May 5, 1936. J. G. FERGUSON 2,039,640

SWITCHING SYSTEM

Filed July 20, 1935 8 Sheets-Sheet 1

FIG. 1

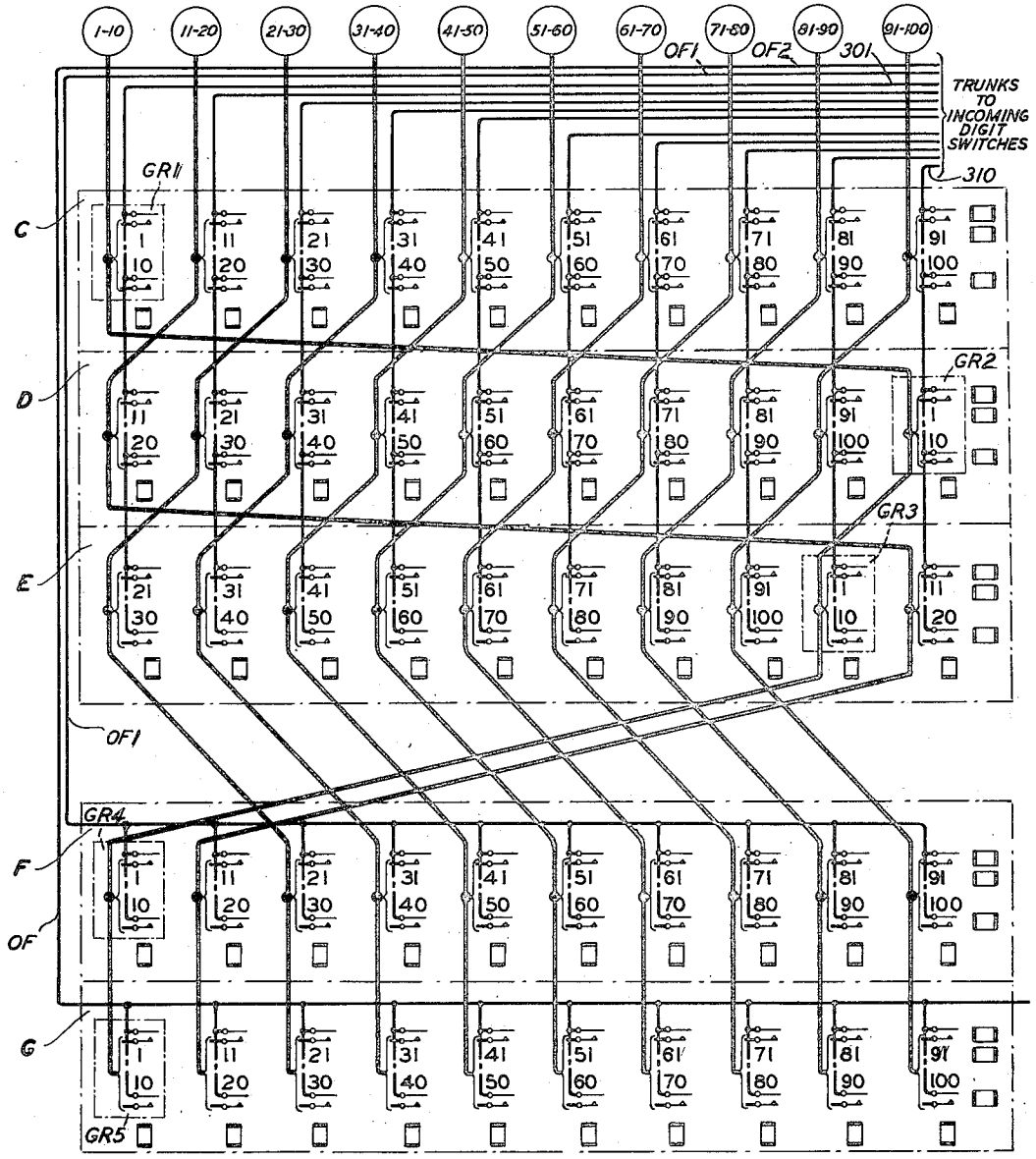

FIG. 2	FIG. 3
FIG. 4	FIG. 5
FIG. 6	FIG. 7
	FIG. 8

FIG. 9

INVENTOR
J. G. FERGUSON
BY
ATTORNEY

May 5, 1936. J. G. FERGUSON 2,039,640

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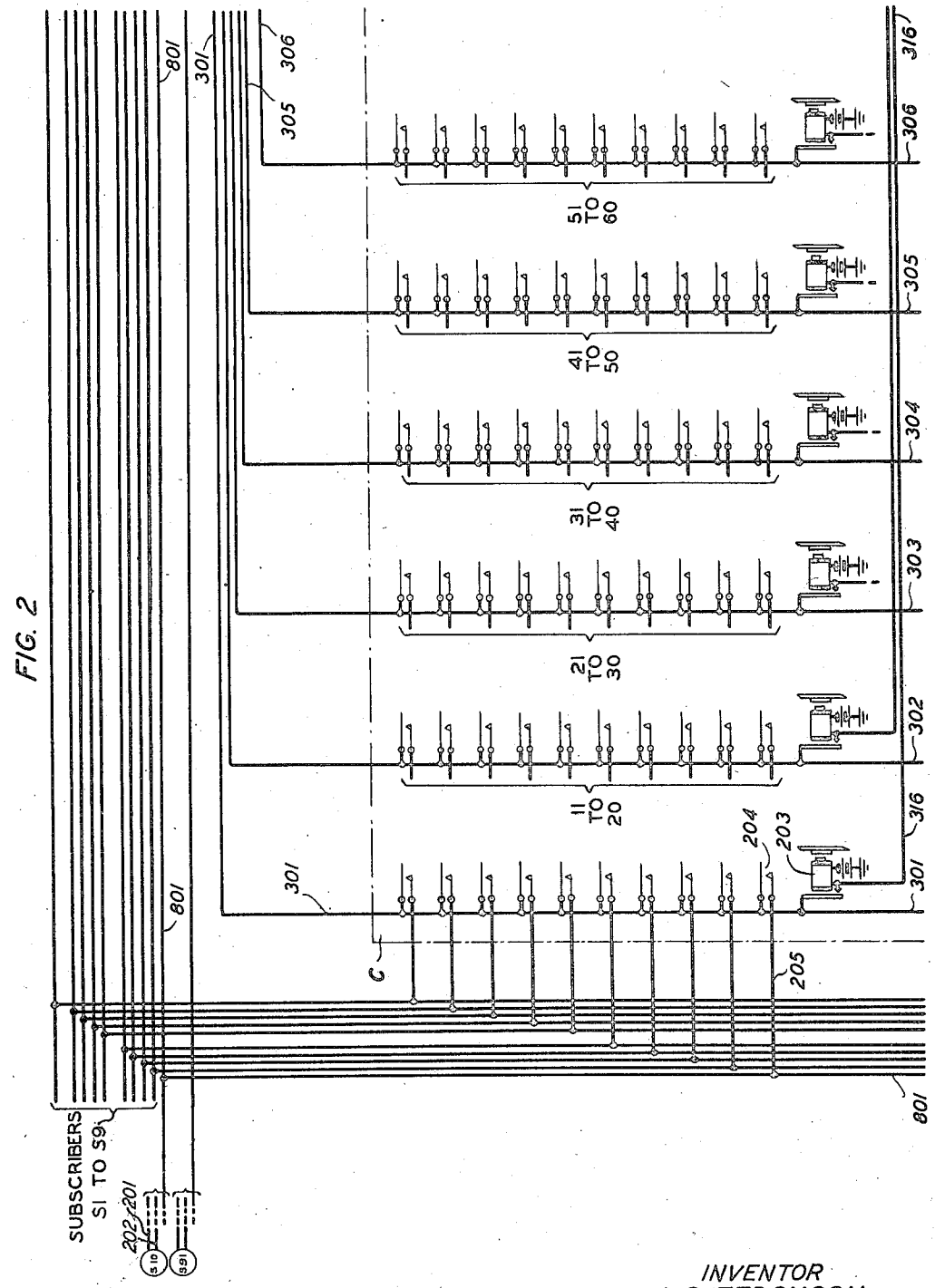

FIG. 2

INVENTOR
J. G. FERGUSON
BY
ATTORNEY

May 5, 1936. J. G. FERGUSON 2,039,640

SWITCHING SYSTEM

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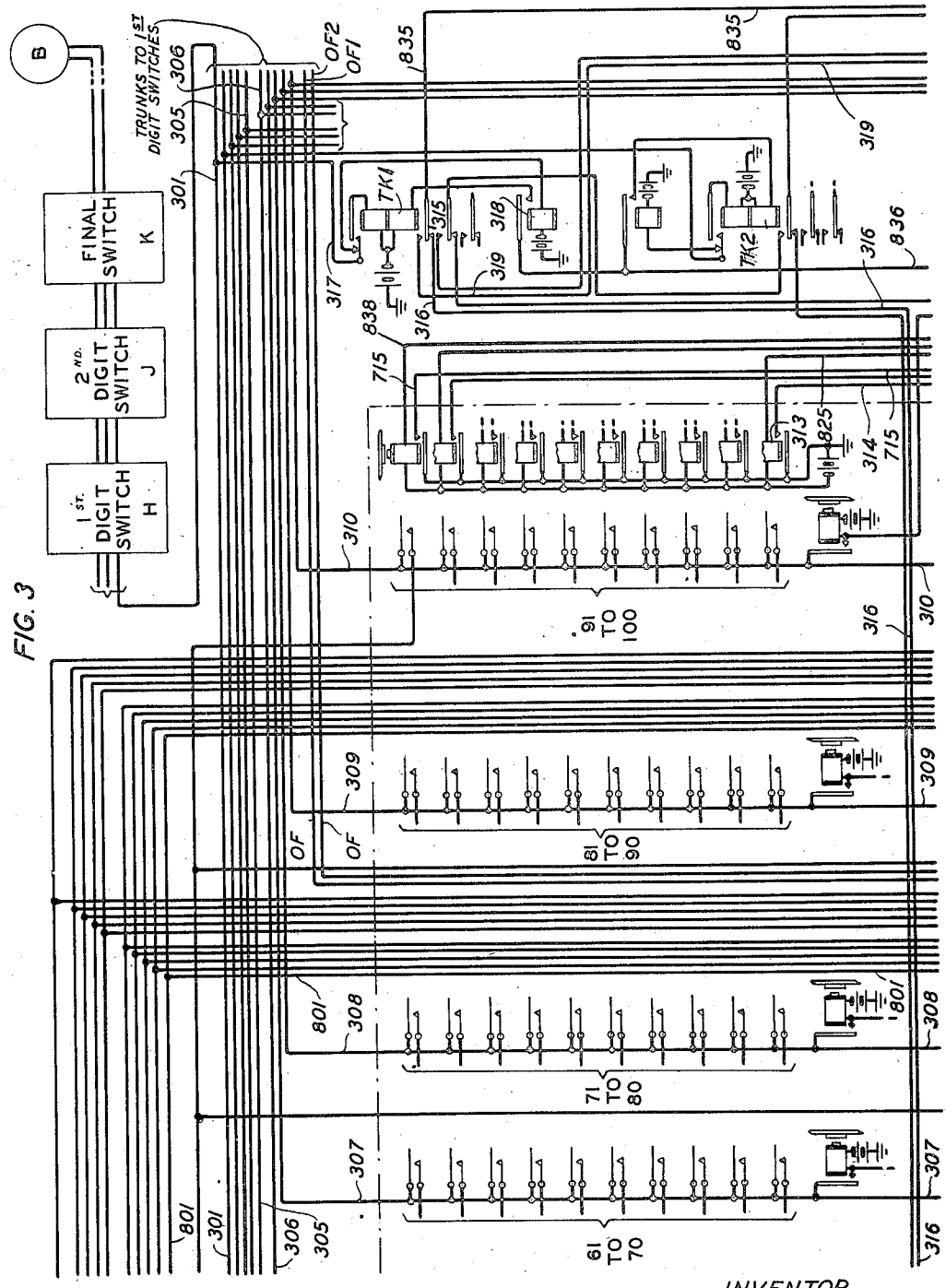

FIG. 3

INVENTOR
J. G. FERGUSON
BY
ATTORNEY

May 5, 1936. J. G. FERGUSON 2,039,640

SWITCHING SYSTEM

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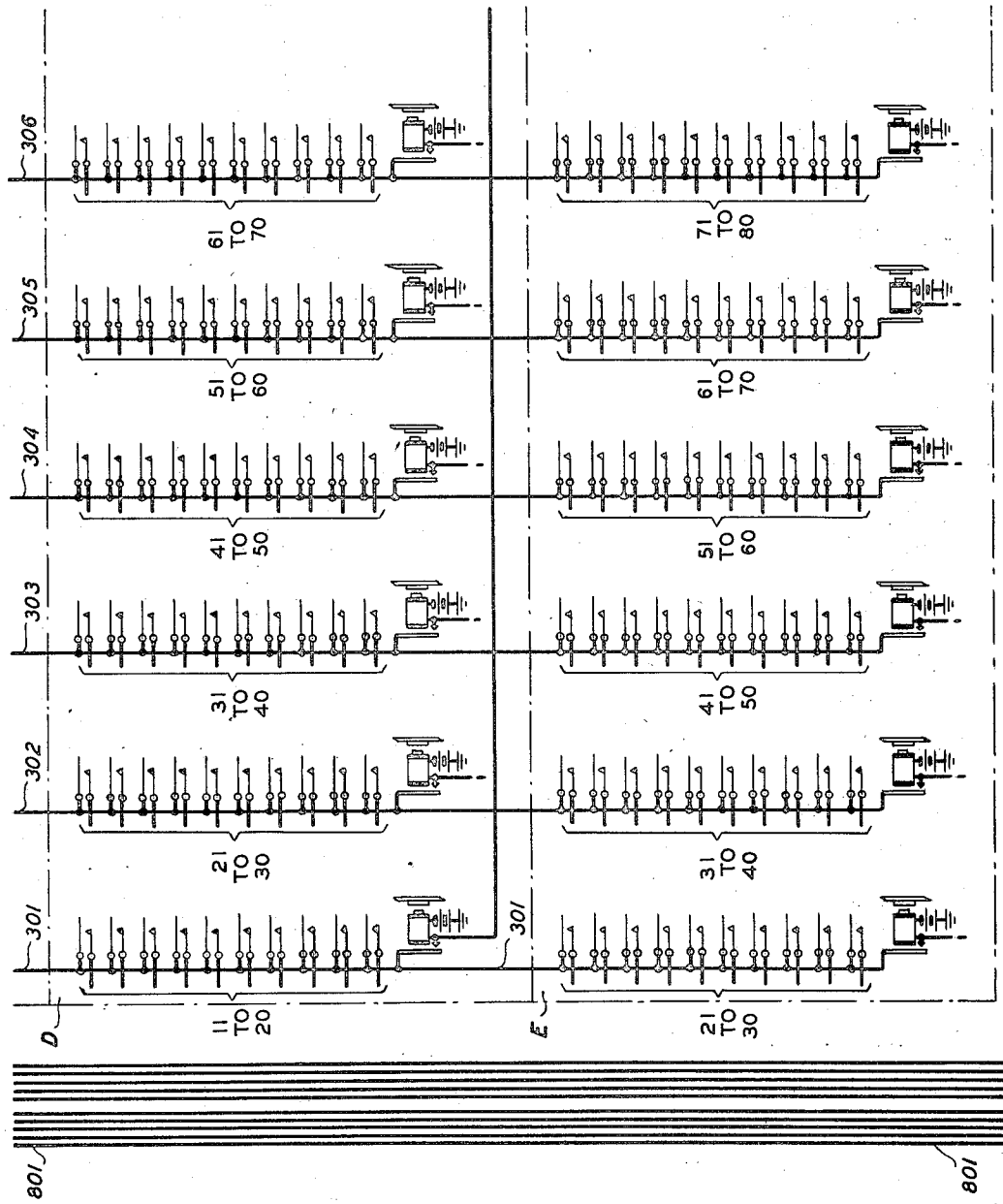

FIG. 4

INVENTOR
J. G. FERGUSON
BY
ATTORNEY

May 5, 1936. J. G. FERGUSON 2,039,640

SWITCHING SYSTEM

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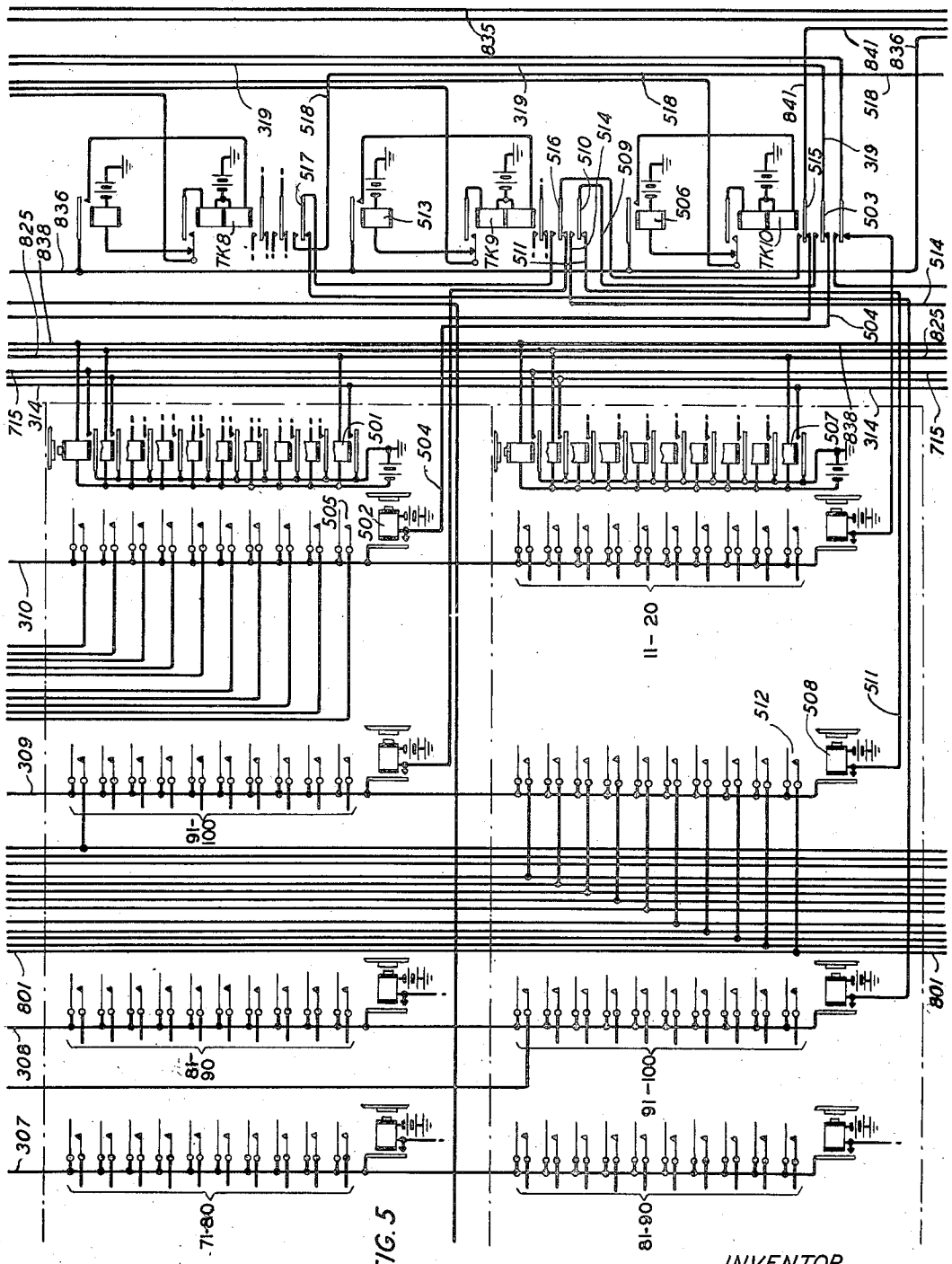

FIG. 5

INVENTOR
J. G. FERGUSON

BY

ATTORNEY

May 5, 1936. J. G. FERGUSON 2,039,640

SWITCHING SYSTEM

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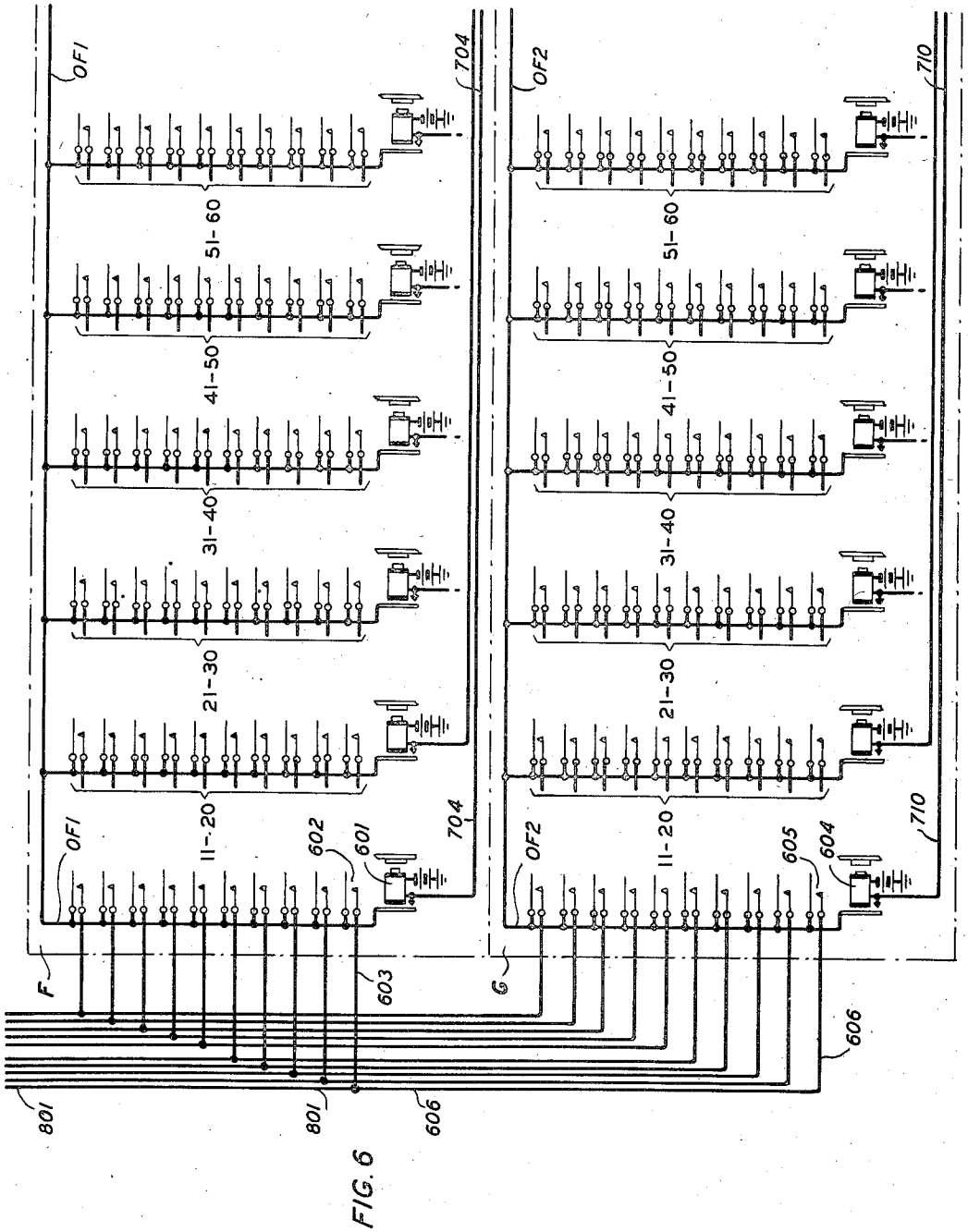

FIG. 6

INVENTOR
J. G. FERGUSON
BY
ATTORNEY

May 5, 1936. J. G. FERGUSON 2,039,640

SWITCHING SYSTEM

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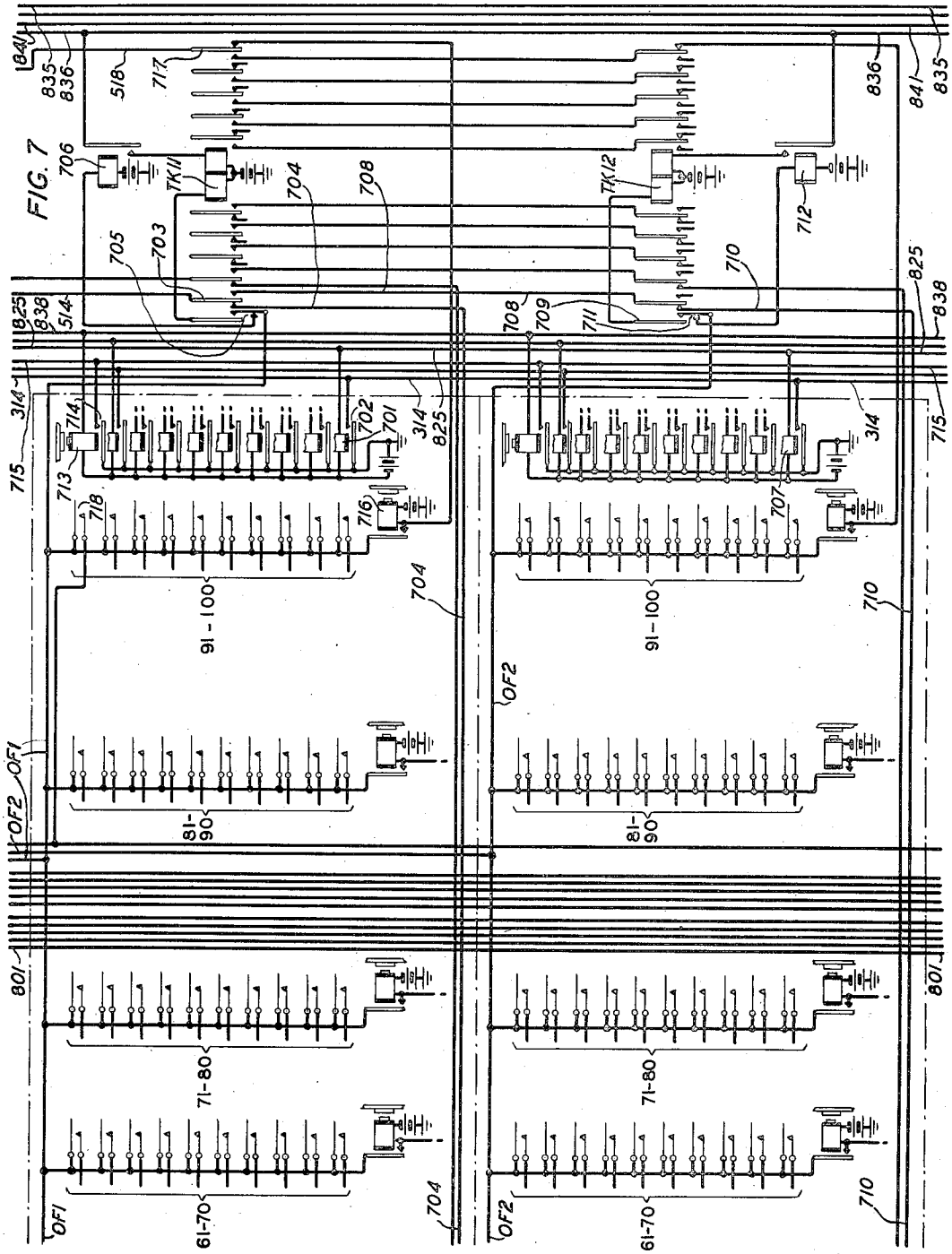
FIG. 7



INVENTOR
J. G. FERGUSON

BY M. P. McKenney

ATTORNEY

May 5, 1936. J. G. FERGUSON 2,039,640

SWITCHING SYSTEM

Filed July 20, 1935 8 Sheets-Sheet 8

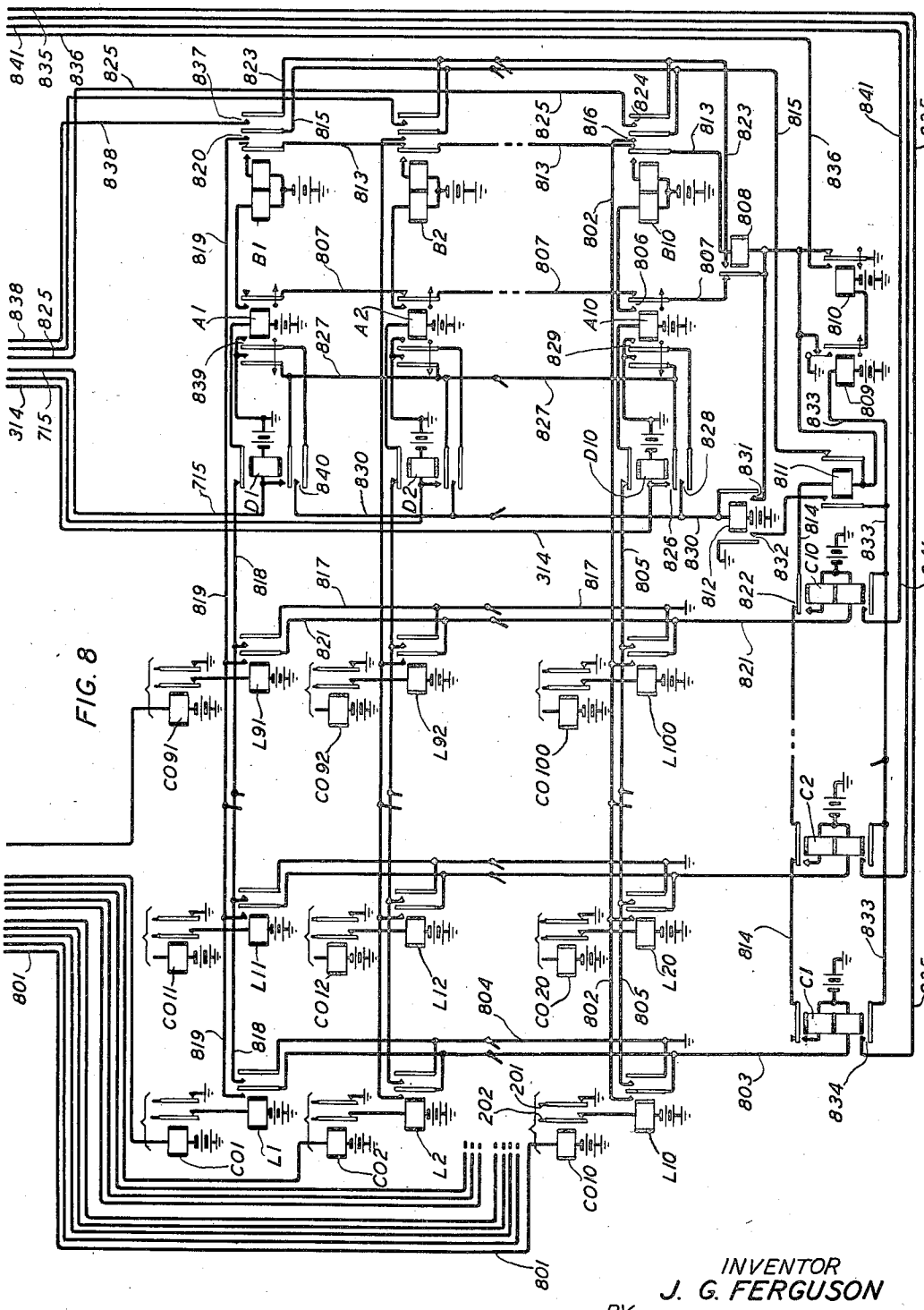


FIG. 8

INVENTOR
J. G. FERGUSON
BY
ATTORNEY

Patented May 5, 1936 2,039,640

UNITED STATES PATENT OFFICE

2,039,640

SWITCHING SYSTEM

James G. Ferguson, Rutherford, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application July 20, 1935, Serial No. 32,318

4 Claims. (Cl. 179—18)

This invention relates to switching arrangements for telephone systems and particularly to those employing switches of the cross-bar type.

The object of the invention is to reduce the amount of switching equipment necessary to handle the calls in a group of lines by giving all lines access to a limited number of regular switches and also access to a number of second-choice or overflow switches.

Heretofore systems have been devised for directing the traffic originating in a group of lines through first-choice switches if idle and through reserve or overflow switches if all of the first-choice switches are busy. The present invention contemplates the application of this principle to systems utilizing switches of the cross-bar type and the effecting of considerable economies by a novel arrangement of the lines and trunks in these switches.

According to a feature of the invention the lines of a group appear in a limited number of regular cross-bar switches and in a limited number of second-choice or overflow cross-bar switches. The several subgroups of the group appear in respective rows of contacts of each switch, each line having a single appearance in each switch, and each subgroup appearing in non-corresponding rows of contacts in the regular switches and in corresponding rows of contacts in the overflow switches. The outgoing trunks from the regular switches are multipled to all of these switches so that each trunk occupies a corresponding row of contacts in each of said switches. Each of the overflow switches has access to a single outgoing trunk, these trunks appearing in all of the contact sets of the respective overflow switches.

By this arrangement a particular line, instead of occupying all or a substantial part of the contacts in a row as is usual in cross-bar switches of the prior art, occupies a single set of contacts in a row of each of several switches, thus giving it access to a different trunk outgoing from each such switch and also permitting a large number of lines to be served by the switches.

The foregoing 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 in which Fig. 1 shows the general plan of the system, Figs. 2 to 8, inclusive, when placed together as indicated in Fig. 9, illustrate the details of one method of extending incoming calls to trunks which lead to first, second, and final digit switches.

These drawings show complete circuit connections between typical calling subscribers' lines S10 and S91 and a called subscriber's line B. The connection is completed through the medium of any one of the five cross-bar switches C, D, E, F, or G to a trunk leading to a first digit selector switch H, a second digit selector switch J and final switch indicated at K, all of any well known type, to the called subscriber B. The cross-bar switches shown in Figs. 1 to 7 may be of any well-known type, such as the one shown and described in detail in the application of J. N. Reynolds, Serial No. 702,453, filed December 15, 1933, issued as Patent 2,021,329, Nov. 19, 1935.

In the switching arrangement shown in the drawings 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 has three or more contacts at each cross-point, two contacts being required for the talking leads besides the control lead. The arrangement of switches is such that any contact set is capable of operation upon conjoint displacement in definite order of the two bars, not shown, which intersect in the locality of this set of contacts. The contact sets are maintained actuated by the displacement of the last actuated one of the two bars, and 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 right of each row of contact sets in each switch, and 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.

The trunk arrangement is shown in schematic form in Fig. 1 wherein one hundred incoming subscriber lines are divided into subgroups of ten lines with provision for assigning an idle trunk to one calling line at a time. Each subgroup has first-choice access indicated at GR1 to one of ten trunks, second-choice access indicated at GR2 to a second one of the trunks, third-choice access indicated at GR3 to a third one of the trunks. If all three trunks are busy, then the same subgroup has access, indicated at GR4, to an overflow trunk, and if said trunk is busy the group it has access, indicated at GR5, to another overflow trunk. The illustrated system includes five cross-bar switches arranged as primary switches with ten trunks to the digit switches running vertically through the first three switches and two additional overflow trunks connected one

to each of the two overflow switches shown at the bottom of Fig. 1. Arranging the line multiple in this manner provides a high degree of trunk accessibility considering the number of line appearances. If the calling rate of these lines requires it, additional switches may be added and the group slip of ten lines extended to one or more trunks before connecting with one or more overflow switches.

Figs. 2 to 5 show three regular cross-bar switches C, D and E wherein each contact provides a means for connecting an individual line with a given trunk, each line having a total of three multiple appearances. In order to control the holding magnets for these switches, the leads to the magnets are carried through what may be called trunk busy relays TK1 to TK10 located to the right of the switches. Thus, whenever a trunk is busy, 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. This ground operates the associated TK relay and thereby maintains the leads to the holding magnets always connected to those magnets that are associated with an idle trunk.

Figs. 6 and 7 show two cross-bar switches F and G wherein each contact provides means of connecting an individual line with one of two overflow trunks also leading to first digit selector switches. The two relays to the right of these switches in Fig. 7 are used as busy relays to transfer the holding magnet leads whenever the associated trunk is busy. Fig. 8 shows typical line and cut-off relays in which the subscriber lines terminate, arranged to represent a group of one hundred lines. The first vertical row of relays represent lines one to ten, the second vertical row represents lines eleven to twenty and a third row, lines ninety-one to one hundred with only the multiple wiring 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 ten horizontal rows of line relays (L1, etc.). These relays in conjunction with another group of control relays such as C1, etc., at the bottom of each vertical row of line 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 located in the lower right corner of Fig. 8 which function to prevent more than one line at a time from being connected to an idle trunk as well as to direct the selection of the idle trunk. A detailed description will now be given of the manner in which an incoming call may directly reach any one of three trunks that may be idle, or if these are busy, it will be shown how either one of two overflow trunks may be selected.

When the subscriber at station S10, for example, removes his receiver from the switch-hook, a bridge is placed across line conductors 201 and 202 of Fig. 2 which causes line relay L10 of Fig. 8 to operate due to ground being connected to lead 201 at outside right break contact of cut-off relay CO10 and battery connected through winding relay L10 to lead 202 at inside break contact relay CO10. The sleeve or control lead, local to the office for this line, is traced over lead 801 to battery through the winding of relay CO10. Upon operating, relay L10 at its right inner contact prepares a path for operating relay C1 by connecting lead 802 to lead 803 as later will be described. Relay L10 also closes the circuit for operating relay A10 over a path traced from ground on lead 804, right outer contact relay L10, lead 805, top break contact relay D10 to battery through winding relay A10. Relay A10 at its front contact 806 connects lead 807 to left winding relay B10. Lead 807 being a test lead running through the armatures and back contacts on other relays A1 to A9 will be open at the left back contact relay 808 if another call is already in the process of selecting a trunk. Assuming, however, that relay 808 is not operated, then ground from the break contacts of relays 809 and 810 will be connected through break contact relay 808, lead 807, contact 806 on relay A10 and through left winding relay B10 to battery. Relay B10 operates to close a circuit from battery through the right winding relay B10 and front contact to another test lead 813 to ground through winding relay 808. Relay 808 operating, then opens lead 807 as mentioned above and prevents later calls from interfering with the handling of the call on line 10. Had it been assumed that calling subscribers S1 and S2 originated calls simultaneously on lines 1 and 2, then relays A1 and A2 would both have operated but due to test lead 807 only relay B2 would operate and lock to test lead 813 thus giving the call on line 2 preference over the call on line 1. Test leads 807 and 813, therefore, control the vertical preference and permit the highest of the calling lines in any group of ten 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 is made to select a trunk.

Just as the vertical preference described above is determined by the group relays B1 to B10 and common relay 808 so the horizontal preference permits the highest of the ten subgroups of lines to search for a trunk and lock out all other lines. This is determined by the common relay 811 and relays C1 to C10, inclusive, together with lead 814. Therefore, immediately after the vertical preference is determined, the B10 relay closes a circuit for operating relay C1 over a path traced from ground at the top break contact relays 809 and 810 through armature and right back contact relay 811, thence over multiple lead 815, contact 816 on relay B10, multiple lead 802, through operated inner contact on relay L10, multiple lead 803, and through bottom winding relay C1 to battery. Relay C1, in operating, locks to ground through its top winding and front contact to lead 814, traced through all the top break contacts and armatures of relays C2 to C10, thence through winding of relay 811 to ground at break contacts of relays 809 and 810. Relay 811, in operating, opens its right break 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 10. 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 B10 and C1, remain operated.

Another example illustrating this horizontal preference is given by assuming that subscribers on lines 1 and 91 lift their receivers about the same time, in which case line relay L1 and corresponding B1 and C1 relays operate in a similar manner to that described for line 10. Line relay L91 also operates and connects ground that is on lead 817 to lead 818. Since both L1 and L91 relays connect ground to lead 818, which path is further

traced through relay A1 to battery, it will be 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 819 at contact 820 by relay B1, a circuit is established for operating both the C1 and C10 relays, traced over lead 819 to right inner contact relay L91 and lead 821 to battery through lower winding relay C10; also traced over lead 819 through inner contact relay L1, lead 803 to battery through lower winding relay C1. In this case the locking circuit through the upper winding relay C10 is completed back over lead 814 through the winding of relay 811 to ground, while the locking circuit through the upper winding of relay C1 is held open at contact 822 on relay C10. Relay 811 operating thus opens at its top break contact the circuit for energizing the lower windings of relays C1 and C10 so that relay C1 releases and relay C10 remains operated. In this manner, line 91 is identified as the calling line to be handled first, and connection to an idle outgoing trunk will be directed by the combination of the B1 and C10 relays remaining operated as will later be described.

Going back to the condition ensuing forthwith upon the identity of calling line 10 being determined by relay B10 and relay C1 remaining in an operated condition, there will now be described the manner in which line 10 is connected to an idle trunk. Relays 808 and 811 of Fig. 8 it will be remembered, are also operated at this time which prevents interference from other lines that might originate calls at this time. Since each calling line has access to five different incoming trunks, it will be assumed that the first-choice trunk 301 for line 10 is idle. Relay TK1 of Fig. 3, therefore, is normal because if the trunk were busy this relay would be operated as will presently appear. The circuits of this invention are organized for positive operation by preventing the circuit for a holding magnet from being closed until the selecting magnets have operated. In the case of line 10 selecting magnet 313 of Fig. 3 will be operated over a path traced from ground at the back contact of relays 809 and 810 to armature and front contact on relay 808 to multiple lead 823, through contact 824 on relay B10 to multiple lead 825, thence through all five selecting magnets in multiple located at the bottom of each cross-bar switch including selecting magnet 313 to battery at the bottom of cross-bar switch C. Selecting magnet 313, when operated, connects ground to lead 314 through winding relay D10 to battery. Relay D10 operating at its top break contact opens the circuit of slow releasing relay A10 causing it to restore to normal. At contact 826 relay D10 prepares a locking circuit for itself traced to multiple lead 827 to ground at left outer contact relays A10 to A1 as will later be explained. At contact 828, relay D10 closes a temporary path from ground at contact 829 on relay A10 to lead 830, to battery through winding of relay 812. Relay 812 operates in this circuit and closes a locking circuit for itself through its own contact 831 to ground at back contact on relays 809 and 810. Relay 812 at contact 832 connects ground to left front contact relay 811, thence to lead 833, for operating the holding magnet 203, Fig. 2, associated with line 10 and trunk 301. The holding magnet thus operates in a path traced further through contact 834 on relay C1, lead 835, armature 315 and back contact on relay TK1, lead 316 to battery through holding magnet 203. The closure of ground to lead 833 also operates slow release relay 809 which in turn operates slow operate relay 810. The latter relay provides a time interval in which to insure operating the holding magnet before ground is removed from the control relays 808, 811 and 812. Relay 809 provides another time interval before restoring ground to the control relays, preparing the system to receive another call. The holding magnet in the circuit traced above extends the line 10 to the trunk 301 through cross-bar switch contacts 204.

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 the receiver to the switch-hook all in a manner well understood in the art. Therefore, soon after contact 204 in the switch C of Fig. 2 connects the calling line 10 with the incoming trunk 301, ground may be traced on the trunk sleeve 301 through armature and front contact on holding magnet 203 to battery, thus maintaining the latter operated until the subscriber hangs up the receiver. At this time, cut-off relay CO10 of Fig. 8 also operates from ground on trunk sleeve 301 traced through switch contact 204 and lead 205 to multiple sleeve lead 801 to battery through winding relay CO10. Relay CO10 operating releases relay L10, this action taking place before ground is removed by the control relays 808 and 809. Relay CO10 remains operated as long as the connection is held and prevents relay L10 from reoperating. Ground returned on trunk sleeve 301 may also be traced over lead 317, through top break contact relay TK1 to battery through winding relay 318. The latter relay, when it operates, prepares a path for operating relay TK1 so that when relay 810 operates, ground placed on multiple lead 836 may further be traced through operated contact on relay 318 to battery through lower winding relay TK1. The latter relay operates to close a locking circuit through its top winding to lead 317 and thence to ground on the trunk sleeve 301. In this manner, the ground that serves to operate the holding magnet 203 is prevented from operating a second holding magnet which would be the case if relay TK1 were allowed to operate upon ground first being connected to trunk sleeve 301. The operation of relay 810 also releases relay 808 and selecting magnet 313 and in turn relay B10, relay D10 and relay 812. Relay 809 releases after an interval, thus restoring ground to the control relays for functioning on the next call.

Having described the call from subscriber S10 on the assumption that trunk 301 was idle, the call will now be traced on the assumption that trunk 301 is busy and that the next trunk 310 is available. In this case it will be observed that the second-choice appearance of line 10 is in the cross-bar switch D in the top right-hand portion of Fig. 5. The removal of the subscriber's receiver causes the B10 relay and the C1 relay of Fig. 8 to operate and mark the location of the calling line as previously described. These relays together with relays 808 and 811 remain operated until the line is connected to the trunk. When relay 808 first operates, ground is connected to lead 823 for operating selecting magnet 501 over a path traced through contact 824 on relay B10, lead 825, thence to battery through all five selecting magnets in multiple including selecting magnet 501 of the switch D. Operating selecting magnet 501 at its lower contact connects ground to multiple lead 314 for operating

relay D10 of Fig. 8 which in turn operates relay 812 and connects ground to multiple lead 833 for operating holding magnet 502. Ground on lead 833 is traced further through contact 834 on relay C1 to lead 835 and thence to the armature of relay TK1, but if the associated trunk 301 is busy, as is now assumed, ground on the sleeve lead 301 and lead 317 holds relay TK1 operated and lead 835 is thereby extended over lead 319 to armature 503 of the next relay TK10 associated with trunk 310. Relay TK10 is not operated at this time because trunk 310 is idle. Therefore, ground that is on leads 835 and 319 is extended over lead 504 for operating holding magnet 502. The operation by the holding magnet of switch contact 505 thus completes the connection of this line to incoming trunk 310. According to the usual operation ground is returned on the incoming trunk sleeve lead 310, through left-hand locking contact and winding of holding magnet 502 to battery before ground is removed from lead 504 by the slow operate control relay 810 of Fig. 8. When relay 810 does operate, it connects ground to lead 836 for operating relay TK10 through the operated contact of relay 506 and as previously described prepares the system for the next call.

Let it now be assumed that both trunks 301 and 310 are busy and that the third-choice trunk 309 is available when subscriber S10 removes his receiver from the switch-hook. So far as the selecting magnet circuit is concerned, it may be traced as previously described, because it will be observed that while the selecting magnets on all five switches operate, only one of the holding magnets is caused to operate, thus selecting the idle trunk. Selecting magnet 507 may, therefore, be assumed to have operated and connected ground to relay D10 for operating relay 812 which connects ground through contact on relay 811 to lead 833. The holding magnet 508 of the cross-bar switch E in Fig. 5, therefore, is operated from ground on lead 833 through contact 834 on relay C1, lead 835, armature 315 and front contact on relay TK1, lead 319, armature 503 and front contact on relay TK10, lead 509 through armature 510 and back contact on relay TK9, lead 511 to battery through holding magnet 508. The operation of the holding magnet at switch contact 512 thus completes the connection of line 10 to incoming trunk 309 and according to the usual operation, ground is returned by the incoming trunk on sleeve lead 309, through left locking contact and winding of holding magnet 508 before ground is removed from lead 511 by the slow operate control relay 810 of Fig. 8. When relay 810 finally operates and connects ground to lead 836, the relay TK9 will be operated through the contact on relay 513 and the system prepared for the next call as previously described.

If incoming trunks 301, 310 and 301 are busy when subscriber S10 originates a call, then one of the overflow trunks OF1 or OF2 will be preempted to connect the subscriber with a first digit switch, such as H. For a description of this condition it will be assumed that incoming trunk OF1 is idle. As previously described, the lifting of the subscriber's receiver results in the operation of all five selecting magnets connected to lead 825 which includes selecting magnet 701 of the cross-bar switch F. Selecting magnet 701 at auxiliary contact 702 connects ground to lead 314 for operating relay D10. Relay D10 operates relay 812 which connects ground through contact on relay 811 to lead 833. The holding magnet 601 of switch E is then operated over the same path from ground on lead 833 as described in the preceding paragraph, except at armature 510 on relay TK9 the circuit is traced further through the front operated contact over lead 514, armature 703 and back contact relay TK11, lead 704, to battery through holding magnet 601 of Fig. 6. The operation of the latter at switch contact 602 thus completes the connection of line 10 to incoming trunk OF1. Ground returned on sleeve lead of trunk OF1, therefore, may now be traced to the armature and front contact on holding magnet 601 to battery for holding the switch contact 602 operated during the time the line is busy. This ground also may be traced through contact 602 to lead 603 and thence over multiple lead 801 to battery through relay CO10 of Fig. 8 for preventing further operation of relay L10. The same ground is further traced through contact 705 on relay TK11 to battery through winding of relay 706. Relay 706 operating, prepares a path for operation of relay TK11 when slow relay 810 finally operates to connect ground to lead 836. The operation of relay TK11 thus transfers the operating circuit for the holding magnets of cross-bar switch F to the magnets of cross-bar switch G ready for the next call.

The description given in the preceding paragraph assumed overflow trunk OF1 to be idle. If this trunk were also busy, then the call on line 10 would be connected to overflow trunk OF2, assuming it to be idle. The tenth selecting magnet on all five switches will operate from multiple lead 825, as before stated, including selecting magnet 707, thereby connecting ground to lead 314 for operating relay D10. Relay D10 operates relay 812 which connects ground through contact on relay 811 to lead 833. The holding magnet 604 of switch G is thus operated over the same path from ground on lead 833 as described in the preceding paragraph, except at armature 703 on relay TK11 the circuit is further traced through the front operated contact over lead 708, armature 709 and back contact on relay TK12, lead 710 to battery through winding holding magnet 604 of Fig. 6. The operation of the latter at switch contact 605 thus completes the connection of line 10 to incoming trunk OF2. Ground returned on sleeve lead OF2 of incoming trunk, therefore, may now be traced through the armature and front contact on holding magnet 604 to battery for holding the switch contact 605 operated during the time the line is busy. This ground also may be traced through contact 605 to lead 606 and thence over multiple lead 801 to battery through cut-off relay CO10. The same ground is also traced through contact 711 on relay TK12 to battery through winding of relay 712. Relay 712 operated, closes the path for operating relay TK12 upon the closure of ground to lead 836 by relay 810. The operation of relay TK12 thus opens the circuit for all holding magnets and prevents any further trunk selection from taking place.

If subscriber S10 should originate a call when trunks 301, 310, 309, trunks OF1 and OF2 are all busy, then the five selecting magnets operate as before, but, relay TK12 being operated, the holding magnet circuit is held open until relays 809 and 810 operate when another attempt to select a trunk will be made.

When simultaneous calls are originated by subscriber stations S1 and S91, the call on line 91 will be handled first as previously described. In this case, relays B1 and C10 remain in an operated

position and for the purpose of this description it will be assumed that the first three trunks to which this line has access, namely, trunks 310, 309 and 308 are busy. Also, that the first overflow trunk OF1 is idle. Trunk busy relays TK10, TK9 and TK8 are, therefore, operated and relay TK11 is normal when control relay 808 first operates to close ground to lead 823. This ground path is further traced through contact 837 on relay B1 to multiple lead 838 and thence to battery through the first selecting magnet winding on each of the cross-bar switches C to G, including selecting magnet 713 of switch F in Fig. 7. The latter magnet, upon operating, connects ground at its auxiliary contact 714 to multiple lead 715 for operating relay D1 which then locks through its own contact to multiple test lead 827. If one or more calls are waiting in other trunk groups for a trunk selection, their corresponding A2, etc., relays will be operated and will be connecting ground to the test lead 827. This prevents the release of relay D1 after a trunk is assigned to the calling line and thereby prevents other calls in the subgroup of lines from receiving trunk assignments until one call in each of the other subgroups of lines have received an assignment. This, in effect, prevents calls in a particular group locking out calls in less favored groups. Referring again to the operation of relay D1, it will be observed that the circuit to relay A1 is opened at the top break contact relay D1. Relay A1 is, however, sufficiently slow in releasing to permit ground at contact 839 to operate relay 812 over lead 830 and contact 840 on relay D1. The operation of relay 812 connects ground at contact 832 to lead 833 through left contact and armature on relay 811. Ground on lead 833 through bottom contact relay C10, lead 841 causes the holding magnet 716 to operate. Because of the trunks 310, 309 and 308 being busy, this path over lead 841 is further traced through armature 515 and front contact relay TK10, armature 516 and front contact relay TK9, armature 517 and front contact relay TK8, lead 518 to armature 717 and back contact relay TK11, to battery through winding holding magnet 716. The operation of the latter magnet thus connects line 91 with incoming overflow trunk OF1 at contact 718 in the bank of the cross-bar switch F. The system is then prepared for another call by releasing selecting magnet 713, operating relays 809 and 810 and restoring other control relays normal, all as previously described.

From the above description it will be apparent that this system provides a flexible trunking arrangement whereby subscriber lines in a cross-bar system may be given almost any number of accesses, depending on the amount of traffic required by said line.

What is claimed is:

1. In combination, switches, each having rows of separately operable contact sets, a group of incoming lines appearing in non-corresponding rows of contacts in a portion of said switches as first-choice switches and in one of said switches as an overflow switch, outgoing lines appearing in said first-choice switches, each outgoing line appearing in corresponding rows of said first-choice switches, and an outgoing line appearing in said overflow switch.

2. In combination, switches, each having coordinate rows of separately operable contact sets, a group of incoming lines appearing in non-corresponding rows of contacts in a number of said switches assigned to said lines as regular switches and in one of said switches assigned to said lines as an overflow switch, each line having only one appearance in each of said switches, outgoing lines appearing in said regular switches, each outgoing line appearing in corresponding rows of said regular switches, and an outgoing line appearing in all of the rows of said overflow switch.

3. In combination, cross-bar switches, each having a plurality of coordinate rows of contact sets, subscribers' lines arranged in a plurality of groups, certain said switches serving said lines as regular-choice switches and other of said switches serving as overflow switches, said groups of lines appearing in non-corresponding vertical rows of contacts in each of said regular switches and in corresponding vertical rows of contacts in said overflow switches, outgoing trunks multipled to each of said regular switches, and an outgoing trunk for each of said overflow switches.

4. The combination in a telephone system of cross-bar switches, each having a plurality of coordinate rows of contact sets, lines arranged in a plurality of groups, said switches serving said lines in a successive preferential order, each group of lines appearing in certain of said switches in non-corresponding rows of contacts and in others of said switches in corresponding rows of contacts, and trunks accessible to said lines through said contacts, some of said trunks being multipled to a number of said switches and others of said trunks appearing in a single one of the switches.

JAMES G. FERGUSON.