

June 11, 1935.

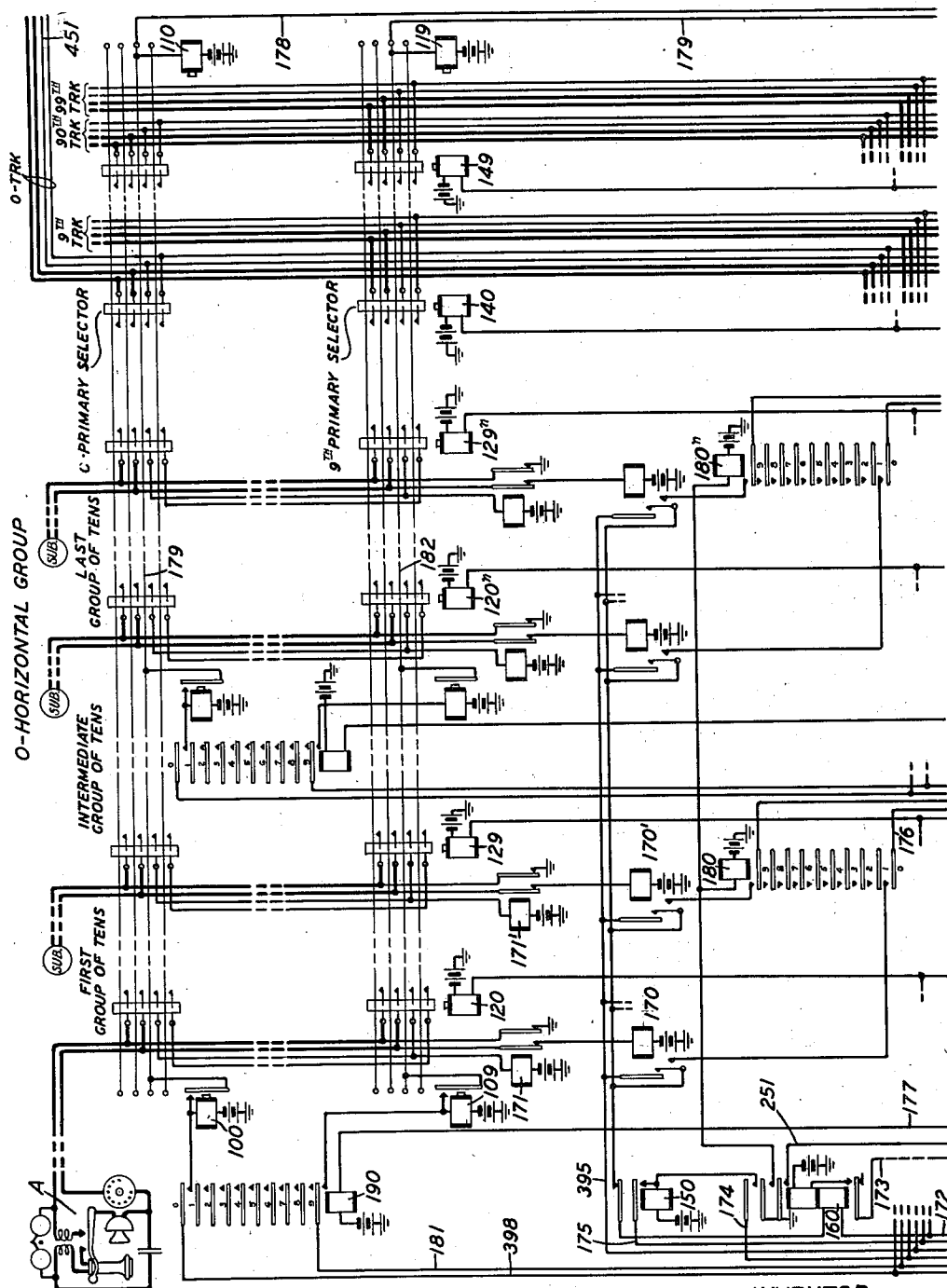
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2,004,599

TELEPHONE SYSTEM

Filed July 19, 1933

8 Sheets-Sheet 1



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8 Sheets-Sheet 2

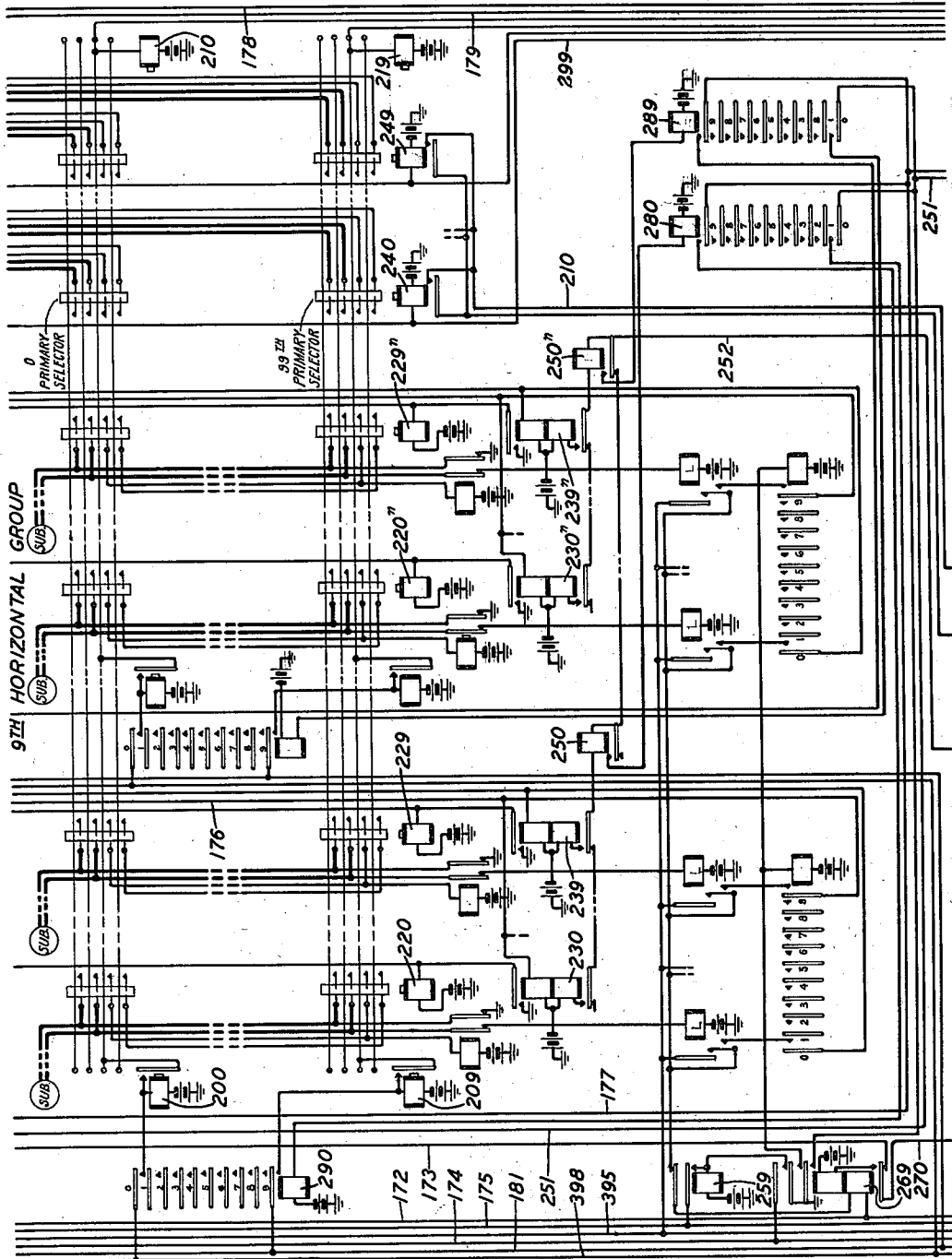


FIG. 2

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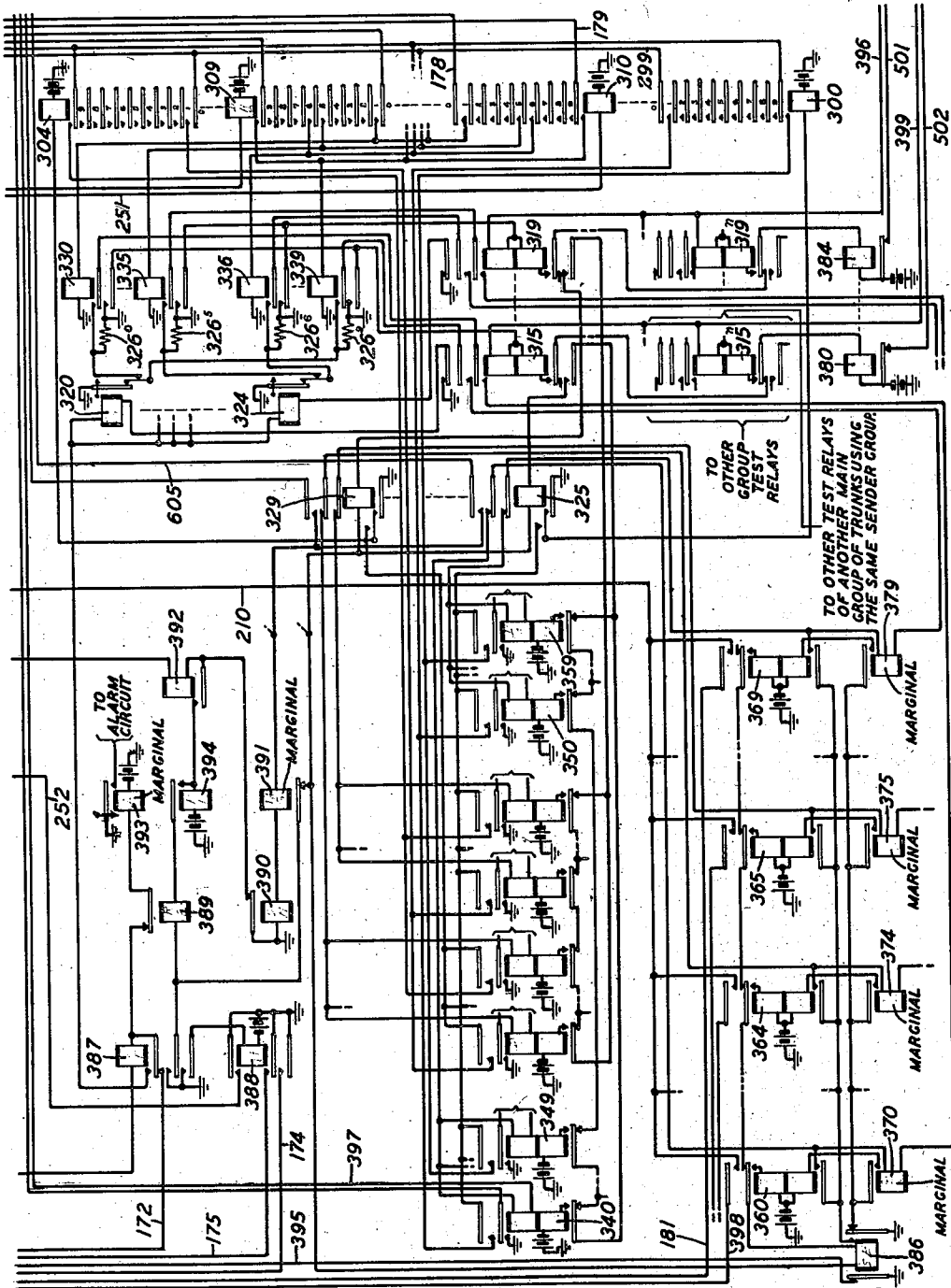
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8 Sheets-Sheet 3



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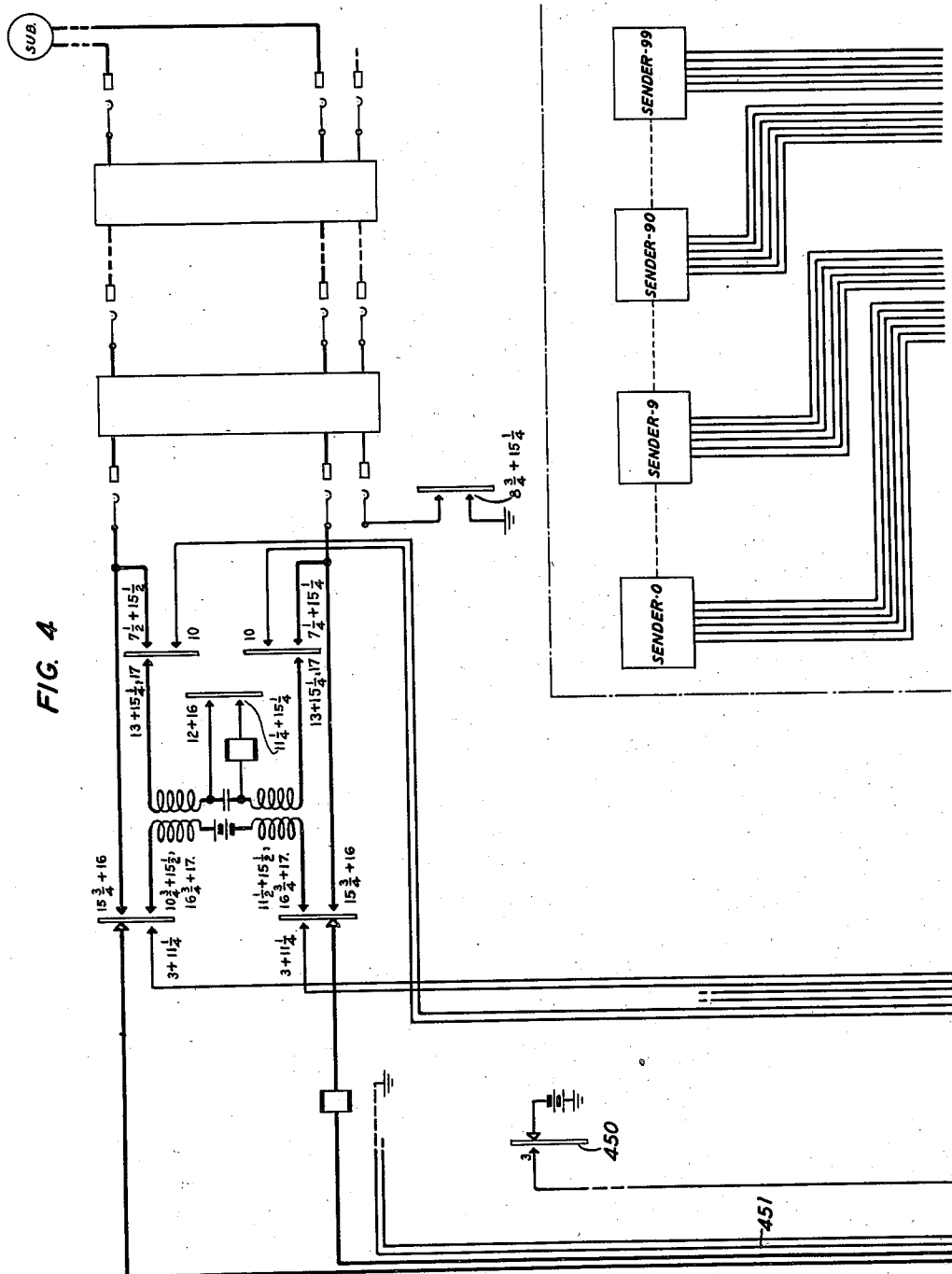
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8 Sheets-Sheet 4



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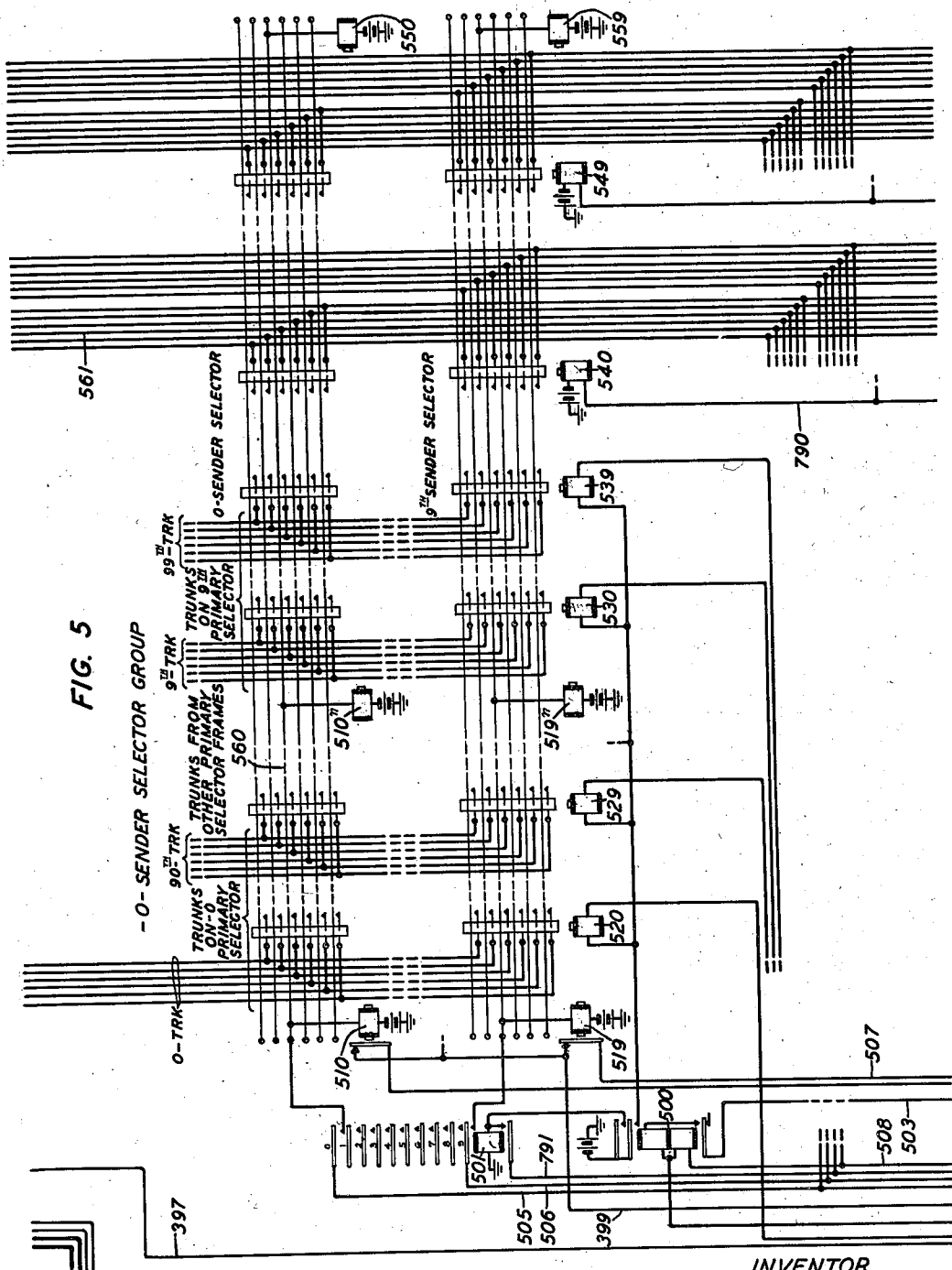
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8 Sheets-Sheet 5



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8 Sheets-Sheet 6

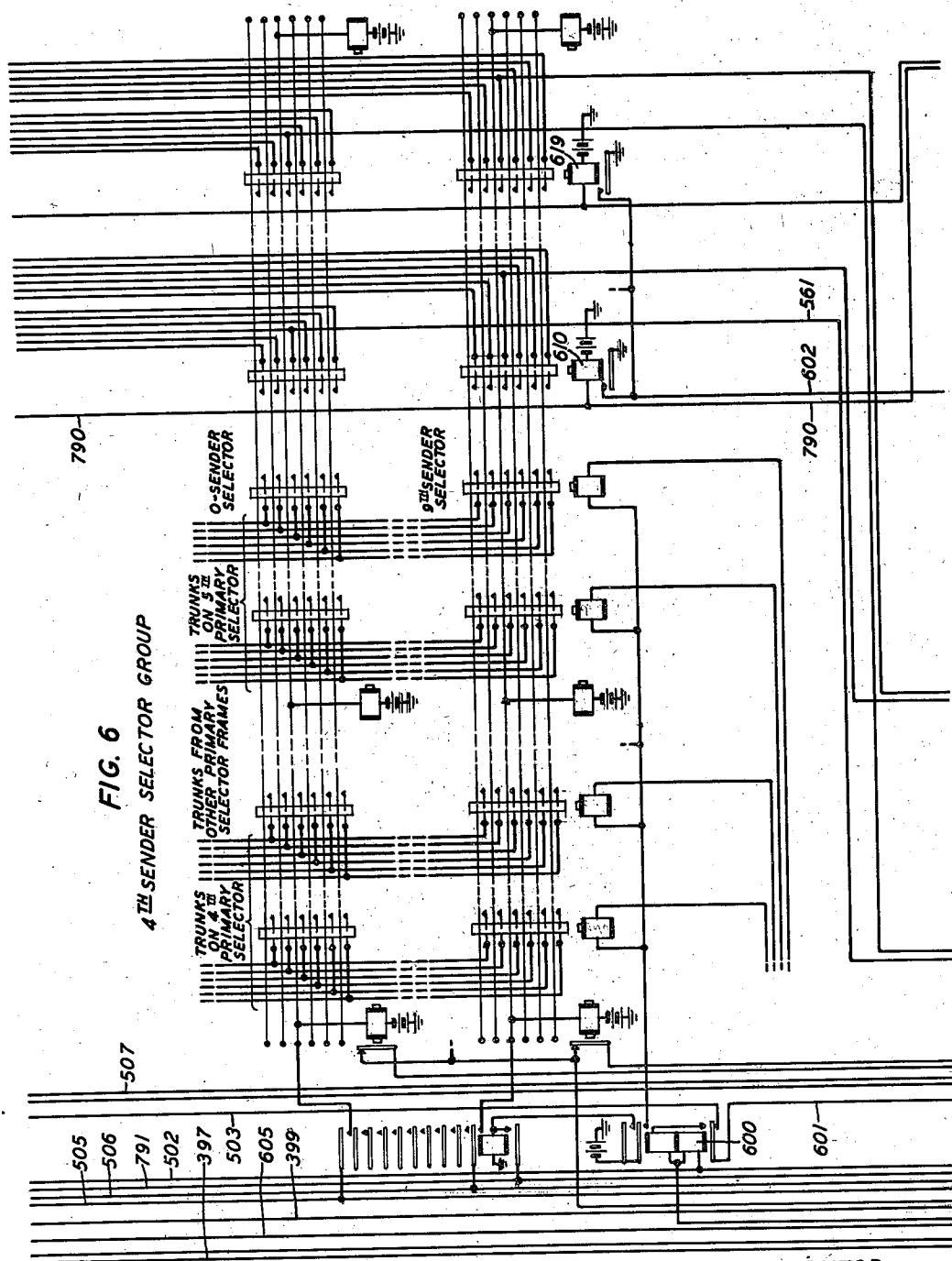


FIG. 6

4th SENDER SELECTOR GROUP

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8 Sheets-Sheet 7

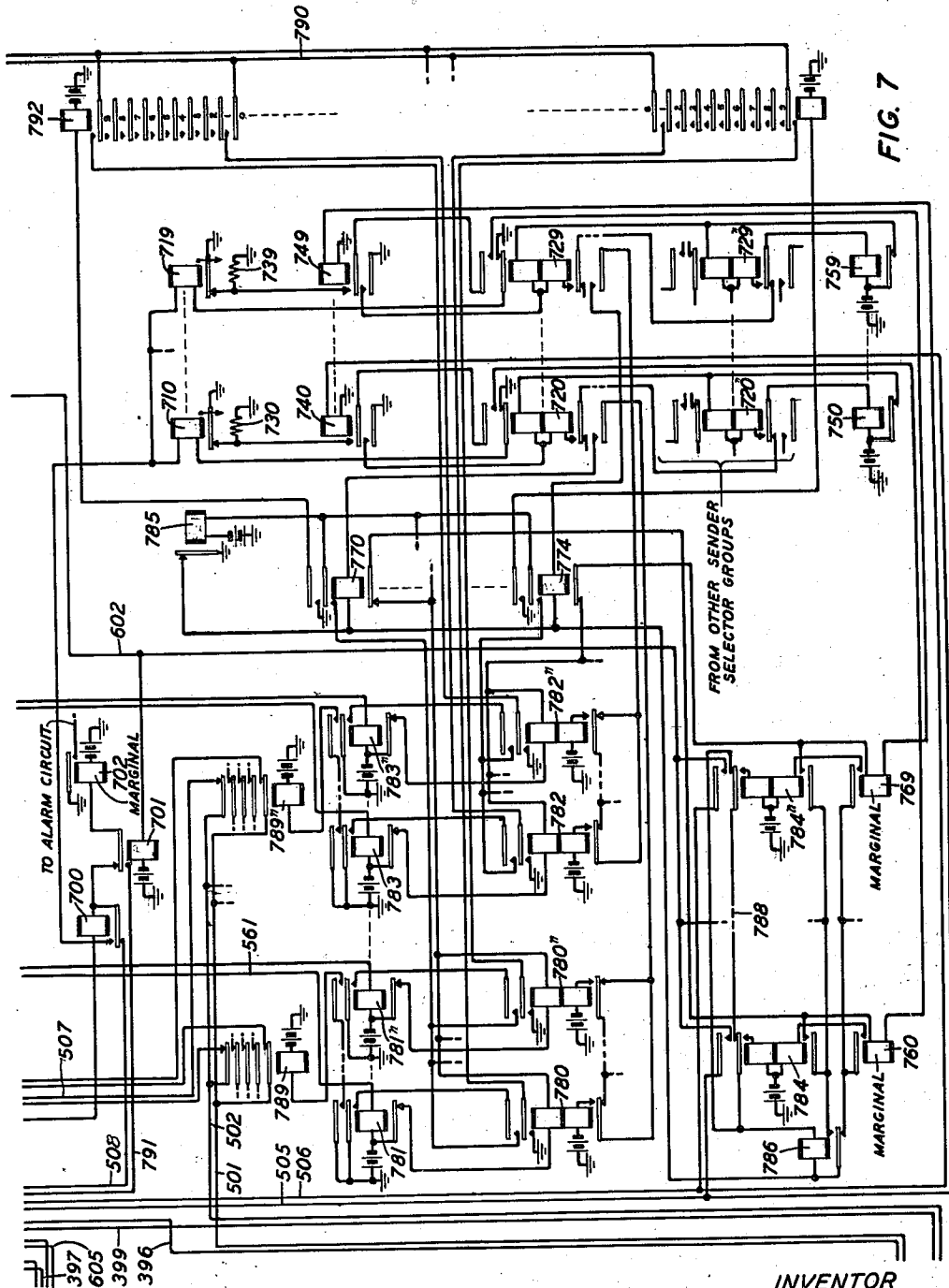


FIG. 7

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UNITED STATES PATENT OFFICE

2,004,599

TELEPHONE SYSTEM

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23 Claims. (Cl. 179—18)

This invention relates to telephone systems and more particularly to a link circuit for extending subscribers' lines to switching trunks and to register senders. The invention has for its object an increase in the traffic carrying efficiency of the switching and registering apparatus required for establishing the connections.

Owing to the relatively small capacity of the switches used in automatic telephone systems, the subscribers' lines and trunks are divided into small groups each having access to a particular group only of all the outgoing trunks of the corresponding switching stage. It is known that this grouping of lines increases the total number of trunks required to handle the traffic and, consequently, reduces the traffic carrying efficiency of the trunks themselves because of the greater traffic variations in small groups. It is also recognized that the larger the groups of trunks worked in common, the more efficient is the service and the fewer the total number of trunks required to carry the traffic. The same, of course, is true of register senders.

It has been proposed to improve the efficiency of trunks and senders by interconnecting an additional switching stage between subscribers' lines and outgoing trunks thereby giving subscribers' lines access to a larger number of outgoing lines and an additional switching stage between trunks and senders without increasing the capacity of the connecting switches. The known double pre-selecting system is an example of this method of increasing the efficiency of the trunks without increasing the capacity of the switches and my invention is concerned with further increasing the efficiency of such systems and further extending the principle thereof to register senders.

In accordance with the invention, therefore, one specific embodiment of which is disclosed herein by way of illustration this is accomplished in the following improved manner:

The link circuit which is the subject of this invention uses a switching medium of known construction of the coordinate type. It comprises a primary selector and a sender selector, the former being arranged to connect subscribers' lines arranged in main groups and subdivided into horizontal groups of convenient size in the known coordinate manner, with outgoing trunks accessible through the primary selector, and the latter being arranged to connect an available outgoing trunk with an idle sender which is accessible through the sender selector. Each link

is accessible to a particular horizontal group of lines and is associated with other links in the same horizontal group through a horizontal lock-out circuit which controls the extension of calling lines from its own horizontal group, and also a common vertical lock-out circuit for controlling the extension of calling lines from different horizontal levels.

The primary selector comprises a connecting relay which has access to a horizontal group of lines and to a plurality of outgoing trunks. If, for example, a decimal arrangement is assumed for convenience and then primary selectors to each horizontal group of lines are provided and each primary selector, in turn, with accessibility to ten outgoing trunks, it is evident that each horizontal group of subscribers' lines has an overall accessibility to one hundred outgoing trunks, the same trunks, of course, being multiplied to the primary selectors of other horizontal groups of lines. By using the subscribers' lines in larger main groups than is now possible with mechanical line finder frames of known construction, and outgoing trunks also in larger groups, greater efficiency in the use of the equipment can be realized and, therefore, less apparatus needed for carrying the same traffic load.

The sender selector is generally of the same construction as the primary selector and, in the present embodiment of the invention, comprises a group of connecting relays each having access to a plurality of groups of trunks and to a group of senders through each sender selector. The groups of trunks are multiplied to as many sender selectors as are necessary by traffic conditions and each sender selector to which said trunks are extended increases the number of senders with which said trunks may establish connection by the number of trunks available through said selector. The senders may be extended to as many sender selector groups as may be required for the most efficient handling of the traffic.

One novel feature of my invention is the correlation of each group of ten outgoing trunks with a particular group of sender selectors; that is, the selection of an outgoing trunk in a group reached through a particular primary selector involves the simultaneous selection of an idle sender in the group of sender selectors correlated with the particular group of outgoing trunks containing the chosen trunk. If, in fact, a trunk is available while a sender selector is not available in the correlated sender selector group then, after a momentary interval, selections will be made in another available

correlated group of trunks and sender selectors through a control circuit which advances preferably to successive correlated groups. In order to reduce this "cover-up" effect resulting from the possible non-use of idle outgoing trunks and senders, all trunk groups are made available to a plurality of main subscriber groups so that the correlated groups of trunks and senders are heavily loaded up with traffic from all the main groups.

In general, my invention works in the following way: When a calling subscriber in any horizontal group initiates a call, the horizontal and vertical group lock-out circuits operate to extend the calling line to one of the ten primary selectors through each of which a group of outgoing trunks may be reached. Each primary selector is tested for its idle or busy condition and all the idle primary selectors cause the operation of corresponding test relays which, in turn, close through the respective group control circuits of the outgoing trunk groups associated with each of the idle primary selectors. These control circuits are each serially extended through the test circuit of the correlated group of sender selectors and should no sender selector be available in any or all of the correlated sender groups, then the corresponding group control circuits remain open and the selection of a trunk and sender is restricted to a preferred trunk group whose correlated sender selector group does contain an idle sender selector and available senders thereover.

The selection of a preferred trunk group from all available trunk groups is made by simultaneously and separately making a trunk group test of all said available groups. If there is more than one idle trunk in each group then the group selected is the one in the highest order of preference. If, on the other hand, all the trunks or all the trunks but one in each group are busy, the entire group tests as if all the trunks within it were busy. Under such circumstances the failure to lock-in a trunk group during the trunk groups test causes the trunk group test of all said groups to be canceled and the groups are then retested to select the one idle trunk in a preferred group which had previously tested all busy but which, in fact, did contain an idle trunk. In this way all groups are tested so as to spread the flow of traffic as evenly as possible through all groups.

The sender selector operations in any or all groups are so much like what has already been described with reference to the primary selectors that it is hardly necessary to repeat it in this brief digest, it being readily understood from the following detailed description and appended claims.

The scope and purpose of the invention will be the more clearly understood by the following description taken in connection with the attached drawings in which:

Fig. 1 represents the first horizontal group of lines with the associated group of primary selectors.

Fig. 2 represents the last horizontal group of lines with the associated group of primary selectors.

Fig. 3 shows the line and primary selector control circuits.

Fig. 4 shows a skeletonized outgoing trunk selector of the panel type, and a diagrammatic presentation of a group of senders.

Fig. 5 shows the first group of sender selectors with associated trunk and sender groups.

Fig. 6 shows the last group of sender selectors with associated trunk and sender groups.

Fig. 7 shows the sender selector control circuit.

Fig. 8 shows a diagrammatic representation of the relationship which exists between subscriber primary selector, sender selector and sender groups.

Fig. 9 indicates how Figs. 1 to 8 should be arranged with respect to each other in order to completely disclose the invention.

Before proceeding to a detailed description of the particulars of the invention, it may be well to consider it somewhat in general terms from a study of Fig. 8.

For purposes of illustration it may be assumed that Fig. 1 represents a main group of 1000 subscribers' lines. These lines are subdivided into ten groups of 100 lines each and each group arranged for connection to any one of ten primary selectors. Since there are ten groups of lines, there will be ten horizontal groups of lines and selectors, namely the zero horizontal group up to and including the ninth horizontal group. It will be further assumed that there are 100 outgoing trunks which may be used in common by said group of 1000 lines and also by other similar groups if the quantity of the traffic warrants it. This main group of 100 trunks is divided into ten separate subgroups of ten trunks each and each trunk within each subgroup is arranged for connection to a particular primary selector in the first or zero horizontal group and to corresponding selectors in other groups. For instance, the first or zero trunk of 0-subgroup might be arranged for connection with the first or zero primary selector in the zero horizontal group and for connection with the correspondingly numbered selector in other horizontal groups. In the same way the corresponding trunk in each subgroup would be multiplied to the same corresponding selector in each group, which is the way the trunks are shown for connection in Fig. 8.

But while the lines and primary selectors are arranged in ten horizontal groups, the sender selectors are arranged in five horizontal groups composed of ten sender selectors to the group. To each of these horizontal groups of sender selectors are extended two trunk subgroups available to the 1000 subscribers and also to other pairs of trunk subgroups available to other groups of 1000 subscribers. For instance, the zero horizontal group of sender selectors may be connected with trunk subgroup zero and trunk subgroup 9, the third horizontal group with trunk subgroups 2 and 7, while the fourth or last with trunk subgroups 4 and 5. This distribution is, of course, not intended to limit the invention to the arrangement as shown, but simply indicates that where the traffic density permits it, the number of trunk subgroups terminating on any horizontal group of sender selectors may be increased or diminished as desired. It might be possible, for example, to have ten groups of sender selectors and terminate one trunk subgroup over from each group of lines on one sender selector group.

The main group of senders is available to all sender selectors, and is arranged for connection amongst them in the same way as the trunks were arranged amongst the primary selectors; that is, each sender is connectible to one sender

selector of a horizontal group of selectors and to each corresponding selector in each of the other horizontal groups of sender selectors.

Obviously, the connection of a calling line in any horizontal group with an idle trunk and an idle sender must take place through the intermediate agency of a primary selector and a sender selector. Calling line A, for instance, may establish a connection with an idle sender only through the selection of an idle primary selector which has accessibility to a trunk in a subgroup whose correlated group of sender selectors also contains an idle sender selector which has accessibility to an idle sender. If a sender selector and a sender is not available, then the calling line must select an idle trunk from some other trunk subgroup accessible through the primary selectors but which, at the same time, can obtain an idle sender selector and an idle sender through its own correlated group of sender selectors and senders.

A detailed description of the system will now be given with reference to the remaining figures of the drawings.

When a subscriber A in any horizontal group, the 0-group, for instance, removes his receiver from the hook, a circuit is closed for relay 170 which extends from battery through the winding of relay 170, the inner contacts of relay 171, subscriber's loop, to ground through the outer contacts of relay 171. The operation of relay 170 causes a circuit to be closed extending from ground on the left contacts of relay 386, conductor 395, outer contacts of relay 170, back contact of relay 150, lower winding of relay 160, conductor 172, back contact of relay 387, contacts of relay 389, winding of relay 393 to battery. Relay 160 operates in this circuit and locks over another circuit extending from battery through its top winding and bottom front contact, conductor 173, over a chain path including the bottom back contact of each relay corresponding to relay 160 in the successive horizontal groups including the bottom back contact of relay 269 in the 9th or last horizontal group, conductor 270, winding of relay 387, contacts of relay 389, winding of relay 393, to battery. Relay 160 further closes a circuit from ground on its inner upper contact, conductor 251, winding of relay 310 to battery. Relay 310 operates and performs functions which are described hereinafter. Another circuit is also closed from ground on the top middle contact of relay 160, to the windings in parallel of all the tens group relays 180—189^a of which there are as many in each horizontal group as there are minor subdivisions of ten line groups in each of said horizontal groups. Relays 180—189^a operate and since the calling line A belongs to the first group of ten lines controlled through relay 180, said relay closes a circuit whose path and function are also described hereinafter.

Relay 387 operates in the locking circuit of relay 160, opens the operating path of relay 160 in each horizontal group so that said relays are prevented from operating after one of their number has operated and locked in series with relay 387, closes an obvious circuit to the winding of relay 388 which operates to perform other functions that are noted hereinafter, and further closes a group of five separate circuits to the relays 320—324 extending from battery through the winding of relay 393, contacts of relay 389, inner front contact of relay 387, in

parallel through each of the windings of relays 320—324 to ground for each of said circuits on the top outer contacts of relays 315—319 respectively. Relays 320—324 operate and remove the short circuit around resistances, such as 325^o and 326^o which are used for making primary selector and trunk tests as described hereinafter. Relay 393 is marginal and slow-to-operate and does not operate in the above named circuits. It operates only if, due to some trouble condition, two horizontal group relays, say relays 160 and 269, should remain operated at the same time after an interval long enough to have caused the opening of their operating circuits through the contacts of relay 387. Under such circumstances, the current flowing through the two separate circuit branches and combined through the winding of relay 393 will be sufficient to energize said relay, whereupon a circuit is closed to an alarm circuit (not shown) which calls the attention of the maintenance force to the presence of the trouble condition.

With regard to the horizontal distribution of subscriber's line groups, the above chain lock-out circuit through the various horizontal group relays 160—269, makes it clear that one horizontal group at a time will be recognized as calling. If there are two or more subscribers initiating calls in different horizontal groups, then the relay in each group corresponding to relay 160 of the 0-group, or relay 269 of the 9th group, would be operated by circuits similar to the circuit of relay 160 described above. Since, however, the locking circuit of each preceding relay is controlled through the normally closed contacts of each succeeding relay, it follows that although the group lock-out relay in each group may operate in response to the initiation of simultaneous calls in their respective horizontal groups, yet only the lock-out relay which is electrically nearest to relay 387 can possibly lock; that is, the relay whose locking path through the winding of relay 387 is undisturbed by the open back contacts in the chain of previous relays which may have been operated. The breaking of the locking circuit at any point will cause all horizontal group relays to release except the one which has been successfully locked. All the other horizontal group relays will then await their turn on the re-establishment of the operating circuit, which occurs when the calling line in the horizontal group which has been locked in has been connected to an outgoing trunk, as more completely described hereinafter.

Assuming, however, that relay 160 of the first horizontal group has been locked in and that no line in any other group, or in the same group, is calling simultaneously with line A, then a circuit is closed to the winding of relay 150 which extends from battery through the winding of said relay, top outer contacts of relay 160, conductor 174, lower outer contacts of relay 388 to ground. Relay 150 operates, opens the path from the contacts of line relay 170 to the operating winding of relay 160, and locks through its inner contacts, conductor 175, to ground on the lower inner contacts of relay 388. Now, at the time relay 160 operated, relay 180 was also operated as already described. Consequently, a circuit is then closed extending from ground on conductor 395, contacts of relay 170, No. 0 contact-set of relay 180, conductor 176, upper winding of relay 230 to battery. Re-

lay 230 operates, locks in a circuit extending from battery through its bottom winding and bottom front contacts, over a chain path including the bottom back contacts of other relays 231—239, one of which is furnished for each vertical row of subscribers' lines in each tens horizontal sub-group, winding of relay 250, which is a common relay for ten successive vertical rows of lines, back contacts of similar intermediate relays, back contact of the end relay 259ⁿ, conductor 252, top contacts of relay 388, to ground. Over its top contacts, relay 230 closes an obvious circuit to the windings of all vertical selecting magnets, 220—120 in the first vertical row of the first tens subgroup; that is, the one which contains the calling line. These magnets operate and position the wire bar of the switch to lock the cross contacts at the appropriate time, as more completely described hereinafter.

It will be observed that the ground for the locking circuit of each of the relays 230—239 and the winding of each of the relays 250—259ⁿ, one of which is in the above mentioned locking circuit of a relay in the appropriate group, is taken over a series chain of back contacts of each of said relays 250—259ⁿ. In the present embodiment of the invention, the subscriber's lines are divided into ten main horizontal groups. Each group is further subdivided into a plurality of subgroups of ten lines each, and provided with a group relay, such as relay 190 for the first subgroup of ten lines in the 0-horizontal group, through each of whose ten sets of contacts a calling line served by a particular subgroup relay may be further extended into the control circuit. Consequently, if there are simultaneous calls in different subgroups of the same or different horizontal group, the operation of the lock-out relay in the group 250—259ⁿ in series with the most preferred relay in a group of relays 230—239 cuts off the operating circuit of all succeeding relays 250—259ⁿ and the locking circuit of all relays in the preceding groups 230—239, by virtue of the fact that the operating ground of each preceding relay is cut off at the back contacts of each succeeding relay. By means of this arrangement, only one relay in the group 280—289 can operate as described hereinafter, and all horizontal groups containing calling lines must wait until the calling line in the most preferred horizontal group has been connected to an outgoing trunk before the lines in the less preferred groups can be extended for further operation. In this manner, successive horizontal subgroups are locked out to await their turn in accordance with the preference arrangement.

In the meanwhile, the operation of relay 250 closes a circuit for relay 280 extending from ground on the top contacts of relay 388, conductor 252, back contacts of relay 250ⁿ, back contact series path of intermediate relays in the group of relays 250—259ⁿ, front contacts of relay 250, winding of relay 280 to battery. Relay 280 operates and closes a path to relays 190, 290, etc. of each horizontal group. Since a line in the 0-horizontal group is calling while all other groups are locked out, a circuit is completed for relay 190, extending from battery through the winding of relay 190, conductor 177, No. 0 contact set of relay 280, conductor 251, top inner contacts of relay 160 to ground, and in parallel therewith over conductor 251, winding of relay 310 to battery. Relay 190 operates

and partially closes through each of ten paths to the ten separate horizontal magnets of the first subgroup of lines in the 0-horizontal group which contains the calling line. The circuit of the appropriate horizontal magnet is not completed, however, until a primary selector, an idle outgoing trunk accessible through said selector and an idle sender connectible to said outgoing trunk have all been selected, as more completely described hereinafter.

It will be recalled that relay 310 operated at the time relay 160 operated. Relay 310 partially closes circuits through the windings of the horizontal magnets of a group of ten primary selectors connecting with the whole group of outgoing trunks all of which are accessible to the lines in the 0-horizontal group through said ten primary selectors, as more completely described hereinafter.

Now, each primary selector provides accessibility to a subgroup of ten outgoing trunks and the test for an available trunk, therefore, is divided into two separate but simultaneous tests; first, the test for an available primary selector and secondly, a test for an idle trunk accessible through the available primary selector. Each busy primary selector is arranged to have its horizontal magnet operated, and since the winding of this magnet is connected directly to the sleeve conductor of the associated selector, the ground on this conductor also furnishes the test of the availability of the selector. Consequently when relay 310 operates, each of the sleeve conductors of each of the primary selectors in the group of the calling line is extended through the contact sets of relay 310 to a winding of a test relay. These relays are 330 to 339, inclusive. Idle primary selectors have no ground connected to the sleeve conductor and hence, upon the operation of relay 310, a circuit is closed for each idle primary selector from battery through the winding of the horizontal magnet of each idle primary selector to the winding of the test relay. A typical circuit is that for the 0-primary selector which extends from battery through the winding of the selector horizontal magnet 110, conductor 178, No. 0 contact set of relay 310, winding of relay 330, to ground. Relay 330 operates but the quantity of current flowing through the circuit is not sufficient to permit the magnet to operate. Each test relay in the group 330—339 corresponding to an idle primary selector thus operates in the same manner.

Now the outer contacts on each of what may be designated the first pair of test relays, namely, relays 330 and 339, are connected to the windings of a relay 315, while those of relays 335 and 336, the last pair, are connected to the windings of relay 319, the contacts of intermediate pairs of test relays (not shown) being connected, respectively, to the windings of the intermediate relays 316, 317 and 318 (not shown) in the group of five relays 315—319. Consequently, those test relays which have operated as a result of the idle condition of the primary selector to which they were connected, further close circuit paths from ground through their bottom outer contacts, top winding of relay 315, for example, if it be assumed that the 0 or 9th primary selector or both are idle and that, in consequence, relay 330 or 339 or both have been operated, conductor 399, contacts of any normal horizontal magnet of the group of sender selectors 0 to 9, in the 0-horizontal

group of sender selectors, as, for instance, contacts of magnet 519, conductor 507, back contacts of relay 789ⁿ, which relay is normal if any sender available through the 9th sender selector of the 0-horizontal group is idle, as more completely described hereinafter, conductor 502, back contacts of relay 389, to battery. Relay 315 operates in this circuit and locks over its lower winding and lower inner front contacts, over the series chain of back contacts of other relays identical with 315, such as 315ⁿ associated with other main district groups which have accessibility to the same subgroup of senders as more completely described hereinafter, winding of relay 399, to battery. Relay 360 operates in this circuit and, by opening conductor 502, opens the operating circuit of every like relay in the chain 315-315ⁿ. The operation of relay 315 further opens the circuit of relay 320 but this relay, being slow to release, does not release immediately. In the meanwhile, and during the interval in which relay 320 remains in its operated position, relay 315 causes a circuit to be closed from ground, through resistance 326 and inner contacts of relay 339, if this relay has operated in response to the idle condition of the 0-primary selector, top inner contacts of relay 315, winding of relay 370, top middle back contact of relay 325, in parallel through the upper winding of each of the relays 340 to 349, conductor 397 of relay 340 and a similar conductor on each of the other relays in said group of relays 340-349, contacts of cam 450, to battery in each of the outgoing trunk selectors correlated to the ten relays of the group of relays 340-349. If each selector is idle, then each of their respective sequence switches are in position 3 and all relays 340 to 349, inclusive, operate. On the other hand, if any selector is busy, its associated sequence switch will have been advanced beyond position 3 in the well known manner and a circuit will not be closed through the winding of its corresponding relay in the group of relays 340-349. Assuming, however, for purposes of illustration, that the district selector shown in Fig. 4 and associated with relay 340 is idle and in position 3, while at the same time other trunks in the same group are also idle, then the circuit through relay 340 and others in the group corresponding to said idle trunks is closed and if two or more trunks are idle then relay 370, which is marginal, operates but the quantity of current flowing through the separate test relays 340-349 is not sufficient to cause said relays to operate. Relay 370, on operating, closes a circuit extending from ground on the right back contacts of relay 386, contacts of relay 370, lower winding of relay 360, to battery causing relay 360 to operate and lock in a circuit extending from battery through its top winding and top inner front contacts, winding of relay 386, contacts of relay 391 to ground on the middle contacts of relay 387. The operation of relay 386, opens the operating circuit of relay 360 and closes a circuit from ground on its front contacts, bottom front contacts of relay 380 to the circuit path of relay 340 as already described. Relay 340 now operates and locks in a circuit over its bottom winding and bottom contacts, bottom contacts of relay 315, winding of relay 325, back contacts of relay 391 to ground on the contacts of relay 387. Relay 325 operates, opens the operating circuit of all relays in groups 340-349 and 350-359, and closes a circuit for relay 300 extending from ground on the lower front contacts of relay 325, winding of relay 300 to battery, causing said relay to operate. Another circuit is also closed extending from ground on the lower inner contacts of relay 325, top outer contacts of the operated relay 340, No. 0 contacts of relay 300, conductor 299, to the windings in parallel of all vertical magnets of the first vertical group of outgoing trunks, that is, vertical magnets 240, 140, etc. These magnets operate and a circuit is then closed extending from ground on the contacts of relay 390, winding of relay 392, contacts of the last vertical magnet 240, conductor 210, top outer contacts of relay 360, conductor 398, No. 0 contact set of relay 190, to the winding of horizontal magnet 100. This magnet now operates and since vertical magnets 220-120 are already operated, the line contacts of the calling line A are extended to the 0-primary selector. When the contacts are closed, the ground which operated magnet 100 is further extended through its own contacts to the 0-primary selector sleeve conductor 179, winding of 0-primary selector horizontal magnet 110 to battery. Magnet 110 operates to close through the contacts of the 0-primary selector to the 0-district selector shown in Fig. 4 thereby extending the calling line to said trunk. Relay 392 operates in the circuit of magnet 100 and causes the operation of relay 394 which, in turn, operates relay 389. Relay 389 then opens the original starting circuit through relay 387, causing said relay to release, releasing thereby relay 338 and also unlocking relay 160. Relay 160 releases, causes the release of relays 130, 130', etc. and relays 190 and 150. The release of relay 190 opens the operating circuit of line horizontal magnet 100 but this magnet does not release since, in the meanwhile, and as described hereinafter, the district selector to which the calling line has been extended has advanced to a position where ground is connected from the selector to conductor 179 thereby holding both the line and primary selector horizontal magnets 100 and 110 respectively, in an operated position. With the release of relay 388, relay 250 releases, thereby releasing relays 230, 280 and the line vertical magnets 120-220. The release of relay 280 releases relay 310 thereby opening the circuit of all selector vertical magnets and further releasing the relays in the group of relays 330-339 which were operated in response to idle selectors. The line group and line start circuits are now all normal awaiting the initiation of another call in any of the horizontal groups.

It will be observed that in tracing the origination of a call from the line station in any horizontal group to the connecting primary selector and thence to the trunk selector, it has been tacitly assumed that (1) the 0-primary selector was available; (2) that two or more trunks connectible through said idle primary selector were idle, and (3) that the sender group correlated with said trunk group contained an idle sender. The first assumption was indicated by the operation of relay 330 in series with the horizontal magnet 110 of the 0-primary selector; the second condition was evidenced by the operation of the required relays in the group of relays 340 to 349 of the trunks accessible through the 0-primary selector while the third was manifested by the circuit closure of relay 315 through the contacts of at least one horizontal magnet in the 0-horizontal group of sender selectors and

the back contacts of relay 789ⁿ which is normal if two or more senders accessible through the sender selector correlated to the normal horizontal magnet are idle as more completely described hereinafter.

Obviously, there may be a variation in any one or all of these factors. There may be, for instance, no available primary selector in the horizontal group to which the calling line belongs, although the separate trunks connectible therethrough may all be idle. Also, the primary selectors may all be idle and yet all the trunks connectible therethrough may all be busy; then, again, while an idle primary selector and an idle connectible trunk thereover may both be simultaneously available, yet the sender selector group having access to the trunk group containing the idle trunk may have no available sender selector or no idle sender. In the first instance supposed the call may be either dismissed with an "all busy" signal transmitted to the calling subscriber, or said subscriber may be made to wait for a short interval until a primary selector is available. Each of the two last conditions mentioned, however, produces its own reaction by virtue of which the calling line is transferred to another primary selector with available idle trunks in trunk groups associated with sender selector groups containing free sender selectors and free senders thereover. Each of these separate conditions will now be considered in detail.

Primary selectors all busy

When relay 310 operates, one side of the horizontal magnet of each primary selector in the horizontal group of selectors available to the calling line is connected to a test relay; magnet 110 of the 0-primary selector being connected to the winding of relay 330 and magnet 119 of the 9th primary being connected to the winding of relay 339. If all of the primary selectors are busy, then ground is connected to the winding of each of their respective magnets, thereby short-circuiting the winding of each of the test relays 330 to 339, inclusive, none of which, in this case, will operate. Under such circumstances there is no primary selector outlet in the horizontal group to which the calling line is assigned and the subscriber will be supplied with a suitable tone signal (not shown) indicating the absence of an outlet for the extension of the line. The subscriber, upon hearing the tone, will restore the receiver and then try again, after a brief interval.

More than one primary selector available

The most general condition which will be met in the practice of the invention, however, will be the situation wherein some of the primary selectors appertaining to the horizontal group will be busy and some will be idle. Let it be supposed, therefore, that at the time subscriber A initiates a call, primary selectors 1 to 8, inclusive, are busy and that the first and last, that is 0 and 9th primary selectors are idle. Then, when the primary selector test is being made, primary selectors 1 to 8, inclusive, will have ground connected to their respective sleeve conductors while selectors 0 and 9 will not. Under such circumstances relays 331 to 338 inclusive, (only relays 335 and 336 being shown) of the group 330 to 339 will not operate. Relays 330 and 339, however, will operate. The circuit of relay 330 has already been traced

while the circuit of relay 339 extends from battery through the winding of horizontal magnet 119 of the 9th primary selector, conductor 179, No. 9 contact set of relay 310, winding of relay 339, to ground. Relays 330 and 339, in operating, close a previously described circuit for relay 315 provided that the group of sender selectors correlated to both primary selectors contains an available sender selector and idle senders connectible therethrough. If, however, both a sender selector and a sender accessible thereover are not available simultaneously, the circuit of relay 315 is not completed in which case, since it has been assumed that the 0 and 9th primary selectors are the only ones idle, all further operations are suspended and the subscriber is supplied with an "all busy" tone in any suitable manner.

In this connection it must be recalled, of course, that the preferred embodiment of the invention shows a pair of primary selectors correlated to one group of sender selectors, which, in turn is further correlated to other pairs of primary selectors assigned to other line groups. It is, however, just as possible to have a greater number of groups of sender selectors and to associate the trunk group or groups of but one primary selector with each group of sender selectors. Since there is one group of marking relays in the primary selector control circuit for each group of sender selectors such as, for instance, relays 315—315ⁿ for the 0-sender selector group and relays 319—319ⁿ for the 4th sender selector group, with intermediate relay groups like 316—316ⁿ etc. (not shown) for intermediate sender selector groups, then, an increase in the number of sender selector groups to equal the number of primary selectors in each horizontal line group would necessarily call for additional marking relays for the added groups. Under such circumstances, each of two primary selector test relays, as for instance, relays 330 and 339, instead of closing parallel circuits to the same sender group marking relay 315, would each close a circuit to a separate relay each of which would mark the sender selector group to which the primary selector in the line group tested by the relay is correlated. If these additional sender groups were supplied, then, in the illustration assumed, relays 330 and 339 would close circuits to separate relays like relay 315 and if the correlated sender selector groups contained no available sender selectors or idle senders connectible therethrough, neither of these marking relays would operate, in which event the calling subscriber would again receive busy tone as described.

It will be further observed that the marking circuit of each sender selector group in the primary selector control circuit comprises a group of relays 315—315ⁿ for each of said sender selector groups. The number of relays which comprise each marking circuit depends on the number of primary selector frames using the same sender selector groups; there being one relay for each frame. Each of said relays is, in turn, controlled by the test relays of the primary selector frame which said relay marks. When therefore, a calling line in any of these other frames seeks access to an outgoing trunk in a group of trunks accessible over a particular idle primary selector, say the zero primary selector, the test relay of said selector, corresponding to relay 330, will partially close the circuit of a relay, such as 315ⁿ in the sender selector marking

circuit of the sender selector group which has access to the trunk group containing the idle trunk. If the sender selector group contains an idle sender selector and an idle sender accessible
 5 thereover, relay 215ⁿ will operate and thereafter control further marking tests on its correlated frame as the already described operations of relay 315 control the marking operations on the frame under consideration.

10 Relay 330, in operating, closes a circuit for relay 370 in parallel with the separate relays of the trunk group marked by the relay group 340 to 349, as already described, while relay 339 operates and closes a circuit extending from ground,
 15 resistance 326ⁿ, inner contacts of relay 339, top middle contacts of relay 315, winding of relay 379, top inner contacts of relay 325, windings in parallel of each of the relays in the group 350—359 which appertain to a trunk group of
 20 ten trunks accessible through the 9th primary selector, to battery on a cam corresponding to cam 459 of the trunk shown in Fig. 4, in each of the trunks in said group that are idle. Assuming that there are two or more idle trunks, then
 25 relay 379 operates and closes a circuit for relay 369 from ground on the right back contacts of relay 386, contacts of relay 379, bottom winding of relay 369 to battery.

It will be observed at this point that the idle
 30 condition of the 0-primary selector and the presence thereon of more than one idle trunk accessible therethrough resulted in the operation of relay 370 while the idle condition of the 9th primary selector and the presence thereon of
 35 more than one idle trunk accessible therethrough resulted in the operation of relay 379. These relays cause the operation of relay 360 and relay 369, respectively. But, inasmuch as the locking circuit of each succeeding relay in the
 40 group of relays 360—369 is controlled through the back contacts of a relay immediately preceding, only one of the relays so operated can remain locked. And the one which will remain
 45 locked is the one whose locking circuit is undisturbed by the operation of the preceding relays in the chain. In the case here being illustrated, the locking circuit of relay 369 is
 50 opened at the back contacts of relay 360, while that of the latter is continuous through the winding of relay 386 as already described. Consequently, when relay 386 operates and opens
 55 the operating circuits of both relays 360 and relay 369, said relay 369 releases while relay 360 remains locked. With the operation of relay
 386, circuits are closed to operate the particular relays in the group 340—349 whose circuits are closed through the respective idle trunks to
 which they appertain.

Thus, if two or more primary selectors are
 60 both available and each of them contains idle trunks, that selector is chosen for the connection whose trunk group test relay, such as relay 360 for 0-primary selector or relay 369
 65 for the 9th primary selector, is nearest in electrical preference to relay 386. In the case under illustration, since it has been assumed that both the 0-primary selector and the 9th primary
 70 selector were both idle as shown by the operation of their respective test relays 330 and 339, and since both have two or more idle trunks available, as shown by the operation of relays
 370 and 379, then the 0-primary selector and an idle trunk accessible therethrough are chosen
 75 for connection to the calling line as already described. The number of relays in the group

340 to 349 which will operate depends, of course, on the number of idle trunks. But the one which will remain operated and locked, thereby marking that trunk for service, will be the one
 5 nearest in the preference in respect to relay 325, since, when the relays operate, a locking circuit for one of them will be closed extending from ground on the middle contacts of relay
 337, contacts of relay 331, winding of relay 325, bottom outer contacts of relay 315, series back
 10 contact chain in the group of relays 340 to 349, front contacts of relay 340, if it is assumed that the trunk it marks is idle, lower winding of relay 340 to battery. Relay 325 operates,
 15 opens the operating circuit of all trunk test relays in the group 340 to 349 which will now release except relay 340 of the first trunk in the group which is locked in series with relay
 325. Relay 309 operates as already described and a circuit is now closed for the primary
 20 vertical magnets as before. When the primary selector vertical magnet 240 operates, a circuit is closed extending from ground on the back contacts of relay 390, winding of relay 392, con-
 25 tacts of magnet 240, conductor 210, top outer contacts of relay 360, conductor 398, No. 0 contact set of relay 190, winding of horizontal magnet 100 to battery. Horizontal magnet 100
 30 operates and closes through the contact wires of the calling line on the 0 horizontal path which extends to the 0 primary selector. The operation of the horizontal magnet 100 further
 extends its operating ground through its con-
 35 tacts, conductor 179, winding of the 0 primary selector horizontal magnet 110 to battery. Magnet 110 operates and extends the calling line to the 0 outgoing trunk selector, after which the line and start circuit release as before.

Should there be a plurality of primary selectors available, then the one which will be
 40 chosen is that which is nearest in electrical preference as determined by the series lock-out circuit of the primary test relays 360 to 369 as already described. However, as respects the
 45 available trunks accessible through each of the free primary selectors, the selection of a trunk is not necessarily made from that primary selector which is of a preferred choice should
 50 there be two or more idle primary selectors available for the connection. The choice of the primary selector, as between two or more available ones, depends under such circumstances,
 55 on which of them has more than one idle trunk available and of those which do have more than one idle trunk then the primary selector chosen is the one which is the earliest electrical preference. A primary selector which has but one
 60 idle trunk is chosen only when all other primary trunks also have but one idle trunk each and the primary selector so chosen is, under such
 65 circumstances, then again determined by the order of electrical preference. The object in this "reserve" feature is to spread the flow of traffic to the less loaded primary selectors in
 70 periods of heavy loads. Since the entire group of 100 trunks is available to a main group of calling lines subdivided into several horizontal groups, each of which may have different traffic
 75 densities, it is obvious that some trunk groups would obtain an unequal portion of the traffic while other trunk groups would be idle or less heavily loaded. Hence, by arranging the order of traffic distribution in a manner such that when nine out of the ten trunks available through one primary selector are busy, the suc-

ceeding call can be transferred to a primary selector which has more than one of its accessible trunks available, traffic is distributed evenly throughout the entire trunk group. This feature works as follows:

Let it be assumed for the purpose of illustration that primary selectors 1 to 8 are again busy, that primary selector 0 has but one trunk available, let us say trunk 0; that primary selector 9 has more than one trunk available and that further, the sender group correlated to said two primary selectors has available sender selectors and senders. Then, when subscriber A initiates a call, primary selector test relays 330 and 339 both operate, each in the manner previously described, and relay 315 operates in consequence of the availability of a sender selector and sender, and thereafter locks. Since the operation of relays 330 and 339 signifies that both primary selector 0 and primary selector 9 are available for extending the connection, two separate trunk group test circuits are closed, namely, that controlled by relay 360 and the individual test relays 340 to 349 testing the individual trunks available through primary selector 0, and that controlled by relay 369 and the individual test relays 350 to 359 testing the individual trunks available through primary selector 9. Now, it has been assumed that primary selector 0 has but one trunk idle, that is trunk 0, marked by relay 340; hence a circuit is established extending from ground, resistance 326, upper contacts of relay 330, top inner contact set of relay 315, winding of relay 370, top outer contacts of relay 325, top winding of relay 340 of the 0-trunk, conductor 397, battery on cam 450 of the idle 0-trunk. Relay 370, however, is marginal in that, when connected in series with but one relay of the associated group of individual test relays 340—349 and resistance 326, the quantity of current flowing through circuit is not sufficient to operate it. Neither, of course, does relay 340 operate.

But while the trunk group test circuit of the trunks available through primary selector 0 is in progress and results in the circuit operations above described, the group test circuit of the trunks available through primary selector 9 concurrently operates, for a circuit path was simultaneously completed extending from ground, resistance 326, inner contacts of relay 339, bottom inner contacts of relay 315, winding of relay 379, top inner contacts of relay 325, through the separate windings, in parallel, of all relays 350 to 359 of the separate idle trunks in the group accessible through primary selector 9, to battery on cam 450 in each of the separate trunks. According to the assumption, this group contains more than one idle trunk and hence two or more parallel circuits are closed through the separate trunk marking relays in the group of relays 350—359 and the combined current, all flowing through the winding of relay 379 is sufficient to cause said relay to operate. Relay 379 operates relay 369, which, in turn, locks in a previously described circuit which causes the operation of relay 386. The operation of relay 386 then causes the closure of previously described circuits for operating the preferred relay in the group of relays 350—359 corresponding to an idle trunk and further causes the operation of relay 325 as previously described. Relay 369 also closes the circuit of horizontal magnet 109 in the manner described for horizontal magnet 100 thereby

locking the calling line to primary selector 9 through which the line is further extended to the idle trunk appertaining to the relay in the group 350 to 359 which was locked in series with relay 325. In this manner, the selection of the one available trunk in a preferred primary selector is avoided if there are two or more idle trunks accessible through any other available primary selector thereby distributing traffic evenly to all groups.

If it should happen that all trunk groups available through the separate idle primary selector each have but one trunk available, then the line is switched for connection to the idle primary selector which is first choice in the preference arrangement of primary selectors. This is accomplished as follows: Let it be assumed that all sender groups have available sender selectors and senders. Then, when all trunk groups accessible through each primary selector have but one trunk idle, and all corresponding primary selectors in the horizontal group containing the calling line are available, the primary selector test relays 330 to 339 operate. Then the simultaneous group test conducted through relays 370 to 379 will cause a failure of each of these relays to operate as already described since each of these relays will not operate in series with a resistance such as 326 and one trunk marking relay. It will be observed, however, that at the time relay 387 operated, relays 320 to 324 inclusive, operated and their operation served to remove the short circuits which normally exist about each resistance such as resistance 326 controlled through a set of contacts on each of the primary selector test relays 330—339. It will also be remembered that the trunk group test is made with each of these short circuits removed. Now when all the relays 315 to 319, inclusive, operate in response to the availability of the sender selector groups which they mark, the circuits of relays 320 to 324 are opened. These relays, however, are slow to release and will remain in their operated position after the opening of their respective circuits for a length of time sufficient to test the ten trunk groups by means of relays 370—379. By the time relays 320 to 324 release, either some primary selector and a trunk in the group accessible through it has been selected as evidenced by the operation and locking of some one relay in the group 370 to 379, or each trunk group has tested busy, either because all of the trunks are busy and no circuit closure was possible for the group test relays 370—379, or all the trunks but one in each group are busy, in which case no relay in the group 370 to 379 has operated since, as already described, relays 370—379 are marginal and do not receive sufficient current in a circuit which consists of the winding of a trunk test relay, its own winding and the resistance controlled through the contacts of the operated primary selector test relay. If no group test relay is operated, then, when relays 320 to 324 release, ground is applied through their respective back contacts to short circuit each of the resistances associated with each of the relays 330 to 339, and since no group test relay has operated, no further operations take place. Therefore, when relays 320 to 324 release, resistances such as resistances 326—326^a are short circuited and the group test is made again, only this time there is no resistance in series with each of the relays 370 and 379. Since it has been assumed that all trunk groups each have but one trunk

available, the separate circuit of each of the group test relays 370 to 379 is now closed from solid ground on the contacts of relays 320—324, through the upper contacts of relays 330—339, appropriate contacts on the corresponding relays 315—319, winding of each of the relays 370 to 379, respectively, back contacts of the relays 325 to 329, through the upper winding of the one relay in each trunk group appertaining to the idle trunk in that group, to battery on cam 450 of each of the associated idle trunks. The quantity of current flowing through each circuit of the separate relays 370 to 379 is now sufficient to operate each of said relays which, in turn, causes the operation of each of their corresponding locally controlled relays 360—369. Previously traced circuits for relays 360, 366 and 340 (assuming that the idle trunk in the group accessible through the 0-primary trunk is that marked by 340) and 325 are now closed causing these relays to operate. With the operation of relay 366 and the locking of relay 360, all the other group relays 361—369 release, and the operation and locking of relay 340, as already described, causes the trunk marked by said relay to be the one chosen for connection with the calling line. The trunk selected, therefore, is the 0-trunk in the trunk group accessible through primary selector 0. Horizontal magnets 100 and 110 are now operated for extending the line to the available trunk, while all of the relays associated with the line, start and sender group start circuits are released as previously described.

In the foregoing description it has been assumed that when the trunk groups are tested, their correlated sender selector groups all have available sender selectors and senders as evidenced, for instance, by the continuity of the separate circuits of each of the relays 315 to 319 marking the sender selector group correlated with each of the trunk groups accessible through primary trunks 0 to 9, respectively. In the actual practice of the invention, however, this is not necessarily true as it is possible that, although free primary selectors may have available trunks, yet no sender in the groups appertaining to the trunk group accessible over said primary selectors may be available, in which event no trunk from such group can be selected. Under such circumstances, it becomes necessary to shift the selection of a trunk to other free primary selectors which have available trunks in the trunk groups accessible therethrough and also available senders in the group correlated with said trunk groups.

Thus, if primary selectors 0 and 9, both have available trunks and the sender group correlated with said selectors and marked by relays 315 to 315ⁿ have no senders or sender selectors available, the circuit for relay 315 is not completed since said circuit is completed through the normal contacts of the horizontal magnet of each sender selector and the normal contacts of relays 789—789ⁿ which are operated when all the senders available through said selector are also busy, there being one such relay such as relay 789 for each group of senders available through each sender selector. The failure to operate relay 315 precludes all possibility of testing the trunk groups accessible through primary selectors 0 to 9 and identified by relays 370 and 379 since, as already described, their respective circuits are controlled through the operated contacts of relay 315.

But if, at the same time, any other two trunk

groups, say the trunk groups associated with primary selectors 4 and 5 do have available senders in the correlated sender group identified by relay 319, then the circuit of this relay would be closed over a path controlled over conductor 396, through the back contacts of all magnets of idle sender selectors in the 4th sender selector group and the back contacts of relays 789 and other similar relays which would be normal if all the senders available through the particular selectors are not busy, conductor 501, to battery. Under such circumstances, a trunk would be selected from one of the trunk groups accessible through primary selectors 4 or 5, or through whatever other pair of primary selectors had an available sender and sender selector in the respective correlated trunk group which is nearest in electrical preference with respect to the selection of such sender selector groups as determined the chain preference circuit of relays 370—379. Once the available sender selector groups are determined, then the selection of the trunk groups is determined by the preference selection circuit of the group of relays 370—379. Actual trunk group and trunk selections are then carried out as described above.

Sender selection

Let it be assumed that trunk 0 is connected to the subscriber's line over primary selector 0. The sender selector group marked by relay 315, according to the above described operations, has available sender selectors and senders in it; otherwise a trunk accessible through primary selector 0 (or primary selector 9) could not have been selected. When relay 325 operates, it closes a circuit extending from ground through the winding of relay 390, the winding of relay 391, top outer contacts of relay 325, conductor 605, bottom winding of relay 500, conductor 503, back contacts of relay 700, back contacts of relay 701, winding of relay 702 to battery. Relay 500 operates, locks in a circuit extending from battery through its upper winding and bottom contacts, conductor 503, over the back contacts of the normal lock-out relays of other sender groups, such as relay 600, conductor 601, winding of relay 700, back contacts of relay 701, to battery through the winding of relay 702. Relay 700 operates and opens the operating circuit of all relays 500—600, so that, during the interval when relay 500 is operated, no other lock-out relay in other sender selector groups can operate. Relay 500, over its top outer contacts, closes an obvious circuit for relay 501 which operates and partially closes the paths for ten groups of horizontal magnets 510—510ⁿ to 519—519ⁿ, inclusive, one group for each one of the ten primary sender selectors of the 0 sender selector group, while over its top inner contacts, relay 500 partially prepares circuits to the vertical selecting magnets 520—529, intermediate groups of vertical magnets groups 530—539 inclusive.

In the meanwhile, the operation of relay 700 closes a circuit extending from battery through the winding of relay 702, back contacts of relay 701, front contacts of relay 700, winding of relays 710—719 in parallel, top inner contacts of relay 720—729, respectively, to ground. Relays 710—719 operate and remove the short circuit around the respective resistances 730—739. With the relay 501 operated, the winding of each test relay 740—749 is connected to the test conductor of each sender selector in the

0 sender selector group in the vertical contacts of which terminate each of the trunks in the groups accessible through primary selector 0 and primary selector 9, as well as other trunk groups belonging to another main group of 100 trunks serving other main groups of subscribers' lines. If any of the sender selectors in this group are busy with a connection between a trunk terminating thereon and a sender accessible through said selector, such a selector will have ground on its sleeve conductor. Those which are not busy and, therefore, available, do not have ground connected to their respective sleeve conductors and consequently cause separate circuits to be closed between the winding of each horizontal magnet 510—519 and the winding of corresponding test relay in the group of relays 740—749; a typical circuit being one between magnet 510 and relay 740 which extends from battery, through the winding of horizontal magnet 510, No. 0 contact set of relay 501, conductor 505, winding of relay 740 to ground, causing thereby the operation of relay 740 but not that of magnet 510. In the same way, all other idle sender selectors cause the operation of their corresponding test relays. If it is assumed that the first or 0 sender selector is idle, then relay 740 is operated as just described and a circuit is further closed extending from ground through the outer contacts of relay 740, top winding of relay 720, back contacts of relay 750 to battery. Relay 720 operates, closes a locking circuit for itself over its bottom winding and bottom inner front contacts, back contacts of other relays such as relay 720ⁿ in a series chain, winding of relay 750 to battery. Relay 750 operates and opens the operating circuit of all the relays 720—720ⁿ.

In this connection, it will be noted that there is more than one relay 720 supplied for controlling the circuits relating to the establishment of a connection over a 0 primary selector, such as for instance, 720ⁿ and that a similar provision is made for each of the other selectors, such as for instance, relay 729ⁿ. The reason for this is due to the fact that the senders which are accessible through each of the sender selectors available through the five sender selector groups, may likewise be multiplied for the use of other groups of sender selectors which are, in turn, connectible to other primary selectors serving entirely different groups of trunks. But due to the quantity of traffic which is handled by this other trunk group, a separate sender group may not be justified in which event one sender group may be used in common by more than, say, five groups of sender selectors. Each additional group of sender selectors, and the separate selectors therein corresponding to the numerical order of selectors in corresponding groups, would have a cut-in relay such as relay 720ⁿ or 729ⁿ operated from the contacts of a corresponding test relay of the control circuit of said other sender selector group and its operation would then serve to connect the calling trunk with a chosen sender by operating the horizontal magnets of the appropriate sender selector through which such connection can be established.

The operation of relay 720 opens the circuit of relay 710 but this relay, being slow release, does not release immediately, whereupon a circuit is closed, extending from ground through the non-inductive resistance 730, top inner contacts of relay 740, top outer contacts of relay

720, winding of relay 760, back contacts of relay 770, through the winding of each of the respective relays in the group 780—780ⁿ, to battery on the back contacts of the corresponding relays 781—781ⁿ. Relays 781—781ⁿ, 783—783ⁿ and similar groups of relays (not shown) are test relays each of which is connected to an individual sender available over similar sender selectors in the different groups and the operated or non-operated condition of each of the said relays marks the associated sender as busy or idle respectively. Each of the relays in the group 781—781ⁿ appertains to a sender in the first or 0-primary sender selector in each horizontal group while each of the relays in the group 783—783ⁿ appertains to a sender in the last or 9th primary sender selector in each horizontal group.

Now the trunk circuit which has been assumed to have been marked for the connection, namely, the 0-trunk, appears in the first or 0-group of ten sender selectors, which fact was indicated by the operation of relay 500. That is to say, by virtue of the fact that the connection of a selected trunk can be extended to a sender through any one of ten possible horizontal paths, it may have accessibility to any one of the idle senders available through any one of said sender selector paths. And at the time the test of each horizontal path was made over a circuit connection between the horizontal magnet and its corresponding test relay (such as magnet 510 and relay 740 as already described) the number of idle sender selectors was determined which, in turn, indicated that the selector testing idle was free. Consequently, the number of relays in the group 740—749 which was operated at the time the selector test was made indicated the number of such selectors that were idle. Each of these operated relays further closed a group test circuit through the corresponding group relays 760—769, each with its own group of sender test relays, such as for instance, relay 760 with the group of ten relays 780—780ⁿ locally controlled through contacts of relays 781—781ⁿ for testing each of the senders in the first or 0-primary selector, and relay 769 with the group of ten relays 782—782ⁿ for testing each of the senders in the last or 9th primary selector, while the same is true for the intermediate groups which are not shown.

If more than one sender is idle in each group, each of the separate group relays 760—769 will operate in parallel with the windings of the separate sender test relays in their respective groups which mark idle senders, one such circuit having been traced through relay 760 and relays 780—780ⁿ to battery on the back contacts of relays 781—781ⁿ. The separate sender test relays, however, do not operate. When the group test relays operate, they close individual operating circuits for their locally controlled relays 784—784ⁿ, one of said circuits being traced from ground on the back contact of relay 785, back contacts of relay 786, front contact of relay 760, lower winding of relay 784 to battery. Relay 784, and all the others in the group 784—784ⁿ which have had similar circuits closed, all operate. Each of them will endeavor to close a locking circuit for itself from battery through its respective upper winding and top inner front contacts, through the top inner back contacts of other relays in the group which have not been so operated, said locking circuit extending in a series chain over the back contacts of said relays

through conductor 788, winding of relay 786 to ground on the back contact of relay 785. However, in view of the fact that the locking circuit of each succeeding relay is controlled through a back contact of the relay immediately preceding, only one of those operated can lock and this relay will be the one whose locking circuit path is nearest to the winding of relay 786. If, therefore, relay 784 has operated in response to the idle condition of more than one sender in the group of senders available through the sender selector marked by the test relay 740, that is, the 0-selector, then, since relay 784 is nearest in electrical preference to relay 786, said relay 784 will lock in series with relay 786, the latter relay also operating in said locking circuit. The operation of relay 786 opens the operating circuit of all relays in the group 784—784ⁿ which will release all those which had operated except relay 784. Thus, the available sender selectors are chosen according to a definite preference beginning with the zero selector and ending with the ninth.

After the sender selector has been marked as selected and the group of senders available therethrough has also been marked both by relay 784, if the sender selector chosen is the 0-selector, an idle sender in the group accessible through that selector is then selected from among those that are idle. When relay 786 operates, it closes a circuit extending from ground on the contacts of relay 785, front contacts of relay 786, bottom front contacts of relay 784, bottom contacts of relay 770, top windings in parallel of all relays in the group 780—780ⁿ to battery on the back contacts of all corresponding relays in the group of relays 781—781ⁿ which are normal because of the idle condition of the corresponding senders they mark. The locking circuit of each of these relays is controlled through the bottom back contacts of the next succeeding relay in the group so that the operation of a preceding relay opens the locking circuit of the succeeding relay. Hence, if relay 780 is operated, said relay will lock over a circuit path extending from battery through its lower winding and front contacts, bottom outer front contacts of relay 720, winding of relay 770 to ground on the back contacts of relay 785. Relay 780 locks and relay 770 operates in series with said locking circuit, the former opening the locking circuit of all other sender test relays in the group and the latter, by opening its back contacts, opens the operating circuit of all other test relays causing them all to release.

The sender in the group accessible through the marked sender selector is thus also chosen according to an electrical preference arrangement. If the sender marked by relay 780 had been busy and, in consequence, relay 780 would not have been operated, then the test relay or test relays of other idle senders would have operated and the one whose test relay did not have its locking circuit opened by a preceding relay would lock and cause the corresponding sender to be chosen.

When relay 770 operates, it closes a circuit extending from ground through its upper contacts, winding of relay 792 to battery. Relay 792 operates and extends the windings of all five groups of vertical magnets, to the contacts of the separate test relays of all senders. Hence, when relay 780 operates, a circuit is closed extending from ground through the top inner contacts of relay 780, No. 0 contact set of relay

792, conductor 790, winding of vertical magnet 610 to battery, and in parallel therewith, the winding of each of the other vertical magnets in each vertical group, up to and including vertical magnet 540. All of said magnets operate, in preparation for closing through the selected trunk to the selected sender.

In the meanwhile, the operation of vertical magnet 610 closes a circuit extending from ground on its contacts, conductor 602, winding of relay 701 to battery and, in parallel with said winding, top outer front contacts of relay 784, conductor 505, No. 0 contact set of relay 501, winding of horizontal magnet 510 to battery and in parallel therewith to the windings of all other horizontal magnets in the selector including magnet 550. Since vertical magnets 520 and 540 are operated, the cross points of trunk 0 and the cross points of sender 0 are closed through on the common conductors of the selector, thereby establishing the required connection between trunk and sender.

When the trunk and sender are closed through, the usual operations in the sender will cause ground to be connected to conductor 561 which will replace that on conductor 560 to hold the horizontal magnets operated after the selector control circuit has released.

The operation of horizontal magnet 510 opens a contact in the number of parallel circuit paths of relay 315 so that when all of the sender selectors in the 0-horizontal group are busy, the continuity between conductors 399 and 502 is broken as a signal that no senders are available through this group.

At the time the circuit of magnet 510 was closed, another circuit in parallel with it was closed to the winding of relay 701, as already described. Relay 701 operates, opens the circuit of relay 700 and closes a holding circuit for relay 501 from battery winding of relay 702, the front contacts of relay 701, conductor 791, bottom contacts of relay 501 to the winding of said relay, holding said relay when relay 500 releases at the time relay 701 operates. This is done in order to insure that the circuit connection to the horizontal magnets is long enough to allow for the sender to operate and connect ground to conductor 561 to hold said magnets. In the meantime, the release of relay 700 causes the release of relay 500 which, in turn, releases the vertical magnet 520.

Further, when ground is connected to conductor 561 by the sender, a circuit is closed from said ground on conductor 561, winding of relay 701 to battery. Relay 701 operates and closes a circuit extending from ground on its inner front contacts, top outer contacts of relay 780, top inner contacts of relay 770, winding of relay 785 to battery. Relay 785 operates, opens the circuit of relays 770 and 786 both of which release, in turn, releasing relays 792 and 784. The release of relay 792 opens the circuit of the vertical magnets 610—540 while magnet 610, in releasing, opens the circuit of horizontal magnet 510 which is now held operated in the previously described circuit to ground on conductor 561. It further releases relay 701 which, in releasing, opens the holding circuit of relay 501 which also releases. The entire circuit is now restored to normal with the exception of horizontal magnets 510 and 550 which are holding the established connection between the trunk and sender.

The relationship between sender selectors and

sender groups accessible through said selectors contains the same "reserve" feature that is contained in the relationship between primary trunk selector and trunk groups. The operation of the circuits with respect to these features will now be described.

It will be remembered that in extending the connection to an idle sender it has been tacitly assumed that (1) the 0-sender selector in the group containing the marked trunk was available; (2) that more than one sender of the group of senders connectible therethrough were idle. The first assumption was indicated by the operation of relay 740 in series with the horizontal magnet 510 of the 0-sender selector; and the second condition was evidenced by the operation of relays in the group 781—781ⁿ which correspond to idle senders accessible through the 0-sender selector. Obviously, as respects these two conditions there may be a variation in either or both of these two factors. There may be, for instance, no available sender selectors in the 0 group which contains the tentatively marked trunk although there may be two or more senders available in each of the sender selectors comprising the group. Also, the sender selectors may all be idle and yet the selectable senders which may be reached through them, may all be busy; or again, while an idle sender selector and an idle connectible sender may both be simultaneously available yet there may be other idle sender selectors connectible to the tentatively marked trunk which have more than one sender available. Each of the last two conditions produces its own reaction by virtue of which the calling line is transferred, respectively, to another sender selector in the same group connectible to the tentatively marked trunk, or to another trunk which is connectible to the same main group of senders but through an entirely different group of sender selectors than the one associated with the tentatively marked trunk. In the latter case the previously marked trunk is dropped and another trunk is marked which is connectible to the senders by way of another group of sender selectors. Each of these separate conditions will now be described in detail.

Sender selectors all busy

If the sender selectors in the horizontal group accessible to the tentatively marked trunk are all busy, such as for instance, the ten sender selectors of the 0-horizontal group accessible to the trunk 0, then horizontal magnets 510—519 are all operated and the circuit of relay 315 is broken at each of the pair of contacts carried by said separate magnets. Consequently when the line start control circuit shown in Fig. 3 operates to test the various sender selector groups correlated with the various trunk groups, the relay 315 which tests the 0-sender selector group will have its circuit opened. The failure of the relay 315 to operate under such circumstances is a signal to the line start control circuit that a trunk in the group correlated to the 0-horizontal group of sender selectors can not be marked since there are no sender selectors available which can be used to establish a connection between a trunk which terminates on said sender selectors and the senders accessible therethrough. The line start circuit, of course, is at the same time testing other sender selector groups through the association of other relays similar to 315, such as relays 316—319 corre-

lated to other four sender selector groups and which have their circuit closures controlled through the back contacts of the respective horizontal magnets of said sender selector groups. The line control circuit then proceeds to mark a trunk in a group correlated to a sender selector group whose marking relay in the group 315—319 has operated. If more than one trunk group shows a simultaneous availability of correlated sender selector groups, then the line control circuit will mark a trunk in a preferred group as previously described.

On the other hand, the sender selectors in the 0-sender selector group may all be idle but the senders accessible therethrough may all be busy. This condition is evidenced by the fact that as each sender becomes busy, its test relay in the control circuit is operated. When, therefore, all the senders in the group accessible through the 0-sender selector of the 0-sender selector group are busy, all of the sender busy relays corresponding to senders accessible through said selectors, and consisting of relays 781—781ⁿ are all operated, each over a circuit of the character already described for relay 781. It will be observed, however, that the circuit of the marking relay 315 is not only controlled through paralleled contacts on the horizontal magnets 510—519 but is further carried over the back contacts of relays 789—789ⁿ. Consequently, when the circuit of relay 315 is being established and its circuit path is continuous through the back contacts of the horizontal magnets 510—519, then, if the senders available through the 0-sender selectors are all busy, relay 789 will be operated as already described, and the path joining conductors 399 and 502 at the back contacts of this relay is opened. The circuit of relay 315, however, has other parallel paths through the other horizontal magnets, namely through magnets 511—519. If, therefore, any sender group accessible through the corresponding sender selectors have more than one sender available therein, the group relay 789 corresponding to the group of busy relays similar to 781—781ⁿ will be normal, whereupon the circuit is then completed through the back contacts of the horizontal magnet of the idle sender selector and the normal contacts of the relay 789 allocated to the group of relays similar to relays 781—781ⁿ corresponding to the sender group available through said sender selector. As each sender group becomes busy and its corresponding group relay 789 is operated, another parallel path of the circuit of relays 315 is opened, so that when all groups are busy, all paths are opened and relay 315 can not operate. Hence, if all selectors in the group are busy, all paths are opened at the contacts of the horizontal magnets of said selectors; if all sender groups available through said sender selectors are busy, said paths are broken at the appropriate back contacts on the operated group relays 789—789ⁿ, and if all selectors and all sender groups accessible through said selectors are busy, then all paths are broken and relay 315 can not operate. Under such circumstances, the line control circuit then proceeds to mark a trunk in a group correlated to one of the other four sender selector groups, each of whose marking relay 316—319 may have operated.

If, on the other hand, all selector groups are busy and all sender groups are busy simultaneously, the circuit paths of the five marking relays 315—319 are all opened and none of these

relays can operate, in which event, an all busy signal is transmitted to the subscriber in any suitable manner. The circuit is thus guarded both by the condition when no sender selector is available in any group and when no sender groups are available through idle sender selectors.

More than one primary selector available

10 The most general condition which will be met in the practice of the invention, however, will be the situation wherein some of the sender selectors appertaining to a group will be busy and some will be idle. Let it be supposed, therefore, 15 that at the time subscriber A initiates a call, sender selectors 1 to 8, inclusive, in the zero group are busy and that the first and last, that is, 0 and 9, sender selectors are idle. Then, when the sender selector test is being made, selectors 1 to 8 will have ground connected to their respective test conductors while selectors 0 and 9 will not. Under such circumstances relays 741 to 748 (not shown) of the selector test group of relays 740—749 will not operate. Re- 25 lays 743 and 749, however, will operate. The circuit of relay 740 has already been traced while the circuit of relay 749 extends from battery through the winding of magnet 559 of the 9th sender selector, No. 9 contact set of relay 30 501, conductor 596, winding of relay 749 to ground, causing relay 749 to operate. Relay 740, in operating, closes a circuit for relay 760 in parallel with the separate relays of the sender group marked by relay group 781—782ⁿ, as already described, while relay 749 closes a circuit 35 extending from ground on its outer contacts, top winding of relay 729, back contacts of relay 759 to battery. Relay 729 operates and closes a locking circuit from ground through its lower winding, back contacts all other similar relays including relay 729ⁿ, winding of relay 759 to battery. Relay 729 locks and relay 759 operates in said locking circuit and opens the operating path of all relays 729—729ⁿ. Now if the 40 sender group accessible through the 9th primary selector, that is, the primary selector tested by relay 749 contains more than one idle sender, then a circuit is closed extending from ground through resistance 739, inner contacts of relay 749, top outer contacts of relay 729, winding of 50 relay 769, bottom contacts of relay 774 to the windings in parallel of all sender test relays in the group of relays 782—782ⁿ, which represent senders accessible through the 9th sender selector, to battery on the respective back con- 55 tacts of all relays in the group of relays 783—783ⁿ corresponding to idle senders in that group. Since it has been assumed that there are idle senders in the group accessible through the 0-primary selector and since, further, it has been assumed that there are available senders to the 9th primary selector, both relays 769 and 769 operate and the further operation of their corresponding locally controlled relays 784 and 784ⁿ 60 through a preference locking circuit finally causes the selection of a sender in the group which can be reached over the 0-primary selector as already described.

Should there be more than two sender selectors available then the one which will be chosen is that which is nearest in electrical preference as determined by the series lock-out arrangement of the lock-out relays 784—784ⁿ as already described. However, as respects the available 75 senders accessible through each of the available

sender selectors, the selection of a sender is not necessarily made from the sender selector which is of a preferred choice should there be two or more idle sender selectors available for the connection. The choice of the sender selector as between two or more available ones depends, under such circumstances, on which of them has more than one idle sender available and, of those which do have more than one idle sender, then the sender selector chosen is the one which is the earliest electrical preference. A sender selector which has but one idle sender is chosen only when all other idle sender selectors also have but one idle sender each and the sender selector so chosen is then again deter- 15 mined by the order of the electrical preference. The object of this "reserve" feature is to spread the flow of traffic to the less loaded sender selectors and thus distribute the load evenly amongst all senders. This feature functions as 20 follows:

Let it be assumed for purposes of illustration that sender selector 0 has but one idle sender, let us say sender 0, and that sender selector 9 has more than one sender available and that, further, the intervening sender selectors are all busy. Then, when the sender group marking relay 315 operates in evidence of the availability of senders and sender selectors in the group correlated with the tentatively marked trunk, 30 and the sender selector control circuit operations are initiated thereby, relays 740 and 749 both operate as already described and relays 720 and 729 operate in consequence and thereafter lock. Since the operation of relays 740 35 and 749 signifies that both sender selector 0 and sender selector 9 are available for extending a trunk terminating thereon to a sender accessible thereover, two separate sender group test circuits are closed, namely that controlled by 40 relay 760 and the individual relays 780—780ⁿ responsive to senders available through sender selector 0 and that controlled by relay 769 and the individual relays 782—782ⁿ responsive to senders available through sender selector 9. Now 45 it has been assumed that sender selector 0 has but sender 0 idle; hence, a circuit is established from ground through resistance 730, inner contacts of relay 740, winding of relay 760, back contacts of relay 770, upper winding of 50 relay 780, to battery on the back contacts of relay 781. Relay 760, however, is marginal in that when operating in series with but one relay of the associated group of test relays 780—780ⁿ and resistance 730, the quantity of 55 current flowing through the circuit is not sufficient to operate either relay 769 or relay 780 and, with the failure of relay 760 to operate, relay 784 can not operate as a result of which the operating circuit of relay 780 can not be 60 closed through the front contacts of relay 784.

But while the test of the group of senders available through the sender selector 0 is in progress and results in the operations above described, the group test circuit of the senders available through sender selector 9 simultaneously operates, for a circuit path is concurrently completed for relay 769 in parallel with the separate operating windings of the individual relays in the group 782—782ⁿ which are responsive 70 to senders available through sender selector 9. Now, according to the assumption, this group of senders contains more than one idle sender and, hence, more than one unoperated relay in the group 782—782ⁿ so that the quantity of cur- 75

rent flowing through the winding of relay 769 is sufficient to cause it to operate. With the operation of relay 769, relay 784ⁿ operates which, in turn, locks in series with relay 786 as already described; relay 786 operating in said locking circuit and connecting solid ground from the back contacts of relay 785, front contacts of relay 786, bottom contacts of relay 784ⁿ, back contacts of relay 774 to the separate windings in parallel in the group 782—782ⁿ to battery on the back contacts of relays 783—783ⁿ whose normal condition attests the idleness of their associated senders. The particular sender selected in the group marked by relay 782—782ⁿ is the one which is nearest in electrical preference to the locking circuit of relay 782 as already described. In this manner the selection of the last sender in a preferred sender selector is avoided, if there are two or more idle senders accessible through any other available sender selector, thereby causing an even distribution of traffic amongst all sender selector groups.

If it should happen that all sender groups available through the separate sender selectors each have but one sender idle, then the connection is established to the idle sender selector which is first choice in the preference selection of sender selectors. This is accomplished as follows: Let it be assumed that all sender groups available through each of the sender selectors have been one available sender and that all of the sender selectors are idle. Hence at the time the connection is extended to the sender control circuit all of the relays 740—749 will operate in consequence of the fact that all sender selectors of the 0-sender selector group are idle. Then the simultaneous group test conducted through relays 760 to 769, inclusive, will cause a failure of each of these relays to operate as already described. It will be observed, however, that at the time relay 700 operated a circuit was established for each relay in the group 710—719. These relays remain operated only so long as relays 720 to 729 are normal. As soon as they operate, however, in response to the operations of relays 742—749 the circuit of these relays is opened, but being slow-release relays, said relays will not release immediately and during the time that they remain in an operated condition the group test for available sender groups is then made as described. Should that test fail, however, and it then becomes necessary to retest the groups for the one available sender in each group, then by the time this test is to be made, relays 710 to 719 will have been released, at which time each of them will short circuit their corresponding resistances 730 to 739. With these resistances short circuited the group test through all of the groups is then made again by connecting solid ground to the winding of each of the relays 760 to 769 over a remaining path to each of the relays in the group tests which corresponds to the idle sender in that group. Since resistances 730 to 739, inclusive, have been short circuited the quantity of current now flowing through each of the relays 760 to 769, inclusive, will be sufficient to operate said relays, whereupon all of the relays in the group 784 to 784ⁿ, inclusive, will operate and close a locking circuit to the one most electrically preferred, which is to say, relay 784. When relay 786 operates in this locking circuit, as already described, a previously traced circuit for relay 780, or any other relay in the group whose circuit is completed to the normal relay in the

group 781—781ⁿ which corresponds to an idle sender, is then established, thereby marking the choice of sender 0 as the sender selected for connection to the trunk. All the other relays in other groups, of course, will not have operated since, with the locking of relay 784, all other relays in said group released.

The connection between the calling line and a sender having been established through a trunk which connects them both, the subscriber proceeds to establish the call in the known manner. The sender may be of any well known type and adapted to control selections over the particular character of selecting system used. For instance, if the outgoing trunk is of the panel type over which selections are controlled by reveritive impulses, the sender may be the kind shown and described in Patent No. 1,862,549, granted June 14, 1932 to R. Raymond and W. J. Scully. The subscriber receives the usual dial tone when the sender has become connected to his line and then proceeds to dial the proper code of digits to set the registers of the sender in accordance with the route and number of the wanted subscriber. The sender then proceeds to set the trunk selector to select the other required selectors in succession to reach the wanted subscriber.

At the time the selector is seized and its sequence switch is advanced out of position 3 in the usual manner, ground is connected to conductor 451 which serves to hold the horizontal magnets of the primary selector in an operated position; said ground being maintained so long as the connection is established, after which, as the sequence switch is advanced to normal, ground is removed from conductor 451 and said magnets are likewise restored to normal thereby freeing the primary selector for other connections.

When the sender has completed its function in establishing the required connection, ground is removed from conductor 561 and the horizontal magnets of the sender selector are also restored to normal thereby freeing the sender selector for other connections.

What is claimed is:

1. In a telephone system having subscribers' lines, outgoing trunks and primary selectors for connecting said outgoing trunks with calling subscribers' lines, each of said primary selectors having access to a plurality of trunks, a control circuit responsive to the initiation of a call by one of said lines for choosing one of said primary selectors having accessibility to two or more free outgoing trunks from which to select an outgoing trunk for connection with said line.

2. In a telephone system, a plurality of groups of lines, a group of primary selectors for each of said groups of lines, a plurality of groups of trunks accessible through each of said groups of primary selectors, a group of sender selectors for one or more of said groups of trunks, a plurality of groups of senders accessible through each of said groups of sender selectors, means responsive to the initiation of a call by a line in any of said groups of lines for connecting said line to a free trunk in any one of said groups of trunks by the selection of said trunk through a free primary selector in the group available to said line, and means for further connecting said selected trunk to a free sender in any one of said groups of senders by the selection of said sender through a free sender selector in the group of sender selectors avail-

able to the trunk group containing the selected trunk.

3. In a telephone system, the combination of a plurality of groups of lines, a group of primary selectors for each of said groups of lines, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection with said lines, and a control circuit for said lines, selectors and trunks comprising relay means responsive to the initiation of a call by a line in any of said groups for testing the condition of said primary selectors, group test means for testing the idle condition of trunks in each of said groups of trunks, and means responsive to said relay means when operated to mark free primary selectors for controlling the operation of those group test means which test trunk groups accessible over said free primary selectors.

4. In a telephone system, the combination of a plurality of groups of lines, a group of primary selectors for each of said groups of lines, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection with said lines, and a control circuit for said lines, selectors and trunks comprising relay means responsive to the initiation of a call by a line in one of said groups for testing the condition of each of the primary selectors of the group available to the calling line group, group test means for testing for the idle condition of two or more trunks in each of said groups of trunks, and means responsive to said relay means when operated to mark free primary selectors for controlling the operation of those group test means which test trunk groups accessible over said free primary selectors.

5. In a telephone system, the combination of a plurality of groups of lines, a group of primary selectors for each of said groups of lines, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection with said lines, and a control circuit for said lines, selectors and trunks comprising relay means responsive to the initiation of a call by a line in one of said groups for testing the condition of each of the primary selectors of the group available to the calling line group, group test means for testing for the idle condition of trunks in each of said group of trunks, means responsive to said relay means when operated to mark free primary selectors for controlling the operation of those group test means which test a trunk group accessible over each of said free primary selectors, and means responsive to the presence of free trunks in trunk groups accessible over said free primary selectors for selecting a trunk in a preferred trunk group of all tested trunk groups containing free trunks for connection with said calling line.

6. In a telephone system, the combination of a plurality of groups of lines, a group of primary selectors for each of said groups of lines, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection with said lines, and a control circuit for said lines, selectors and trunks comprising relay means responsive to the initiation of a call by a line in one of said groups for testing the condition of each of the primary selectors of the group available to the calling line group, group test means for testing for the idle condition of two or more trunks in each

of said groups of trunks, means responsive to said relay means when operated to mark idle primary selectors for controlling the operation of those group test means which test trunk groups accessible over free primary selectors, and means responsive to the presence of two or more free trunks in each group accessible over said free primary selectors to mark a preferred trunk group from which to select an idle trunk for connection with said line.

7. In a telephone system, the combination of a plurality of groups of lines, a group of primary selectors for each of said groups of lines, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection with said lines and a control circuit for said lines, selectors and trunks comprising relay means responsive to the initiation of a call by a line in one of said groups for testing the condition of each of the primary selectors of the group available to the calling line group, group test means for testing for the idle condition of trunks in each of said groups of trunks, individual test means for each trunk, means responsive to said relay means when operated to mark idle primary selectors for operating the group test means which tests the group of trunks accessible over said free primary selectors, means responsive to the operation of said group test means for marking a preferred trunk group, and means responsive to the operation of said individual test means of each idle trunk in said marked trunk group for selecting a free trunk in a given order of preference for connection with said line.

8. In a telephone system, the combination of a plurality of groups of lines, a group of primary selectors for each of said groups of lines, a plurality of groups of trunks accessible through each of said primary selectors for connection with said lines, and a control circuit for said lines, selectors and trunks comprising relay means responsive to the initiation of a call by a line in one of said groups for testing the condition of each of the primary selectors of the group available to the calling line group, group test means for testing for the idle condition of trunks in each of said groups of trunks, individual test means for each trunk, means responsive to said relay means when operated to mark idle primary selectors for controlling the operation of those group test means which test trunk groups accessible over said free primary selectors, means responsive to the operation of said group test means for marking a preferred available trunk group from which an idle trunk can be selected, and means responsive to the operation of said individual test means for each trunk in said marked trunk group for selecting a preferred trunk for connection with said line.

9. In a telephone system, lines, outgoing trunks arranged in groups and primary selectors arranged in groups, each of said primary selectors having accessibility to certain of said lines and to a particular one of said trunk groups, and a control circuit responsive to the initiation of a call by one of said lines comprising means for marking all free primary selectors having at least one free trunk in the trunk group accessible thereto, and means responsive to said marking means for choosing a preferred primary selector of all those so marked for the selection of a free trunk accessible thereover to connect with said line.

10. In a telephone system, the combination

of a plurality of groups of lines, a group of primary selectors for each of said groups of lines, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection with said lines, and a control circuit for said lines, selectors and trunks comprising relay means responsive to the initiation of a call by a line in one of said groups for testing the condition of each of the primary selectors of the group available to the calling line group, group test means for testing for the free condition of two or more free trunks in each of said groups of trunks, individual test means for each trunk, means responsive to said relay means when operated to mark idle primary selectors for controlling the operation of said group test means through said individual test means responsive to free trunks in the trunk group accessible over said free primary selectors, means responsive to the busy condition of all trunks but one in each of said trunk groups accessible over said free primary selectors for altering the test condition of each of said group test means to test the idle condition of the one free trunk in each of said trunk groups, and means responsive to the operation of each of said group test means when operating in response to the one free trunk in its correlated trunk group for selecting the one free trunk in a preferred trunk group for connection with said line.

11. In a telephone system, a plurality of groups of lines, a group of primary selectors for each of said groups of lines, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection with said lines, a group of sender selectors for one or more of said groups of trunks, a plurality of groups of senders accessible through each of said groups of sender selectors for connection with trunks accessible thereover, and a control circuit comprising means responsive to the initiation of a call by a line in one of said groups for selecting a free trunk in a group of trunks accessible over a free primary selector for connection with said line and for selecting a free sender in a group of senders accessible over a free sender selector connectible with the group of trunks containing said free trunk for connecting said sender with said free trunk.

12. In a telephone system, a plurality of groups of lines, a group of primary selectors for each of said groups of lines, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection with said lines, a group of sender selectors for one or more of said groups of trunks, a plurality of groups of senders accessible through each of said groups of sender selectors for connection with trunks accessible thereover, means responsive to the initiation of a call by a line in any of said groups of lines for marking free primary selectors in the group of primary selectors available to said calling line group and means responsive to said marking means for marking each sender selector group associated with trunk groups accessible over said marked primary selectors which contain free sender selectors and free senders in the sender groups accessible thereover.

13. In a telephone system, a plurality of line groups, a group of primary selectors for each of said groups of lines, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection to said lines, a group of sender selectors for one or more of

said groups of trunks, a plurality of groups of senders accessible through each of said groups of sender selectors for connection to trunks in the trunk groups associated with each of said sender selector groups, means responsive to the initiation of a call by a line in any of said groups for marking free primary selectors in the group of primary selectors available to said calling line group, means responsive to said marking means for marking each sender selector group associated with trunk groups accessible over said marked primary selectors containing a free sender selector and a free sender accessible thereover, and group test means responsive to the operation of said last means for testing the condition of trunk groups available over those marked primary selectors whose trunk groups are associated with marked sender selector groups.

14. In a telephone system, a plurality of line groups, a group of primary selectors for each of said line groups, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection to said lines, a group of sender selectors for one or more of said groups of trunks, a plurality of senders accessible through each of said groups of sender selectors for connection to trunks accessible thereover, means responsive to the initiation of a call by a line in any of said groups for marking free primary selectors in the group available to said calling line group, means responsive to said marking means for marking each sender selector group associated with trunk groups accessible over said marked primary selectors and which contain a free sender selector and a free sender accessible thereover, group test means responsive to the operation of said last means for testing the condition of trunk groups available over said marked primary selectors whose trunk groups are associated with marked sender selector groups, and means responsive to the operation of said group test means associated with trunk groups having free trunks for selecting an idle trunk from a preferred trunk group for connection with said calling line.

15. In a telephone system, a plurality of line groups, a group of primary selectors for each of said line groups, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection with said lines, a group of sender selectors for one or more of said groups of trunks, a plurality of senders accessible through each of said groups of sender selectors for connection with trunks accessible thereover, means responsive to the initiation of a call by a line in any of said line groups for marking the free primary selectors in the group available to said calling line group, means responsive to said marking means for marking each sender selector group associated with trunk groups accessible over said marked primary selectors and which contain a free sender selector and a free sender accessible thereover, group test means responsive to the operation of said last means for testing the condition of trunk groups available over marked primary selectors whose trunk groups are associated with marked sender selected groups, means responsive to the operation of said group test for choosing a free trunk from a preferred trunk group for connection with said calling line, means responsive to the selection of said trunk for connecting said calling line to said trunk by the operation of the marked primary selector having access to said trunk and other means for connecting said trunk

to said sender by the operation of the marked sender selector having access to said sender.

16. In a telephone system, a plurality of line groups, a group of primary selectors for each of said line groups, a plurality of groups of trunks accessible through each of said groups of primary selectors for connection to each of said lines, means for marking trunk groups containing idle trunks, a group of sender selectors for one or more of said trunk groups, a plurality of sender groups accessible through each of said groups of sender selectors for connection to trunks in the trunk groups accessible thereover, and a control circuit for said sender selectors and said senders comprising means responsive to the initiation of a call by a line in any of said line groups for marking a particular group of sender selectors associated with a marked group of trunks, relay means for testing the condition of the sender selectors in said group, group test means for testing for the idle condition of two or more senders in each of said group of senders, and means responsive to said relay means when operated to mark idle sender selectors for controlling the operation of said group test means for testing sender groups accessible over said free sender selectors.

17. In a telephone system, a plurality of line groups, a group of primary selectors for each of said line groups, a plurality of groups of trunks accessible through each of said primary selector groups for connection with said lines, a group of sender selectors for one or more of said trunk groups, a plurality of sender groups accessible through each of said groups of sender selectors for connection to trunks in the trunk groups associated with each of said sender selector groups, means responsive to the initiation of a call by a line in any of said line groups for marking a free primary selector and a free trunk from a trunk group accessible thereover for connection to said line, and a control circuit for said sender selectors and senders comprising means responsive to said primary selector and trunk marking means for marking the sender selector group connectible to the trunk group containing said marked trunk, relay means for testing the condition of the sender selectors in said group, group test means for testing the condition of each of said sender groups, means responsive to said relay means when operated to mark free sender selectors for controlling the operation of said group test for those sender groups accessible over a free sender selector, and means responsive to the presence of free senders in sender groups accessible over said free sender selectors for selecting a sender in a preferred sender group of all available sender groups for connection with said marked trunk.

18. In a telephone system, a plurality of line groups, a group of primary selectors for each of said line groups, a plurality of groups of trunks accessible through each of said primary selector groups, a group of sender selectors for one or more of said trunk groups, a plurality of sender groups accessible through each of said groups of sender selectors for connection to trunks in the trunk groups associated with each of said sender selector groups, means responsive to the initiation of a call by a line in any of said line groups for marking a free primary selector and a free trunk from a group accessible thereover for connection to said line, and a control circuit for said sender selector groups comprising means responsive to said primary selector mark-

ing and trunk marking means for marking the sender selector group connectible to the trunk group containing said marked trunk, relay means for testing the condition of said sender selectors, group test means for testing for the idle condition of two or more senders in each of said sender groups, means responsive to said relay means when operated to mark idle sender selectors for controlling the operation of said group test means of the group of senders accessible over each free sender selector, and means responsive to the presence of two or more free senders in groups accessible over said free sender selectors for marking a preferred available sender group from which to select an idle sender for connection to said marked trunk.

19. In a telephone system, a plurality of line groups, a group of primary selectors for each of said line groups, a plurality of groups of trunks accessible through each of said primary selector groups for connection with said lines, a group of sender selectors for one or more of said groups of trunks, a plurality of sender groups accessible through each of said groups of sender selectors for connection to trunks in the trunk groups associated with each of said sender selector groups, means responsive to the initiation of a call by a line in any of said line groups for marking a free primary selector and a free trunk from a group accessible thereover for connection to said line, and a control circuit for said sender selector groups comprising means responsive to said primary selector marking and trunk marking means for marking the sender selector group connectible to the trunk group containing said marked trunk, relay means for testing the condition of said sender selectors, group test means for testing for the idle condition of senders in each of said groups of senders, individual test means for each sender, means responsive to said relay means when operated to mark idle sender selectors for operating said group test means of the group of senders available over each of said free sender selectors, and means responsive to the operation of said individual test means of each idle sender in said group for selecting an idle sender in a given order of preference for connection with said marked trunk.

20. In a telephone system, a plurality of line groups, a group of primary selectors for each of said line groups, a plurality of groups of trunks accessible through each of said primary selector groups for connection with said lines, a group of sender selectors for one or more of said groups of trunks, a plurality of sender groups accessible through each of said groups of sender selectors for connection to trunks in the trunk groups associated with each of said sender selector groups, means responsive to the initiation of a call by a line in any of said line groups for marking a free primary selector and a free trunk from a group accessible thereover for connection to said line, and a control circuit for said sender selector groups comprising means responsive to said primary selector and trunk marking means for marking the sender selector group connectible to the trunk group containing said marked trunk, relay means for testing the condition of said sender selectors, group test means for testing for the idle condition of senders in each of said groups of senders, individual test means for each sender, means responsive to said relay means when operated to mark idle sender selectors for controlling the operation of

said group test means of the group of senders available over each of said free selectors, means responsive to the presence of free senders in groups accessible over said free sender selectors to mark a preferred available sender group from which an idle sender can be selected, and means responsive to the operation of said individual test means for each sender in said preferred sender group for selecting a preferred sender in said group for connection with said marked trunk.

21. In a telephone system having calling lines, outgoing trunks and primary selectors for associating said outgoing trunks with calling lines, means for marking a free trunk for connection with a calling line, senders, sender selectors for associating said senders with outgoing trunks and a control circuit for said sender selectors and said senders comprising means responsive to a calling line for choosing a free sender selector which has accessibility to two or more free senders from which to select a sender for connection with a trunk marked for connection with said calling line.

22. In a telephone system having trunks arranged in groups, sender selectors arranged in groups, senders arranged in groups, each of said sender selectors having accessibility to one of said sender groups and to one or more of said trunk groups, a control circuit responsive to

the selection of a trunk in one of said groups for marking all free sender selectors in the group of selectors connectible with the trunk group containing the trunk selected, and having at least two senders in the sender group accessible through each of them, and means responsive to the operation of said marking means for choosing a preferred sender selector from those so marked for the selection of a free sender in the group connectible thereover for connection with said selected trunk.

23. In a telephone system having trunks arranged in groups, sender selectors arranged in groups, senders arranged in groups, each of said sender selectors having accessibility to one of said sender groups and to one or more of said trunk groups, a control circuit responsive to the selection of a trunk in one of said groups for marking all free sender selectors in the group connectible with the trunk group containing the trunk selected, and having at least one free sender in the sender group accessible through each of them, and means responsive to the operation of said marking means for choosing a preferred sender selector from those so marked for the selection of the free sender in the group connectible thereover for connection with the selected trunk.

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