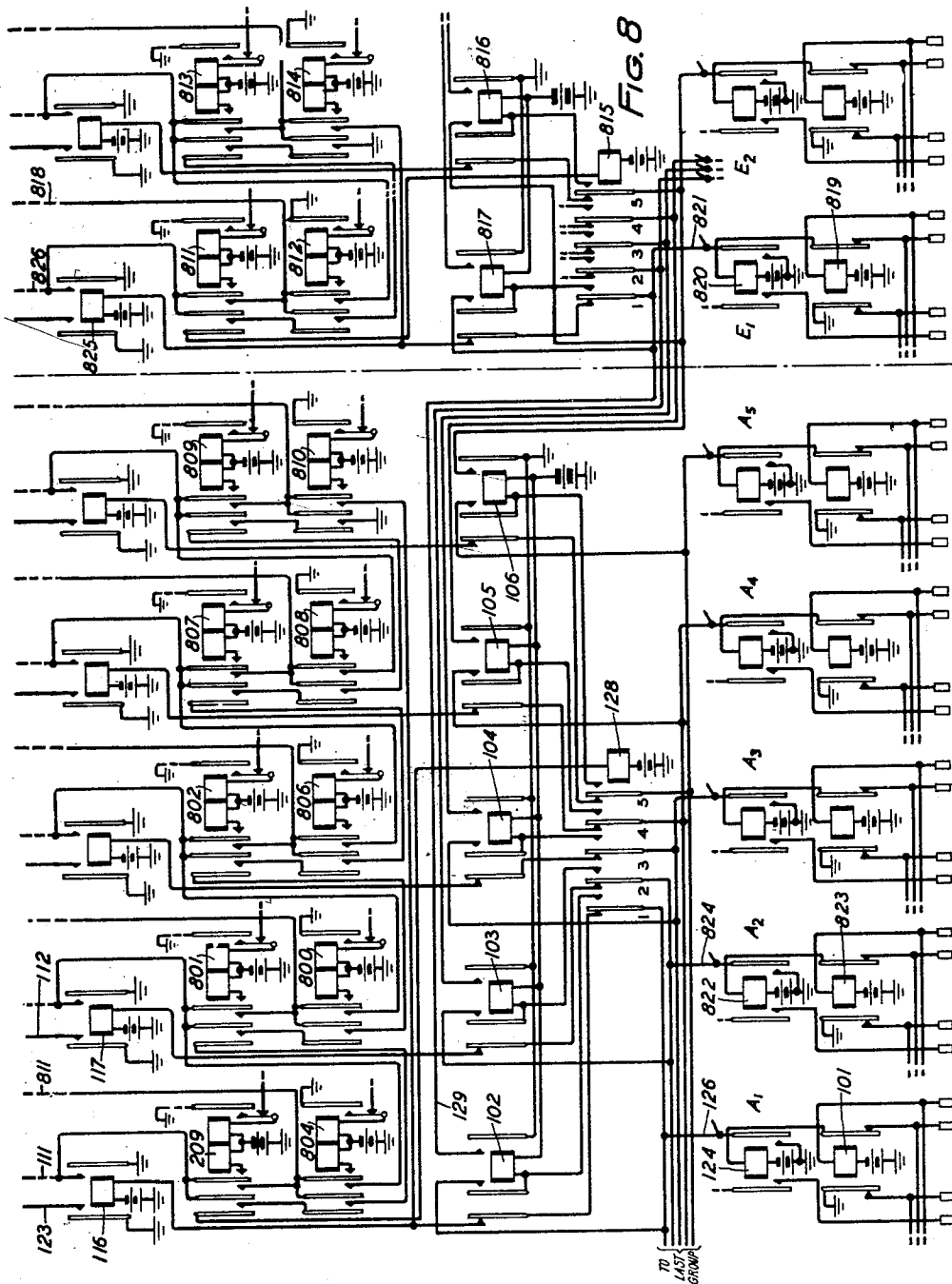
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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Application filed July 7, 1930. Serial No. 466,073.

This invention relates to an automatic telephone exchange system and more particularly to systems in which line finders are employed for establishing connections between calling lines and idle trunks. The object of the invention is to provide, in a system of the foregoing character, an arrangement of line finders such that calling lines are extended with greater speed and facility, a greater economy in apparatus is realized and line finders having the same mechanical structure as the other line extending switches of the system may be utilized, thereby simplifying manufacture, installation and maintenance.

Where non-numerical or finder switches are employed for seizing and extending subscribers' lines either to succeeding selector switches or to operators' positions, a convenient method of handling incoming calls is to divide the subscribers' lines into groups and to assign the requisite number of finder switches to serve each of such groups of lines. In systems employing panel type power driven switches, it has been the practice to provide the finders with a plurality of sets of brushes each having access to a subgroup of a group of lines. By this arrangement only the particular set of brushes having access to the subgroup of lines containing the calling line need be taken for use and therefore the finder is not required to move over the entire group of lines it serves, but only over a smaller subgroup individual to a set of brushes in hunting for and seizing a calling line. Thus to serve a group of 400 lines, each line finder having access thereto would, for example, be equipped with ten sets of brushes, each brush set having access to a subgroup of forty lines.

To further shorten the hunting movement of such a line finder and thereby reduce the time consumed in seizing a calling line, it has been proposed to divide each brush group into two further subgroups and to connect the lines to the terminal banks in such a manner that the lines of one subgroup appear as first choice lines to the brushes of half of the finders and as second choice lines to brushes of the remaining finders. Likewise,

the lines of the second subgroup appear as first choice lines to the second half of the finders and as second choice lines to the first half of the finders. Normally when a call originates in one of the subgroups a finder having first choice access to this subgroup is taken for use. Hence, the finder is only required to move over the first half of a brush group, or, for example, over twenty line terminals. When all finders having access to a subgroup as first choice are engaged and a call originates in that subgroup, one of the finders having second choice access to the subgroup is utilized if any of these be idle at the time.

As hereinbefore indicated, finders which have been proposed for functioning in the manner described have been provided with ten sets of brushes and with a separate tripping magnet for each brush set common to all of the finders serving a main group of calling lines, the particular magnet operated on any initiated call being determined by the brush group of lines in which a calling line is located. This structure of the line finder thus differs materially from the structure of other panel type switches employed in a telephone system, since such other switches, for example, the district switch, has a tripping magnet individual thereto, which through staggered tripping fingers on the trip rod operated thereby may trip any one of the five sets of brushes with which the switch is equipped. The difference between the mechanical structures of a line finder of the type above described and a selector switch may be readily noted by referring to the patent to J. L. McQuarrie No. 1,177,044, granted March 28, 1916 showing a line finder structure and to the patent to E. B. Craft and J. N. Reynolds No. 1,123,696, granted January 5, 1915 showing a selector switch structure.

From manufacturing, installing and maintenance standpoints, it would be highly desirable to eliminate specially constructed line finders and to provide, in lieu thereof, switches having the same mechanical structure as other switches employed in the exchange system. This has not, however, been heretofore practicable inasmuch as the standard selector switch has but five sets of brushes

and therefore, when used as a line finder, each brush group of lines served thereby would, for example, contain eighty lines which when subdivided into first and second choice subgroups would require the finder brushes to hunt over a maximum of forty lines to seize a calling line. Obviously, this would materially increase the time required to extend a calling line to a trunk and thereby slow up service. A line finder structure of this type has heretofore been proposed as disclosed in the patent to A. E. Lundell, No. 1,471,617, granted October 23, 1923.

In accordance with the present invention it is proposed to attain the desirable feature of utilizing line finders having the same general mechanical structure as other selector switches employed in the system and at the same time reduce the size of the line subgroups over which hunting must be done to seize any calling line. This is accomplished in accordance with one embodiment of the invention, disclosed herein by way of illustration, by dividing the subscribers' lines into main groups of 400 lines each, further dividing each main group into five major subgroups of eighty lines each and then still further dividing each of such subgroups into five minor subgroups of sixteen lines each. On the frame of line finders assigned to serve such a main group of lines, each brush group or bank is then composed of one minor subgroup from each major subgroup.

To serve a main group of lines, for example, fifty line finders are provided, divided into five groups of ten finders each, half of the finders of each group being located on the front of the frame and half on the back of the frame to function with the front and back, respectively, of the banks. Similarly, the banks themselves are each separated into five vertical sections and the minor subgroups of lines which are connected to each bank are slip-multiplied between the five sections of such bank so that each minor subgroup appears in each of the sections, but in a different position in each. The subgroups appear, however, in the same order in each section, although each section begins with a different subgroup. Also, the lines of a subgroup appear in the same order in all appearances. Further, the five minor subgroups of any major subgroup appear in the same position in the banks in any vertical row of bank sections.

Each subgroup of ten line finders serving a vertical section of the banks is first choice for those minor subgroups of lines appearing in the first position of the bank sections before which they are located, second choice for the minor subgroups in the second position of the banks and so on through the minor subgroups. Each such subgroup of finders is further subdivided into five minor subgroups of two finders each, one finder of each such

minor subgroup serving the front of the bank and the other serving the back of the bank and each such pair of finders being arranged to trip a different set of brushes for any given selecting movement. Thus, a pair of finders is given the preference for the minor subgroups of lines in its banks which it can select with the shortest brush selecting movement.

Associated with each subgroup of ten line finders are five start relays each of which is normally connected to the line relay contacts of one of the minor subgroups of lines for which the minor subgroup of two finders is first choice through the contacts of corresponding advance relays. Each start relay when operated grounds a commutator segment of each line finder of the subgroup and closes a start circuit to the minor subgroup of line finders which is the preference for its minor subgroup of lines. The start wires are advanced from one line finder to the next in a closed chain by contacts in the finder circuits in accordance with the familiar so-called paddle wheel start circuit. The chain extends through the complete subgroup of ten finders so that when both the finders of a minor subgroup become busy, the corresponding start wire is connected to the start wire of the next minor subgroup.

The five advance relays which are also provided for each subgroup of line finders in association with the five start relays are arranged when all of the finders of the subgroup are busy to transfer the start wire from its corresponding minor subgroup of lines to the corresponding start relay in the next succeeding or second choice subgroup of finders. These advance relays are arranged to hold up in case a line finder of the associated subgroup becomes idle while a call is going through to the second choice finders. However, only the advance relays of the minor subgroups of lines from which calls are actually going through are held under this condition, so that the first choice finders become available immediately to the other minor subgroups.

Each line finder has a five segment commutator which is marked by the start relays of the subgroup for brush selection, the commutators of all the finders in a subgroup being connected in multiple with a slip between minor subgroups so that when any start relay operates, it grounds segments corresponding to different banks in each such minor subgroup of finders. The trip rods of the finders of each subgroup are arranged with the trip fingers slipped to correspond with the commutator slip so that the proper brush will always be selected even though the commutator segments are not in the same relative position as the corresponding banks. The arrangement of the trip fingers and commutator segments of any finder is such that

in each minor subgroup of finders the bottom segment is grounded by the start relay of the minor subgroup of lines for which it is the preference. If two or more finders in a subgroup are started at once, each one will trip into the bank for which it is the preference.

In general the system functions in the following manner: When a line originates a call at a time when there are finders idle in its first choice group, the start relay for the minor subgroup in which the line is located is operated, marking all of the commutators of the first choice subgroup of finders and closing the start circuit of the preference minor subgroup of finders. If there is an idle finder in this minor subgroup, the first idle one will start and run to its first brush tripping position where it is stopped by the marking ground on its first commutator segment. Due to the slipped arrangement of the trip fingers, this causes the tripping of the proper brush set. If calls originate in two or more minor subgroups of the same major line group at the same time, the first commutator segment of each of the corresponding minor subgroups of finders is grounded so that if a finder is started in each minor subgroup, each will stop in the position to trip the brush for its preference bank. If two lines in the same minor subgroup call at once, only one line finder is started so that the call on the upper one of the lines must wait until the other has been picked up and another finder started.

In case all of the finders of the minor subgroup which is the preference for the calling line are busy, the start wire is extended to the next minor subgroup. The second segments of the commutator of this minor subgroup are grounded so that an idle finder thereof will stop in its second brush selecting position. If, however, there is a call at the time from the line in a minor subgroup for which this finder is the first preference, the first commutator segment will also be grounded and the first finder started will stop in the first brush selecting position, so that the other call must wait until the call in that finder's own minor subgroup is answered.

If all the finders in a major subgroup are busy, the line relay contacts of the corresponding minor subgroups are extended to the start relays of that finder subgroup before which the lines appear in the second position in the banks, these being the second choice finders for those minor subgroups of lines. Brush selection and line hunting take place in the same manner as described for the first choice line finders, the finder passing over one of the minor subgroups of lines for which it is first choice before reaching the calling line.

In case all of the finders in two consecutive major subgroups of finders are busy, the line

relay contacts of the minor subgroups of lines normally served by such major subgroups of finders are connected to the start relays of the next succeeding major subgroup of finders.

A clearer conception of the scope and purpose of the invention will be obtained by consideration of the following description taken in connection with the attached drawings in which:

Fig. 1 shows a subscriber's group circuit; Figs. 2 and 3 show a combined line finder and district selector;

Fig. 4 shows a link group start circuit;

Fig. 5 shows a link circuit;

Fig. 6 is a schematic drawing of a sender;

Fig. 7 shows schematically the arrangement of the line finder elevators and part of a line finder frame together with the arrangement of all line groups and commutator marking terminals;

Fig. 8 shows schematically the control circuits for the representative subscriber groups having access to the line finder elevators in Fig. 7;

Fig. 9 shows the manner in which Figs. 1, 2, 3, 4, 5 and 6 are to be arranged with respect to each other for a complete disclosure of the present embodiment of the invention;

Fig. 10 shows the manner in which Figs. 7 and 8 are to be arranged with respect to each other in order to show clearly the interconnection between the line finders and the control circuits.

It is to be noted that Fig. 5 is a skeletonized disclosure of the sender shown in U. S. Patent 1,589,940 granted to O. H. Kopp June 22, 1926 and as modified by Patent 1,690,206 granted to A. Raynsford on November 6, 1928 reference to both patents is made herein for operations not completely described.

When a call is initiated by a subscriber in a particular group, such as subscriber of station 100 of group A₁ for example, by removing his receiver from the switchhook, a circuit is closed for relay 124 extending from battery through resistance 125, winding of relay 124, inner contacts of relay 101, over the subscriber's loop to ground at the outer contacts of relay 101. Relay 124 operates and closes a circuit from ground on its outer contacts, conductor 126, No. 1 back contacts of relay 128, back contacts of relay 102, winding of group start relay 116 to battery. Relay 116 operates in this circuit and closes a ground on conductor 130 over its left contact to conductor 123 which extends to the marking segment of all commutators of the line finders serving the particular vertical section of the line finder frame in which the calling line is located as first preference. It also extends the same ground on conductor 130 over the right contacts of relay 116 to conductor 111, left outer back contacts of relay 213, conductor 251, conductor 332, left

upper contact and cam 305 in position 1, cam 317 and right upper contact thereof, conductor 331, left winding of relay 206 to battery. Relay 206 operates and closes a circuit for sequence switch magnet 300 from ground on cam 320 and right lower contact thereof, conductor 328, right inner back contacts of relay 205, right inner front contacts of relay 206, conductor 326, left upper contact and cam 319, winding of magnet 300 to battery. Magnet 300 operates and advances the switch to position 2. When the switch has advanced beyond position 1 the operating circuit for relay 206 is opened at the left upper contact of cam 305 but a holding circuit exists for this relay over its left winding and left outer contacts, conductor 254, lower contacts of cam 308 to ground. When the switch reaches position 2 a circuit is closed for relay 205 from the aforetraced ground on conductor 251, left lower and upper contacts of cam 301, conductor 321, conductor 237, winding of relay 205 to battery. The ground on conductor 321 is further extended in parallel through the right outer back contacts of relay 213, to the winding of relay 212 to battery. Both relays 212 and 205 operate in this circuit. The operation of relay 212 causes its back contacts to be broken but otherwise performs no useful function at this time. The operation of relay 205, however, closes a circuit for the updrive magnet 215 from ground on cam 320 and right lower contact thereof, conductor 328, right inner front contacts of relay 205, conductor 248, cam 303 and left upper contact thereof, conductor 329, left outer contacts of relay 205, conductor 247, right inner contacts of relay 213, winding of line finder updrive magnet 215 to battery. The elevator will now be raised and as soon as brush 229 makes contact with the terminal to which conductor 123 is connected, a circuit for relay 213 is closed from the aforetraced ground on conductor 123, brush 229, left inner normally made contacts of relay 213, winding of relay 213 to battery. Relay 213 operates, locks via conductor 233, commutator segment 236, to ground on brush 234, opens the operating circuit of relay 205 at its left outer contacts and opens the circuit of updrive magnet 215 at its right inner back contacts thereby causing the elevator to stop its upward movement. Although the operating circuit of relay 205 has been opened, relay 205 does not release since it is provided with a holding circuit from ground on brush 241, commutator strip 239 with which brush 241 makes contact, conductor 223, left back contacts of relay 202, conductor 249, upper contacts of cam 316, conductor 238, left inner contacts of relay 205, winding of relay 205 to battery.

After relay 213 has operated as above described a circuit is closed for the trip magnet

214 from battery through the winding of trip magnet 214, right outer front contacts of relay 213 to the aforetraced ground on conductor 321.

By reference to Figs. 7 and 8 where the same numerical designations are used for those identical elements of Figs. 1 and 2, which are shown therein, it will be observed that conductor 123 is multiplied to the same segment of the second line finder 700 of the minor subgroup of line finders having first preference to the subgroup of lines in the first section of the lowest bank of the frame and that the commutator segment is thereafter staggered for each pair of other line finders next in preference for the line group as will be more fully explained hereinafter. If we assume that the line finder seized by the local group start circuit is one of the two line finders of the minor subgroup having first choice access to the first bank of the line finder frame such as, for example, line finders 701, then trip finger 702 is so staggered with respect to the first set of associated brushes on the line finder elevator that, upon the elevator having been advanced one step and the trip magnet operated thereafter, the trip finger will engage the brush releasing lever of the first set of brushes.

Meanwhile when relay 213 operates, the circuit for relay 212 is opened at its right outer back contacts. Relay 212 is made slow to release and will, therefore, close its contacts some time after trip magnet 214 is operated. When, however, its contacts are made, a circuit is again closed for the updrive magnet 215, this time through the contacts of relay 212 which are paralleled to the same conductor 247 connecting with the aforetraced magnet operating circuit to ground on cam 320. The line finder is now moved upwardly and trips the set of brushes engaged by the trip finger and thereafter proceeds to hunt for the calling line in group A₁ which, from an inspection of Fig. 7, is to be found in the lowest subgroup of lines of the first bank in the first section of the line finder frame. When the terminals of the line are encountered a circuit is completed from battery through resistance 109, inner contacts of relay 124, conductor 114 and associated terminal, brush 238, conductor 220, winding of relay 202, conductor 235, right upper and lower contacts of cam 308 to ground. Relay 202 operates in this circuit and, at its left back contacts, opens the holding circuit of relay 205 to brush 241. This relay, however, does not release immediately as it also has another holding circuit by way of ground through brush 231, centering commutator strip 232, conductor 221, conductor 249, upper contacts of cam 316, conductor 238, left inner contacts of relay 205, winding of relay 205 to battery. Relay 205 remains operated until the updrive magnet 214 has

driven the elevator to the centering position of the calling line terminals whereupon an insulating segment is encountered on the centering commutator, the locking circuit is opened thereat and relay 205 is then released.

When relay 202 operates a circuit is closed for relay 209 from ground on the right contacts of relay 202, right normally made contacts of relay 209, right winding of relay 209 to battery. Relay 209 operates and locks through its right make contacts, conductor 233, commutator segment 236, to ground on brush 234. Relay 209, over its left middle contacts, advances the start conductor 111 to the next idle line finder in the preference for succeeding calls and, on its left outer contacts, closes two contacts of a series chain circuit for operating master transfer relay 128 at the appropriate time as more fully described hereinafter.

The release of relay 205 opens the circuit of the updrive magnet 215 and stops the line finder on the terminals of the calling subscriber's line. It also connects ground from cam 304 and right lower contact thereof, left lower and upper contacts of cam 318, conductor 323, right middle contacts of relay 205, bottom middle back contacts of relay 200, resistance 242, conductor 219 and associated brush, conductor 110 and associated terminal, winding of relay 101 to battery. Relay 101 operates and releases line relay 124 thereby removing the calling condition from conductor 114, opening the circuit of relay 116 and thereby removing the ground from conductor 123 and associated marking terminal on the commutator and the starting ground from conductor 111. Relay 202 will release when battery through resistance 109 is disconnected from conductor 114 by the release of relay 124. Should it come to pass, however, that when the line finder connects with the calling line and the aforetraced circuit for relay 101 is opened because of some trouble condition and relay 101 fails to operate, then relay 202 will remain operated and close on its left front contacts a parallel circuit from an aforetraced ground on conductor 223, left front contacts of relay 202, low resistance 240 to the winding of relay 202. This circuit, in parallel with the one through the winding of relay 202, imposes a low potential on the line terminal associated with conductor 114, marking the terminal as busy by shunting the circuit of relay 202 of any other passing line finder in search of a calling line, thereby preventing the false operation of relay 202 of this other line finder and the consequent false stopping of its associated line finder elevator on the terminals of a line with a trouble condition on relay 101 or its circuit path. The connection to ground with conductor 110 and associated terminal by way of conductor 219, resistance 242, lower middle back contacts

of relay 200, cam 304 and right upper contact thereof to ground, marks terminal 127 and other multiple terminals of calling line 100 in the terminal banks of final selectors with a reduced potential to render the line busy to hunting final selectors.

When the line finder elevator moves off normal ground is connected through brush 234, commutator segment 236, conductor 233, back contacts of relay 207, conductor 409, left outer back contacts of relay 406, right inner contacts of relay 404, left back contacts of relay 402, conductor 410, commutator segment 500 of the link finder circuit, brushes 501 and 502 in the normal position of the link finder elevator, commutator segment 504, conductor 510, bottom No. 1 back contacts of relay 505, top back contacts of relay 512, winding of relay 506 to battery, winding of relay 507 in parallel to battery. Both relays 506 and 507 operate and perform functions which will be described hereinafter. In the meanwhile the release of relay 205 closes a circuit from battery through the winding of sequence switch magnet 300, cam 319 and left upper contact thereof, conductor 324, right inner front contacts of relay 206, right inner back contacts of relay 205, conductor 328, right lower contact and cam 320 to ground. Sequence switch 300 is advanced in this circuit to position 3, and relay 206 is unlocked at the left lower contact of cam 308. Switch 300 will remain in position 3 until a signal is received from a sender connected to the line finder through the medium of the link shown in Fig. 5 and which signal is to the effect that the line finder circuit may begin to extend the connection to the distant office under the control of operated registers in the sender.

Mention was made of the operation and locking of relay 209 and its function of advancing start conductor 111 to the next idle finder available to calling groups of subscribers. A consideration of Figs. 7 and 8, studied in connection with Figs. 1 and 2 will make this apparent. When the chosen line finder reaches the calling line, relay 209 operates and locks as described and conductor 111, through which the circuit for relay 205 of the chosen line finder was extended, is opened by the advance of associated sequence switch 300 to position 3. If another call should now come from a subscriber associated with the group of subscribers controlled through start relay 116, such as for example, group A₁, relay 116 will operate as formerly and ground will be connected by conductor 123 to the appropriate marking commutator segment on all line finders of the section. Since conductor 111 has been cut off at the first line finder and relay 209 of that line finder has been operated and locked by the previous call, the starting ground on conductor 111 through the right contacts of relay 116, is now transferred over the left middle contacts of relay

209 to relay 205 of the next line finder in the group, this circuit being characterized by conductor 811 in Fig. 8. When relay 205 of this second line finder circuit operates and performs functions similar to those described above with relation to the line finder circuit associated with elevator 701, a relay 804, individual to the second line finder, is likewise operated and locked and causes the starting ground at relay 116 of the local group circuit then to be advanced over the left middle contacts of relays 209 and 804, to the next idle line finder of the group. Advance relays 209, 804 and all other advance relays of the individual line finders also close their left outer contacts controlling a chain circuit for master transfer relay 128 which operates in a manner to be described hereinafter.

It will be apparent that any call coming from a subscriber located in group A₁ which, according to the schematic arrangement shown in Fig. 7, is the first preferred group in the first section of the first bank, will have accessibility to all of the line finders of the first section by the successive advancement of the start conductor 111 over a chain circuit of all previously operated line finder advance relays to the next line finder in the chain which is idle.

It will be noted, however, that although relay 116, used by all subscribers in group A₁, grounds the first commutator segment of commutators 200 and 700 of the minor subgroup of line finders having first choice access to group A₁, yet conductor 123 is multiplied to the second marking terminal on commutators 706 and 707, the third marking terminals on commutators 708 and 709, the fourth on 710 and 711 and the fifth on 712 and 713. The pairs of line finders forming the minor subgroups each have preference to group A₁ in the order in which they have been named. When, therefore, the updrive magnet 744 of the line finder in the second minor subgroup of line finders having next to the first choice access to group A₁ proceeds to hunt for the calling line, the elevator will not stop when its associated commutator brush 745 makes with the first marking segment of the commutator but will stop when contacting with the second marking terminal which has been grounded by conductor 123. The trip fingers on trip rod 732, however, and likewise those of trip rod 733, are staggered in the manner already described so that while two steps have been taken by the elevator associated with trip rod 733 before encountering the grounded marking terminal, the trip finger 719 will engage the lowest set of brushes while all other trip fingers are cleared from the trip levers of their associated brushes on the elevator having access to the other banks. When, therefore, the elevator proceeds on its second upward movement, after the trip magnet has been oper-

ated in the manner described, the first set of brushes will be tripped and the operations of selecting the calling line will then proceed as described.

In the same manner all line finders of the group of ten in the first section are operated by a calling line in group A₁ when all previous ones are busy, each line finder operating its advance relay when taken into use and closing thereby another contact in the chain circuit of master transfer relay 128. Each succeeding pair of line finders of a minor subgroup has its trip finger staggered an additional step corresponding to the staggering of conductor 123 on the marking segments of their respective commutators so that, in the case of the elevator associated with trip rod 739, which is one of the two elevators of the minor subgroup of the section last taken into use by a calling line in group A₁, a call coming from group A₁ and utilizing line finder circuit associated with elevator 739 will cause the elevator to take five steps on the first updrive operation before the updrive magnet circuit is opened and the trip magnet energized. The first set of brushes will then be tripped by trip finger 726 on the second up drive movement of the elevator to connect with the calling line.

When the last line finder having trip rod 739 in the first section is taken into use and all previous line finders of the section are busy a chain circuit is closed from ground on the left outer contacts of relay 810, left outer contacts of relays 809, 808, 807, 806, 802, 800, 801, 804 and 209, winding of relay 128 to battery. Relay 128 operates in this circuit. When a call originates in group A₁ during the time that relay 128 is operated relay 102 is operated from ground on conductor 126, No. 1 front contacts of relay 128, winding of relay 102 to battery. Relay 102 operates, locks to the operating ground by way of its left inner contacts and closes, at its right contacts, a ground to conductor 129 to the No. 1 back contacts of master transfer relay 815 in the next section of the line finder frame where subscriber group A₁ appears as second choice. This circuit is then extended by way of the left back contacts of relay 817 to the winding of relay 825 which corresponds to relay 116 in the preceding group. Relay 825 operates, marks the first segment of the commutator by grounding conductor 746 and closes a circuit for relay 205 in the corresponding line finder circuit as previously described. The line finder then proceeds to function in the manner already described for the circuit operations as disclosed in detail by the circuits shown in Figs. 1, 2, 3, etc.

As already noted, the subscribers' lines belonging to group A₁ appear as second choice in the second section of the line finder frame so that the elevator will now travel over a minimum of sixteen lines before reaching the

group in which the terminals of the calling line appear. Should it come to pass, however, that a subscriber in the group which is first choice in the second section such as for example, group E_1 , initiates a call during the time when the elevator associated with trip rod 740 is passing over the first group of sixteen lines the elevator brush set for the first bank, having been tripped, will test the terminals of all lines alike and, as soon as it reaches the terminals of the line in group E_1 it will stop and cause circuits to be operated for cutting off the associated line finder relay 205 and operating advance relay 811. Under such circumstances the ground on conductor 126 will still prevail since line relay 124 of the calling subscriber in group A_1 has not yet been released, relay 102 remains locked and relay 825 remains operated. The operation and locking of relay 811 of the chosen line finder now transfers the starting ground on conductor 826 to the next line finder over the left middle contacts of relay 811 to conductor 818 whereupon the elevator associated with the next line finder circuit will proceed to hunt for the calling line in the second choice group A_1 . All succeeding line finders in the second choice will operate in the same manner as already described for the line finders of the first section, master relay 815 operating when all of them have been taken into use and further extending the starting conductors of all previous busy groups, including its own, to the line finders of the next section.

In case a plurality of calls are initiated simultaneously in any one of the groups such as, for example, group A_1 , line finders are taken into use in successive rotation in the particular section in which the group is first choice, conductor 126 being multiplied to the front contacts of all line relays 124 of the group so that, as soon as the line finder associated with trip rod 701 is taken into use, to choose as an illustration the first line finder of the minor subgroup having first preference for group A_1 , relay 209 is operated and locked. When the terminal of the calling line has been found the particular line relay 124 will release in the manner already described. Ground from the other operated line relays, however, is still present on conductor 126 and will be extended over the No. 1 back contacts of relay 128 to relay 116 which thereby remains operated. The starting ground on the right contacts of relay 116 to conductor 111 is then transferred in the manner described through the contacts of relay 209 to the next line finder having trip rod 731 in whose associated circuit a relay 205 will operate in the manner described. When the line finder associated with trip rod 731 is thus taken into use, the starting ground is next extended to the line finder associated with trip rod 732 of the next minor subgroup. In this case conductor 123,

is staggered to the second marking terminal of the associated commutator 706 so that elevator associated with trip rod 732 will travel to the second marking segment before the initial updrive circuit is interrupted. Due to the staggering of the elevator trip fingers as already described, the stopping of the elevator associated with trip rod 732, after taking two steps, will cause the first set of brushes associated with trip finger 719 to be tripped and, on the second updrive operation of elevator the first set of brushes will connect with the next calling line in group A_1 . In the same manner, all of the line finders of the first section can successively be taken into use so that the tenth line finder associated with trip rod 739, after taking five steps before the trip finger 726 engages the trip lever of the brush, likewise connects with the terminals of a calling line in group A_1 . Should the plurality of calls be greater than the number of line finders available in the first section, master transfer relay 128 will then operate in the manner described and transfer the remainder of calling subscriber lines in group A_1 to the line finders in the next section of the line finder frame where operations will take place similar to those already described.

The subscribers' lines in groups A_2 , A_3 , A_4 and A_5 operate in a similar manner as those in group A_1 except that each of these other groups appears as first choice in the first section of the four remaining banks and the starting conductor of each group is connected through the back contacts of master transfer relay 128 of the particular section in which the line terminals of the group appear as first choice. Thus, for example, the subscribers of group A_2 are first choice in the second bank, those in A_3 first choice in the third bank, A_4 first choice in the fourth bank and A_5 first choice in the fifth bank and the respective line relays of the subscribers in these groups have their starting conductors extended through the back contacts of a particular one of five contact sets of relay 128. Thus, the starting conductor 824 of group A_2 is extended through the right contacts of the operated line relays of the group, such as relay 822, the No. 2 back contacts of master transfer relay 128, left outer contacts of relay 103, to relay 117. This relay, on operating, extends ground over its left contacts, conductor 112 to the fifth marking segment of commutators 257 and 700 and the first marking segments of commutators 706 and 707 of the minor subgroup of line finders of the next section. Line finders associated with trip rods 732 and 733 compose together the preferred minor subgroup of line finders for subscriber groups in the first section of the second bank so that a call from a subscriber in line group A_2 will cause the elevator associated with

triprod 732 to stop after taking one step. Due to the fact, however, that brush 745 encounters ground on the first marking segment of its associated commutator, and since the trip fingers are staggered, the one step taken by this elevator will now cause the tripping of the second set of brushes associated with trip finger 748 in contrast to the previously described condition wherein the upward movement for two steps causes the tripping of the first set of brushes associated with trip finger 719. In this manner the elevator associated with trip rod 732 will then proceed to hunt for a calling line in group A_2 . Lines in this group will, accordingly, have line finder circuits allotted in the order of preference using line finders associated with trip rods 732 and 733 as the minor subgroup of first choice and thereafter extending to the successive minor subgroups of the section and ending with line finders associated with trip rods 701 and 731 as those to be chosen if all other succeeding line finders of the section are busy. Should, in fact, all line finders of the section be busy, master transfer relay 128 operates in the described manner and transfers the starting ground to the next section of the bank by the operation of relay 103 in which bank the same cycle of operations take place. Subscribers' groups in the third bank will, in the same manner as previously described have, as first choice, line finders associated with trip rods 734 and 735 wherein the trip fingers are staggered so that one upward step of the elevator will trip the third set of brushes. Subscribers' lines located in the fourth bank similarly have line finders associated with trip rods 736 and 737 as first choice and in which one step in the first upward movement of the respective line finder elevators will cause the trip finger to trip the fourth set of brushes. Subscriber groups located in the fifth bank have line finders 738 and 739 as first minor subgroup and in which the upward movement of one step of the elevator will cause the tripping of the fifth set of brushes. In every one of the cases considered the rotation of the line finders of the section will always start from the minor subgroup which is first choice to the calling line group and thereafter progress to each successive choice of minor subgroups in that section. If all the line finders of the section are busy at the time that a line finder is to be taken into use, the operation of the master transfer relay of the section causes the starting ground to be transferred to the next section where the same cycle of operations is repeated.

It will be evident that if there are simultaneous calls in the first preferred groups in all of the banks of the first section such as for example, a call in group A_1 , a call in group A_2 , a call in group A_3 , a call in group

A_4 and another in group A_5 , line finders will be simultaneously allotted from each of the minor subgroups having first preference for each of these banks, if such line finders are available. Thus, for a calling line in group A_1 line finders associated with trip rods 701 or 731 would be taken into use. A call from group A_2 line finders associated with trip rods 732 or 733. Likewise a call from group A_3 will utilize line finders associated with trip rods 734 or 735, a call from group A_4 line finders associated with trip rods 736 or 737, and a call from group A_5 line finders associated with trip rods 738 or 739. Should it come to pass that the line finders of any preferred minor subgroup are busy at the time that a call originates in a group for which these line finders would be first choice, the starting ground is transferred by way of operated relays 209 and 804, if the calling subscriber is from group A_1 , to the line finder of the next minor subgroup of the section wherein is assumed to exist a simultaneous call from group A_2 and in which both line finders associated with trip rods 732 and 733 are available. Under such circumstances the selected line finder, such as the one associated with trip rod 732, will proceed to hunt for the calling line in the group for which it is first choice since relay 117 has been operated by a line in that group and relay 117 has grounded the first marking segment of its associated commutator by way of conductor 112. The line finder elevator, therefore, will trip the set of brushes associated with the second trip finger 748 and not those associated with first trip finger 719. Due to the fact that relays 209 and 804 were previously operated and relay 801 operates as soon as the calling line is found, the starting ground in the first group A_1 is thus transferred to the operating circuit of the line finder associated with trip rod 733. This line finder, however, on taking one step, will not find the first marking segment grounded because the connection of line finder associated with trip rod 732 with the terminals of the calling line in group A_2 caused the release of relay 117 so that elevator 733 will take two steps before encountering the marking segment grounded by conductor 123 of the group A_1 and, as already described, the taking of two steps will result in the tripping of the first set of brushes thereby permitting line finder 733, which is normally first choice for group A_2 , to connect with a calling subscriber in group A_1 . In the same way it can be easily shown that calling groups in various banks will always be served either by line finders of first preference or those of each succeeding preference. It can also be shown that similar operations take place in the other four sections of the frame in which other groups are staggered as first preference.

Returning now to a continuation of the fur-

ther operation of the selected line finder shown in Figs. 2 and 3, it will be recalled that, as soon as the line finder elevator moved off normal a circuit was closed for link relays 506 and 507 causing both of these relays to operate. Relay 506 closes a circuit for the updrive magnet 513 of the link finder elevator from ground on the top contacts of relay 508, top outermost contacts of relay 506, winding of updrive magnet 513 to battery. Relay 507 connects the winding of the associated trip magnet 514 through the inner front contacts of relay 507, conductor 515, to the right contacts of relay 401. Now the line finders appearing on the subscribers line finder frames are terminal-ended on panel banks similar to those above described except that each line finder appears on three corresponding terminals of two superimposed banks, there being, however, but four banks to each frame. The inter-relation between the distribution of line finders on the terminals of the link finder banks together with the associated link finder elevators and cooperating circuits form the basis of my copending application Serial No. 480,852, and reference is made thereto for a complete description of such parts of the link circuit as are not described herein. The arrangement of having a line finder circuit appear on three corresponding terminals on two superimposed banks makes it necessary to have a link finder elevator using four sets of brushes arranged for tripping in two pairs of sets. These brushes are so arranged on the elevator rod with respect to the associated tripping mechanism that when the rod is not engaged and turned by the operation of the trip magnet the bottom two sets of brushes are tripped. On the other hand, if the trip magnet is energized and the trip finger rotated the upper two sets of brushes are tripped for connection with a line finder located in the two upper banks.

Each group of link finders has its own link start circuit, it being associated with a group of links serving as first choice that group of line finders which appear as first choice on the finder banks, not shown, with the additional provision that each start circuit associated with line finders appearing in the two upper banks of the link finder frames have a trip magnet circuit so that the two upper brushes of a link finder elevator may be tripped for connecting with a calling line finder located therein, while the start circuit associated with groups of line finders appearing on the two lower banks of the line finder frames have no trip magnet circuit. Arrangements are also provided whereby if all of the links of the preferred group are busy the start circuit is advanced to the next idle group of links.

The updrive magnet 513 will now drive the link finder elevator in search of the calling line finder with the trip magnet 513 energized or not depending upon whether the calling line finder appears in the two upper banks or the two lower banks of the link finder frames. If it is located in the two upper banks then the starting ground on conductor 411 connected to such a line finder, will close a circuit for relay 401 over the left inner back contacts of relay 406, right inner contacts of relay 405, right inner back contacts of relay 402, winding of relay 401 to battery. Relay 401 operates in this circuit and, at its left contacts, grounds start conductor 410 while, at its right contacts, it grounds conductor 515 which closes the circuit of trip magnet 414 as already described. As soon as the link finder elevator has been driven beyond the normal position the operating circuit for relays 506 and 507 is opened at commutator segment 504. Relay 506 is slow to release, however, and holds over until a circuit is closed for relay 516 from ground on brush 517, commutator strip 518, which closes with brush 517 as soon as the elevator is off-normal, conductor 519, bottom outer contacts of relay 508, winding of relay 516 to battery. Relay 516 operates in this circuit, supplies a locking ground for relay 506 through its No. 2 contacts, and supplies another ground for the updrive magnet 513 from its No. 1 contacts over the top outer contacts of relay 516. Relay 507 may have released at the time the operating circuit was removed but no harm is done since the tripping operation is completed before this occurs and, when the locking ground is supplied for relay 506 it will reoperate again over an obvious circuit. The operation of relay 506 also closes through the winding of relay 508 to brush 520 by way of the top middle contacts of relay 506. When the terminals of the calling line finder are encountered relay 508 operates in series with relay 207 in the following circuit: battery through the winding of relay 508, top middle contacts of relay 506, brush 520, conductor 521 and associated terminal, right winding of relay 207, top contacts of jack 243, conductor 255, left upper and right lower contacts of cam 302 to ground. Relay 207 operates and locks to ground over its left winding, conductor 233, commutator segment 236, brush 234 to ground and opens the start conductor 409. Relay 508 locks over the operating circuit through its bottom inner contacts directly to brush 520 independent of the contacts of relay 506. The updrive magnet circuit is not opened, however, as relay 516 is held locked to ground on the centering commutator segment 522, conductor 560, top outer contacts of relay 523, to winding of relay 516. When an insulating segment is encountered, indicating thereby a proper centering of the elevator brushes on the contacts with which they make, relay 516

releases, opens the circuit of the updrive magnet 513 and brings the link finder elevator to rest with the brushes on the terminals of the calling line finder. Relays 506 and 507 are also released by the release of relay 516.

In the meanwhile the sender selector of the link circuit has been hunting for an idle sender. An idle sender is characterized by battery connected to conductor 524 and the brushes of the sender selector elevator are normally connected to the terminals of a sender, which is to say that the elevator does not restore to normal when a connection to a sender is terminated but only after it has successively hunted to the top of the frame and returned to normal as more fully described hereinafter. When the link finder elevator moved off normal and brush 517 grounded commutator segment 518, a circuit was closed from ground on commutator 518, conductor 519, bottom outer contacts of relay 523, No. 3 contacts of relay 505, top middle normally made contacts of relay 527, top winding of relay 526 to battery. Relay 526 operates and, at its top outer front contacts, closes a circuit for relay 527 from ground on the above mentioned contacts, top inner normally made contacts of relay 527, winding of relay 527 to battery. Relay 527 operates and locks to grounded conductor 519 by way of its top middle front contacts and, at the same time, opens the aforetraced operating circuit of relay 526. If, at this time, the sender selector is connected to the contacts of an idle sender there will be no circuit to hold relay 526 because brush 569 of the centering commutator 531 is making contact with an insulating segment in the known manner, and provides no holding circuit for the top winding. The locking circuit of the bottom winding is connected to brush 530 which, in turn, is connected to battery. If, on the other hand, the elevator brushes are connected to the terminals of a busy sender then ground on the bottom front contacts of relay 527 of the link operatively connected to the sender is present on terminal 524 and holds relay 526 operated over its lower winding.

Under such circumstances a circuit is closed for the updrive magnet 528 from ground on the top outer front contacts of relay 526, top inner front contacts of relay 527, winding of updrive magnet 528 to battery. The sender selector proceeds in search of an idle sender, relay 526 being prevented from releasing by the ground circuit through the centering commutator 531 and connecting conductor 555 to the top inner contacts and top winding of relay 526. When an idle sender is encountered, the presence of battery on the lower winding of relay 526 and the absence of the holding circuit over its top winding through the centering commutator, causes relay 526 to release, opening the updrive mag-

net circuit and causing the elevator to come to rest with its brushes on the terminals of the selected sender. The release of relay 526 also closes a circuit for cut-through relay 525 from ground on the top outer back contacts of relay 526, top outer contacts of relay 527, No. 4 contacts of relay 505, No. 4 contacts of relay 516, winding of relay 525 to battery. Relay 525 operates and connects the conductors leading to the selected sender with the brushes of the link finder connected with the terminals of the calling line finder. The release of relay 526 connects the test brush 530 through the bottom back contacts of relay 526 to ground on the bottom front contacts of relay 527 thereby causing the sender seized by the link to test busy to all other hunting links.

If all senders test busy, then the sender finder elevator will continue its upward movement until the commutator brush 561 connects with commutator segments 554 and 562 whereupon a circuit is closed from ground on commutator segment 554, brush 561, commutator segment 562, conductor 557, winding of relay 505 to battery. Relay 505 operates in this circuit and locks over conductor 559, commutator segment 551 to ground on brush 563. Relay 526 releases since its lower test winding is no longer connected to the sender testing terminals and its top winding is disconnected from the centering commutator, the updrive magnet circuit is opened and relay 505 closes the circuit for the downdrive magnet 529 from ground on its No. 2 contacts thereby restoring the elevator to normal whereupon relay 505 releases and the original operating circuit for relay 526 is again closed and the above cycle of operations is repeated until an idle sender is found or starting ground removed from conductor 410.

It will be recalled that when the line finder seized the calling line, relay 205 released and switch 300 was left in position 3. In this position a path is closed from battery through relay 203, conductor 244, to the left upper contact and cam 310. Another path is likewise closed from battery through the upper winding of relay 200, conductor 256, to the left lower contact and cam 310. These two paths in parallel are extended over cam 310 and right lower contact thereof, conductor 539 and associated terminal, brush 567, conductor 534, No. 3 contacts of relay 525, brush 564, conductor 547 and associated terminal, left back contacts of relay 605, left back contacts of relay 604, middle and left winding of relay 603 to ground. Relay 200 is marginal and does not operate. Relay 203 operates but is ineffective at this time. Relay 603 operates and closes an obvious circuit for relay 607 which, in turn, closes a circuit for relay 609. Relay 609 closes a circuit for relay 610.

As soon as sequence switch 300 arrived in position 3 it prepared the pulsing circuit for receiving dial impulses. This circuit may be traced from battery through the left winding of relay 600, conductor 549 and associated terminal, brush 565, No. 5 contacts of relay 525, conductor 532, brush 565, conductor 541 and associated terminal, left contact and cam 245, winding of relay 201, bottom inner contacts of relay 200, conductor 218 and associated brush, conductor 113 and associated terminal, over the subscriber's loop, conductor 107 and associated terminal, conductor 217 and associated brush, top contact of relay 200, cam 246 and left contact thereof, conductor 540 and associated terminal, brush 566, conductor 533, No. 4 contacts of relay 525, brush 566, conductor 548 and associated terminal to ground on the contacts of relay 613. Relay 600 operates, in turn operating relay 618 in a well known manner, relay 618, operating relay 619. A circuit is therefore closed from the source of tone 616 to the right winding of relay 600, switch 620 in its normal position, front contact of relay 619, contact and cam 614, to ground on the right outer front contacts of relay 609. This tone is transmitted to the calling subscriber to inform him that the sender is ready to receive impulses which he may then send out by manipulating his dial.

The registers of the sender are positioned, translator 630 operated and selections made under the control of the sender as described in the above identified patent to O. H. Kopp. The district selector is controlled through the closure of the fundamental circuit with district sequence switch 300 in positions 4 and 6 in the known manner after the subscriber has dialed the office code and sequence switch 300 is advanced to position 8 to move the district elevator brushes over the district bank terminals for the selection of an idle trunk in the wanted direction. Thereafter the district selector sequence switch 300 is advanced to position 10 in the known manner to await the positioning of the selectors in the called office. When the connection has been set up to the called subscriber's line reverse battery from the incoming selector operates relays 622 and 623 in the usual manner. These relays in turn cause the operation of relay 631 and relays 624 and 604. With these relays operated the sender is then advanced to position for making talking selections and the district selector sequence switch 300 is advanced out of position 10 toward position 16. In passing through positions $12\frac{3}{8}$, $13\frac{3}{8}$ and $14\frac{3}{8}$ ground impulses are sent back to the sender in the usual manner for talking selection and when the sender is satisfied, the fundamental circuit is opened and relay 206, which forms a part of the fundamental circuit, is released. The district selector sequence switch 300 is

thus advanced to either position 13, 14 or 15 depending upon which talking selection is made. When switch 300 is advanced beyond position 11 the parallel circuit of relays 200 and 203 is broken at cam 310. Relay 203, however, is not released as a locking circuit is provided from ground on cam 312 and left upper contact thereof, conductor 325, contacts of relay 201, which relay is held energized over the calling subscriber's loop in the known manner, resistance 246, winding of relay 203 to battery. This ground, however, is also connected by way of cam 312 and left lower contact thereof to conductor 539 and thence over an aforetraced circuit to the windings of relay 603. Relay 603 now releases in turn releasing relay 607. The release of relay 607 does not release relay 609 since this relay is locked to its own right inner contacts. A circuit is therefore closed from ground over the left inner back contacts of relay 607, left contacts of relay 609, to the winding of relay 605 which operates and locks over its left inner front contacts to conductor 547 and to ground as above traced.

After talking selections are completed relay 615 operates, connecting battery through resistance to conductor 547 in parallel with the winding of relay 605. Relay 508 of the link circuit is held over brush 520 in series with the right winding of relay 207 to ground in the district selector through position 12 of sequence switch 300 over cam 302. When the switch 300 advances beyond position 12 during the talking selection the holding circuit for relays 508 and 207 is transferred to ground on the right outer contacts of relay 206 and conductor 253 which relay is operated for talking selection. When relay 206 releases at the termination of talking selection this locking circuit is opened and relay 508 releases. The release of this relay closes a circuit for relay 516 from ground on commutator segment 518, conductor 519, bottom back contacts of relay 508, winding of relay 516 to battery. Relay 516 operates and closes a circuit for relay 523 from battery through winding of relay 523, bottom inner contacts of relay 506, No. 3 contacts of relay 516, bottom back contacts of relay 508, conductor 519, commutator segment 518, to ground on brush 517. Relay 523 operates, closes an obvious circuit for the downdrive magnet 566 and the link finder elevator is restored to normal disconnecting the sender from the line finder and causing the release therein of relay 605 which in turn restores the sender to normal in the known manner. When the elevator reaches the normal position, ground is disconnected from commutator segment 518 thereby releasing relay 523 and opening the circuit of the downdrive magnet. Since relay 207 is still locked over its left winding, starting ground is not connected to conductor 410. With the restoration of the link

finder elevator to normal relay 527 is likewise released, in turn releasing 525 which disconnects the sender selector brushes from the sender.

5 Inasmuch as the present invention is not concerned with the specific operation of the district selector shown in Figs. 2 and 3 beyond what has heretofore been described, or the operation of selectors to further extend
10 the calling line and the function of the sender to control selections, no detailed description thereof has been given therein as such operations are completely described in Patent 1,567,072 granted to W. H. Matthies on
15 December 29, 1925 as well as the above mentioned patent to O. H. Kopp. The selector circuits employed in the establishment of the talking connection are released following the termination of the conversation in the manner fully set forth in the patents hereinbefore
20 referred to while the operation of the circuits shown in Fig. 4 beyond what has already been described, may be obtained from my copending application Serial No. 480,852,
25 to which reference has been made above.

What is claimed is:

1. In a telephone exchange system, calling lines arranged in groups, major subgroups and minor subgroups, a plurality of superimposed contact banks divided into a plurality of sections, a group of line finders arranged for cooperation with each of said sections, the various major subgroups of lines being so arranged in the various sections that a different major subgroup appears as first choice in each of said sections and that the minor subgroups of each major subgroup appear as first choice respectively in the several banks of the section in which such major subgroup has first choice appearance, and means operative upon the initiation of a call for starting an idle one of the finders which serve a section of said banks in which the major group containing the contact set of the calling line appears as first choice.
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2. In a telephone exchange system, calling lines arranged in groups, major subgroups and minor subgroups, a plurality of superimposed contact banks divided into a plurality of sections, a group of line finders arranged for cooperation with each of said sections, each group of finders being divided into a plurality of subgroups, the various major subgroups of lines being so arranged in the various sections that a different major subgroup appears as first choice in each of said sections and that the minor subgroups of each major subgroup appear as first choice respectively in the several banks of the section in which such major subgroup has first choice appearance, and means operative upon the initiation of a call for starting an idle one of the finders of that subgroup of a group of finders which serve a section of said banks in which the major group containing the con-
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tact set of the calling line appears which is first choice preference to the minor subgroup in which the calling line appears.

3. In a telephone exchange system, calling lines arranged in groups, major subgroups and minor subgroups, a plurality of superimposed contact banks divided into a plurality of sections, a group of line finders arranged for cooperation with each of said sections, the various major subgroups of lines being so arranged in the various sections that a different major subgroup appears as first choice in each of said sections and that the minor subgroups of each major subgroup appears as first choice respectively in the several banks of the section in which such major subgroup has first choice appearance, means operative upon the initiation of a call for starting an idle one of the finders which serve a section of said banks in which the major group containing the contact set of the calling line appears as first choice, and means operative when all finders having first choice access are busy for starting an idle one of the finders of the next succeeding group before which the said calling line appears as second choice.
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4. In a telephone exchange system, calling lines arranged in groups, major subgroups and minor subgroups, a plurality of superimposed contact banks divided into a plurality of sections, a group of line finders arranged for cooperation with each of said sections, each group of finders being divided into a plurality of subgroups, the various major subgroups of lines being so arranged in the various sections that a different major subgroup appears as first choice in each of said sections and that the minor subgroups of each major subgroup appear as first choice respectively in the several banks of the section in which such major subgroup has first choice appearance, means operative upon the initiation of a call for starting an idle one of the finders of that subgroup of a group of finders which serves a section of said banks in which the minor subgroup of lines containing the contact set of the calling line appears as first choice and first preference, and means operative when all finders of the subgroup are busy for starting an idle one of the finders of the next succeeding subgroup before which said line appears as first choice, second preference.
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5. In a telephone exchange system, calling lines arranged in groups, major subgroups and minor subgroups, a plurality of superimposed contact banks divided into a plurality of sections, a group of line finders arranged for cooperation with each of said sections, each group of finders being divided into a plurality of subgroups, the finders of each group having first choice access to the several major subgroups of lines respectively and the finders of each subgroup of a group having preference access respectively to the several minor
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subgroups of the major subgroup of lines served by the particular group of finders, and a chain start circuit for each group of finders having points of access for each minor subgroup of lines of the major subgroup which that group of finders serves, whereby when any line in a minor subgroup calls, an idle finder having preference access to the calling line is started over the corresponding point of access and whereby if no idle finders in that subgroup are available, said point of access is extended to the next succeeding subgroup of finders.

6. In a telephone exchange system, calling lines arranged in groups, major subgroups and minor subgroups, superimposed contact banks divided into a plurality of sections, a group of line finders arranged for cooperation with each of said sections, each group of finders being divided into a plurality of subgroups, the finders of each group having first choice access to the several major subgroups of lines respectively and the finders of each subgroup of a group having preference access respectively to the several minor subgroups of the major subgroup of lines served by the particular group of finders, a chain start circuit for each group of finders having points of access for each minor subgroup of lines of the major subgroup which that group of finders serves, whereby when any line in a minor subgroup calls, an idle finder having preference access to the calling line is started over the corresponding point of access and whereby if no idle finders in that subgroup are available, said point of access is extended to a succeeding subgroup of finders in which there is an idle finder, and means operative when all finders of the group are busy for extending said points of access to corresponding points of access in the chain start circuit of the next succeeding group of finders.

7. In a telephone exchange system calling lines arranged in groups and subgroups, a plurality of superimposed contact banks divided into a plurality of sections, a group of line finders arranged for cooperation with each of said sections, each group of finders being divided into a plurality of subgroups, each subgroup of finders being first choice for those subgroups of lines appearing in the first position of the bank sections which it serves, second choice for the subgroups of lines appearing in the second position of the bank sections and so on, a brush set for each finder for cooperation with each bank, means for operating each finder in a brush selection and in a line finding movement, and a trip rod for each finder having a brush tripping finger corresponding to each brush set, the trip fingers on the trip rods of the several subgroups of each group of finders being arranged to trip a different set of brushes for any given brush selecting movement.

8. In a telephone exchange system, calling lines arranged in groups and subgroups, a plurality of superimposed banks in which said lines terminate, a group of line finders arranged for cooperation with said banks, said group of finders being divided into a plurality of subgroups, a brush set for each finder for cooperation with each bank, means for operating each finder in a brush selection and in a line finding movement, and a trip rod for each finder having a brush tripping finger corresponding to each brush set, the tripping fingers on the trip rods of the several subgroups of finders being arranged to trip a different set of brushes for any given brush selecting movement.

9. In a telephone exchange system, calling lines arranged in groups and subgroups, a plurality of superimposed banks in which said subgroups of lines terminate, a group of line finders arranged for cooperation with said banks, each of said groups of finders being divided into a plurality of subgroups, each of said finders having a brush set for cooperation with each of said banks, means for operating each finder in a brush selection and in a line finding movement, means individual to each finder for selecting brush sets in accordance with the extent of the brush selecting movement, each said subgroup of finders being the preference for the subgroup of lines in the bank associated with the brush set which it selects with the shortest brush selecting movement, and means operative upon the initiation of a call in a line subgroup to start an idle one of the subgroup of finders which is the preference for that subgroup of lines.

10. In a telephone exchange system, calling lines arranged in groups and subgroups, a plurality of superimposed banks divided into a plurality of sections in which said subgroups of lines terminate, the subgroups of lines terminating in any one bank being multiplied between the sections of said bank, a group of line finders arranged for cooperation with each of said sections, each group of finders being divided into a plurality of subgroups, each group of finders being first choice for those subgroups of lines appearing in the first position of the bank sections which it serves, second choice for the subgroups of lines appearing in the second position of the banks and so on, each of said finders having a brush set for cooperation with each of said banks, means for operating each finder in a brush selection and in a line finding movement, each said subgroup of finders being the preference for the subgroup of lines in the bank associated with the brush set which it selects with the shortest brush selecting movement regardless of whether the subgroup of finders is used as second or further choice for some subgroups of lines other than the ones for which it is

first choice, and means operative upon the initiation of a call in a subgroup of lines to start an idle finder.

11. In a telephone exchange system, calling lines arranged in groups and subgroups, a plurality of superimposed banks in which said subgroups of lines terminate, a group of line finders arranged for cooperation with said banks, said line finders being divided into a plurality of subgroups, a brush set for each finder for cooperation with each bank, means for operating each finder in a brush selection and in a line finding movement, a commutator for each finder having a segment for each brush selection position of said finder, multiple connections between the corresponding segments of the commutators of each subgroup of finders, the multiplied segments of each subgroup of finder commutators being slip-multiplied to the multiplied segments of succeeding finder commutators, a trip rod for each finder having a brush tripping finger corresponding to each brush set, the trip fingers on the trip rods of the several subgroups of finders being mechanically slipped in accordance with the slipping of the commutator segments thereof, and means controlled by said commutators whereby a different set of brushes in the finders of said subgroups of finders is tripped for any brush selecting movement.

12. In a telephone exchange system, calling lines arranged in groups and subgroups, a plurality of superimposed banks in which said subgroups of lines terminate, a group of line finders arranged for cooperation with said banks, said line finders being divided into a plurality of subgroups, a brush set for each finder for cooperation with each bank, means for operating each finder in a brush selection and in a line finding movement, each said subgroup of finders being the preference for the subgroup of lines in the bank associated with the brush set which it selects with the shortest brush selecting movement, a commutator for each finder having a segment for each brush selection position of said finder, multiple connections between the corresponding segments of the commutators of each subgroup of finders, the multiplied segments of each subgroup of finder commutators being slip-multiplied to the multiplied segments of succeeding finder commutators, and means operative upon the initiation of a call in a line subgroup to start an idle one of the subgroup of finders which is the preference for that subgroup of lines and to mark a commutator segment to cause the selection of the brush set having access to the calling line.

13. In a telephone exchange system, calling lines arranged in groups and subgroups, a plurality of superimposed banks in which said subgroups of lines terminate, said superimposed banks being divided into a plurality

of sections, a group of line finders arranged for cooperation with corresponding sections of each of said banks, said line finders of each group being divided into a plurality of subgroups and each finder having a brush set for cooperation with each bank, means for operating each finder in a brush selection and in a line finding movement, a commutator for each finder having a segment for each brush selection position of said finder, multiple connections between the corresponding segments of the commutators of each subgroup of finders, the multiplied segments of each subgroup of finder commutators being slip multiplied to the multiple segments of succeeding finder commutators of the group of finders, a trip rod for each finder having a brush tripping finger corresponding to each brush set, the trip fingers on the trip rods of the several subgroups of finders being mechanically slipped in accordance with the slipping of the commutator segments thereof, and means controlled by said commutators whereby a different set of brushes in the finders of said subgroup of finders is tripped for any brush selecting movement.

14. In a telephone exchange system, calling lines arranged in groups and subgroups, a plurality of superimposed banks in which said subgroups of lines terminate, said plurality of superimposed banks being divided into a plurality of sections, a group of line finders arranged for cooperation with corresponding sections of each of said banks, said line finders of each group being divided into a plurality of subgroups, a brush set for each finder for cooperation with each bank, means for operating each finder in a brush selection and in a line finding movement, each said subgroup of finders being the preference for the subgroup of lines in the bank associated with the brush set with which it selects with the shortest brush selecting movement, a commutator for each finder having a segment for each brush selection position of said finder, multiple connections between the corresponding segments of the commutators of each subgroup of finders, the multiplied segments of each subgroup of finder commutators being slip multiplied to the multiplied segments of succeeding commutators of the group of finders, and means operative upon the initiation of a call in a line subgroup to start an idle one of the group of finders which is the preference for that subgroup of lines and to mark a commutator segment to cause the selection of the brush set having access to the calling line.

15. In a telephone exchange system, calling lines arranged in groups and subgroups, a plurality of superimposed banks in which said subgroups of lines terminate, a group of line finders arranged for cooperation with said banks, each of said groups of finders being divided into a plurality of subgroups,

each of said finders having a brush set for cooperation with each of said banks and an advance relay, means for operating each finder in a brush selection and in a line finding movement, means individual to each finder
 5 for selecting brush sets in accordance with the extent of the brush selecting movement, each said subgroup of finders being the preference for the subgroup of lines in the bank associated with the brush set which it selects with the shortest brush selecting movement,
 10 a start relay for each line subgroup, a start circuit controlled thereby for starting the first line finder of the subgroup of finders which is the preference for that subgroup of lines and means for operating the advance relay of a line finder when such finder becomes busy to extend the start circuit of that subgroup of finders to the next idle finder
 15 of the subgroup.

16. In a telephone exchange system, calling lines arranged in groups and subgroups, a plurality of superimposed banks in which said subgroups of lines terminate, a group of line finders arranged for cooperation with said banks, said group of finders being divided into a plurality of subgroups, each of said finders having a brush set for cooperation with each of said banks and an advance
 20 relay, means for operating each finder in a brush selecting and in a line finding movement, means individual to each finder for selecting brush sets in accordance with the extent of the brush selecting movement, each said subgroup of finders being the preference for the subgroup of lines in the bank associated with the brush set which it selects with the shortest brush selecting movement, a start
 25 relay for each line subgroup, a start circuit controlled by each start relay for starting the first line finder of the subgroup of finders which is the preference for that subgroup of lines, and means for operating the advance relays of all busy finders to extend a start
 30 circuit to the first idle finder of the preference subgroup of finders or to an idle finder which is the preference for a subsequent subgroup of lines.

17. In a telephone exchange system, calling lines arranged in groups and subgroups, a plurality of superimposed banks divided into a plurality of sections in which said subgroups of lines terminate, a group of line finders arranged for cooperation with each
 35 of said sections, each groups of finders being divided into a plurality of subgroups, the finders of each group having first choice access to the groups of lines respectively and the finders of each subgroup of a group having preference access respectively to the several subgroups of lines served by the particular group of finders each of said finders having a brush set for cooperation with each bank of a section and an advance relay,
 40 means for operating each finder in a brush

selecting and in a line finding movement, a start relay for each subgroup of lines, a start circuit controlled by each start relay for starting the first line finder of the subgroup which has preference access to the subgroup
 70 of lines corresponding to the operated start relay, means for operating the advance relays of all busy finders of a group to extend a start circuit to the first idle finder of the group and a transfer relay for each group of finders operable when all of the advance
 75 relays of a group of finders are operated to render the start relays which normally serve the subgroups of lines to which the group of finders serving the next succeeding section of the banks have first choice access operable by the subgroups of lines which are first
 80 choice to the preceding group of finders.

18. In a telephone exchange system, calling lines arranged in groups and subgroups, a plurality of superimposed banks divided into a plurality of sections in which said subgroup of lines terminate, the subgroups of lines in any one bank being slip multiplied between the sections of said bank, a group of line finders arranged for cooperation with each of said sections, each group of finders being divided into a plurality of subgroups, each group of finders being first choice for those subgroups of lines appearing in the first
 85 position of the bank sections which it serves, second choice for the subgroups of lines appearing in the second position of the bank sections and so on, a brush set for each finder for cooperation with each bank and an advance
 90 relay, means for operating each finder in a brush selection and in a line finding movement, each said subgroup of finders being the preference for the subgroup of lines in the bank associated with the brush set which it selects with the shortest brush selecting movement, a start relay for each subgroup of lines, a start circuit controlled by each start relay for starting the first idle
 95 finder of a subgroup which is the preference for the subgroup of lines corresponding to the operated start relay, means for operating the advance relays of all busy finders of a group to extend a start circuit to the first idle finder of the group, and a transfer relay for each group of finders operable when all of the advance relays of a group of finders are operated to render the start relays which normally serve the subgroups of lines to which the group of finders serving the next succeeding section of the banks have first
 100 choice access operable by the subgroups of lines which are first choice to the preceding group of finders.

In witness whereof, I hereunto subscribe my name this 28th day of June, 1930.

CHARLES L. GOODRUM.