March 2, 1937. C. A. COLLINS 2,072,476

SWITCHING SYSTEM

Filed Aug. 13, 1935 5 Sheets-Sheet 1

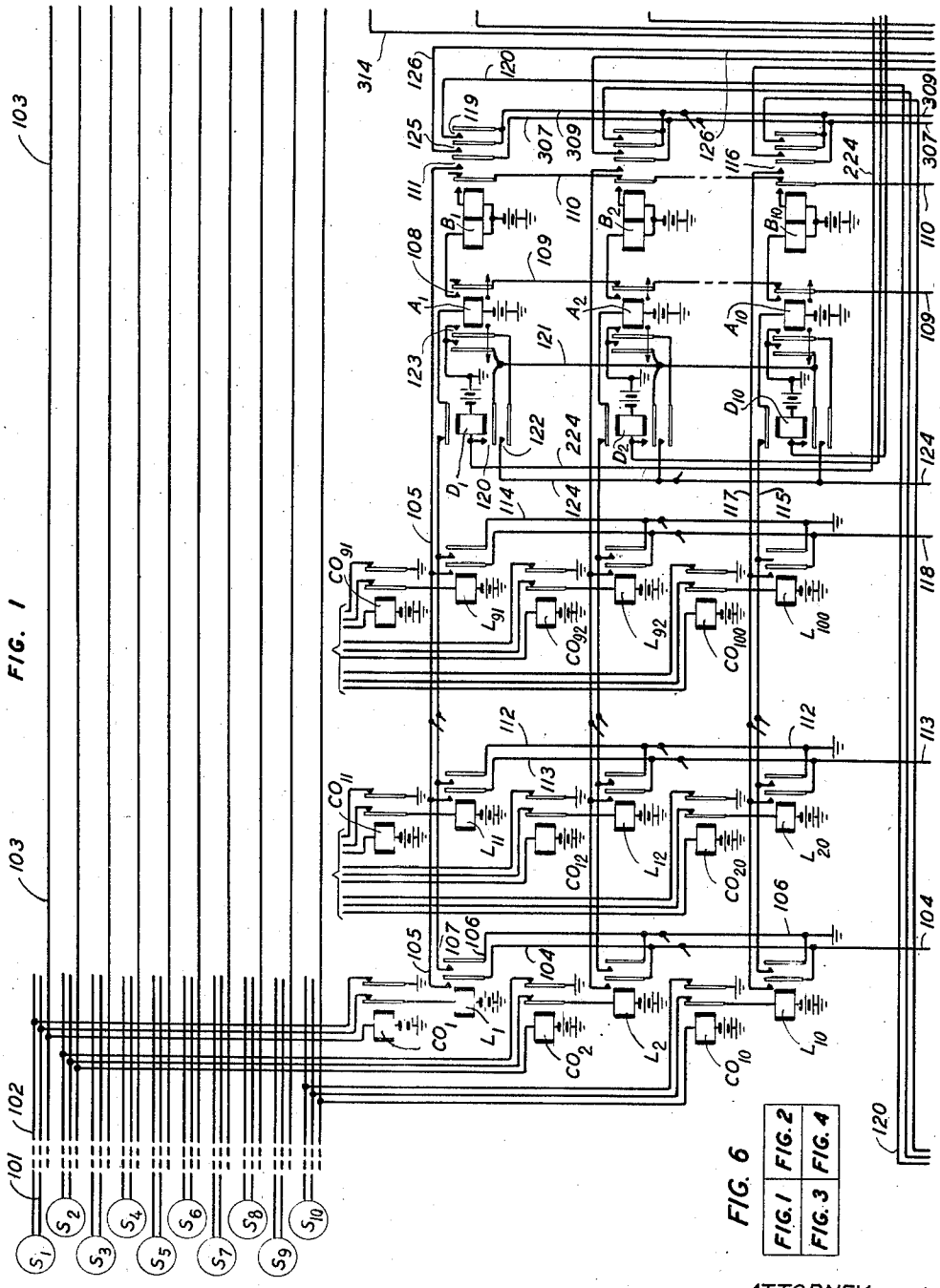

FIG. 1

FIG. 1	FIG. 2
FIG. 3	FIG. 4

FIG. 6

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SWITCHING SYSTEM

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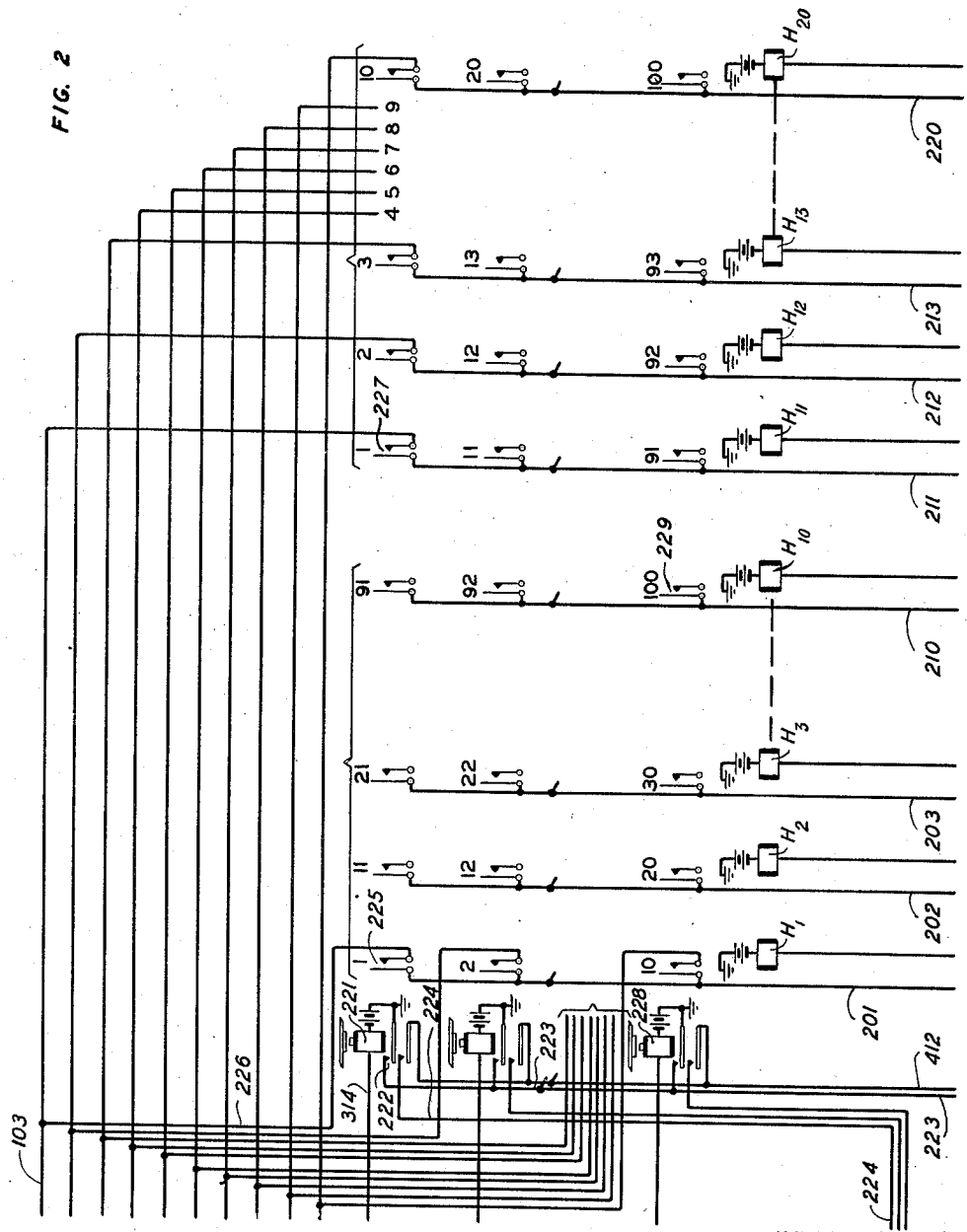
FIG. 2



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SWITCHING SYSTEM

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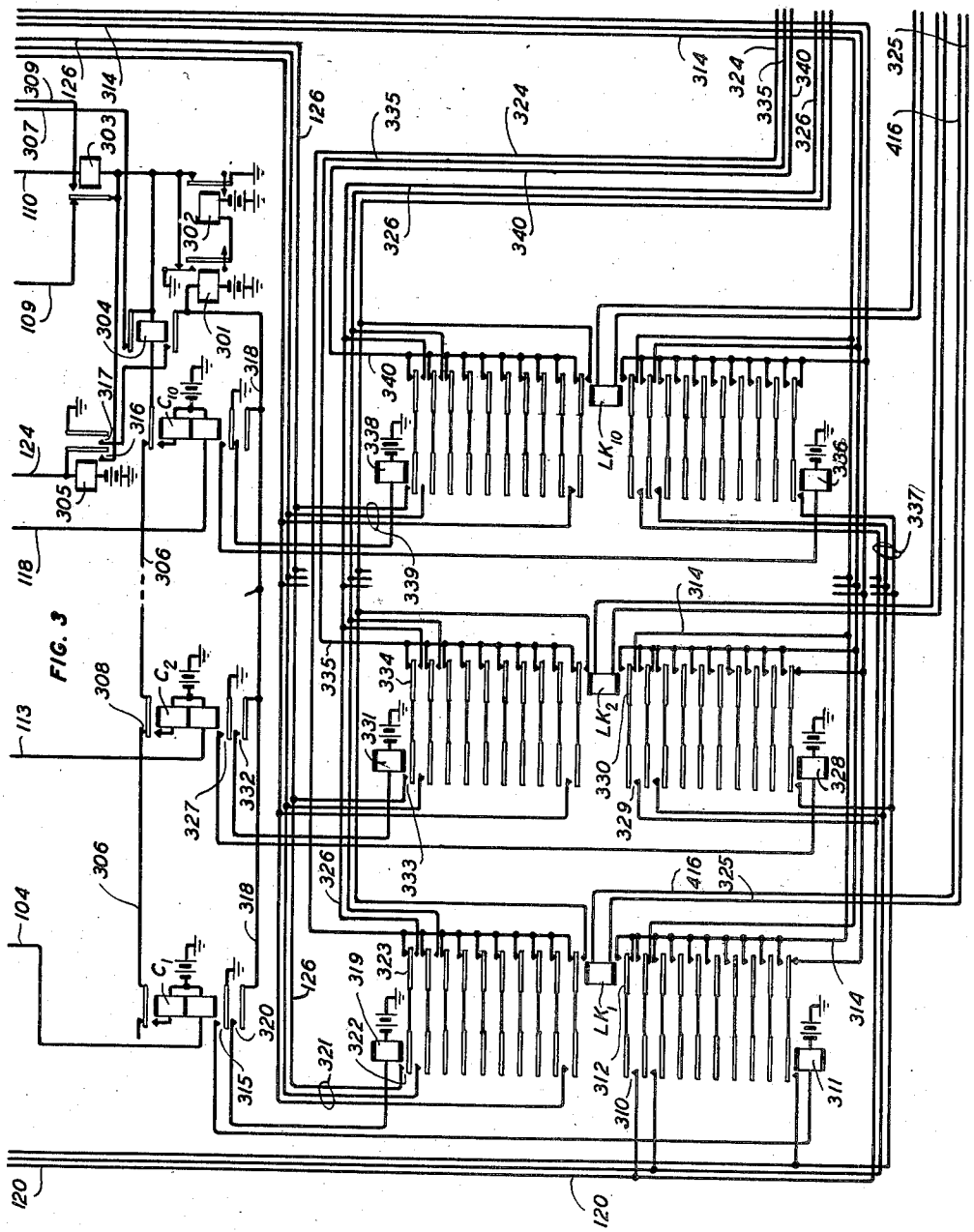

FIG. 3

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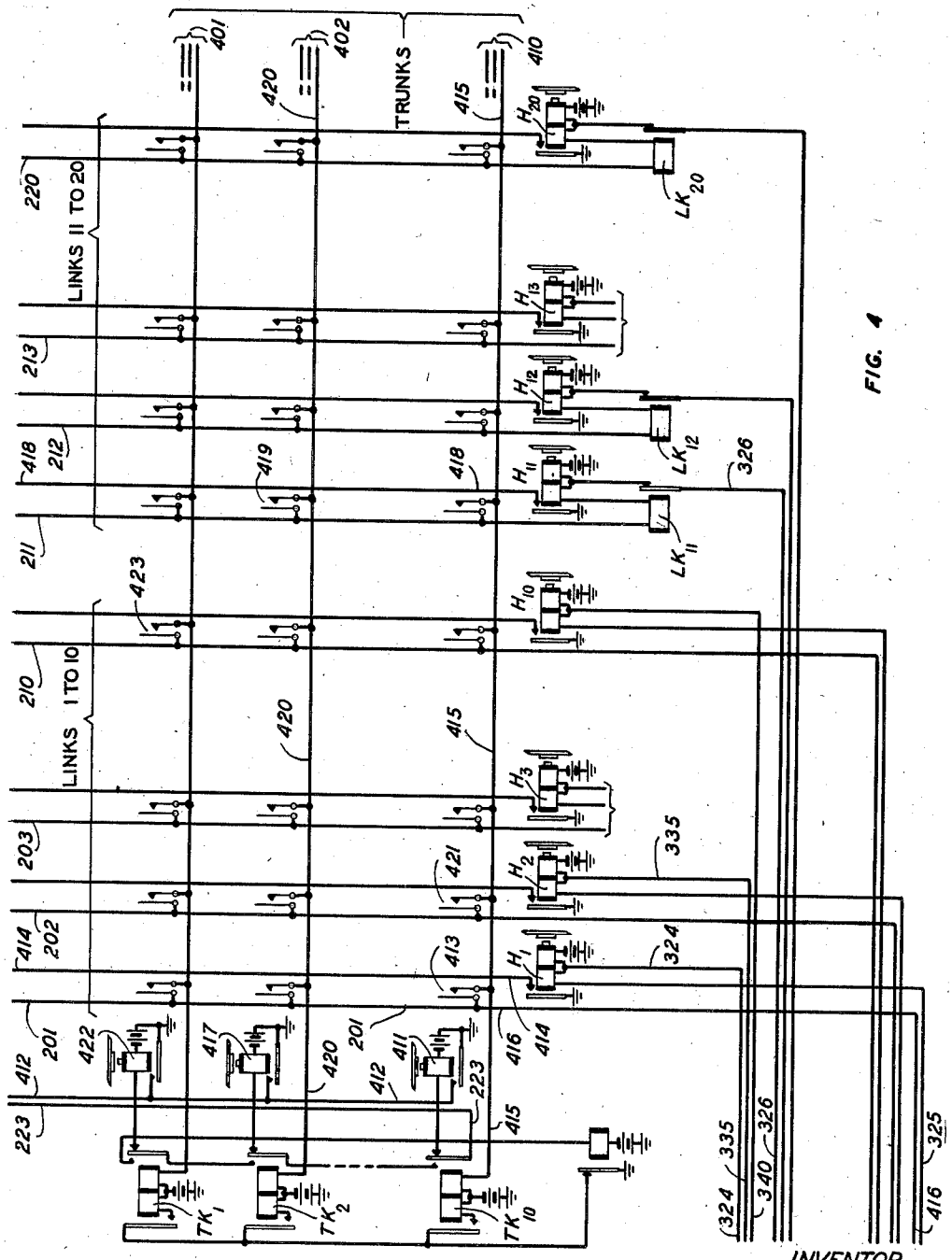

FIG. 4

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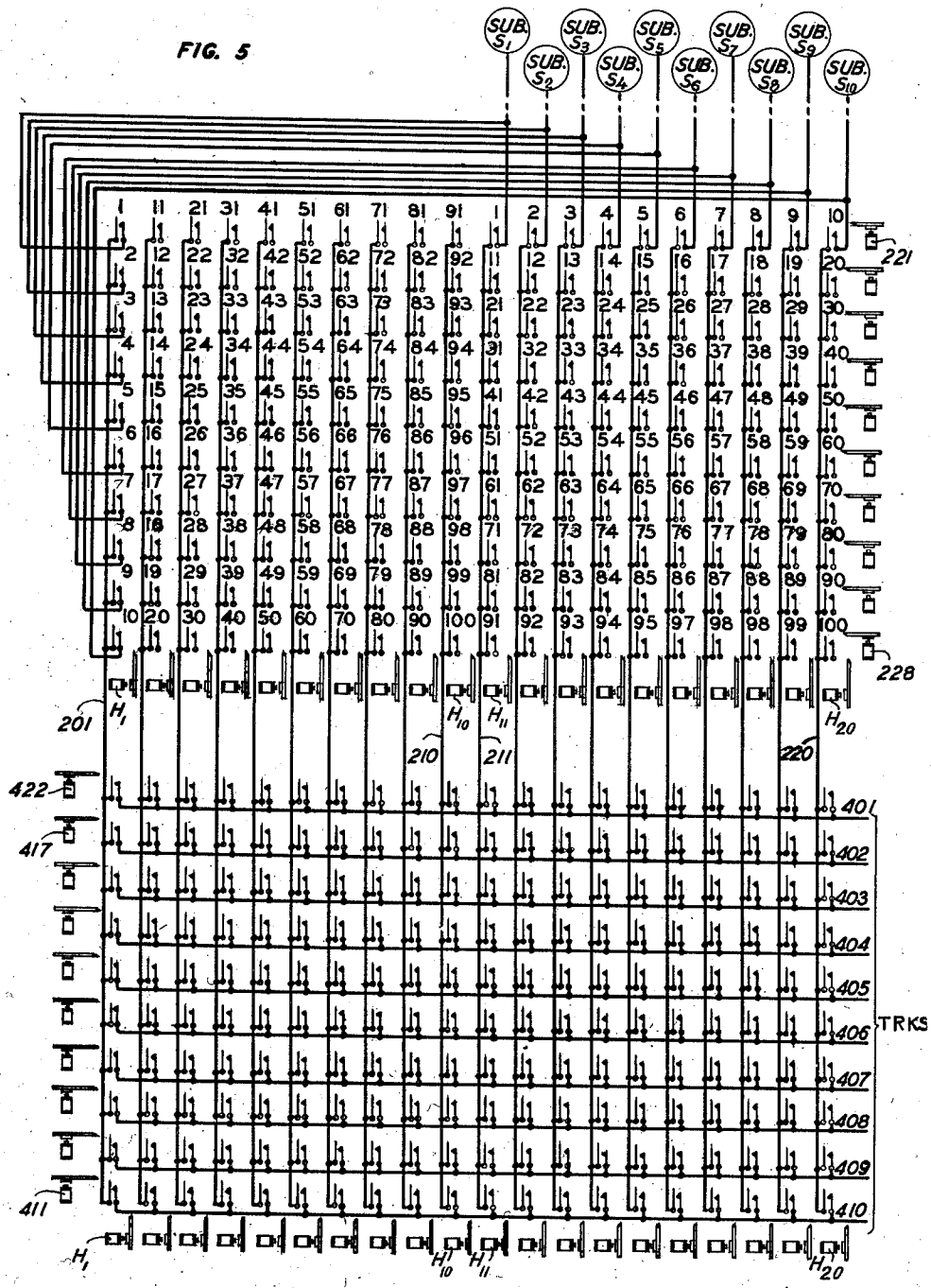
FIG. 5



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Patented Mar. 2, 1937 2,072,476

UNITED STATES PATENT OFFICE

2,072,476

SWITCHING SYSTEM

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Application August 13, 1935, Serial No. 35,925

7 Claims. (Cl. 179—18)

This invention relates to switching mechanism and particularly to switching mechanism of the type used in automatic telephone systems.

The objects of the invention are to increase the accessibility of lines or other circuits by giving each group of lines a plurality of appearances in the same switch; to enable a connection to be made involving one line in a given group without blocking calls in any other group; to enable calls to be placed in a given group without blocking other calls in the same group; and to otherwise improve systems of the foregoing character.

According to the invention these objects are attained by arranging a switching mechanism, comprising a field of circuit making contacts, in coordinate rows and by dividing the lines served by the switch in groups, each of which groups has two appearances, one in a vertical row and one in a horizontal row, and providing means for selectively operating said contacts to extend calls to said lines. By assigning a link to each vertical row, a call may be extended by any group of lines in its vertical-row appearance without decreasing the accessibility of any other group. Moreover, since each group appears in a horizontal row of contacts, other calls may be extended by said group of lines in its horizontal-row appearance, provided there are links not engaged in calls from other horizontal-appearance groups.

Another feature is a switching mechanism in which the foregoing arrangement is applied to a cross-bar switch, the contacts of said line groups in both their vertical-row and horizontal-row appearances being operated by the conjoint action of the bars of the same switch structure.

These and other features of the invention will be more clearly understood from the following detailed description, taken in connection with the accompanying drawings, and also from the appended claims.

In the accompanying drawings Fig. 5 shows the general plan of a system embodying the invention, and Figs. 1 to 4, inclusive, when placed together as indicated in Fig. 6 illustrate the details of one method of extending incoming calls to an idle one of a number of trunks leading to selector switches not shown.

The cross-bar switches shown in Figs. 2, 4 and 5 may be of any well-known type such as the specific structure described in detail in the pending application of J. N. Reynolds, Serial No. 702,453, filed December 15, 1933, granted as Patent 2,021,329, Nov. 19, 1935. While the invention is shown and described in connection with cross-bar switches, it is not so limited in some of its broader aspects but may be embodied in other kinds of switches, such as relay switches; also the invention is applicable to other switching stages, such as intermediate and final stages.

For the purpose of simplifying this description only one switch contact is shown at each cross-point in the sleeve or control lead of each line, whereas the switch in actual practice would carry 3 or more contacts at each cross-point, two contacts being required for the talking leads shown at the top of Fig. 1 The arrangement of the switches is such that any contact set is capable of operation upon conjoint displacement in definite order of the two bars, illustrated in Fig. 5, which intersect in the locality of said set of contacts. The contact sets are maintained actuated by the displacement of the last actuated one of the two bars, and they are restored to normal on the release of the last actuated bar. The first bar to be actuated in operating any given contact set is referred to as the horizontal bar and is actuated by a selecting magnet shown immediately to the left of each row of contact sets in each switch. The second bar to be actuated is referred to as the vertical bar and is actuated by a holding magnet shown directly below the vertical row of contact sets in each switch unit.

Referring first to Fig. 5, the cross-bar switch arrangement is here shown in schematic form in order to bring out more clearly the manner in which the subscriber lines are given access to incoming trunk circuits. The primary cross-bar switch in the upper portion of this figure is the same as shown in detail in Fig. 2 and provides each of the 100 subscriber lines with two multiple appearances arranged in such a way that each subgroup of 10 successive lines appears in a vertical row in the first half of the switch with direct access over a particular link to any one of the incoming trunks and in a horizontal row in the second half of the switch where the lines have access over different links to any one of the incoming trunks multipled horizontally in the secondary cross-bar switch located in the lower portion of this figure. Arranging the line multiple in this manner provides a high degree of trunk accessibility, considering the number of line appearances, because in any subgroup of 10 lines one link circuit is available for reaching any one of the incoming trunks. If said trunk is busy, then each line has a link over which the call may reach an incoming trunk. Thus if 10 incoming calls should be centered in one subgroup of 10 lines, all 10 calls will have access to

the incoming trunks over separate links and no call will be blocked unless a link is engaged on a call to some other horizontal appearance group.

Referring now to the drawings comprising Figs. 1 to 4, they show by means of the usual circuit diagrams a sufficient amount of the equipment in an automatic telephone exchange system embodying the features of the invention to enable the invention to be understood. Fig. 1 shows typical line and cut-off relays arranged to represent a group of 100 lines in which the first vertical row of relays represents lines 1 to 10. The second vertical row represents lines 11 to 20, and a third row represents lines 91 to 100, with only the multiple indicated for the intermediate relays. Also a group of control relays such as A1, B1, and D1 are shown at the extreme right of each of the 10 horizontal rows of line relays. These relays in conjunction with another group of control relays such as C1 of Fig. 3, corresponding with each vertical row of line and cut-off relays, identify the number of the line that is calling so that the trunk to which the line has access may be tested for busy, as will later be described. The control relays referred to above are further controlled or directed by relays 301, 302, 303, 304, and 305 located in the upper right corner of Fig. 3 and prevent more than one line at a time from being assigned to an idle trunk as well as direct the selection of the trunk. The system also includes two cross-bar switches, shown in Figs. 2, 4 and 5, arranged as primary and secondary switches with 20 links running vertically and connecting with 10 trunks running horizontally. The vertical row of the TK1 etc. relays to the left of Fig. 4 act as busy test relays, causing the call being connected over one of the vertical links to be directed to the first idle trunk of the incoming trunk group.

A detailed description will now be given of the manner in which an incoming call may reach any idle trunk over a particular link circuit or if said link is busy, the manner in which the call may reach any idle trunk over a different link circuit. When the usual receiver is removed at a subscriber's station, such as S1, a bridge is placed across the line conductors 101 and 102 of Fig. 1. This causes line relay L1 to operate, ground being connected to lead 102 at outside right break contact of cut-off relay CO1 and battery through winding relay L1 is connected to lead 101 at inside break contact of relay CO1. Upon operating, relay L1 at its right inner contact prepares a path for operating relay C1 by connecting lead 104 to lead 105 as later will be described. Relay L1 also closes a circuit for operating relay A1 over a path traced from ground on lead 106, right outer contact relay L1, lead 107, top break contact relay D1 to battery through winding relay A1. Relay A1 at its front contact 108 connects lead 109 to left winding relay B1. Lead 109 being a test lead running through the armatures and back contacts on other relays A2 to A10 will be open at the left back contact relay 303 if another call in the group of lines is already in the process of selecting a trunk. Assuming, however, that relay 303 is not operated, then ground from the break contacts of relays 301 and 302 will be connected through break contact relay 303, lead 109, through the break contact of relays A10 to A2 make contact on relay A1 and through left winding relay B1 to battery. Had it been assumed that simultaneous calls had originated on subscriber lines 1 and 2 or on lines 1 and 10 then relays B2 or B10, respectively, would have operated in the path previously traced, in preference to relay B1. Since a call from line 1 is being traced, relay B1 operates to close a circuit from battery through the right winding relay B1 and front contact to another test lead 110 through the armatures and break contacts on other B relays to ground through winding relay 303. Relay 303 operating, then opens lead 109 as mentioned above and prevents later calls from interfering with the handling of the call on line 1. Test leads 109 and 110 therefore control the vertical preference and permit the lowest of the calling lines in any group of 10 to search for a trunk and lock out all other lines until an idle trunk is found or until the call is timed out when another attempt will be made to select a trunk.

Before a search is made for an idle trunk for the call on line 1, it is necessary to find out in which vertical group of 10 lines the calling line is located, otherwise referred to as the horizontal preference. This is determined by the common relay 304 in upper right corner of Fig. 3 and the relays C1 to C10 inclusive, together with lead 306. Therefore, immediately after the vertical preference is determined, described in the preceding paragraph, the B1 relay closes a circuit for operating relay C1 of Fig. 3 over a path traced from ground at the top break contact relays 301 and 302, through armature and back contact relay 304, thence over multiple lead 307, contact 111 on relay B1, multiple lead 105, through operated inner contact on relay L1, multiple lead 104, and through bottom winding relay C1 to battery. Relay C1 in operating, locks to ground through its upper winding and front contact to lead 306, traced through all the top break contacts and armatures of relays C2 to C10, thence through winding of relay 304 to ground at break contacts of relays 301 and 302. Relay 304 in operating opens its own top contact which breaks the operating circuit previously traced for the lower winding of relay C1, thus preventing later calls that might originate in other groups of lines from interfering with the handling of the call on line 1. The identity or location of the calling line is thus established by virtue of the fact that only one of the B and one of the C relays, namely B1 and C1, remain operated. Before proceeding to show how this line is actually connected with an idle one of the incoming trunks, it is thought that this vertical and horizontal preference will be more clearly understood if a description is given of several other cases where more than one line originates a call at the same time.

Assuming for example that subscribers S1 and S11 lift their receivers about the same time, line relay L1 and corresponding B1 and C1 relays operate as previously described. Line relay L11 also operating connects ground that is lead 112 to lead 107. Since both relays L1 and L11 connect ground to lead 107, which path is further traced through relay A1, it is evident that only the B1 relay will operate. The vertical preference is thus determined by the B1 relay being operated, both lines being the topmost one in their respective subgroups. When, therefore, ground is placed on lead 105 at contact 111 by relay B1, a circuit is established for operating both the C1 and C2 relays, traced over lead 105 to right inner contact relay L11 and lead 113 to battery through lower winding relay C2; also traced over lead 105 through inner contact relay L1, lead 104, to battery through lower winding relay C1. In this case the locking circuit through the upper winding relay C2 is completed back over the series lead

306 to the winding of relay 304 to ground, while the locking circuit through the upper winding of relay C1 is held open at contact 308 on relay C2. Relay 304 operating thus opens at its top break contact the circuit for energizing the lower windings of relays C1 and C2, so that relay C1 releases and relay C2 remains operated. In this manner, line 11 is identified as the calling line to be handled first, and search for an idle incoming trunk will be directed by the combination of the B1 and C2 relays remaining operated, as will later be described.

Another example is assumed where subscribers S1, S11 and S100 lift their receivers nearly simultaneously, in which case relay A1 operates over lead 107 through contacts on relays L1 and L11 as previously traced. Line relay L100 also operating connects ground that is on lead 114 to lead 115, thence through top contact and armature on relay D10 through winding relay A10 to battery. The operation of relay A10 causes relay B10 to operate from ground on lead 109, and at the same time the right break contact of relay A10 opens the circuit to the armature relay A1 and prevents relay B1 from operating. The failure of relay B1 to connect ground to lead 105 prevents relay C1 and C2 from operating. On the other hand, relay B10 at contact 116 connects ground to lead 117 for operating relay C10, further traced through inner contact relay L100, lead 118, to battery through lower winding relay C10. In this manner line 100 is identified as the calling line to be handled first and search for an idle incoming trunk is determined by the combination of the B10 and C10 relays remaining operated, as will later be described.

Going back to the condition ensuing forthwith upon the identity of calling line 1 being determined by relay B1 the relay C1 remaining in an operated condition, there will now be described the manner in which a search is made for an idle trunk. Relays 303 and 304 of Fig. 3 it will be remembered are also in an operated condition at this time, which prevents interference from other lines that might originate calls. Since each calling line has two possible link paths for selecting an idle trunk, it will be assumed that the first choice path is available. Said path includes link 201 and any one of the trunks 401 to 410. It is further assumed that trunk 410 is idle. Relay LK1 of Fig. 3 and relay TK 10 of Fig. 4 therefore are normal, because if the above link and trunk were busy these relays would be in an operated condition as will presently appear. The circuits of this system are organized for positive operation by preventing the holding magnet circuit of the cross-bar switches from being closed until the selecting magnet of both the primary and secondary cross-bar switches have operated. The circuit for selecting magnet 221 of the primary switch of Fig. 2 may be traced from ground on break contacts of relays 301 and 302, to armature and front contact on relay 303 to multiple lead 309, thence through contact 119 on relay B1, lead 120, through contact 310 on relay 311 which is operated at this time, armature 312 on relay LK1 and back contact over lead 314 through winding of selecting magnet 221 to battery. In the path just traced, relay 311 is operated because the horizontal preference relay C1 connects ground at contact 315, thence to battery through winding relay 311. Selecting magnet 221 when it operates prepares a path at its bottom contact for operating relay D1 of Fig. 1 as will later be described. It also connects ground at contact 22 to lead 223 for operating one of the selecting magnets of the secondary cross-bar switches of Fig. 4, dependent on the associated incoming trunk being idle. Trunk 410 in this case being assumed to be idle, lead 223 may further be traced through the armature and back contact of relay TK10 to battery through selecting magnet 411.

The operation of selecting magnet 411 connects ground to lead 412 for causing the holding magnets H1 associated with link 201 to operate. Ground on lead 412 thus may further be traced to the bottom contact of selecting magnet 221, lead 224 through winding relay D1 to battery. Relay D1 operating, at its top break contact, opens the circuit of slow releasing relay A1, causing it to restore to normal. The slow release feature delays its release long enough to insure the operation of relay 305. At contact 120 relay D1 prepares a locking circuit for itself traced to multiple lead 121 to ground at left inner contact relays A1 to A10, as will later be explained. At contact 122 relay D1 closes a temporary path from ground at contact 123 on relay A1 to lead 124, to battery through winding relay 305. Relay 305 operated closes a locking circuit for itself through its own contact 316 to ground at back contacts on relays 301 and 302. Relay 305 at contact 317 connects ground to lower front contact relay 304, thence to lead 318 for operating timing relays 301 and 302 and operating relay 319 through contact 320 on relay C1 to prepare the 10 leads indicated at 321 for operating one of the holding magnets. Although relay 319 closes the circuit for ten holding magnet control leads, only one lead will have ground connected to it depending on which one of the B1 to B10 relays is operated. Since the call on line 1 involves the operation of relay D1, as previously described, the circuit for operating holding magnet H1 of the secondary switch of Fig. 4 may be traced from ground through operated make contact on relay 303, multiple lead 309, contact 125 on relay B1 over lead 126, through contact 322 on operated relay 319, thence through armature 323, relay LK1 and back contact over lead 324 to the mid-point of the two windings on holding magnet H1 of Fig. 4 and through the right-hand winding to battery. The holding magnet operating in this circuit extends the link 201 to the trunk 410 through cross-bar switch contacts 413. This holding magnet is also equipped with a make contact which at this time connects ground to lead 414 for operating the holding magnet H1 of Fig. 2 to battery, thus extending line 1 to the link 201 through the primary cross-bar switch contacts 225.

In the system of this invention upon connecting with an idle trunk, ground is returned over the sleeve or control lead for holding the connecting switches until the subscriber restores his receiver to the switchhook all in a manner well understood in the art. Therefore, soon after calling line 1 is extended to incoming trunk 410, ground may be traced from the trunk sleeve 415 through contacts 413, lead 416 through winding of relay LK1, lead 325, and left winding holding magnet H1 of Fig. 4 to the mid-point of the magnet windings to which direct operating ground was traced in the previous paragraph. Thus when the timing relays 301 and 302 operate as described below and remove ground from the lead connected to the mid-point of the holding magnet winding, the magnet continues to remain operated on the trunk holding ground through both windings in series. Furthermore, since the

winding of relay LK1 is included in the path just traced, relay LK1 also operates and remains operated as long as the connection is held by the subscriber, thereby transferring the trunk selecting circuits to a second set of link circuits. At this time cut-off relay CO1 also operates from ground on trunk sleeve 415, over link sleeve 201, switch contacts 225, and leads 226 and 103 to battery through winding relay CO1. Relay CO1 operating releases relay L1, this action taking place before the timing relays 301 and 302 function.

Referring again to the locking circuit for relay D1 to ground on lead 121, this feature provides a more uniform distribution of trunks to calling lines by permitting only one call at a time in a given horizontal row of lines to select an incoming trunk. That is, if some other relay such as A2 is operated when relay D1 comes to release, then ground placed on lead 121 by relay A2 prevents relay D1 from releasing and thereby at its top break contact holds lead 107 open, thus preventing the reoperation of relay A1. Therefore with any abnormal number of lines calling, the effect of this feature is to allow one call to be assigned a trunk in each of the ten groups of lines before a second call in any group may be assigned a trunk.

As described above, relay 305 connects ground to lead 318 for operating the cross-bar switch holding magnets which thus completes the connection of the line to an idle incoming trunk. Timing relays 301 and 302 therefore measure off sufficient time for completing the connection. Relay 302 being slow to operate permits the holding magnets to be operated before it disconnects ground from the hold magnet operating path traced over lead 309 etc. Relay 302 fully operated causes relay 305 to release and in turn the slow relay 301. The latter is sufficiently slow in releasing to allow the LK relay, associated with the link just made busy on the last call, to operate and prepare the system for receiving another call.

Having described the call from subscriber S1 on the assumption that the link 201 was idle, the call will now be traced on the assumption that link 201 is busy and that the next link path is available. In this case it will be observed that the second choice appearance of line S1 is in the right hand portion of the primary cross-bar switch of Fig. 2, and to reach an idle trunk it must be assumed that the link 211 is idle, which means that all cross-bar switch contacts associated with this link are open and that the holding magnets H11 are unoperated. It will be remembered that removal of the subscriber's receiver caused the B1 relay of Fig. 1 and the C1 relay of Fig. 3 to operate and mark the location of the calling line. These relays together with relays 303 and 304 remain operated until the line is connected to a trunk. When relay 303 first operated, ground was connected to lead 309 for operating selecting magnet 221 over the same path as before, due to both appearances of line S1 being served by the same selecting magnet. Operating selecting magnet 221 of Fig. 2 at its lower contact prepares a path for operating relay D1 of Fig. 1 and at contact 222 closes a ground to multiple lead 223 which extends through a series circuit running through the right hand armatures and front and back contacts of the 10 test relays associated with the 10 incoming trunks 401 to 410. Lead 223 connects first to the armature of relay TK10 but if the associated trunk 410 is busy, ground on the sleeve lead 415 operates relay TK10 and lead 223 is thereby extended to the right armature of the next relay TK9, not shown. For purposes of this description it will be assumed that trunks 403 to 410 are busy and that trunk 402 is idle. Lead 223 is thus extended to the right armature of relay TK2, thence over the back contact to battery through selecting magnet 417 associated with trunk 402. Selecting magnet 417 operating connects ground to multiple lead 412, further traced through bottom make contact on operated selecting magnet 221, thence over lead 224 to battery through winding relay D1. The latter relay as previously described supplies ground at contact 122 to lead 124 for operating 305 which starts the holding magnet selection.

Relay 305 operating, closes a ground circuit at contact 317 through lower contact and armature relay 304 to lead 318 for operating relay 319 which closes the 10 holding magnet leads indicated at 321. As previously described the ground connected to lead 309 at relay 303 is further traced through contact 125 on relay B1, lead 126, contact 322 on relay 319, armature 323 on relay LK1 and front contact to lead 326, thence through armature and back contact slow operate relay LK11 to the mid-point of holding magnet H11 of secondary cross-bar switch of Fig. 4. The holding magnet operating to battery through its right hand winding connects ground to lead 418 for operating the holding magnet H11 of the primary cross-bar switch of Fig. 2 and at contacts 419 extends the link 211 to the incoming trunk 402. The operation of the holding magnet at contact 227 extends the calling line 1 to the link 211 thus completing the connection of this line to incoming trunk 402. Relay LK11 referred to in the above circuit acts as a busy relay by opening lead 326 and preventing interference when the link 211 is engaged. According to the usual operation ground is returned by the incoming trunk over sleeve lead 420, link 211, through winding relay LK11, and left winding holding magnet H11 before ground is removed from lead 326 by the slow operate control relay 302 of Fig. 3. Relay LK11 therefore cannot operate until this ground path is opened by the operation of relay 302. The holding magnet H11 continues to be held by a circuit through its two windings and winding relay LK11 in series back to the incoming trunk holding ground. Relay LK11 being operated prevents this ground from backing up over lead 326 and prevents interference with another call that might try to select the same link.

Let it be assumed now that both subscribers S1 and S11 attempt to originate a call at the same time. As previously described, only line S11 will be identified by the control relays of Figs. 1 and 3 wherein relays B1 and C2 remain operated until a connection is established. This line, as in the case of line 1 has two different links over which it may reach any idle one of the incoming trunks, so that for the purpose of this description one path only need be traced which will be assumed to be the one over the first choice link in which the multiple of line 11 appears in the left-hand half of the switch of Fig. 2. The associated link 202 under this assumption being idle at this time means that test relay LK2 and holding magnets H2 are unoperated. Relay C2 being operated connects ground at contact 327 for operating relay 328 which prepares a path for all ten

selecting magnets of the primary switch of Fig. 2. Relay B1 being operated connects ground at contact 119 to lead 120 and through contact 329 on relay 328 for operating selecting magnet 221 traced over armature 330 of relay LK2 and back contact over multiple lead 314 and through winding of selecting magnet 221 to battery. The selecting magnet operating closes ground at contact 222 to multiple lead 223 for selecting an idle incoming trunk, assumed in this example to be trunk 410. Ground on lead 223 is thus further traced through armature and back contact relay TK10 to battery through selecting magnet 411 of the secondary switch in Fig. 4. Operation of this magnet connects ground to lead 412 for operating relay D1 and common relay 305 as previously described, which in turn connects ground to lead 318 for operating the switching relay 331 through contact 332 on relay C2. Relay 331 closes the circuits of all associated holding magnets so that ground connected by relay B1 at contact 125 to lead 126 may then be further traced through contact 333 on relay 331, armature 334 on relay LK2 and back contact over lead 335 to mid-point of windings on holding magnet H2 of Fig. 4, thence through the right hand winding to battery. Line 11 appearing in the left hand side of the switch of Fig. 2 is therefore connected to link 202 which in turn at contact 421 is connected to incoming trunk 410 similar to the manner in which line 1 was previously connected.

If as previously discussed subscribers S1, S11 and S100 originate calls simultaneously, then the control relays of Figs. 1 and 3 will identify line 100 as the line next to be served and relays B10 and C10 will remain operated until the connection is completed. Relay C10 causes the operation of relay 336 which closes the selecting magnet leads indicated at 337 and relay 338 which closes the holding magnet leads indicated at 339. These leads all connect with the armatures of relay LK10 so that if the link 210 is idle the selecting magnet leads over the back contacts will each connect with the corresponding selecting magnets on the primary switch and the 10 holding magnet leads will connect with the one lead 340 leading to holding magnet H10. Then the particular B1 etc. relay will determine which one of the ten selecting magnets is to be energized. In this example, relay B10 remains energized, therefore, selecting magnet 228 will be energized. The latter magnet connects ground to lead 223, causing one of the secondary switch selecting magnets to operate corresponding to the first trunk that is idle. If all except trunk 401 are assumed to be busy then ground on lead 223 operates selecting magnet 422 which connects ground to lead 412 for operating the holding magnet H10 similar to that described in the case of line 1. Line 100 appearing in the primary switch of Fig. 2 is therefore extended through contacts 229, link 210, contacts 423 of secondary switch and thence to incoming trunk 401.

What is claimed is:

1. In combination, a group of lines, a switch having coordinate rows of separately operable contact sets, the lines of said group being connected respectively with individual contacts in a row in one coordinate direction and also connected respectively to individual contacts in a row in the other coordinate direction, and means for selectively operating said contacts.

2. In combination, a switch having vertical and horizontal rows of separately operable contact sets, circuits appearing respectively in said vertical rows of contact sets, and groups of lines appearing respectively in said vertical rows of contact sets and appearing respectively in said horizontal rows of contact sets.

3. In combination, a cross-bar switch having a field of contacts arranged in vertical and horizontal rows, groups of lines, said groups appearing respectively in vertical rows in one portion of said contact field and in horizontal rows in another portion of said contact field, and means for selectively operating said contacts.

4. In combination, an automatic switch having a plurality of separately operable contact sets arranged in vertical and horizontal rows, operating bars individual respectively to the vertical rows, coordinate operating bars individual respectively to the horizontal rows, a group of lines appearing in the contact sets of a vertical row and also appearing in the contact sets of a horizontal row, telephone circuits connectable to said lines either through the contacts of the vertical row or through the contacts of the horizontal row in which said lines appear, and means controlled by the conjoint operation of two of said bars to selectively operate any desired set of contacts.

5. In combination, an automatic switch having a plurality of separately operable contact sets arranged in vertical and horizontal rows, vertical bars individual respectively to said vertical rows, horizontal bars individual respectively to said horizontal rows, groups of lines appearing in the respective vertical rows and also multiplied to appear in the respective horizontal rows, telephone circuits, means for operating one pair of bars to connect a particular line to one of said telephone circuits by actuating the corresponding set of contacts of the vertical row in which said line appears, and means for operating another pair of bars to connect said line to one of said telephone circuits by actuating the corresponding set of contacts of the horizontal row in which said line appears.

6. In combination, an automatic switch having a plurality of separately operable contact sets arranged in vertical and horizontal rows, vertical bars individual respectively to said vertical rows, horizontal bars individual respectively to said horizontal rows, a group of lines appearing in a particular one of said vertical rows and also appearing in a particular one of said horizontal rows, a link appearing in all contact sets of said particular vertical row, a second link having a single appearance in each of said horizontal rows of contacts, means effective if said first link is idle for operating a pair of bars to connect a line of said group to said first link through the corresponding contact set in said vertical row, and means effective if said first link is busy for operating a second pair of bars to connect said line to said second link through the corresponding contact set in said particular horizontal row.

7. The combination with a group of lines of a switch having coordinate rows of separately operable contact sets, the lines of said group being connected respectively to individual contacts in a row in one coordinate direction and multipled to appear respectively in individual contacts in a row in the other coordinate direction, and means for selectively operating said contacts.

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