

Dec 7, 1942.

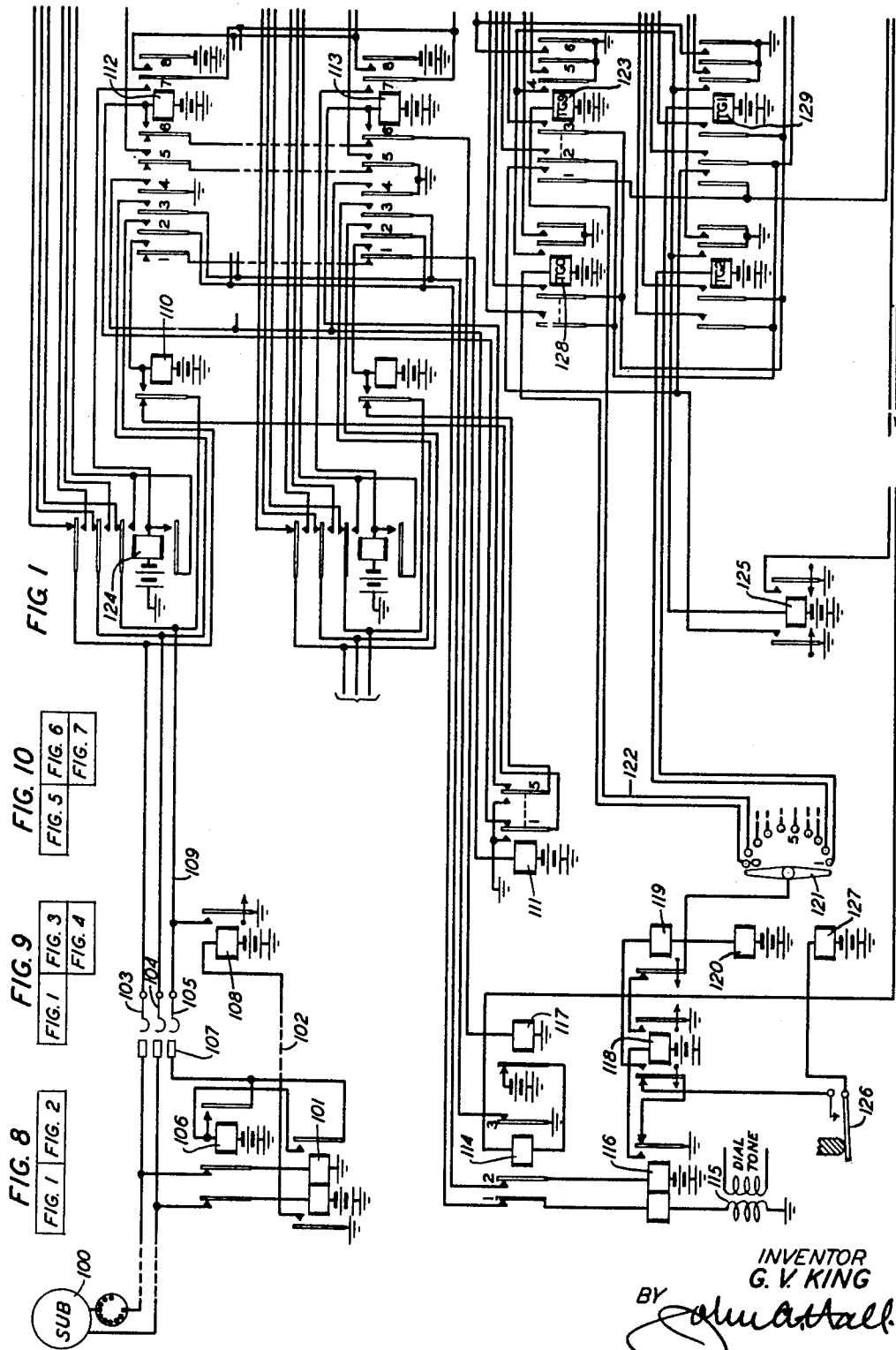
G. V. KING

2,285,985

STEP-BY-STEP OPERATED CROSS-BAR SWITCH

Filed Dec. 28, 1940

7 Sheets-Sheet 1



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June 9, 1942.

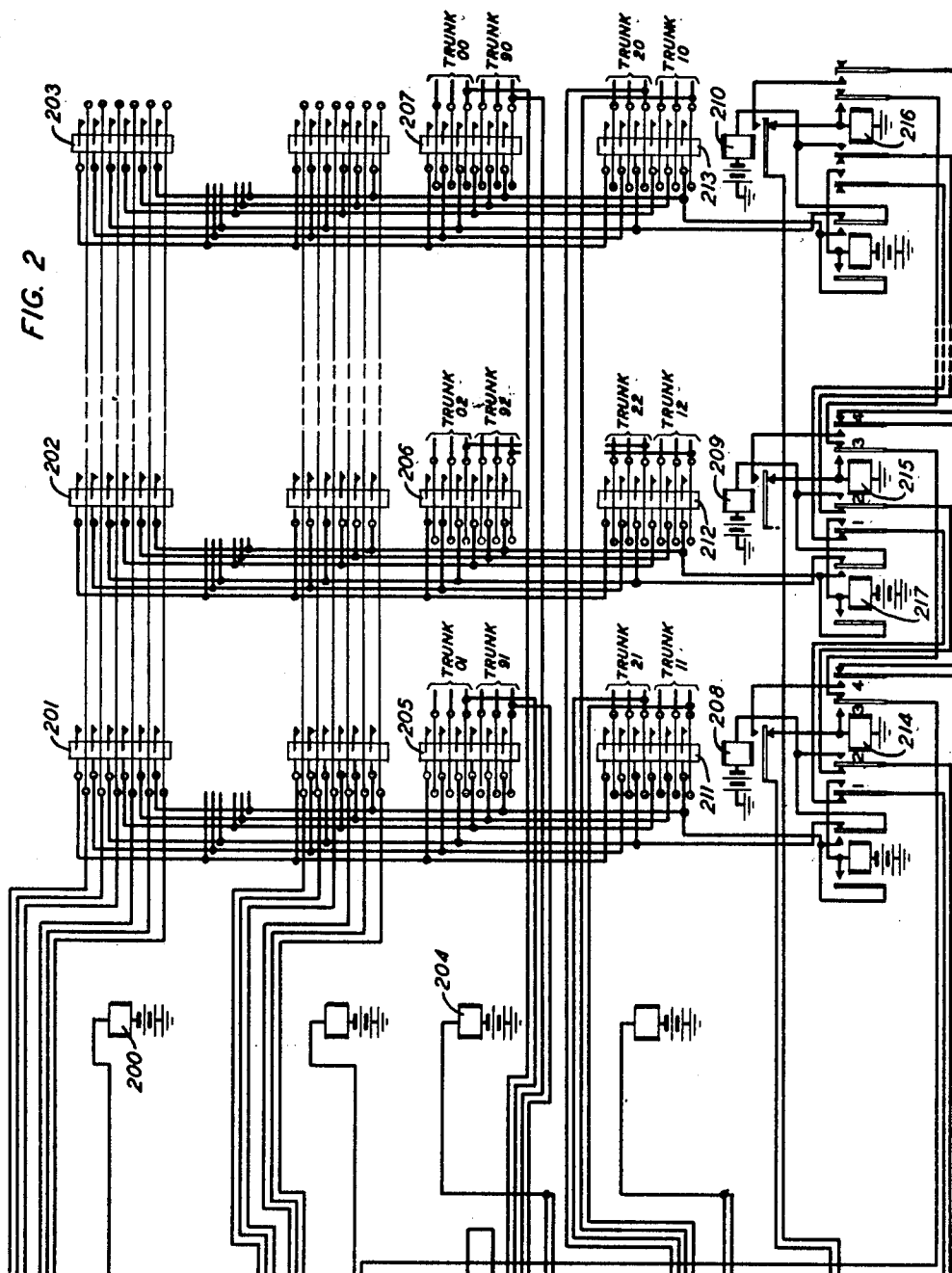
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STEP-BY-STEP OPERATED CROSS-BAR SWITCH

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7 Sheets-Sheet 2



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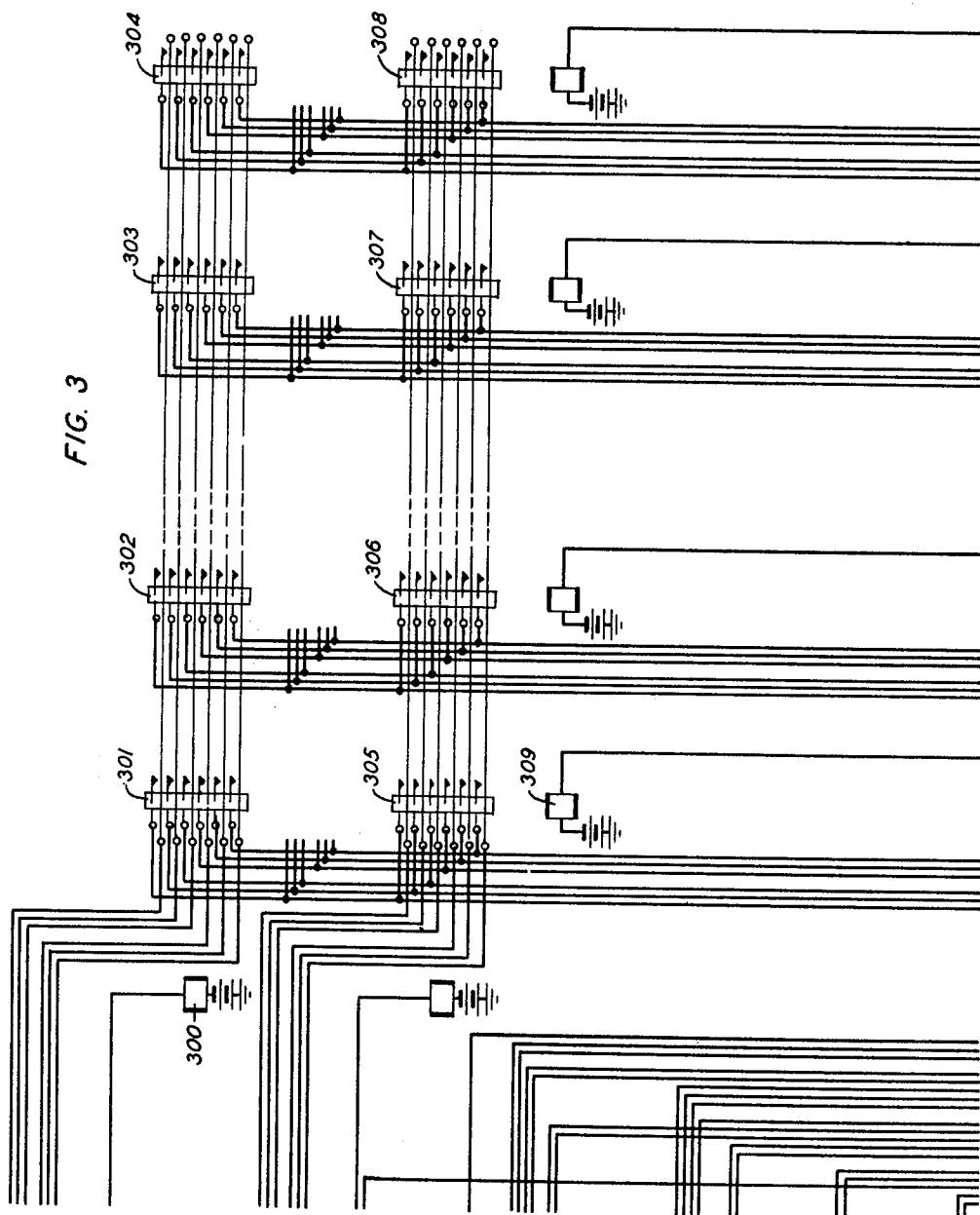
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STEP-BY-STEP OPERATED CROSS-BAR SWITCH

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7 Sheets-Sheet 3



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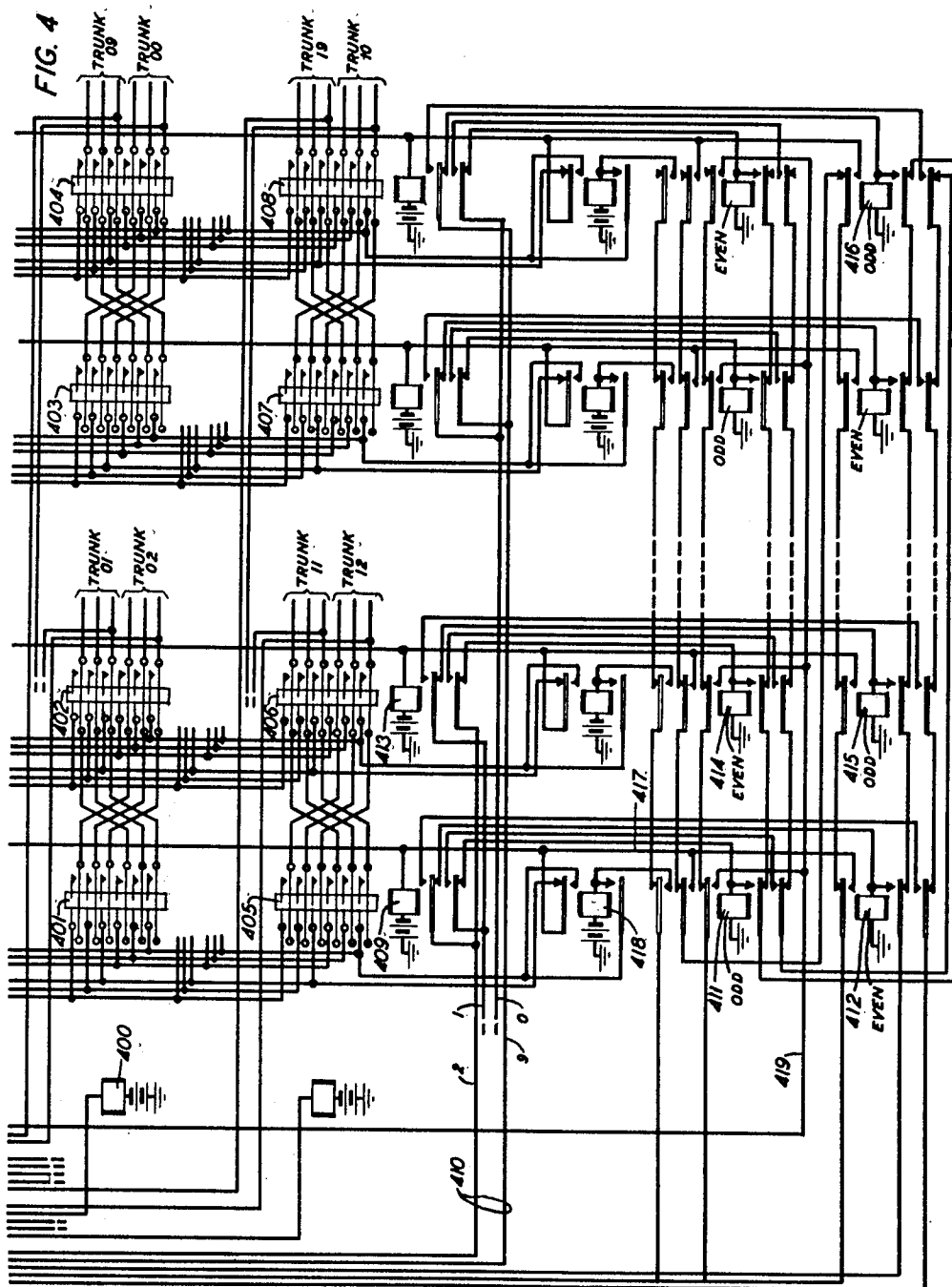
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STEP-BY-STEP OPERATED CROSS-BAR SWITCH

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7 Sheets-Sheet 4



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STEP-BY-STEP OPERATED CROSS-BAR SWITCH

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7 Sheets-Sheet 5

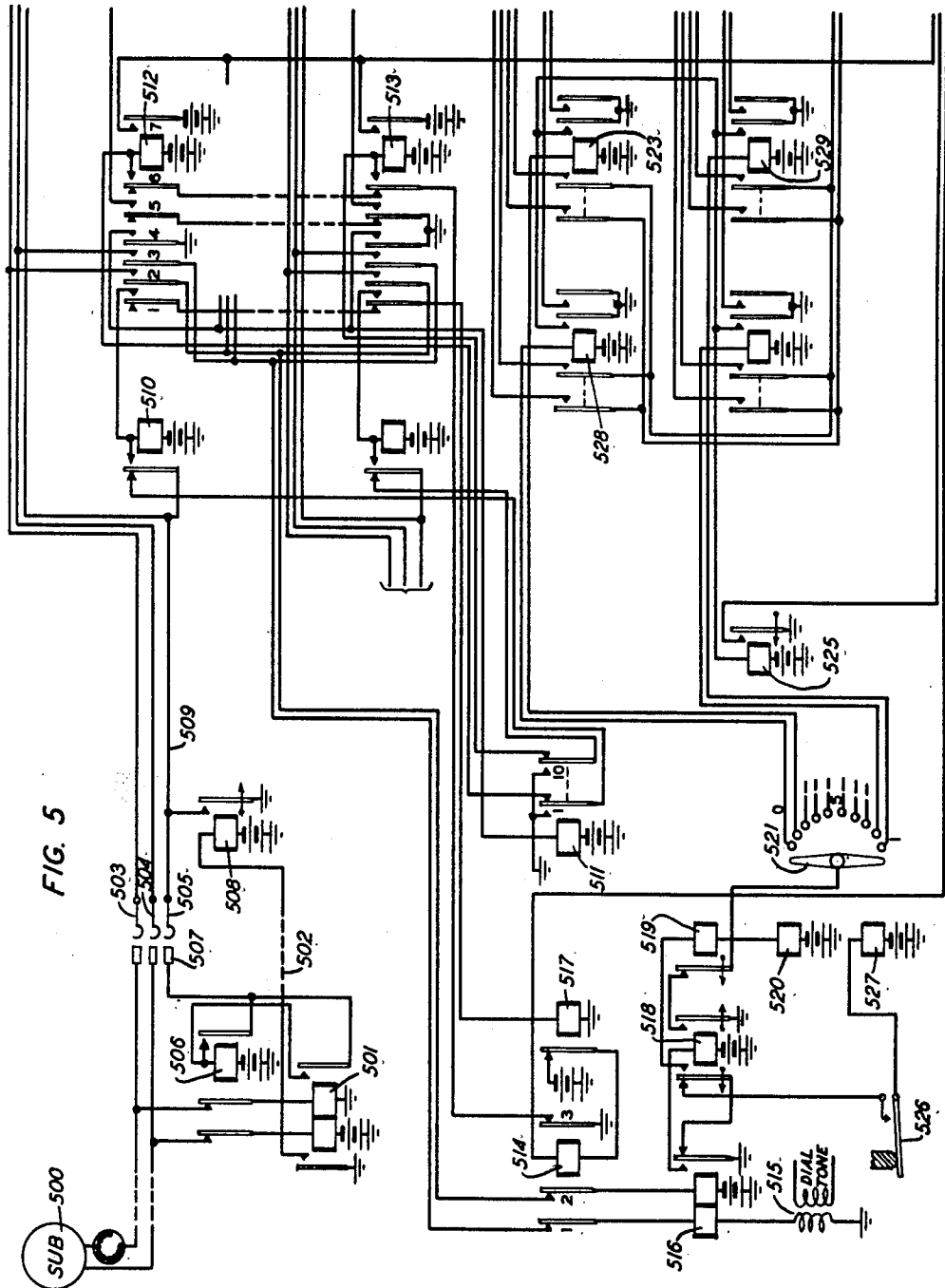


FIG. 5

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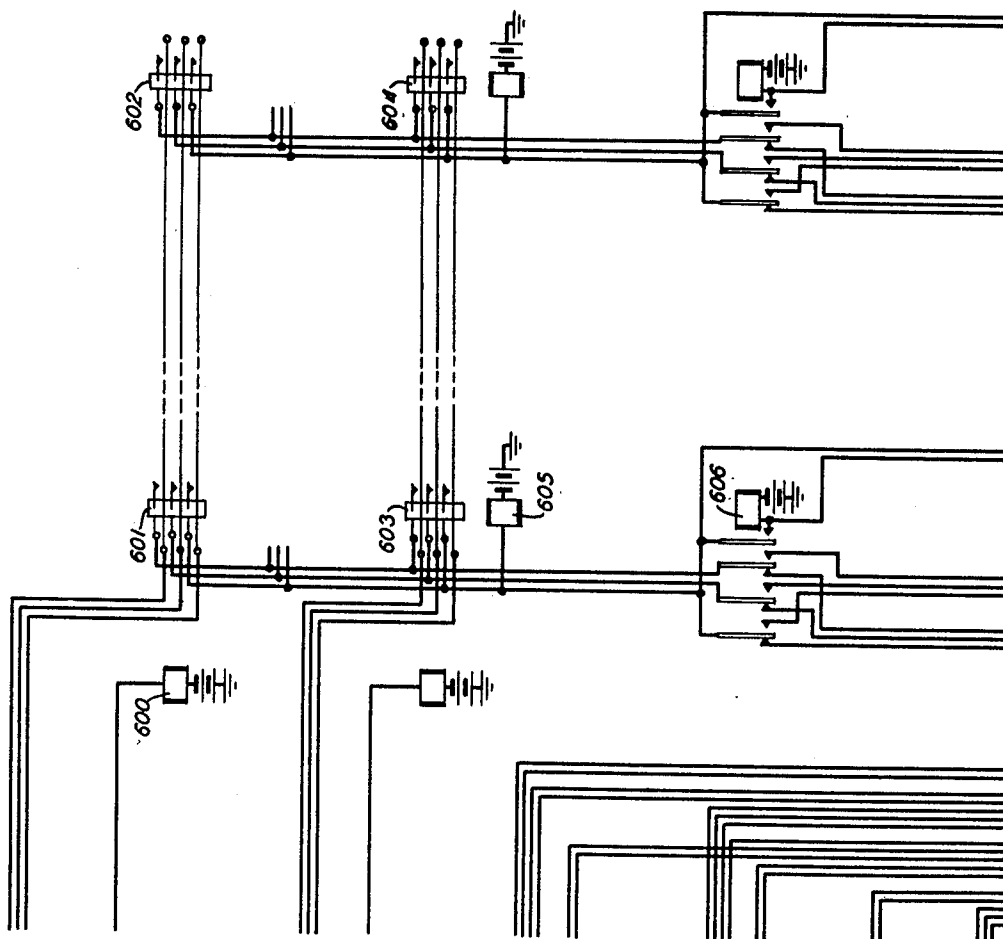
2,285,985

STEP-BY-STEP OPERATED CROSS-BAR SWITCH

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7 Sheets-Sheet 6

FIG. 6



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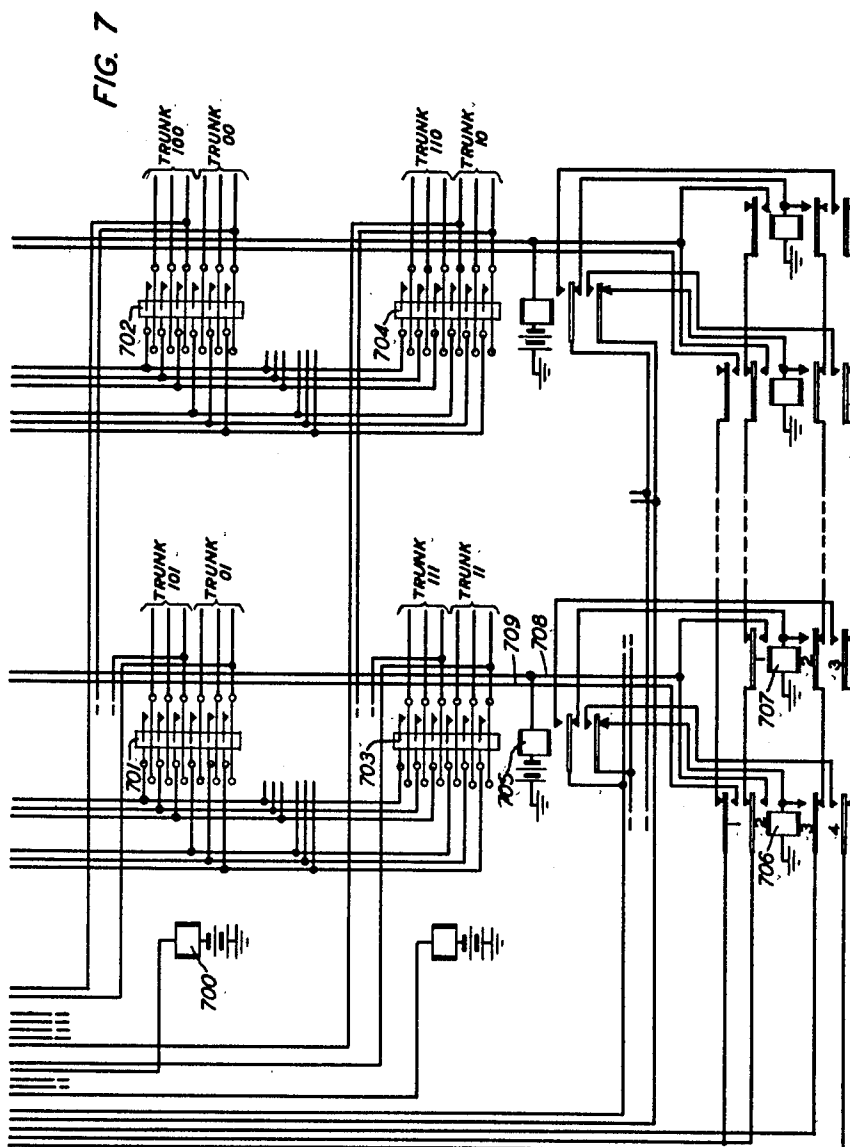
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STEP-BY-STEP OPERATED CROSS-BAR SWITCH

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7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE

2,285,985

STEP-BY-STEP OPERATED CROSSBAR SWITCH

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Application December 28, 1940, Serial No. 372,080

7 Claims. (Cl. 179—18)

This invention relates to selective switches and particularly to switching devices useful in telephone systems of a type through which an incoming line may be extended to an idle outgoing line of any one of a number of groups of such lines by directive and automatic action.

The object of the invention is to adapt the now well-known cross-bar type of switch to step-by-step operation. Applicant is aware that this object in general has been achieved by others but he has devised a new arrangement which has many economical and operating advantages whereby the present invention embodies a step forward in the art.

Broadly stated the present invention resides in the use of cross-bar switches of large sets of permanently paired contacts coordinately arranged accommodating incoming lines, links and outgoing lines whereby a plurality of paths are coincidentally established by the action of a pair of contact sets, one in the field of incoming lines and links and the other in the field of links and outgoing lines. Such a connection is established by control over an incoming line by directive selection of a group of outgoing lines and then an automatic selection of an idle line in the selected group. Since connections are now made to a plurality of outgoing lines including the selected one automatic means are employed to establish a connection from the incoming line to that one of the coincidentally established connections which leads to the selected outgoing line.

A feature of the invention is a means for automatically extending a connection from an incoming line to one of a plurality of coincidentally established connections through the contact sets of a cross-bar switch at a point before any of the switching points in the said switch.

Another feature, alternative to that set forth above, is a means for automatically extending a connection from an incoming line to one of a plurality of coincidentally established connections through the contact sets of a cross-bar switch at a point within the link circuit used as a path between the incoming line and the selected outgoing line.

Another feature of the invention is a multiple connection pattern for the outgoing lines whereby each outgoing line appears in a plurality of contact sets in each of which appear a plurality of outgoing lines, no one outgoing line appearing more than once in a contact set.

The drawings consist of seven sheets of circuit diagram which may be arranged as indicated in Figs. 8, 9 and 10 to show three embodiments of

the invention. Fig. 8 uses Figs. 1 and 2 and shows a single ten by ten six-wire cross-bar switch used as a selector and operated in a step-by-step manner. Fig. 9 uses Figs. 1, 3 and 4 and shows two ten by ten six-wire cross-bar switches arranged as a selector and operated in a step-by-step manner. Fig. 10 uses Figs. 5, 6 and 7 and shows the use of one ten by ten three-wire cross-bar switch and one ten by ten six-wire cross-bar switch arranged to operate as a selector in a step-by-step manner.

For a complete understanding of the mechanism of the cross-bar switch reference may be had to the following patents: 1,953,503, J. N. Reynolds, Apr. 3, 1934; 2,021,329, J. N. Reynolds, Nov. 19, 1935, and 2,040,334, J. N. Reynolds, May 12, 1936.

With Figs. 1 and 2 arranged as indicated in Fig. 8, a call will be traced from a calling substation to an idle trunk in a selected group. The substation 100 terminates at the central office in the usual line and cut-off relay combination and the terminals of a finder switch. The tip and ring conductors are connected to the windings of line relay 101 so that when the subscriber removes his receiver from its hook the relay 101 is operated and the start circuit conductor 102 is grounded. This causes the brushes of the line finder 103, 104 and 105 to hunt for the calling line. The calling line will be characterized by a battery connection through the winding of cut-off relay 106 to the sleeve terminal 107. When the line has been found, the sleeve is grounded and the relay 106 is operated, whereby the relay 101 is disconnected from the line. A slow releasing relay 108 is associated with the start circuit and temporarily places ground on the sleeve conductor 109. This ground is removed a short interval after the brushes 103 to 105 have made connection to the calling line. This action is standard line finder practice and it is explained fully in Patent 1,799,654, granted to R. L. Stokely April 7, 1931.

Thus, in the process of extending the line of substation 100 to the tip, ring and sleeve conductors leading to the selector switch forming the main part of the circuit diagram of Figs. 1 and 2, a ground is connected to conductor 109. Conductor 109 extends through the armature and back contact of relay 110 and thence through armature 1 and back contact of relay 111 from which the circuit extends to the winding of start relay 112 to battery. Through the connection of ground to conductor 109 relay 112 is operated. If no other relay in the chain between

relay 112 and relay 113 is operated, then relay 112 locks in a circuit through its front contact and armature 6 and thence through back contacts and similar armatures of the other relays in this series, including the back contact and armature 6 of relay 113, the back contact and armature 3 of relay 114 to ground. Through the operation of relay 112, battery and ground through the dial tone transformer 115 is connected through the windings of relay 116, the armatures 1 and 2 and their back contacts of relay 114, armatures 2 and 3 and their front contacts of relay 112 to the tip and ring conductors leading to the calling subscriber's line. The calling subscriber is thus given dial tone which indicates to him that the circuit is ready for the receipt of dialing impulses.

During this operation relay 110 is operated in a circuit from battery, the winding of relay 110, front contact and armature 1 of relay 112, back contact and armature 1 of relay 113, winding of relay 117 to ground. Relay 110 operates in this circuit and connects the sleeve conductor 109 through the armature and front contact of relay 110 and thus shunts relay 117 until the ground temporarily connected to this conductor is removed by relay 108. Thereafter the relay 110 is held in series with the winding of relay 117. Through armature 4 of relay 112 ground is extended to the winding of relay 111 which now becomes operated. Relay 111 has one armature for each incoming circuit to the switch shown in Fig. 2 and, therefore, not only grounds the lead to the back contact of relay 110 but the leads to each of the corresponding back contacts of corresponding relays whereby ground is connected to the sleeves of all of these relays to render them temporarily busy during the ensuing dialing period.

Through armature 5 of the start relay 112 a ground connection is extended to the selector magnet 200 to prepare the contact sets 201, 202 and 203 for operation. These contact sets represent ten such contact sets which are associated with the line terminating in line finder brushes 103, 104 and 105.

Through the connection of relay 116 to the calling line a slow releasing relay 118 is operated and at this point the circuit is completely ready for the receipt of dial pulses. Let it be assumed that the digit now dialed is 9. The armature of relay 116 will, therefore, vibrate between its front and back contacts and make nine trips to the back contact, each of short duration, corresponding to nine interruptions of the subscriber's line from the substation 100. Upon each connection established between the armature and back contact of relay 116 an impulse will be sent from ground through the armature and back contact of relay 116, the left-hand armature and front contact of relay 118, the winding of relay 119 and the winding of stepping magnet 120 to battery. Relay 119 will operate upon the first of these impulses and will remain operated steadily throughout this train of impulses and for a short time thereafter due to its slow releasing characteristics. Each of these impulses will operate the stepping magnet 120 to rotate the brush 121 which, in accordance with our assumption, will now come to rest on its ninth contact. After this series of impulses, when relay 119 returns to normal, a circuit will be established from ground, right-hand armature and front contact of relay 118, back contact and armature of relay 119, brush 121 and

its ninth contact, conductor 122 to the winding of relay 123. Relay 123, in operating, closes a circuit from ground through the winding of select magnet 204 which now prepares the contact sets 205, 206 and 207 for operation.

Before proceeding with the description of the circuit changes which take place, a brief explanation of the arrangement of this cross-bar switch will be given. This switch is known as a ten by ten six-wire switch. There are one hundred cross-point contact sets, such as 201, 202 and 203, arranged in ten rows of ten each. Each horizontal row is controlled by a select magnet, such as 200 and 204 described as now being operated. Each vertical row is controlled by a hold magnet, such as 208, 209 and 210.

The first five horizontal rows of these contact sets, starting from the top, are associated with incoming trunks and the last five rows are associated with outgoing trunks. Since three wires are sufficient for a trunk circuit, the lower five rows of contact sets will accommodate one hundred trunks, that is, ten rows of ten trunks each. The lower horizontal row of cross-point contacts 211, 212 and 213 will accommodate trunks 11 to 10, inclusive, and trunks 21 to 20, inclusive, the numbering system here being used running from 1 to 0, corresponding, in fact, from 1 to 10 in each case. Through the operation of the step-by-step switch having the brush 121 any particular level may be selected. As described herein, the ninth level will be selected since the brush 121 has been placed on its ninth contact and since the selecting magnet 204, having control over the ninth and tenth levels, will be operated. At a later period, as will be described hereinafter, some one of the hold magnets 208, 209 and 210 will be operated, let us say 209 by way of example, whereupon the contact sets 202 and 206 will be operated. Thereafter the select magnets 200 and 204 will be released and the connection will be held through the continued operation of the hold magnet 209. Since the ninth level has been selected by the brush 121, then the circuit through the lower three contacts of the set 206 and the lower three contacts of the set 202 will become effective through the automatic operation of relay 124, as will be hereinafter described. Had the tenth level been selected, whereby trunk No. 02 would be used instead of trunk 92, then the upper three contacts of the set 206 and the upper three conductors of the set 202 would have become effective through the failure of relay 124 to operate.

Each of the trunks leading from the contact sets 205 to 207, inclusive, presents under normal conditions a battery connection on its sleeve much as the normal battery connection to the sleeve 109 through the winding of relay 112, as hereinbefore described. Since the select magnet 204 has been operated and it is desired to pick an idle trunk in the ninth level, the trunks 91, 92 to 90, inclusive, will be automatically tested. This is done through the connection of the sleeves of these trunks through the armatures of relay 123 to the test relays associated therewith. Thus, the sleeve of trunk 91 may be traced through the front contact and armature of relay 123, the armature and back contact of holding magnet 208 to the winding of test relay 214. Similarly, the sleeve of trunk 92 will be connected to test relay 215 and the sleeve of trunk 90 will be connected to the test relay 216. If trunk No. 91 is busy, its sleeve will be grounded and, hence, the test relay 214 will not operate. If the vertical row controlled

by hold magnet 209 is busy, although trunk 92 is not busy, the normal connection to the test relay 215 through the armature and back contact of the magnet 209 will be broken. Let it be assumed, however, that this vertical link is idle. Hence, relay 215, which may be of high resistance so as to operate to the battery on the sleeve of trunk 92 but not to cause the operation of the sleeve, will now operate. Relay 215 now becomes locked in a circuit through its front contact and armature 3, the back contact and armature 3 of relay 214, the front contact and armature 8 of relay 112 to battery. Another circuit is now established from the winding of hold magnet 209 through the front contact and armature 2 of relay 215, the back contact and armature 2 of relay 214, the front contact and right-hand armature of relay 125 to ground. Relay 125 is operated from the armature 4 of relay 123. Holding magnet 209 operates and becomes energized and, therefore, operates the contact sets 202 and 206 which have been prepared for operation by select magnets 200 and 204, respectively. A circuit is also established from battery, the winding of relay 217, front contact and armature 1 of relay 215, back contact and armature 1 of relay 214, armature 1 and front contact of relay 123, front contact and left-hand armature of relay 125 to ground. Relay 217 extends the ground for its operation over its front contact and left-hand armature to the sleeve of trunk No. 92 and thereafter remains locked to the sleeve of this trunk even after the ground provided by the operation of relay 125 has been disconnected. Likewise, through the movement of the right-hand armature of relay 217 the hold magnet 209 is connected to the sleeve of trunk 92 so that the continued operation of this cross-bar switch depends upon the ground coming over the sleeve of trunk 92.

At the same time a ground is connected over armature 6 and front contact of relay 123, through armature 7 and front contact of relay 112, to the winding of relay 124. Relay 124 becomes operated and locks to the sleeve of trunk 92. Through the operation of the upper three armatures of relay 124 the trunk ending in brushes 103, 104 and 105 is now connected through the lower three contacts of the set 202 and thence through the lower three contacts of the set 206 to trunk 92. While it is true that trunk No. 02 is connected through the upper three contacts of set 206 and the upper three contacts of contact set 202, this connection is ineffective due to the operation of the upper three armatures of relay 124.

Since the connection has been extended to trunk 92 the ground from the sleeve of this trunk may be traced back to the armature and front contact of relay 110 to hold this relay operated but it will at the same time result in the shunting of relay 117 so that this relay becomes released. Therefore, a connection from the front contact of holding magnet 209 which extends back through the armature of relay 123 to the sleeve of trunk 92 to ground will, therefore, be extended over the front contact and armature 4 of relay 215, the back contact and armature 4 of relay 214, to the winding of relay 114 and thence to battery. Relay 114 now becomes operated and disconnects the windings of relay 116 from the tip and ring conductors leading to the subscriber's substation 100. At the same time the holding ground for relay 112 is removed and

this relay becomes deenergized. Through the release of relay 116 the slow release of relay 118 will shortly take place, whereupon a circuit will be extended from ground, the armature and back contact of relay 116, the left-hand armature and back contact of relay 118, the off-normal contact 126, to the relay magnet 127, whereby the brush 121 is returned to normal. Through the release of start relay 112 the test relay 215 is returned to normal and through the release of brush 121 the group relay 123 is released. Therefore, the select magnets 200 and 204 are in turn released and the connection is held by the holding magnet 209. In this condition relay 124 and relay 110, individual to the incoming trunk, are operated and all other relays are returned to normal. In Fig. 2 the holding magnet 209 is held operated and relay 217 is held operated, both under control of the sleeve of trunk 92. When the connection is released and the ground removed from the sleeve of this trunk, all of these relays will immediately be released and the connection restored to normal.

Thus, a single ten by ten six-wire cross-bar switch will operate to extend calls from five incoming trunks to one hundred outgoing trunks arranged in ten groups of ten each.

With Figs. 1, 3 and 4 arranged as indicated in Fig. 9 another embodiment of the invention is illustrated. In this case the eight contact sets 301 to 308, inclusive, in Fig. 3 represent one ten by ten six-wire cross-bar switch. That is, these contact sets represent one hundred such contact sets arranged in ten rows of ten each. There will be ten such select magnets as that numbered 300 and ten such holding magnets as that numbered 309. In Fig. 4 the contact sets 401 to 408, inclusive, represent a ten by ten six-wire cross-bar switch. In other words, these eight contact sets represent one hundred such sets arranged in ten rows of ten each. In this case there will also be ten such select magnets as that numbered 400 and ten such hold magnets as that numbered 409. The vertical links of these two switches are connected together so that effectually, and particularly since the hold magnets 309 and 409 are multiplied together, a single cross-bar switch twenty by ten is formed. Ten incoming trunks, such as the trunk leading from the finder brushes 103, 104 and 105, are served by the cross-bar switch of Fig. 3. One hundred outgoing trunks are served by the cross-bar switch of Fig. 4. Since each contact set controls six pairs of contacts and only three are needed for an outgoing trunk, there are effectually two hundred outlets. In order to make the so-called coverage better, only one hundred outgoing trunks are used and each trunk is served by two different contact sets each in a different vertical. Thus, trunk No. 12 is served by the upper three contacts of set 405 and the lower three contacts of set 406. Likewise, trunk No. 11 is served by the lower three contacts of set No. 405 and the upper three contacts of set No. 406.

The outgoing trunks are numbered according to the usual step-by-step numbering plan, that is, all of the trunks on the first level served by contacts sets 405, 406, 407 and 408 begin with the digit for indicating the first level. All of the trunks served by the other row of contact sets 401 to 404, inclusive, begin with the digit 0, that is, they are in the tenth level. Other levels, two to nine, inclusive, are indicated by the multiple connections to the vertical wires. Likewise, all of the trunks in the first vertical row

situated on the lower three contacts of the sets end with the digit 1 and those in the second row in a similar position end with the digit 2. It is believed that without further explanation the numbering of these trunks will be clear.

A call is established by substation 100 in the manner hereinbefore described and the select magnet 300 is operated. Let us assume in this case that the digit 0 is dialed. Thereupon the steering switch controlled by the stepping magnet 120 will place its wiper on its tenth or 0 contact whereupon relay 128 becomes operated. Relay 128 connects the sleeves of the various trunks 01 to 00, inclusive, to the conductors 410 which have also been numbered 1 to 9 and 0 in accordance with the last digit of the trunk to which they are connected. If we assume that trunk No. 01 is busy, then a connection will be extended from ground through the lower armature and back contact of hold magnet 409 to the winding of odd test relay 411 and this relay will fail to operate. If we assume that the even trunk No. 12 is idle, then the battery on its sleeve will be connected over the inner armature and back contact of hold magnet 409 to the winding of the even test relay 412.

If we assume that the second link, controlled by the hold magnet 413 is busy, then neither one of the test relays 414 or 415 will be operated since connections to their windings are broken by the operation of hold magnet 413. If magnet 413 is not operated, then the winding of test relay 415 will be in parallel with the winding of test relay 411 and both of these relays will operate.

If we had assumed that, for instance, the test relay 416 were the first to operate, then chain circuits would have been established through the whole line of test relays 412, 415, etc. It has been assumed, however, that test relay 412 becomes operated. This relay, therefore, locks through its front contact and inner lower armature and the front contact and armature 8 of relay 112. Through its upper armature relay 412 extends ground from the front contact and right-hand armature of relay 125 to conductor 417 which leads in parallel to the windings of holding magnets 309 and 409 whereby these two magnets become operated, in turn causing the operation of contact sets 301 and 401. It will be noted that relay 418 does not become operated at this time since its winding is opened at the front contact and uppermost armature of relay 411. Through its lower outer armature and front contact relay 412 extends a connection from the winding of relay 114 to the conductor No. 2 in the bundle designated 410 which leads through one of the armatures of relay 128 to the sleeve of trunk No. 02. Since this sleeve is by this time grounded, in accordance with standard practice, relay 114 will respond as soon as relay 117 releases. Since trunk No. 02 is an even-numbered trunk and since conductor 419 has not been further extended, relay 124 will remain in its normal position so that a connection is extended from trunk No. 02 through the upper three contacts of set 401, the upper three contacts of set 301, the back contacts and upper armatures of relay 124 to the circuit including the brushes 103, 104 and 105. Ground from the sleeve of trunk 02 is now extended over this circuit to the sleeve conductor 109 whence it extends through the armature and front contact of relay 110 to maintain this relay operated and at the same time shunts the winding of relay 117.

Relay 117 becoming released causes the operation of relay 114 which signifies the fact that the connection has been successfully established and, therefore, controls the release of all common relays in the manner hereinbefore described. During the maintenance of the connection relay 110 in Fig. 1 will remain operated and locked to the sleeve and in Figs. 3 and 4 the hold magnets 309 and 409 will remain locked through the upper armature and back contact of relay 418 to the sleeve of trunk 02.

It will be noted that if, contrary to the preceding description, trunk 01 had been idle and trunk 02 had been busy, then the odd test relay 411 would have been operated. In this case the relay 418 would have been operated through the front contact and upper outer armature of relay 411 and conductor 419 would have been grounded, resulting in the operation of relay 124. Therefore, trunk 01 would have been connected through the lower three contacts of set 401, the lower three contacts of set 301, the front contacts and upper three armatures of relay 124, to the trunk terminating in brushes 103, 104 and 105. In this case, during the maintenance of the connection, relays 124 and 110 of Fig. 1 would have been locked to the sleeve of trunk 01 and in Figs. 3 and 4 the hold magnets 309 and 409 and the relay 418 would have been locked to the sleeve of trunk 01.

Figs. 5, 6 and 7, when arranged in the manner indicated in Fig. 10, illustrates a third embodiment of the present invention. The characteristic feature of this embodiment is that the relay which automatically determines the proper link circuit to use is inserted not before the incoming trunk enters the cross-bar switch but rather in the link itself. Thus, the contact sets 601, 602, 603 and 604 represent a ten by ten three-wire cross-bar switch, that is, a cross-bar switch in which there are one hundred sets of contacts arranged in ten rows of ten each. There are ten select magnets, such as that numbered 600, and ten holding magnets, such as that numbered 605. The switch illustrated in Fig. 7 is a ten by ten six-wire cross-bar switch. The contact sets 701 to 704, inclusive, represent one hundred such cross-bar contact sets arranged in ten rows of ten each. There are likewise ten select magnets, such as that numbered 700, and ten holding magnets, such as that numbered 705. The connections between the cross-bar contact sets 601, 603, 701 and 703 is known as a link. This link is in the form of three wires through the cross-bar of Fig. 6 where they extend to the armatures of a relay 606 which performs a similar function to the relay 124 of Fig. 1. The contacts cooperating with the armature of relay 606 extend to six wires leading through the contact sets represented by those designated 701 and 703.

The trunks leading from the contact sets 101 to 704, inclusive, will be two hundred in number since there are one hundred such contact sets and since each such contact set accommodates two trunks. Thus, contact sets 703 and 704, which we will assume to be in the first level, will accommodate trunks 11 to 10, inclusive, and 111 to 110, inclusive, and contact sets 701 and 702, representing the tenth level, will accommodate trunks 01 to 00, inclusive, and 101 to 100, inclusive.

The operation of the circuit of Fig. 5 is similar to the operation of the circuit in Fig. 1 and, since the relays therein have been given corresponding numbers, no further particular description of

the operation of the circuit of Fig. 5 will be given. It should be noted that a relay corresponding to relay 124 of Fig. 1 is missing and that the armatures and contacts of relays 523 and 529 corresponding to relays 123 and 129, used in the one case for operating the relay 124 and in the other case for extending a ground from the left-hand armature of relay 125, are missing. The reason for this will be apparent as the description proceeds.

When a call has been established the select magnet 600 is operated and if the first digit dialed is 0 then the select magnet 700 is operated. Let it be assumed, by way of example, that trunk 101 is busy but that trunk 01 is idle. Then the grounded sleeve of trunk 101 will be extended through one of the armatures of relay 528, thence through the lower outer armature and back contact of hold magnet 705 to the winding of test relay 706. Test relay 706 will not operate in this circuit. The sleeve of trunk 01, however, being connected to battery since this trunk is assumed to be idle, will be connected through the inner lower armature of magnet 705 to the winding of test relay 707, whereupon this relay will become operated. Relay 707 will extend ground from the front contact and armature of relay 525 through the armature 2 and back contact of relay 706, armature 1 and front contact of relay 707, to conductor 708 which leads to the hold magnet 705 and the hold magnet 605, whereupon these magnets become operated. The trunk 01 will now be connected through the lower three contacts of set 701, the back contacts and armatures of relay 606, the contact set 601, to the trunk terminating in finder brushes 503, 504 and 505.

Through its armature 2, relay 707 locks to battery from armature 7 of relay 512 until this relay is returned to normal. Through its armature 3, test relay 707 extends the sleeve of trunk 01 to the winding of relay 514 so that this relay will become operated as soon as relay 517 is deenergized. Relay 517 responds to the completion of the connection from trunk 01 to the trunk circuit of Fig. 5, through the extension of ground from the sleeve now placed on conductor 509, through the armature and front contact of relay 510, to the winding of relay 517, whereby relay 517 is shunted and releases its armature. As in the same manner hereinbefore described, the energization of relay 514 signifies the fact that the trunk has been successfully extended and that the common apparatus is no longer needed.

During the maintenance of the connection relay 510 of Fig. 5 will be tied to the sleeve of the trunk and in Figs. 6 and 7 the holding magnets 605 and 705 will be likewise tied to the sleeve of the trunk.

It should be noted that if trunk 01, for instance, had been busy and trunk 101 had been idle, then test relay 706 would have been energized. In this case relay 706 through its armature 1 will extend ground to conductor 709 for the operation of relay 606. Thus, trunk 101 would have been connected through the upper three contacts of set 701, through the front contacts of relay 606, the contact set 601, to the trunk terminating in finder brushes 503 to 505, inclusive, and during the maintenance of the connection relay 606 will be tied to the sleeve of the trunk as well as the hold magnets 605 and 705.

In either case, when the conversation is ter-

minated and the ground removed from the sleeve of trunk 01 or 101, the relays noted as being energized at this time will return to normal and the entire connection will be instantly broken down.

What is claimed is:

1. A selective switch comprising coordinate rows of sets of permanently paired contacts, incoming lines appearing in certain of said rows, outgoing lines appearing in other certain of said rows, said rows of incoming line contacts and said outgoing line contacts being parallel to each other, link circuits appearing in sets of contacts of rows crossing said rows of incoming and outgoing line contacts, a plurality of outgoing lines and a corresponding plurality of links appearing in each set of contacts in the said outgoing line rows, means for directly selecting a row of outgoing line contacts, means for automatically selecting a link and automatic means for establishing a connection from an incoming line through said selected link to an outgoing line in said selected row of outgoing lines.

2. A selective switch comprising coordinate rows of sets of permanently paired contacts, incoming lines appearing in certain of said rows, outgoing lines appearing in other certain of said rows, said rows of incoming line contacts and said outgoing line contacts being parallel to each other, each said incoming line having alternative paths through each set of contacts in a row, link circuits appearing in sets of contacts of rows crossing said rows of incoming and outgoing line contacts, a plurality of outgoing lines appearing in each set of contacts in the said outgoing line rows, means for directly selecting a row of outgoing line contacts, means for automatically selecting a link and automatic means for connecting a said incoming line to that alternative path leading to the said selected outgoing line.

3. A selective switch comprising coordinate rows of sets of permanently paired contacts, incoming lines appearing in certain of said rows, outgoing lines appearing in other certain of said rows, said rows of incoming line contacts and said outgoing line contacts being parallel to each other, link circuits appearing in sets of contacts of rows crossing said rows of incoming and outgoing line contacts, a plurality of lines and links appearing in each said set of contacts, means for directly selecting a group of outgoing lines, means for automatically selecting a line of said selected group of outgoing lines and means for rendering a single path from an incoming line through a link to a selected outgoing line out of a plurality established by the actuation of an incoming line-link contact set and a corresponding link-outgoing line contact set effective.

4. A selective switch comprising coordinate rows of sets of permanently paired contacts, incoming lines appearing in certain of said rows, outgoing lines appearing in other certain of said rows, said rows of incoming line contacts and said outgoing line contacts being parallel to each other, link circuits appearing in sets of contacts of rows crossing said rows of incoming and outgoing line contacts, a plurality of lines and links appearing in each said set of contacts, each said outgoing line appearing in a plurality of said sets of contacts, means for directly selecting a group of outgoing lines, means for automatically selecting a line of said selected group of outgoing lines and means for automatically connecting an

incoming line to that one of said plurality of paths through said sets of contacts leading to said selected outgoing line.

5. A selective switch comprising coordinate rows of sets of permanently paired contacts, incoming lines appearing in certain of said rows, outgoing lines appearing in other certain of said rows, said rows of incoming line contacts and said outgoing line contacts being parallel to each other, link circuits appearing in sets of contacts of rows crossing said rows of incoming and outgoing line contacts, a connection from an incoming line to an outgoing line being established through said switch by the coincident operation of two of said sets of contacts each in a row defined by a link circuit, each said set of contacts acting to connect a plurality of lines to a plurality of links, means for directly selecting a group of outgoing lines, means for automatically selecting an outgoing line from said selected group and means for automatically connecting an incoming line to that one of said paths established through the operation of said pair of sets of contacts leading to said selected outgoing line.

6. A selective switch comprising coordinate rows of sets of permanently paired contacts, incoming lines appearing in certain of said rows, outgoing lines appearing in other certain of said rows, said rows of incoming line contacts and said outgoing line contacts being parallel to each other, link circuits appearing in sets of contacts of rows crossing said rows of incoming and outgoing line contacts, a connection from an incoming line to an outgoing line being established through said switch by the coincidental operation of two of said sets of contacts each in a row defined by a link circuit, each said set of contacts acting to connect a plurality of lines to a plu-

5 rality of links, each outgoing line appearing in a plurality of contact sets in each of which appear a plurality of outgoing lines, no one outgoing line appearing more than once in a contact set, means for directly selecting a group of outgoing lines, means for automatically selecting an outgoing line from said selected group and means for automatically connecting an incoming line to that one of said paths established through the operation of said pair of sets of contacts leading to said selected outgoing line.

7. A selective switch comprising coordinate rows of sets of permanently paired contacts, incoming lines appearing in certain of said rows, outgoing lines appearing in other certain of said rows, said rows of incoming line contacts and said outgoing line contacts being parallel to each other, link circuits appearing in sets of contacts of rows crossing said rows of incoming and outgoing line contacts, a connection from an incoming line to an outgoing line being established through said switch by the coincidental operation of two of said sets of contacts each in a row defined by a link circuit, each said set of contacts in the link circuit outgoing line field acting to connect a plurality of lines to a plurality of links, each said set of contacts in the link circuit incoming line field acting to connect a single link to a single incoming line, means for directly selecting a group of outgoing lines, means for automatically selecting an outgoing line from said selected group and means for automatically connecting an incoming line to that one of said paths established through the operation of said contact set in said link circuit outgoing line field leading to said selected line.

GERALD V. KING.