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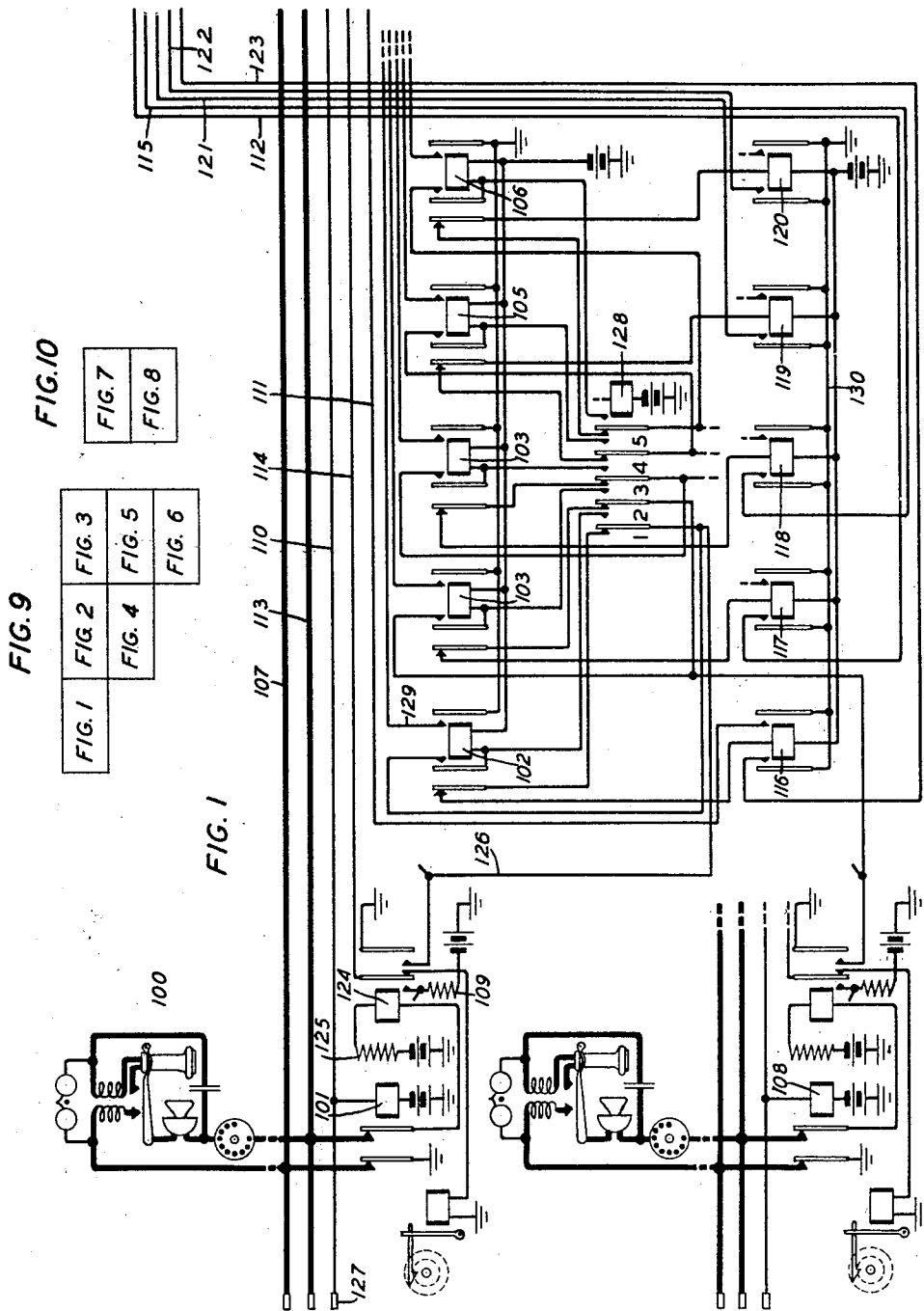
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1,840,357

PANEL DIAL SWITCHING SYSTEM

Filed Sept. 10, 1930

8 Sheets-Sheet 1



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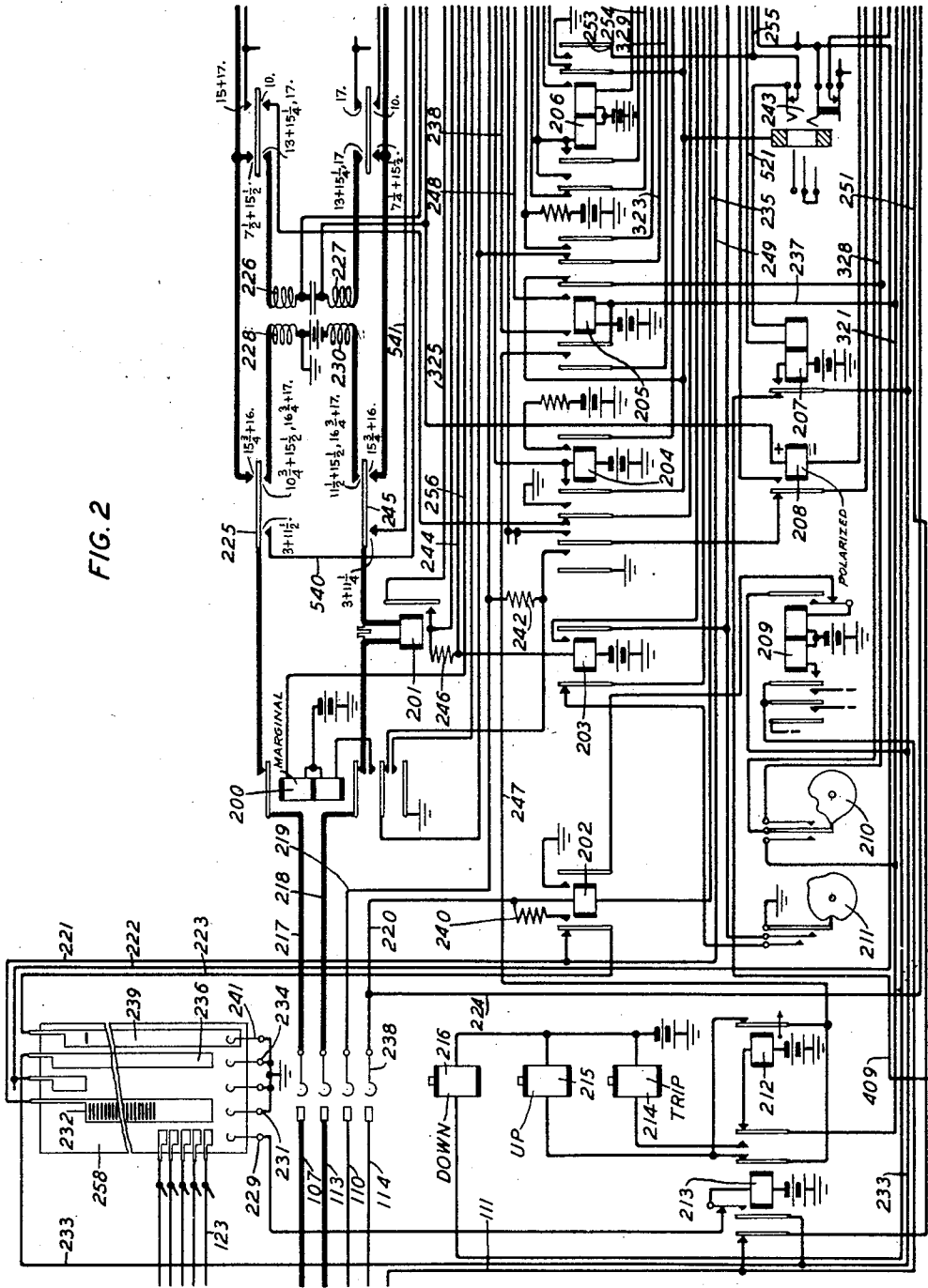
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PANEL DIAL SWITCHING SYSTEM

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FIG. 2



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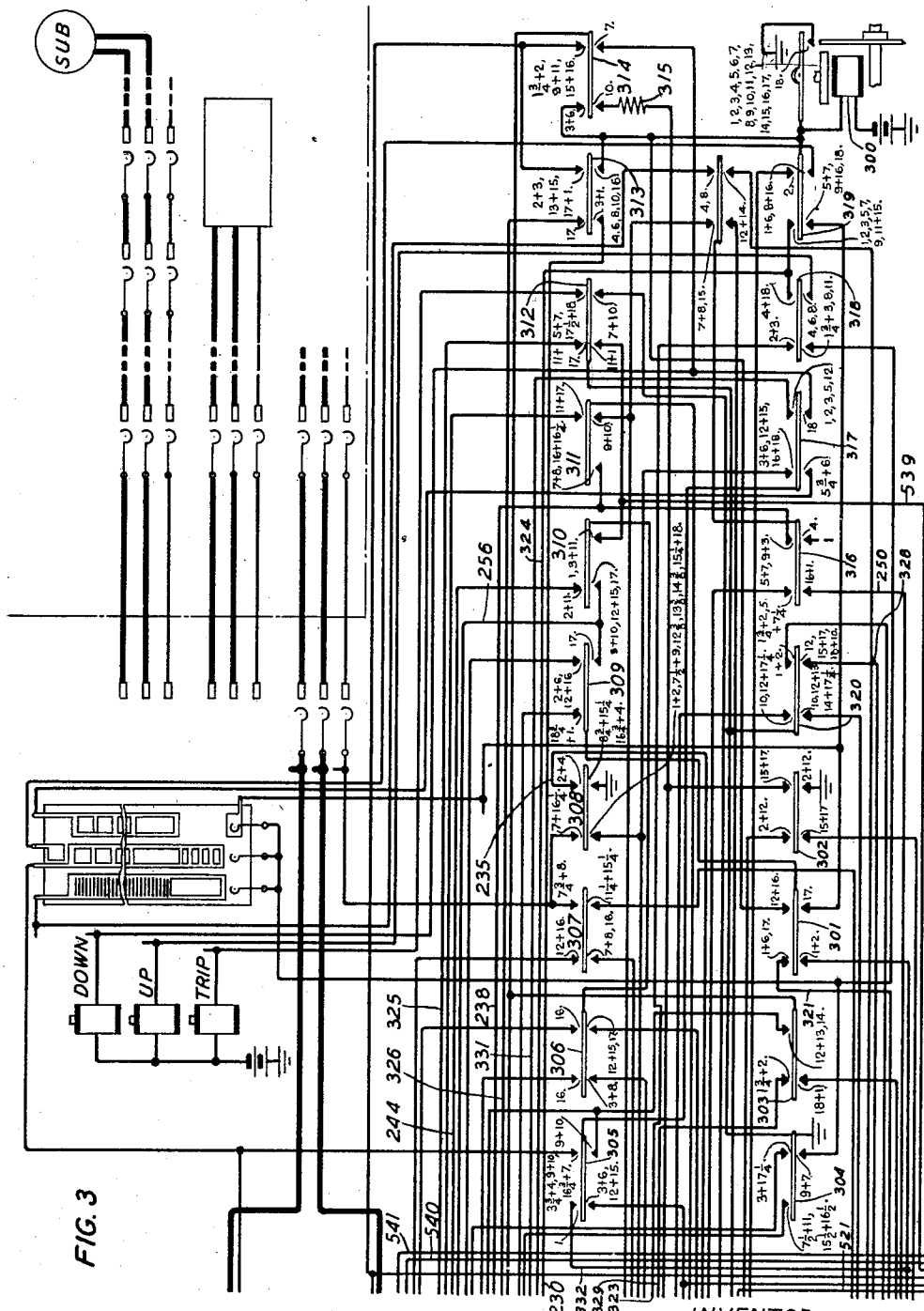


FIG. 3

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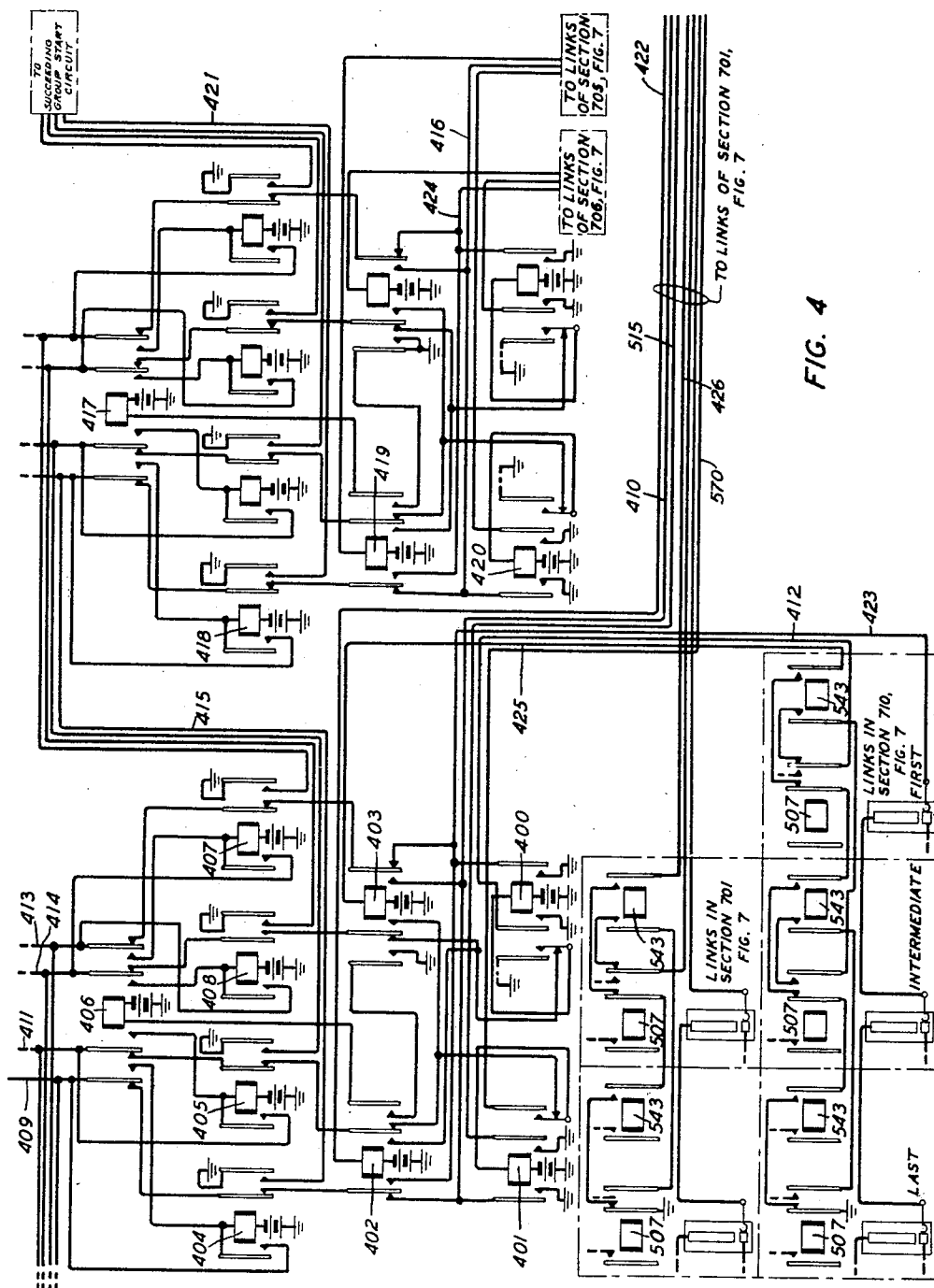
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Filed Sept. 10, 1930

8 Sheets-Sheet 4



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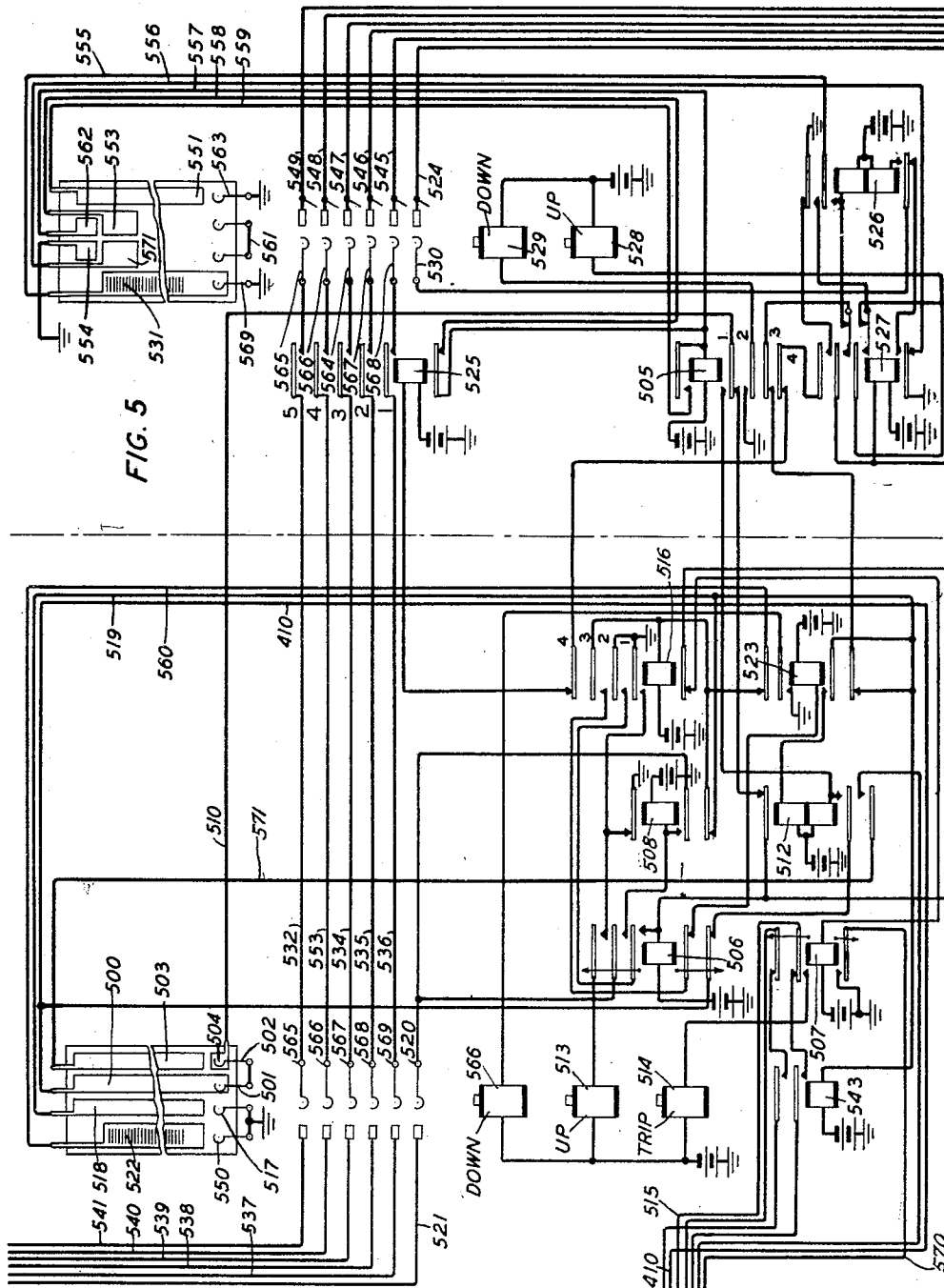
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PANEL DIAL SWITCHING SYSTEM

Filed Sept. 10, 1930.

8 Sheets-Sheet 5



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Filed Sept. 10, 1930

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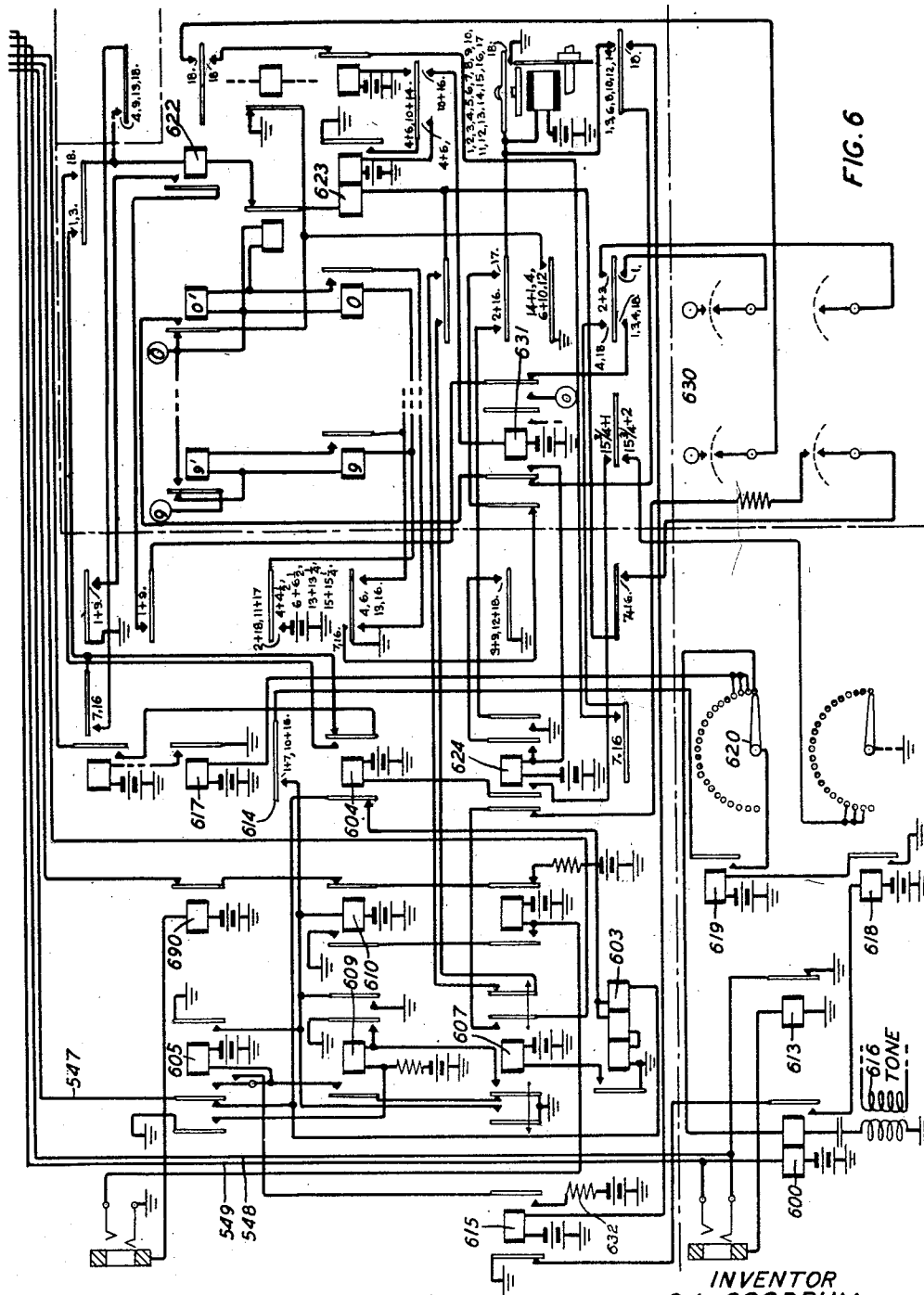


FIG. 6

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PANEL DIAL SWITCHING SYSTEM

Filed Sept. 10, 1930

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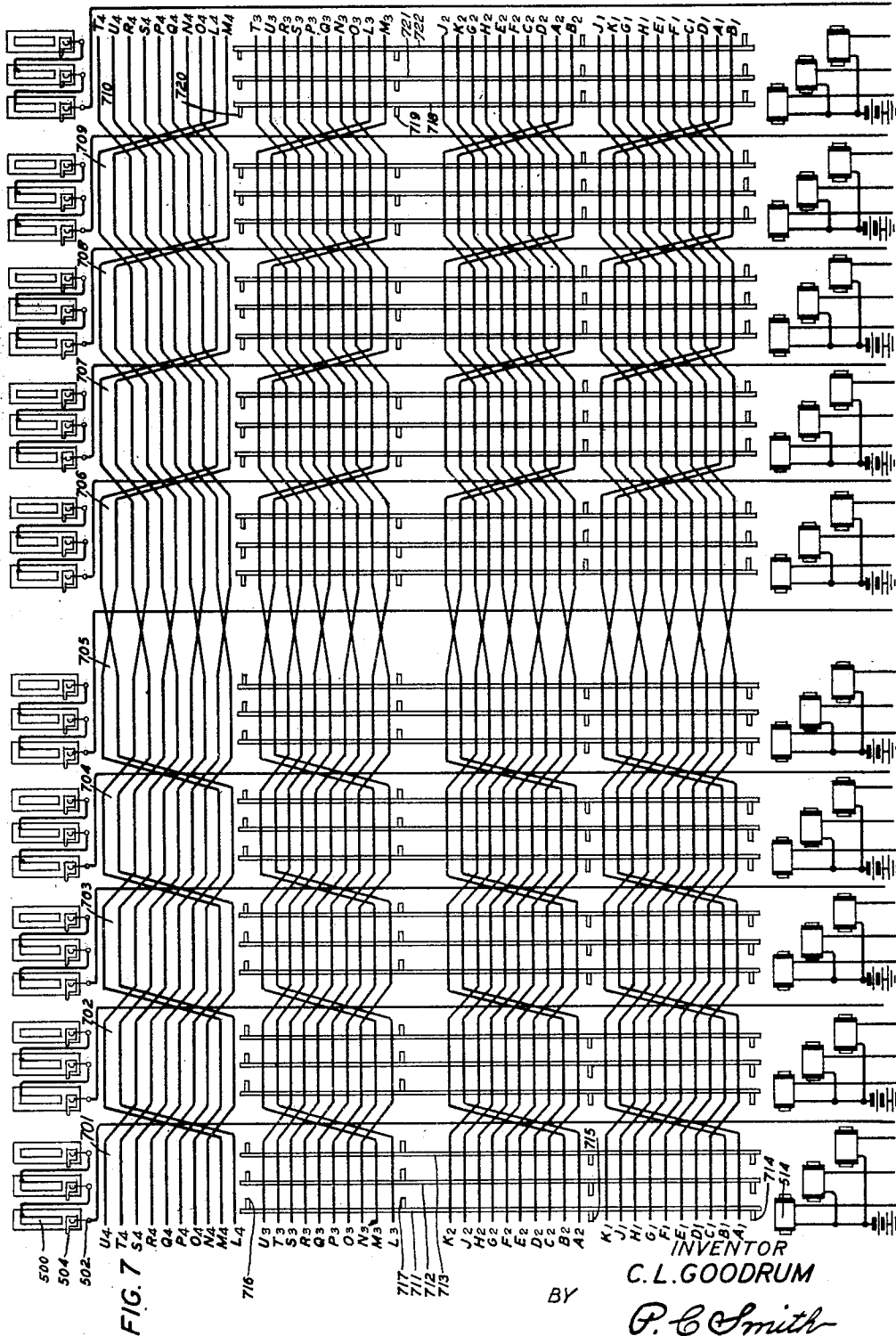


FIG. 7

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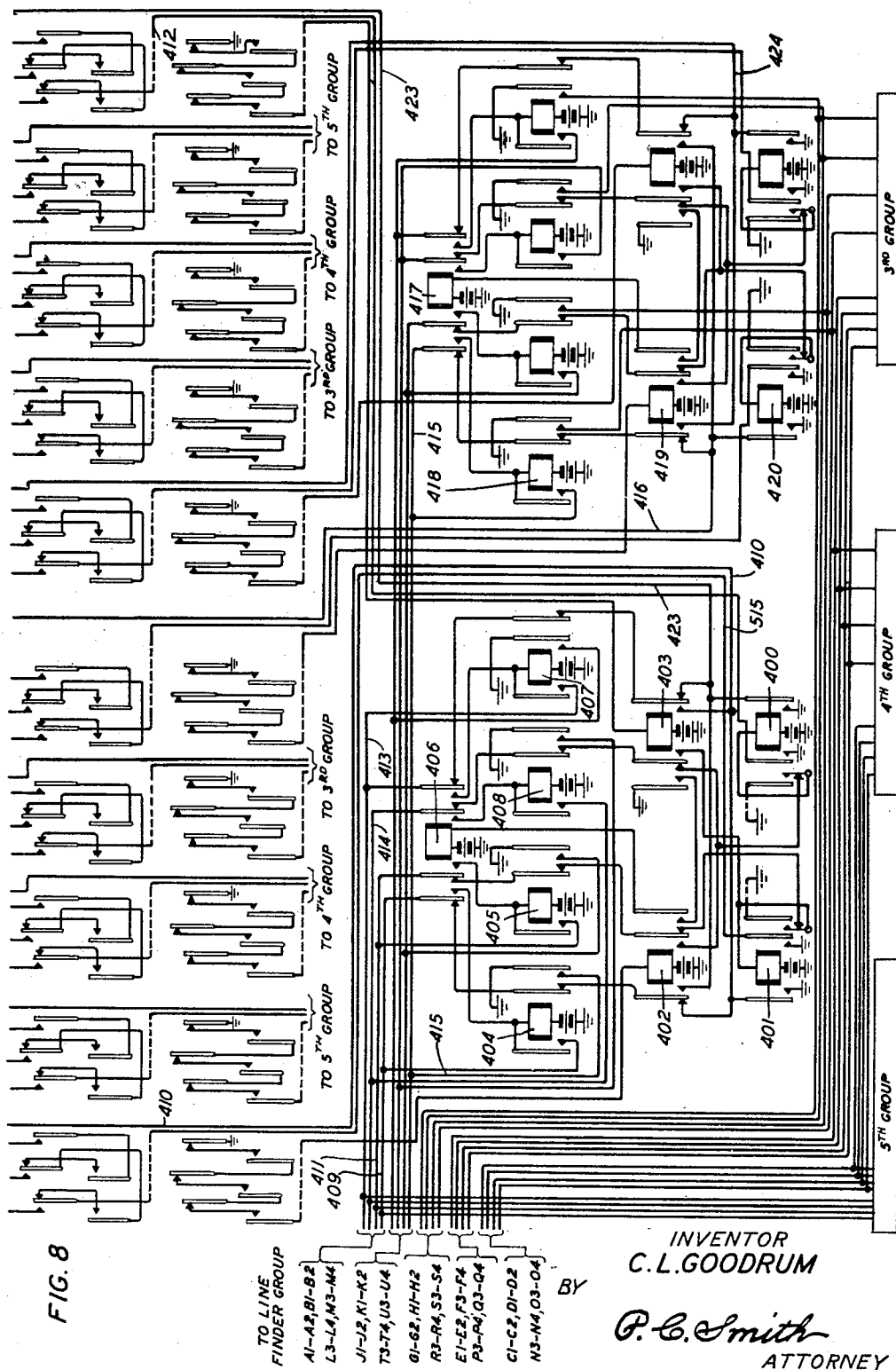
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PANEL DIAL SWITCHING SYSTEM

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8 Sheets-Sheet 8



UNITED STATES PATENT OFFICE

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PANEL DIAL SWITCHING SYSTEM

Application filed September 10, 1930. Serial No. 490,852.

This invention relates to automatic telephone exchange systems and more particularly to a system in which link circuits are used to connect line finders with idle senders.

5 The objects of the invention are to provide in a system of the foregoing character a link circuit of the same mechanical structure as line finders and other line extending switches of the system, thereby simplifying
10 manufacture, installation and maintenance, and also to arrange the distribution of links in respect to line finders terminating on panel selector frames over which said links hunt so as to increase the efficiency of the links.
15 The link circuit contemplates in this invention is in part disclosed by my copending application, Serial No. 466073, filed July 7, 1930, and comprises a line finder selector and a sender selector for automatically connect-
20 ing a calling line finder with an idle sender during the time necessary for the sender to receive dial impulses from the calling subscriber and to thereafter set the train of selectors which connect the calling line with the called line. When the sender has com-
25 pleted this function, the line finder, the link and sender are disconnected from each other, the last two returning to normal while the line finder remains operated as a part of the talking circuit of the established connection.
30 The link, therefore, being essentially a connecting circuit whose holding time is small compared to that of the line finder, is most efficiently used if, after completing one association between a calling line finder and
35 sender is immediately taken into use again to establish, in succession, similar associations between other calling line finders and idle senders.

40 It is well known that the most efficient relation between the size of the line finder group and the size of a cooperating link group is that in which a sufficient number of calling line finders are always available to keep the
45 link in constant operation. To accomplish this purpose it is customary to provide groups of line finders which are large by comparison to the cooperating group of links since it has been found in practice that such
50 an arrangement brings about the most de-

sirable degree of efficiency in operation and economy in respect to the number of links supplied.

One embodiment of the present invention has to do particularly with the application of this principle to panel systems where the use of large contact banks permits the concentration of a large number of line finders on a number of panel banks. It is understood, however, that the invention is not limited to panel systems and can be easily modified for adaptation to other types of apparatus well known to the telephone art. In accordance with the invention, therefore, one specific embodiment of which is disclosed
55 herein by way of illustration, this is accomplished in the following improved manner:

The subscribers' lines in an office are divided into major groups suitable to the number which can be accommodated on the line finder frame or a group of line finder frames containing 50 line finders arranged and distributed as shown in my copending application above referred to and capable of handling the traffic originated by the subscribers whose lines terminate at the frame. These groups of subscribers are divided into major subgroups and the major subgroup, in turn, subdivided into five minor subgroups whose lines are wired to the contacts of the finder banks. It may further be considered that the line finder switches are provided with as many sets of brushes as there are contact banks in the frame and each set of brushes has access to the major subgroup of subscribers in the bank with which the brush in question can operatively cooperate. With the arrangement of tripping the various line finder brushes in the manner disclosed in my copending application above referred to, it is only necessary for the line finder to move a distance sufficient to engage the trip lever for each brush cooperating with the line bank of contacts in which the calling line appears to make contact with any calling line in any of the five minor subgroups wired to the contacts of the bank. That is, when a subscriber initiates a call the particular set of brushes of an idle line finder having access to the group containing his line is tripped and

moved upwardly over the terminals of the group in search of the calling line.

Conforming with the subdivision of the subscriber's group into main units capable of being served by a group of 50 line finders, the line finders of four such subscriber units are terminated on panel banks with which the link finders of the links contemplated in this invention can operatively cooperate. Four multiple banks are used, two for each 100 line finders giving the link group an accessible capacity of 200 line finders. The link group itself consists of 60 elevators which are standard with respect to a panel frame, 30 cooperating when the contact banks on one side of the frame and 30 on the other. The connection between a calling line finder and a sender through the medium of a connecting link requires the use of six conductors so that each line finder appearing on the link finder banks is wired to six contacts of the banks, three contacts on one bank and three corresponding contacts on the second bank. The link finder is provided with four sets of brushes, each brush having access to 100 terminals of the bank with which the brush set can cooperate. Since each line finder appears on two banks, two sets of brushes are tripped for each connection, either the lower two for connection to line finders terminating in the two lower banks or the upper two for line finders terminating on the two upper banks. A trip rod and trip magnet individual to each link finder is used and, when the magnet is normal, the trip rod trips the two lower brush sets and when the trip magnet is energized, the two upper brush sets are tripped.

It is apparent that before a calling subscriber can proceed with dialing the wanted number, the line finder connected to the calling line must also be connected to an idle sender, which last function, in the present invention, takes place through the medium of the link. Since the link circuit is common to a group of line finders and a group of senders, it is necessary for the link, when taken into use, to find the calling line finder and seize an idle sender. The link finder elevator of the link taken into use, must, therefore, hunt for the calling line finder and since the terminals of such a line finder may be anywhere in a pair of one hundred contact banks to which the link finder has access, considerable delay may result if, say, the link finder must travel over one hundred terminals before connecting with the calling line finder. Under such circumstances there is danger that the subscriber will begin to dial before the sender is connected to the line and ready to receive dial pulses. It is desirable, therefore, to make this hunting time, on the average, as short as possible.

To reduce this hunting time to approximately what it takes a line finder in my co-

pending application to find a calling line, it is proposed to divide each group of two hundred line finders into ten major subgroups of finders each and each major subgroup into two minor subgroups of ten line finders each, and to subdivide the link finder switches and associated links into ten groups and to connect the line finders of each subgroup to the terminals of the banks so that a major subgroup of twenty line finders appears as the first choice to the brushes of the first link finder group, second choice to the next group, third choice to the third group and so on up to the tenth group for which the link finders of the last group are last choice. The banks of the frame are divided into ten vertical sections and the minor subgroups of line finders appearing in the first section of the bank are progressively slipped throughout the remaining nine sections in each of which sections appear a group of link finder switches above referred to so that the minor subgroups of line finders which are first choice in one section of the bank for one group of links is second choice in another section for another group of links and so on throughout the entire ten sections; the progressive slipping permitting each minor subgroup of ten line finders to appear as first choice in one of the ten sections of the bank. Normally, therefore, when a call originates in one of the line finder frames and a line finder is taken into use, a link is chosen, if one is available, from the group of links in the section where the line finder minor subgroup containing the calling line finder appears as first choice.

As each link of the group is taken into use, a pair of contacts of a chain circuit is closed which is completed when the last of the six links of the group is made busy. When, now, another call is initiated in the minor subgroup of line finders which are first choice to the group of links in which all links are busy, the above-mentioned chain circuit switches the link start conductor to the group of links appearing in that section of the frame where the line finder group containing the calling line finder appears as second choice. A similar operation takes place in switching a calling line finder to the succeeding preference choices should all of the links of the previous choices be busy. If a first choice link is chosen, the associated link finder will then have to hunt only a maximum of ten terminals in order to locate the line finder taken into use by the calling subscriber. It is possible, however, that during heavy traffic when the links are busy, tenth choice links may be taken into use, in which case the link finder may have to hunt over a maximum of one hundred terminals before locating the line finder associated with the calling subscriber's line.

In general, the system covered by the pres-

ent invention, taken in connection with the invention covered by my above-mentioned copending application, Ser. No. 466,073, filed July 7, 1930, functions in the following manner: When a subscriber in one of the subgroups initiates a call and a line finder of a group having access to the group of the calling line is taken into use, the line finder proceeds to connect with the terminals of the calling line and, at the same time, extends a starting ground to a link start circuit which normally controls the group of links for which the line finder minor subgroup containing the line finder taken into use is a first choice and, also, the group of links for which it is second choice. Since the line finder subgroups are arranged to appear in the link finder frame in such a manner that the line finder minor subgroup appearing as second choice in one section of the bank appear as a first choice in another section of the banks, it is evident that the same start circuit can control two separate groups of links, each group being first choice to the lowest line finder minor subgroup in the section where the link group appears. Since, also, the line finder minor subgroups on the two upper banks on the line finder frame are arranged symmetrically with respect to the line finder groups in the two lower banks, the same start circuit likewise controls the same groups of links for cooperation with the line finder minor subgroups on the two upper banks.

Each start circuit consists of a group of relays and a cooperating circuit while the link circuit consists of a group of relays, a link finder and sender selector elevator together with associated brush sets, commutators and magnet equipment normally forming the component parts of a panel selector. The start conductor of a link start circuit is connected to the first link of the group; each link of the group advancing the start conductor to the next succeeding link by connecting the start wire of the previous link over a commutator segment and brush of the succeeding link to the start wire of the said succeeding link. As soon as the selected link moves off normal the commutator connection of the selected link with the start conductor is broken so that any further electrical condition on the start circuit will no longer affect the selected link, but the start conductor is then connected through an off-normal segment to the start conductor of the next succeeding link. The operation of the link circuit, after it is taken into use, affects the closure of a circuit controlling the up-drive magnet of the link finder, another circuit for the trip magnet if the call comes from a group of line finders located in the two upper banks of the frame, controls the closure of a pair of contacts in the chain circuit containing the entire six links in the

group to indicate that the link is busy and starts still other circuits for controlling the movement of the sender selector elevator to hunt for an idle sender.

As already noted, the entire groups of links accessible to two hundred line finders is divided into small groups of six, each of which is first choice to one major subgroup of twenty line finders. The link start circuits are arranged with reference to each other so that the progressive advancement of the starting conductor from one link start circuit to the next is controlled by a relay in each start circuit which is responsive to the chain circuit above referred to of the links of the group, so that a calling line finder may be switched successively from one group of links to the next in the order of preference which each group of links has for the calling line finder major subgroup appearing at that section of the frame where the available link group is located. This operation of advancing from one group of links to the next through the medium of successive start circuits continues until an idle link in one of the groups is found and taken into use whereupon the associated link finder will proceed to hunt for the calling line finder.

Each link is provided with a relay which, in cooperation with a relay in the start circuit, controls the operation of the trip magnet of the link finder. The operation or non-operation of the relay in the link start circuit determines which of the pair of brushes of the link finder is to be tripped. This determination is made in the link group start circuit where a separate starting conductor is provided for each of the two minor subgroups of line finders, namely, those appearing on the two upper banks and those appearing on the two lower banks of the frame. Those appearing on the two upper banks are each connected to a separate start conductor which, when grounded by the calling line finder connected thereto, controls circuits for operating the trip magnet controlling the tripping of the two upper brush sets. Those link finders appearing on the two lower banks are each connected to other separate start conductors which, when grounded by the calling line finder connected thereto, cause the selection of an available link in the group but do not effect the trip magnet circuit. Under such circumstances, the trip magnet is not operated since the calling line finder is located in the two lower banks and, according to the mechanical structure of the trip mechanism, the two lower brush sets are tripped.

When the link finder has connected with the calling line finder and the sender selector has seized an idle sender, the conductors connecting the line finder with the sender are closed through. Dial tone is thereafter transmitted to the calling subscriber in the

well known manner and the sender functions to control the setting of the selectors to the called subscriber's line.

When this function is completed, circuits are closed in the sender from the line finder which serve to disconnect the link finder switch from the terminals of the calling line finder and cause it to return to normal. The relay connecting the six conductors together is thereafter released and the link circuit is thus restored.

A clearer conception of the scope and purpose of the invention will be obtained by a 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 two link group start circuits; Fig. 5 shows a link circuit;

Fig. 6 is a schematic drawing of a sender; Fig. 7 shows schematically the arrangement of the link finder elevators on a link finder frame together with the distribution of the line finder groups thereon;

Fig. 8 shows schematically the cooperating relationship between the link start circuits of the type shown in Fig. 4 and the link finder frame shown in Fig. 7;

Fig. 9 shows the manner in which Figs. 1 to 6 inclusive are to be arranged with respect to each other for a complete description and understanding 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 line finder groups and the link start 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. Koop, June 22, 1926, and as modified by Patent 1,690,206 granted to A. Ransford on November 6, 1928. Reference to both patents is made for operations not completely described herein.

When a call is initiated by a subscriber in a particular group, such as subscriber of substation #100, 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 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 connects ground on conductor 130 over its left contacts 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 the right lower contact thereof conductor 328, right inner back contacts of relay 205, right inner front contacts of relay 206, conductor 324, left upper contact of cam 319, winding of magnet 300 to battery. Switch 300 operates and advances 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 front 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 afore traced ground on conductor 251, left 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 their respective circuits. 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 the 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 first marking terminal to which conductor 123 is connected, a circuit for relay 213 is closed from the aforetraced ground on conductor 123, brush 229, left 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, it does not release since it is provided with a holding circuit from ground at brush 241, commutator strip 239 with which brush 241 makes contact, conductor 223, left back con-

tacts 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.

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 sometime after trip magnet 214 is operated. When, however, its back contacts are made, a circuit is again closed for the updrive magnet 215, this time through the contacts of relay 212, to 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 the subscriber group. When the terminals of the calling 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 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 221, centering commutator strip 232, conductor 231, 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 215 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 subgroup for succeeding calls and, on its left outer contacts, closes two contacts of a series chain circuit for operating master transfer relay 128, both of which functions are fully explained in my copending application above referred to.

The release of relay 205 opens the circuit of 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 lower contact thereof, left 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 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 open because of some trouble condition and relay 101 fails to operate, then relay 202 will remain operated and close on its 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 connected to 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 the line with a trouble condition on the circuit path of relay 101. 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 bank 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 and battery, and in parallel through the bottom contacts of relay 516, winding of relay 507 to battery. Both relays 506 and 507 operate and perform functions which will be hereinafter described. In the meanwhile the release of relay 205 closes a circuit from battery through the winding of sequence switch magnet 300, cam

319 and the 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 of 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 thru 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.

Figs. 7 and 8 show the relationship, in a schematic manner, between the distribution of the line finders on a link finder frame, shown in Fig. 7 with respect to the trip rods of the link finder elevators on one side of the frame, and the cooperating link start circuits of which two are shown in detail in Fig. 8 and both of which are the same as the two link start circuits shown in Fig. 4 where similar numeral designations are used for identical elements in the figures. Figs. 7 and 8, when considered in connection with Figs. 4 and 5, show clearly the distribution of line finder groups the manner in which links are assigned and also the manner in which the link starting conductors are advanced from one group of links to another when the links of the preceding group are busy.

In Fig. 7 the ten vertical sections of the link finder bank of the frame are represented by 701, 702, etc. to 710 inclusive, and the line finder minor subgroups by A1—A2, B1—B2, L3—L4, M3—M4, etc. The letter designations of the line finder minor subgroups represent the same minor subgroup and the numerical suffix associated therewith indicates the bank in which the minor subgroup appears. Since each group appears in either the two lower banks or the two upper ones the letter designation is the same for each pair of banks.

We will now consider the link start circuits shown in Fig. 4 and particularly the one to which start conductors 409, 411, 414 and 413 are connected. Conductor 409 is the start conductor of the line finder minor subgroup A1—A2 appearing in section 701 as the first choice in the two lower banks of the link finder frame; conductor 411 is the start conductor of the corresponding line finder minor subgroup L3—L4 appearing in section 701 as the first choice in the two upper banks of the link finder frame; conductor 414 is the start conductor of the line finder minor subgroup B1—B2 appearing in section 710 as the first choice in the two lower banks of the link finder frame and conductor 413 is the start conductor of the corresponding line finder minor subgroup M3—M4 appearing in section 710 as the first choice in the two upper

banks of the link finder frame. It is to be noted that while the minor subgroup A1—A2 and L3—L4 appear as first choice in section 701 they appear as second choice in section 710 and while minor subgroups B1—B2 and M3—M4 appear as first choice in section 710 they are second choice in section 701. A further inspection of Fig. 7 also shows that each pair of sections of the frame are symmetrically reciprocal with respect to each other; that is, the first and second choice minor subgroups in one section are second and first choice minor subgroups in the reciprocal second section. For instance, line finder minor subgroup C1—C2 is the first choice group in the two lower banks of section 702 and line finder minor subgroup D1—D2 is second choice in the same section of the bank while in section 709, minor subgroup C1—C2 is second choice and group D1—D2 first choice. An inspection of the drawings will show that the same relationship holds true for all other sections and minor subgroups in both pairs of banks.

It will be observed from an inspection of Fig. 5 that the operation of relay 507 prepares a path from the winding of trip magnet 514 over the upper inner front contacts of relay 507 to conductor 515 which extends to the right inner contacts of relay 401. Since, however, we have assumed that the start ground was connected to conductor 409 associated with the line finder minor subgroup A1—A2 in the two lower banks, no circuit is available to operate relay 401 since, as shown hereinafter, the circuit for this relay is controlled by a ground on conductor 411. When ground is connected to conductor 409, therefore, the trip magnet circuit is not closed at the time relay 507 operates. Under such circumstances, trip rod 711 is not rotated and, due to the mechanical structure of the trip fingers 714 and 715, the brush set associated with each of these trip fingers is tripped when the elevator moves upwardly and not the brush-set associated with the trip fingers 716 and 717 cooperating with the two upper banks. The link finder elevator, when operating, will therefore hunt for and engage the terminals of the calling line finder in minor subgroup A1—A2 in the two lower banks. On the other hand, if start ground is applied to conductor 411 which is connected to the line finder minor subgroup L3—L4 terminating in the two upper banks a circuit is closed from ground on conductor 411, left inner back contacts of relay 406, right inner contacts of relay 405, right inner back contacts of relay 402, right outer normally made contacts of relay 401, winding of relay 401 to battery. Relay 401 operates and, on its left contacts grounds conductor 410 while on its right inner contacts it grounds conductor 515 of the trip magnet circuit above traced. When relay 507 operates, therefore, a circuit

is closed for trip magnet 514, from battery through the winding of trip magnet 514, top inner front contacts of relay 507, conductor 515 to ground. Trip magnet 514 is operated and rotates trip rod 711 to its proper position for tripping the brush-sets associated with trip fingers 716 and 717 on the subsequent upward movement of the link finder elevator. When the up-drive magnet 513 operates, the link finder, with its proper pair of brush sets released, will hunt for and engage the calling line finder in minor subgroup L3—L4. The operation of relay 507 closes ground on conductor 570 which locks relay 401 under control of relay 507.

Conductor 410 is connected with commutator strip 500 of the first link of the group and when the link finder of this first link is moved off normal and brush 502 clears the commutator segment 504 the start circuit connection to the chosen link is broken and when the link finder has moved upward so that commutator brush 502 connects with commutator strip 503 conductor 410 is then extended to conductor 571 of the next succeeding link by the way of brushes 501 and 502, commutator segment 500 and conductor 571. When the link associated with conductor 571 is likewise taken into use and the link finder elevator moved upward so that its commutator brush 502 makes contact with its commutator segment 500 the link start conductor 410 is then further extended to the third link provided, of course, that the first link connected directly to conductor 410 is still busy or its link finder elevator is otherwise off normal. This will be more clearly apparent by reference to Fig. 5. In this manner successive links of the group are taken into use by the link start circuit which controls them. Also, when the link finder elevator moves off normal, brush 517 engages commutator segment 518 and closes a circuit for relay 543 from ground through brush 517, commutator segment 518, conductor 519, winding of relay 543 to battery and, in parallel, through the bottom outer contacts of relay 508, to the winding of relay 516 and battery. Relays 543 and 516 operate. Relay 543, in conjunction with relay 507, which was released in the meanwhile as explained hereinafter, closes a pair of contacts in a chain circuit of the link group of the section through other pairs of contacts of relays 543 and 507 of other busy links of the group to the grounded right contacts of relay 507 of the last link in the group. If, therefore, the whole group of six links serving a section is made busy when the last remaining idle link of the group is taken into use, a circuit is completed from ground on the back contacts of relay 507 of the last link through the chain of pairs of contacts above mentioned, conductor 426, contacts of relays 507 and 543 at end of chain, conductor 422, winding of

relay 402 to battery causing relay 402 to operate. Should, now, another call be initiated and a line finder of minor subgroup A1—A2 associated with conductor 409 be taken into use ground on this conductor is extended to conductor 423 over its previously described path and by way of the left front contacts of relay 402. Conductor 423 is similar to conductor 410 except that it is the starting conductor of the group of links co-operating with the section wherein the line finder minor subgroup A1—A2 is second choice. By reference to Fig. 7 it will be noted that this link group is located in section 710 of the link finder frame. A link is chosen, therefore, in this section to connect with the terminals of the calling line finder of minor subgroup A1—A2 and in which the link finder concerned hunts in the second group to locate the calling line finder.

It will be observed that if, during the time that all the link circuits in section 701 are busy, a line finder in minor subgroup L3—L4 in the two upper banks is connected to a calling line, then conductor 411 will be grounded. Relay 402 being operated as a result of the all-busy condition of the link group of section 701, a circuit is closed for relay 400 from ground on conductor 411, left inner back contacts of relay 406, right inner back contacts of relay 405, right inner front contacts of relay 402, left normally made contacts of relay 400, winding of relay 400 to battery. Relay 400 operates, grounds conductor 423 on its right contacts and, on its left contact grounds conductor 412. Conductor 423 is the start conductor for the link group cooperating with section 710 in which section line finder minor subgroup L3—L4 appears as second choice, and conductor 412 controls the operation of the trip magnet and the chain circuit through relays 507 and 543 of the links. Trip fingers 719 and 720 of the trip rod 718, to choose as an illustration the first link in the group of section 710, would then trip the two upper brushes associated therewith for connecting the link finder with the calling line finder in the second choice minor subgroup L3—L4 in the two upper banks of this section.

Since each line finder minor subgroup is first choice in one of the ten vertical sections of the frame it follows, as has already been shown, that the starting conductor of each of the line finder minor subgroups is connected to that link start circuit which controls the link minor subgroup in the section where the line finder group appears as first choice. It has also been shown, that a link start circuit not only controls the link group having first choice accessibility to the line finder minor subgroup appearing in the section where the links are located, but also controls the link group in the section where the same line finder minor subgroup appear

as second choice. Specifically, the link start circuit shown to the left in Fig. 4, and connected to start conductors 409, 411, 414 and 413 controls the link group of section 701 for the two line finder minor subgroups of the first choice therein, and the link group of section 710 wherein the minor subgroups of first choice in section 701 appear as second choice. Remembering that the link finder frame is divided into pairs of sections, each reciprocal with the other, it follows that the start circuit above mentioned controls the link group of section 701 as first choice for the line finder minor subgroup therein appearing as first choice and the link group in section 710 as second choice for the line finder minor subgroup therein appearing as second choice but which group appears as first choice in section 701. As a concrete illustration conductor 413 is associated with the first choice line finder minor subgroup B1—B2 in the two lower banks of section 710 and conductor 414 with the first choice minor subgroup M3—M4 in the two upper banks of section 710. It will be noted that both of these minor subgroups appear as second choice in section 701. When, therefore, ground is connected to conductor 413 it is extended to conductor 423 by way of the right outer back contacts of relay 406, right inner contacts of relay 407, right back contacts of relay 403 to conductor 423 which, as already shown, is the start conductor for the link group of section 710. Similarly a start ground on conductor 414, associated with the line finder minor subgroups M3—M4, will cause the operation of relay 400 over a circuit from ground on conductor 414, right inner back contacts of relay 406, right inner contacts of relay 408, left inner back contacts of relay 403, left outer normally made contacts of relay 400, winding of relay 400 to battery. Relay 400 operates, grounds conductor 423 and also conductor 412 which, as already described, controls the circuit of trip magnet of each link finder in section 710 for tripping the two upper sets of brushes.

When a call originates in either of these groups and all of the links in section 710 are busy a chain circuit, identical with the one described above in connection with links in section 701, is closed thereby connecting ground over conductor 425 to the winding of relay 403. Relay 403 operates and extends the ground on starting conductor 413 to conductor 410 which, as already shown, is the start conductor for the groups of links in section 701, and connects conductor 414 to the winding of relay 401. When relay 401 operates as the result of a ground on conductor 414 it grounds conductor 410 and also conductor 415, which latter conductor controls the trip magnet of the link group of section 701 as already described.

As each pair of link groups becomes busy,

the starting conductors connected to the associated link start circuit are successively transferred to the succeeding start circuit of another pair of link groups; the calling line finder, in such cases, becoming connected to a link of a more remote preference depending on the link start circuit to which the start conductor with which it is ultimately connected is transferred. This is apparent from an inspection of Figs. 7 and 8 which, together, show the relation between the five start circuits, two of which are shown in detail and are identical with the start circuits shown in Fig. 4, and the ten link groups of the link finder frame. If, for example, the link groups of section 701 and section 710 are busy, then relays 402 and 403 in the associated start circuit will be operated, each by the separate chain circuit of the link groups in sections 701 and 710 respectively. A circuit is now closed for relay 406, from ground at the left outer contacts of relay 403, right outer contacts of relay 402, winding of relay 406 to battery, causing this relay to operate. If, during the period when relay 406 is operated, which is to say when the link group in section 701 and that in section 710 are busy and for which minor subgroups line finder groups A1—A2 and L3—L4 are first and second choices respectively, a call is initiated in minor subgroup A1—A2, then the ground on conductor 409 will close a circuit for relay 404 over the left outer front contacts of relay 406, operating relay 404 and locking it over its left contact to the start conductor 409. Should it come to pass that, during this time, relay 406 is released due to the release of either relays 402 or 403 as a result of links becoming idle in the respective link groups controlled by these relays, then relays 404 will remain locked without being in any way affected by the release of relay 406 and a link will be chosen from the group controlled by the start circuit with which the start conductor has been connected. Relay 404, at its right inner contact, breaks the extension of conductor 409 to the contacts of relay 402, and, on its right outer contact, grounds conductor 415 which is connected to the left outer armature of relay 417 of the next succeeding start circuit, that is, the start circuit controlling the pair of link minor subgroups in the sections where the line finder groups A1—A2 and L3—L4 appear as third and fourth preferences respectively. In Fig. 7 line finder minor subgroups A1—A2 and L3—L4 are third and fourth preference in sections 705 and 706 respectively and relay 417 belongs to the start circuit controlling the link groups of sections 705 and 706. This start circuit is connected to the starting conductors of line finder minor subgroups J1—J2, K1—K2, T3—T4 and U3—U4 which are first and second choices, respectively, in the two sections 705 and 706 in the reciprocal sense in which

choices have been described above in connection with the other line finder minor subgroups. Consequently the ground connected to the contacts of relay 417 by the operation of relay 404 of the previous start circuit becomes, in effect, the start ground for the link start circuit controlling the link group in section 705. Ground on conductor 415 is now extended to conductor 416 by way of the left outer back contacts of relay 417, right inner contacts of relay 418, left back contacts of relay 419 to conductor 416. Conductor 416 is the start conductor for the link group co-operating with section 705 and a link finder would thus be selected to locate the calling line finder in minor subgroup A1—A2 in section 705. On the other hand, if all the links in section 705 are busy as well as those in the previous group then the closure of the chain start circuit as previously described for the links in section 701 would operate relay 419 and transfer the start ground on conductor 415 through the left front contacts of relay 419 to start conductor 424 of the link group in section 706. In this manner it can be easily shown that the start conductors connected to any link start circuit are progressively advanced to the successive start circuits of other link groups having more remote preferences to the calling line finder minor subgroup than all of the previous link groups to which the start conductors have been advanced. The operation continues until connection is made with a start circuit of a pair of link groups which have idle links, one of which can be connected to the calling line finder.

It can likewise be easily shown that simultaneous calls in different line finder groups can be handled by the link start circuit to which such groups are connected. For example, if there were a calling line finder in the group connected to conductor 409 and another calling line finder in the group connected to conductor 411 the ground on conductor 411 operates relay 401 as already described grounding in turn, the link start circuit conductor 410 and the trip magnet circuit conductor 515. The operation of relay 401 will cause the chosen link in the group to trip its two upper brushes and connect with the calling line finder in the two upper banks. Ground on conductor 411 is thereafter removed, as explained hereinafter, causing the release of relay 401, and the consequent removal of ground from conductor 515. The calling line finder in the minor subgroup controlled by the conductor 409, however, has not yet been connected to a link finder so that ground on conductor 410 is still connected thereto from conductor 409 in spite of the release relay 401. The presence of ground on conductor 410 will, of course, start another link and the fact that there is no ground on conductor 515 will

cause the lower set of brushes to be tripped for connection to the terminals of the calling line finder of the two lower banks.

Returning now to a continuation of the further 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 up-drive magnet 513 from ground at the top contacts of relay 508, front uppermost contact of relay 506, winding of the up-drive magnet 513 to battery. Relay 507 connects the winding of the associated trip magnet 514 through the top inner front contact of relay 507, conductor 515 to the right inner contact of relay 401. The up-drive magnet 513 will now drive the link 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 frame as already described. If it is located in the two upper banks then starting ground on conductor 411 connected to said 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, right outer normally made contacts of relay 401, winding of relay 401 to battery. Relay 401 operates in this circuit and, at its left contact, it grounds conductor 410 while at its right inner contacts it grounds conductor 515 which closes the circuit of the trip magnet 414 as already described. As soon as the link finder elevator has been driven beyond its normal position the operating circuit of relays 506 and 507 is opened at commutator segment 504. Relay 506 is slow to release, however, and holds up until a circuit is closed for relay 516 from ground on brush 517, commutator strip 518, which is engaged by 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 locking ground for relay 506 through its No. 2 contacts and supplies another ground for the up-drive magnet 513 through its No. 1 contacts over the top outer contacts of relay 506. Relay 507 will release at the time the operating circuit is removed, but no harm is done since the tripping operation is completed before this occurs, and, with the operation of relay 516, its operating circuit is opened at another point, thereby preserving, in cooperation with the contacts of relay 543, the pair of chain contacts of the link group busy circuit. The operation of relay 506 also connects the winding of relay 508 to brush 520 by way of the top middle contact of relay 506. When the terminals of the calling line 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 over its left winding, conductor 233, commutator strip 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 the 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. Relay 506 is 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 strip 518, a circuit was closed from ground on strip 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 the sender selector is connected at this time to the contacts of an idle sender there will be no circuit to hold relay 526 because brush 569 is in contact with an insulating segment of the centering commutator 531 in the known manner, providing no holding circuit for the top winding and the locking circuit over its bottom winding is connected to the brush 530 which 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 another link operatively connected with 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 magnet 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 sender selectors.

If all senders terminating in the upper portion of the bank of the sender finder test busy, then the sender finder elevator will continue its upward movement until the commutator brush 561 connects with the 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 strip 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 down drive 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 is removed from conductor 410.

It should be noted that the sender selector

commutator is provided with two segments 571 and 553 whose arrangement with respect to the sender selector brushes 565, 566, 564, 567 and 568 is such that when these brushes are connected to the terminals of the tenth sender, counting from the top of the bank, then brush 561 engages segments 571 and 553. Brush 561 continues to make contact with segments 571 and 553 as long as the aforementioned brushes make contact with any of the last ten senders of the upper part of the bank. When any of these ten senders is selected for cooperation with a calling line finder, the subsequent release of the link will not cause the sender selector elevator to remain on the terminals of the sender just used but causes it to return to normal. When relay 527 releases as the result of the removal of ground on conductor 519 by the return of the link finder shaft to normal, relay 525 is also released and a circuit is closed from ground on the bottom outer back contacts of relay 527, conductor 556, commutator segment 571, brush 561, commutator segment 553, conductor 558, bottom contacts of relay 525, winding of relay 505 to battery. Relay 505 closes an obvious circuit for down drive magnet 529 which returns the sender selector elevator to normal.

The object of the foregoing operation when connection is established to one of the upper ten senders is to eliminate, on subsequent calls, the long delay incident to returning the sender selector elevator to normal should it be found that the sender to which the elevator is then connected, as well as those above it, are all busy. Under such circumstances the subscriber would have to wait until the elevator is returned before hunting over the remaining larger number of senders could take place. In order to avoid this, the elevator is returned to normal at the completion of the previous call so that the sender selector can start immediately from the bottom of the bank to hunt for a sender on the subsequent call.

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 of cam 310. Another path is likewise closed from battery through 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 of 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 225 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 operates 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 of 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 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 selector 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 towards 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 the 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 on 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 632 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 in the district selector through position 12 of sequence switch 300. When the switch 300 advances beyond position 12 during the talking selection the circuit for relays 508 and 207 is transferred to ground on the right outer contacts of relay 206 over conductor 253, which relay is operated for talking selection. When relay 206 releases on 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 down drive 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 down drive 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 relay 525 which disconnects the sender selector brushes from the sender.

Inasmuch as the present invention is not concerned with the specific operation of the district selector shown in Fig. 2 and Fig. 3, beyond what has heretofore been described or the operation of selectors to further extend the calling line and the functions of the sender to control selections no detailed description thereof has been given herein as such operations are completely described in Patent 1,567,072, granted to W. H. Matthies on 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 referred to.

What is claimed is:

1. In a telephone exchange system, line finders arranged in groups, major sub-groups and minor sub-groups, a plurality of super-imposed contact banks divided into a plurality of sections, a group of links arranged for cooperation with each of said sections, the various major sub-groups of line finders being so arranged in the various sections that a different major sub-group appears as first choice to the link group in each of said sections and means responsive to the operation of a line finder for starting an idle one of the links which serve a section of said banks in which the minor sub-group containing the contact set of the said operated line finder appears as first choice.

2. In a telephone exchange system, line finders arranged in groups, major sub-groups and minor sub-groups, a plurality of super-imposed contact banks divided into a plurality of sections, a group of links arranged for cooperation with each of said sections, the various major sub-groups of line finders being so arranged in the various sections that a different major sub-group appears as first choice in each of said sections, means responsive to the operation of a line finder for starting an idle one of the links which serves a section of said banks containing the contact set of the operated line finder appearing as first choice, and means operated when all links having first choice access are busy for starting an idle one of the links of the next succeeding group before which said operated line finder appears as second choice.

3. In a telephone exchange system, line finders arranged in groups, major sub-groups and minor sub-groups, a plurality of super-imposed contact banks divided into a plural-

ity of sections, a group of links arranged for cooperation with each of said sections, the links of each group having first choice access to the several major sub-groups of line finders respectively, a start circuit for a plurality of link groups having points of access to a plurality of minor sub-groups of line finders of the major sub-group which the said plurality of link groups serve as first and second preference whereby, when any line finder in one of said plurality of minor sub-groups calls, an idle link having preference access to said operated line finder is started over the corresponding point of access in said start circuit and whereby, if no links in that group are available, said point of access is extended to the next succeeding group of links in the preference.

4. In a telephone exchange system, line finders arranged in groups, major sub-groups and minor sub-groups, superimposed contact banks divided into a plurality of sections, a group of links arranged for cooperation with each of said sections, the links of each group having first choice access to the several major sub-groups of line finders respectively, a start circuit for a plurality of groups of links, having points of access for a plurality of minor sub-groups of line finders of the major sub-group which the said plurality of link groups serve as first and second preference whereby, when any line finder in one of said plurality of minor sub-groups calls, an idle link having preference access to said operated line finder is started over the corresponding point of access in said start circuit and whereby, if no links in the said group are available, said point of access is extended to the next succeeding group of links, and means operated when all links controlled by the said start circuit are busy for extending said point of access to corresponding points of access in the start circuit of another plurality of groups of links in the succession of preference.

5. In a telephone exchange system, line finders arranged in groups and sub-groups, a plurality of superimposed contact banks divided into a plurality of sections, a group of links arranged for cooperation with each of said sections, each group of links being first choice for those sub-groups of line finders appearing in the first position of the bank sections before which the said group of links appears, second choice for the sub-groups of line finders appearing in the second position of the bank section, and further remote choice for other sub-groups of line finders appearing in other positions of said bank sections, a link finder for each link, a brush set for each link finder for cooperation with each bank, means for operating each link finder in a brush selection and terminal finding movement, and a trip rod for each link finder having a brush tripping finger corresponding

to each brush set, the trip fingers of all link finders being arranged to trip a pair of brush sets for any given brush selecting movement.

6. In a telephone exchange system comprising line finders arranged in groups and sub-groups, a plurality of superimposed contact banks, said line finders terminating on corresponding contacts in each of a pair of contact banks, a group of links arranged for cooperation with said plurality of banks, a link finder for each link, a brush set for each link finder for cooperation with each bank, means for operating each link finder in a brush selection and a terminal finding movement, and a trip rod for each link finder having brush tripping fingers corresponding to each brush set, the tripping fingers on the trip rod being arranged in pairs to trip a different pair of brush sets for any given brush selecting movement.

7. In a telephone exchange system, line finders arranged in groups, major sub-groups and minor sub-groups, a plurality of superimposed contact banks divided into a plurality of sections, a group of links arranged for cooperation with each of said sections, the various major sub-groups of line finders being so arranged in the various sections that a different major sub-group appears as first choice to the link group in each of said sections, a link start circuit for each of two groups of links, means for connecting said link start circuit to the said minor sub-groups of line finders which appear as first choice in the sections with which each of said two link groups cooperate, and means responsive to the operation of a line finder in one of said sub-groups operatively connected to said link start circuit for operating said start circuit to start an idle link in that group of links which serves the section of said banks containing the sub-group of the calling line finder as first choice.

8. In a telephone exchange system, line finders arranged in groups, major sub-groups and minor sub-groups, a plurality of superimposed contact banks divided into a plurality of sections, a group of links arranged for cooperation with each of said sections, the various major sub-groups of line finders being so arranged in the various sections that a different major sub-group appears as first choice to the link group in each of said sections, and all the sub-groups being so arranged with respect to all the sections that any two sub-groups of consecutive choice in one section are of consecutive choice in another section but in the reverse order, a link start circuit for each two groups of links, said link start circuit being connected to the said minor sub-groups of line finders which appear as first choice in the sections containing the said two groups of links, and means responsive to the operation of a line finder in one of the said sub-groups connected to

the said link start circuit for operating said link start circuit to start an idle link in that group of links which serves the section of said banks containing the sub-group of the calling line finder as first choice.

9. In a telephone exchange system, line finders arranged in groups, major sub-groups and minor sub-groups, a plurality of superimposed contact banks divided into a plurality of sections, a group of links arranged for cooperation with each of said sections, the various major sub-groups of line finders being so arranged in the various sections that a different major sub-group appears as first choice to the link group in each of said sections and all of the sub-groups being so arranged with respect to all the sections that any two minor sub-groups of consecutive choice in one section are of consecutive choice in another section but in the reverse order, a link start circuit for each two major sub-groups of links, said link start circuit being connected to the said minor sub-groups of line finders which appear as first choice in the sections containing the two groups of links, means in said link start circuit responsive to an all-busy condition of each of said link groups, and means in said link start circuit responsive to the operation of a line finder in one of said minor sub-groups and controlled by said means responsive to said all-busy link condition of the said link group having first choice accessibility to said line finder sub-group containing the said operated line finder for operating said link start circuit to start an idle link in the second group of links which serves the section of said bank containing the sub-group of the calling line finder as second choice.

10. In a telephone exchange system, line finders arranged in groups, major sub-groups and minor sub-groups, a plurality of superimposed contact banks divided into a plurality of sections, a group of links arranged for cooperation with each of said sections, the various major sub-groups of line finders being so arranged in the various sections that a different sub-group appears as first choice to a link group in each of said sections and all of the sub-groups being so arranged with respect to all the sections that any two minor sub-groups of consecutive choice in one section are of consecutive choice in another section but in the reverse order, a link start circuit for each two groups of links, each of said link start circuits being connected by start wires to the said minor sub-groups of line finders which appear as first choice in the sections containing the two groups of links controlled by a start circuit, means in each of said link start circuits responsive to an all-busy condition of each of said link groups, means in each of said link start circuits responsive to the operation of said means for advancing said start wires of the line finder

groups connected to the said link start circuit to the next link start circuit in succession, the said next link start circuit controlling the pair of link groups in the sections where said line finder groups appear next in consecutive choice, and means in the said link start circuit responsive to the operation of a line finder in one of said sub-groups with which the link circuit is connected for starting an idle link in a group controlled by the link start circuit to which the start wire of the line finder sub-group containing the operated line finder has been advanced.

11. In a telephone exchange system comprising line finders arranged in groups and sub-groups, a plurality of superimposed contact banks, said line finders terminating in corresponding contacts in each of a pair of contact banks, a link start circuit accessible to a plurality of line finder sub-groups terminating in a plurality of pairs of contact banks, a link circuit accessible to said link start circuit and having a link finder arranged for cooperation with said plurality of banks, a brush set in the said link finder for cooperation with each bank, means in said link start circuit responsive to the operation of a line finder in a sub-group accessible to said link start circuit and appearing in any pair of said plurality of contact banks, and means responsive to the operation of said means for operating said link finder in a brush selection movement to select the pair of brush sets which cooperate with the pair of contact banks where the said line finder sub-group containing the calling line appears.

In witness whereof, I hereunto subscribe my name this 8th day of Sept., 1930.

CHARLES L. GOODRUM.