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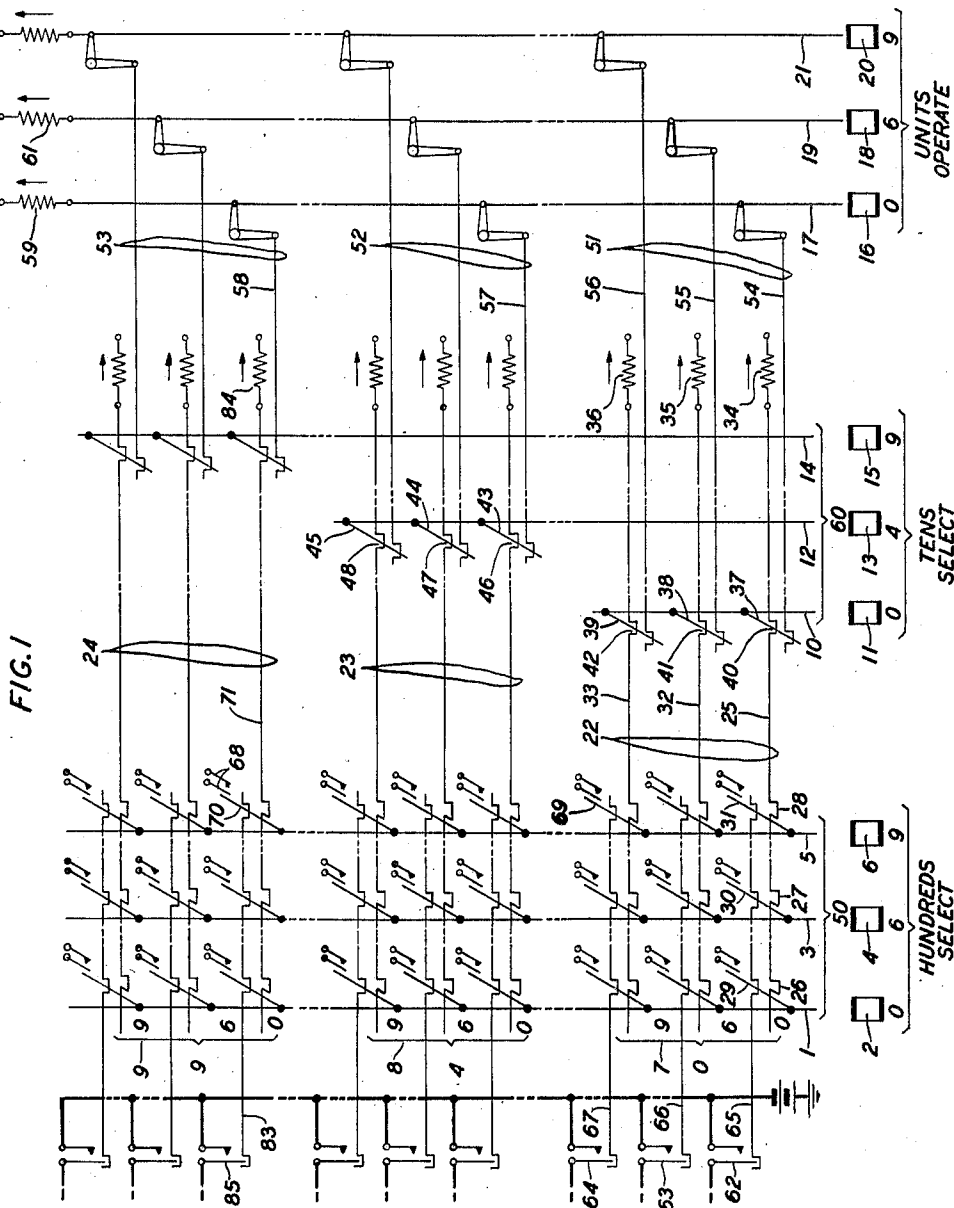
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2,349,279

SELECTIVE SWITCH

Filed March 2, 1943

3 Sheets-Sheet 1



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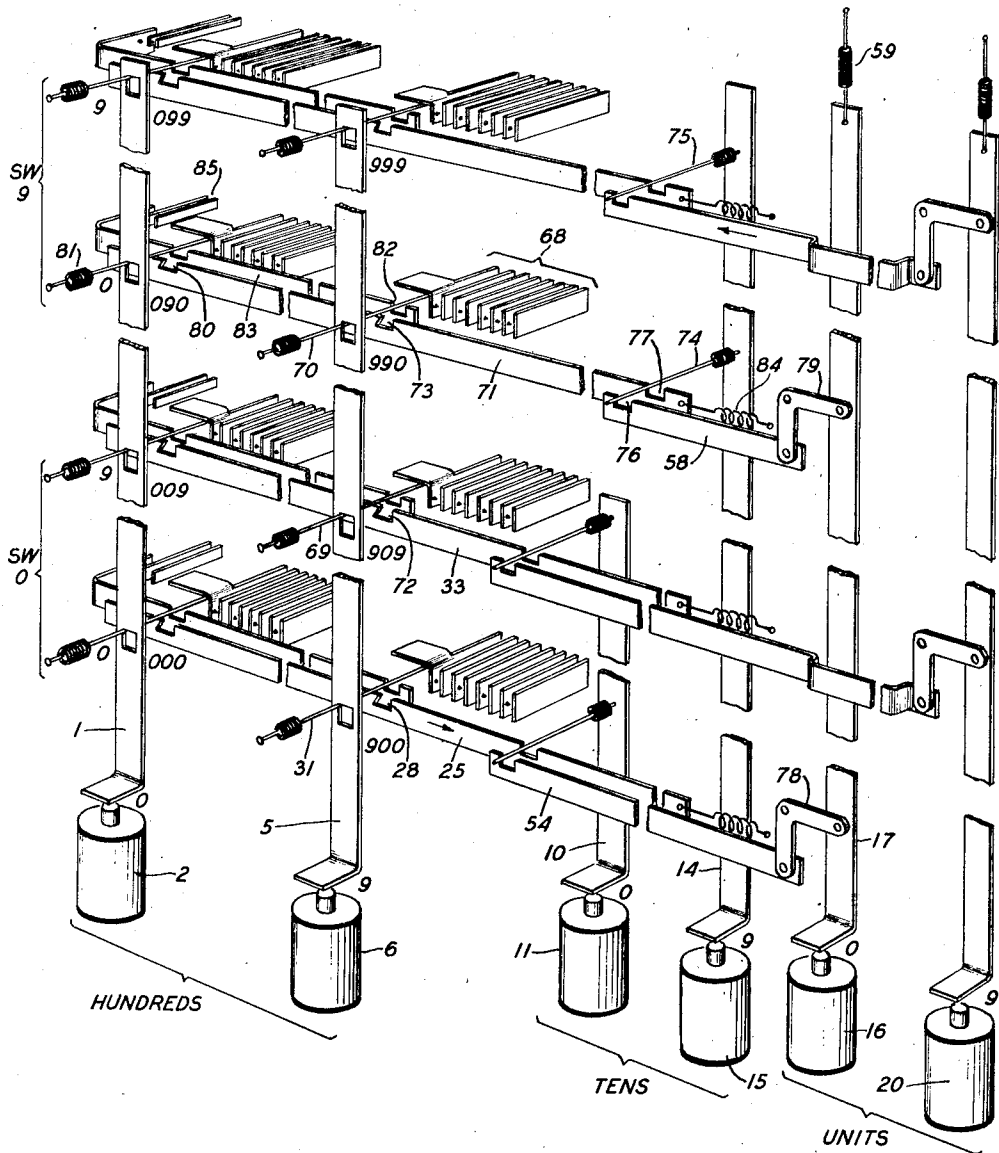
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3 Sheets-Sheet 2

FIG. 2



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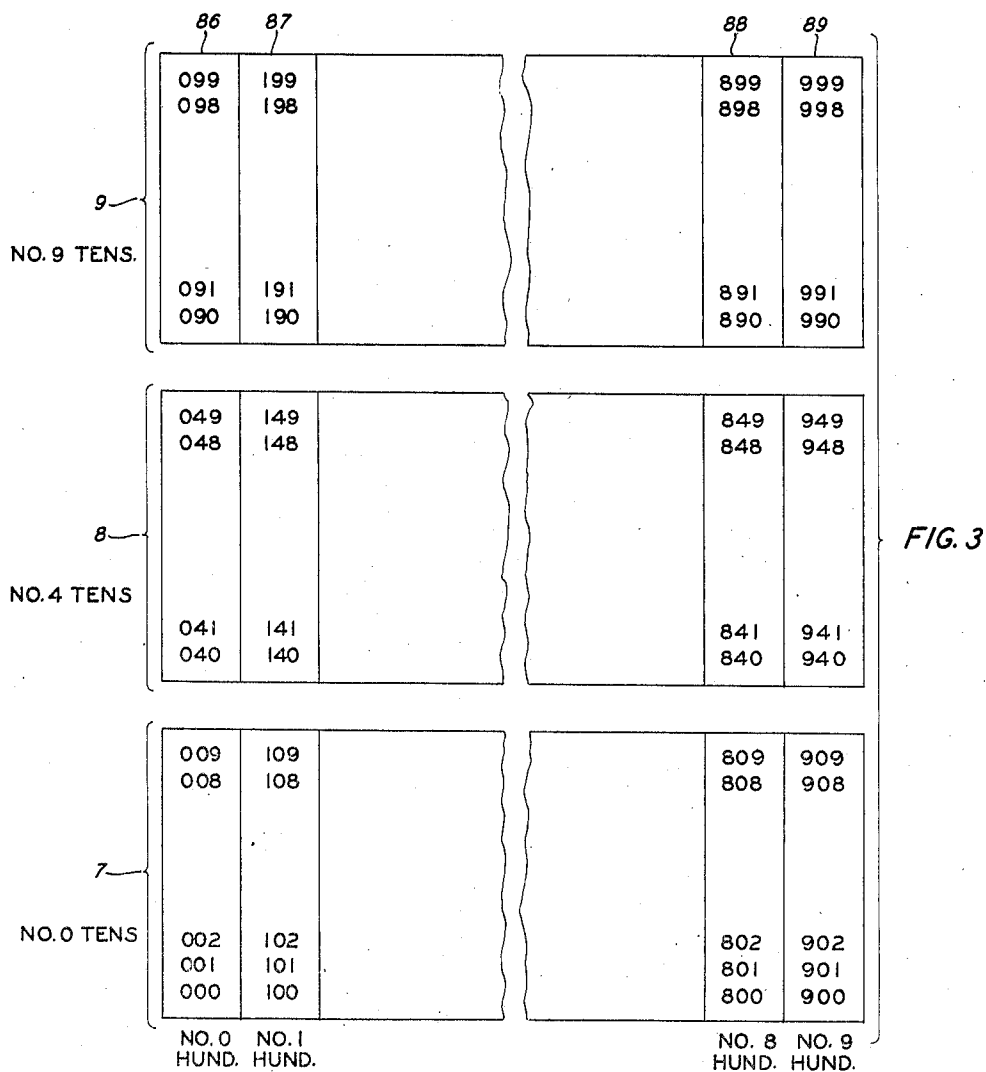
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SELECTIVE SWITCH

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3 Sheets-Sheet 3



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SELECTIVE SWITCH

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4 Claims. (Cl. 179—27.54)

This invention relates to selective switches and particularly to switches of the kind employed in communication and other electrical systems.

The objects are to increase the capacity and also the efficiency of selective switches, to simplify their structure and operation, and to effect other improvements therein.

Switches of the crossbar type have been designed heretofore having capacities of a thousand points and more. Where these large capacities are desired it is usually necessary to provide at least three sets of magnets for actuating the bars to select and operate a desired set of contacts, and it is also generally necessary to keep at least one of the magnets in an operated condition throughout the period the selected set of contacts are closed. Attempts have been made to avoid the current drain in these large-capacity switches by freeing all of the magnets as soon as they have operated the desired contact set. This end, however, has been realized in the past only at the expense of an additional set of magnets and structural complications as well.

In accordance with the present invention advantages are obtained over these prior devices by means of a crossbar switch of large capacity in which only three sets of magnets are required for actuating the switch bars to select and operate the contact sets and in which the magnets participating in the operation of a desired set of contacts may be deenergized forthwith since they are no longer required to maintain the operated contacts in their closed condition. More specifically, the hold bars, which cooperate with the select bars, are so designed that the selected set of contacts is operated by the restoring movement of a hold bar from its off-normal to its normal position; moreover, the contact set thus selected and operated is maintained in the operated condition by the hold bar after it has restored to its normal position.

The selection of a desired set of contacts in a switch of this character, having a capacity of one thousand contact sets, for example, is accomplished by energizing one of ten first select magnets to prepare a group of one hundred select fingers for cooperation with respective hold bars, energizing one of ten second select magnets for positioning the corresponding select fingers with respect to a group of ten of said hold bars, energizing one of ten operating magnets to move a single hold bar against the tension of a retractile spring from its normal position into its actuated position where it is operatively engaged by a single one of the select fingers prepared by the operation of said first select magnet, deenergizing the operating magnet to permit the retractile spring to restore said hold bar to its normal position for the purpose of operating the desired set of contacts, and finally de-

energizing the first and second select magnets. Thus it is possible to select and operate any set of contacts by briefly energizing the appropriate pair of select magnets and the appropriate operating magnet, the retractile spring of the particular hold bar involved in the operation serving to restore and retain the bar in its normal position to maintain the selected contacts closed as long as the connection is desired, all three of the magnets being deenergized at once and remaining deenergized throughout the connection to avoid the consumption of electrical energy. To effect the release of any operated set of contacts, it is only necessary to energize momentarily one of the select magnets and one of the operating magnets.

A feature of the invention is an off-normal contact arrangement for a switch of this character in which a set of off-normal contacts and an off-normal bar are provided for each of the hold bars of the switch. The switch hold bars and the off-normal bars are arranged to cooperate with the select fingers of the select bars in such a manner that the operation of any switch hold bar to effect the closure of any one of the sets of switch contacts associated therewith also causes the operation of the associated off-normal bar to close the individual set of off-normal contacts.

These and other features of the invention will be described more fully in the following specification.

In the drawings accompanying the specification:

Fig. 1 is a simplified diagram illustrating the principles of operation of the switch;

Fig. 2 is a perspective view showing the essential structure of a switch incorporating the features of the invention; and

Fig. 3 shows one convenient numbering plan for the contact sets.

Because of the wide variety of details that may enter into the construction of crossbar switches and since these switches in their numerous types are already well-known in the art, it is believed to be sufficient to illustrate in the present disclosure only those essential features of structure and operation which are necessary to a clear understanding of the invention. And it will be understood that the particular embodiment disclosed is to a large extent diagrammatic and conventional and is not intended to limit the scope of the invention, which obviously may be applied to a large variety of switch structures.

As explained above, the switch disclosed herein is one of large capacity, that is to say, a switch having too many contact sets for convenient selection by the usual two sets of operating bars and magnets. Although the invention is not to be limited to any particular capacity, it is con-

venient to describe and illustrate it in connection with a switch capable of selectively operating any one of a thousand sets of switching contacts. Referring to Figs. 1 and 3, it will be seen that the thousand sets of contacts are arranged in a field comprising ten equal switching units or groups. These contacts are coordinately arranged in vertical and horizontal rows, and the ten vertical rows correspond to the ten hundreds groups of the thousand. These ten hundreds groups are served by a group of ten select bars 50. Three of these vertical rows or hundreds groups are illustrated in Fig. 1: the No. 0 hundreds group, which is served by the No. 0 select bar 1 and the associated select magnet 2; the No. 6 hundreds group, which is served by the No. 6 select bar 3 and the associated magnet 4; and the No. 9 hundreds group, which is served by the No. 9 select bar 5 and the associated select magnet 6. The remaining seven hundreds groups have been omitted for the sake of clearness.

The ten hundreds groups of contacts are divided into ten tens groups, three of these tens groups being illustrated, the No. 0, No. 4 and No. 9 groups, 7, 8 and 9, respectively. These tens groups are served by a second set of select bars 60 and associated magnets, there being a bar and associated magnet for each of the successive tens groups. For example, the No. 0 select bar 10 and its associated select magnet 11 serve the No. 0 group of contacts 7, the No. 4 select bar 12 and associated magnet 13 serve the No. 4 tens group 8, and the No. 9 select bar 14 and associated select magnet 15 serve the No. 9 tens group 9.

Each of the first or hundreds select bars 2, 4, 6, is provided with one hundred flexible select fingers, one for each set of contacts in the corresponding hundreds group. These flexible select fingers cooperate with notched hold bars which are respectively individual to the horizontal rows or units groups of contact sets. The hold bars are arranged in groups 22, 23, 24, corresponding to the tens groups of switching contacts. For example, the hold bar 25 is individual to the No. 0 units group of contacts in the tens group 7 and is provided with ten notches 26, 27, 28, cooperating with the corresponding select fingers 29, 30, 31. Similarly, the hold bar 32 is individual to the No. 6 units group of contacts in the tens group 7 and is provided with notches cooperating with the corresponding select fingers on the hundreds select bars. And the same is true of the remaining hold bars of group 22 and of the other groups. The hold bars 25, 32, 33, etc., are maintained in their normal positions (the position shown in Fig. 1) by means of retractile springs 34, 35, 36, etc.

The second or tens select bars 60 are also provided with flexible select fingers for cooperation with the hold bars. For example, the No. 0 select bar 10 has ten select fingers 37, 38, 39, which cooperate respectively with the notches 40, 41, 42, in the hold bars of the No. 0 tens group 22. The No. 4 select bar 12 is provided with ten select fingers 43, 44, 45, which cooperate respectively with the notches 46, 47, 48, in the hold bars of the No. 4 tens group 23 and the same is true of the remaining eight select bars including the tenth or No. 9 bar 14.

The switch is further provided with ten groups of operate bars 51, 52, 53, one group for each tens group of contacts, each group including a bar for each group of units in the tens group. For example, the operate bars 54, 55, 56, of the group 51 are individual respectively to the No. 0, No. 6

and No. 9 units groups of contacts and are associated respectively with the corresponding hold bars 25, 32, 33. The operate bars 54, 55, 56, of the group 51 are provided with notches with which the respective select fingers 37, 38, 39 cooperate. The same is true of the operate bars in each of the other nine groups including those in the groups 52 and 53 illustrated. These operate bars are controlled by the third set of ten magnets, the operate magnets 16, 18, 20. The No. 0 operate magnet 16, for example, controls the ten operate bars 54, 57, 58, which correspond to the No. 0 units groups of contacts in the ten tens groups. For this purpose the magnet 16 is provided with a drawbar 17 which is mechanically coupled to the ten operate bars 54, 57, 58. The draw-bar 17 is held in its normal position to maintain the operate bars in their normal positions by means of a retractile spring 59. The No. 6 operate magnet 18 controls the ten operate bars serving the No. 6 units groups through the associated drawbar 19 and its mechanical linkages, and the draw-bar 19 is maintained in its normal position by the retractile spring 61. Similarly the remaining operate magnets, including the No. 9 operate magnet 20, control the associated operate bars through corresponding draw-bars and mechanical linkages.

Sets of off-normal contacts are provided for the switch and associated individually with the respective horizontal rows of switch contacts. These off-normal contacts are operated by off-normal bars which are individual to and arranged to cooperate with the corresponding hold bars. For example, the off-normal contact sets 62, 63, 64, associated respectively with the No. 0, No. 6 and No. 9 horizontal rows in the group 7 are operated by the individual off-normal bars 65, 66, 67, which in turn are associated with the hold bars 25, 32 and 33. These off-normal bars are moved to their contact-closing positions and are held in these positions by the corresponding hold bars. To this end the off-normal bars are provided with notches for receiving the actuated select fingers on the vertical bars.

A detailed description will now be given of the operation of the switch structure shown in Fig. 2. For this purpose it may be assumed that the set of switching contacts 68 is to be operated. According to the assumed numbering plan this set of contacts bears the designation "990." That is to say, it occurs in the No. 9 hundreds group, in the No. 9 tens group and in the No. 0 units group. By means of appropriate controlling circuits the magnet 6 is energized to pull the select bar 5 downwardly. The downward movement of the bar 5 flexes the select fingers 31, 69, 70 (of which there are one hundred), against the upper edges of the corresponding hold bars 25, 33, 71. It will be noted that the notches 28, 72, 73, in the hold bars are displaced slightly to the right of the corresponding select fingers when the bars are in their normally retracted positions. For example, if the bar 71 is at this time in its normal position, as indicated in the drawings, the finger 70, on being flexed downwardly by the operated select bar 5, engages the upper edge of the bar 71 and does not enter the notch 73, and the same is true of all other select fingers flexed by the select bar 5.

Assume next that the circuits are arranged to energize the select magnet 15 shortly after the energization of magnet 6. The energization of magnet 15 pulls the select bar 14 downwardly and causes the ten corresponding select fingers

74, 75, to enter the notches in the corresponding pairs of operate and hold bars, provided these bars are at the time in their normal positions. To illustrate, the operate bar 58 and the associated hold bar 71 are provided with notches 76 and 77, respectively, which are in alignment with the select finger 74 when these bars are in their normal positions; hence, the downward movement of the bar 14 causes the select finger 74 to enter both notches 76 and 77. And the same is true of any of the remaining nine select fingers on the bar 14 which corresponds to operate and hold bars occupying their normal positions.

Next the energizing circuit of the operate magnet 16 is closed, and this magnet pulls the drawbar 17 downwardly against the tension of spring 59. The downward movement of the bar 17 acts through the links 78, 79, to impart a sliding movement to the ten operate bars 54, 58, corresponding to the No. 0 units rows of contacts in the respective tens groups. Since, however, only one of the ten select magnets 11, 15, is operated at this time, namely the magnet 15, only the operate bar 58 is effective. The sliding movement of this bar through the medium of the positioned select finger 74, imparts a similar movement to the hold bar 71 against the tension of its retractile spring 84, and the bar 71 moves to the left until all of its ten notches 73, 80, are in vertical registration with the corresponding select fingers 70, 81. Since, however, the select magnet 6 is the only operated one in the group of ten, the corresponding finger 70 is the only one that has been tensioned downwardly against the edge of the bar 71. Therefore, as soon as the bar 71 is advanced by the operate bar 58, the tensioned select finger 70 enters the notch 73 and at the same time enters the notch 82 in the off-normal bar 83, the latter notch being normally in registration with the finger 70.

Finally the magnet 16 is deenergized, followed by the deenergization of magnets 15 and 6. Upon the deenergization of magnet 16 the spring 59 restores the bar 17 and the associated operate bars 54, 58. The restoration of the operate bar 58 removes the operating force from the hold bar 71, and this bar is returned to normal by its retractile spring 84. As the bar 71 returns to normal under the force of the spring 84, the positioned select finger 70 is moved to the right to operate and close the contact springs of the desired set 68. Moreover, the movement of the bar 71 imparts a similar movement to the off-normal bar 83, through the medium of the finger 70, and the off-normal bar 83 closes the associated off-normal springs 85. The restoration of the magnet 15 and the bar 14 permits the select fingers 74, 75, to return to their normal positions, and thus the operate and hold bars 58 and 71 are uncoupled. The restoration of the select bar 5, which occurs slightly following the return movement of the hold bar 71, also permits all of its select fingers 31, 39, etc., to return to their normal positions, with the exception of the finger 70, which is now held in its flexed and contact-closing position by the restored hold bar 71. To insure that the finger 70 is trapped and held after the restoration of the bar 5, the edge of the notch 73 in the hold bar 71 is under-cut slightly as illustrated in the drawings. And the same is true of the remaining corresponding notches in this and in the other hold bars.

select magnets and an operate magnet, following which all three of the magnets are deenergized and are not required thereafter to maintain the selected set of contacts in its operated condition. In a similar manner any desired set of contacts in the switch may be selected and operated to the exclusion of all other sets, or two or more sets of contacts may be selected and operated simultaneously.

When it is desired to restore the operated set of contacts 68, it is only necessary to energize the magnets 15 and 16 momentarily. The energization of the magnet 15 pulls the bar 14 downwardly, causing the select finger 74 to enter the notches 76 and 77. The momentary energization of magnet 16, which occurs shortly thereafter, causes the sliding movement of the hold bar 71 against the tension of the retractile spring 84. As soon as the hold bar 71 has advanced sufficiently the trapped select finger 70 escapes the under-cut edge of the notch 73 and returns to its normal position, permitting the contacts 68 to open. Moreover, the momentary movement of the bar 71 and the restoration of the finger 70 releases the off-normal bar 83 and the associated off-normal contacts 85.

Although not so illustrated in the drawings, it will be understood that separate retractile springs may be provided for each of the off-normal bars, or the off-normal springs themselves may furnish the restoring force.

These off-normal contact springs, associated with the hold bars of the switch, are sometimes required for circuit reasons. For example, it has been the practice heretofore to use the conventional crossbar switch as a line switch, in which case the off-normal contact springs may serve as the cut-off contacts for the subscriber's line. Moreover, the operation of the conventional switch is such that these off-normal springs may be operated directly from the hold bar, which is moved to its operated position and maintained in such position throughout the connection. In the switch disclosed herein, however, the hold bars are normally in their contact-actuating position and also occupy this same position during the contact closure periods. Therefore, the direct movement of the hold bar cannot be utilized to close and maintain closed the associated off-normal contact set. While it would be possible to secure the equivalent of an off-normal contact set at each cross-point, this would increase the size and cost of the switch and would be impractical in other respects. Such an expedient is avoided in the switch disclosed herein by providing the off-normal bar above described for operating the off-normal contact set whenever one of the associated sets of switching contacts is operated.

It will be noted that the switch is not limited to the exact sequence of magnet operation above described. If desired the magnets 6 and 15 may be operated simultaneously, followed by the operation of magnet 16, or the magnet 15 may be operated first, followed by the operation of magnet 6, followed in turn by the operation of magnet 16. In either case the result is the same, namely the selection and closure of the desired set of contacts 68.

A better understanding of the assumed numbering plan may be had from Fig. 3. This figure illustrates the ten hundreds group of contacts arranged in ten vertical rows. Four of these vertical rows 86, 87, 88, 89 are shown, the No. 0, No. 1, No. 8 and No. 9 hundreds groups. The

Thus a set of contacts 68 has been selected and operated by the conjoint operation of two

ten hundreds rows are also divided horizontally into ten tens groups, the groups 7, 8, 9 illustrated being the No. 0, No. 4 and No. 9 tens groups and corresponding to those shown in Fig. 1. The units values of the ten sets of contacts in each tens group are assigned in order beginning at the bottom of the group. For example, the first ten sets in the No. 0 hundred, namely the ten sets comprising the No. 0 tens group 7, are numbered from 0 to 9 beginning at the bottom of the group. Inspection of the figure will show that this same numbering arrangement prevails throughout the complete group of a thousand contact sets. It should be understood, however, that any suitable numbering arrangement may be applied to the switch structure shown and described herein.

What is claimed is:

1. The combination in a switching device of a plurality of switching groups of separately-operable sets of contacts, contact actuating elements individual respectively to said contact sets, said contact sets and actuating elements being arranged in rows in two coordinate directions, bars individual respectively to the rows of actuating elements in a first coordinate direction, first select magnets individual respectively to the rows of actuating elements in the second coordinate direction, each of said rows in the second coordinate direction comprising actuating elements in all of said switching groups, the energization of any one of said first select magnets serving to prepare the associated actuating elements, second select magnets individual respectively to said switching groups, the energization of any one of said second select magnets serving to select for operation all of the bars associated with the corresponding switching group, operate magnets, each serving a bar for each of said switching groups, the energization of any operate magnet in conjunction with said select magnets serving to move a particular bar of the selected switching group into operative relation with the corresponding prepared actuating element, and means acting on said bar for returning it to its normal position when said operate magnet is deenergized, said bar on its return movement acting upon the prepared actuating element to operate the associated set of contacts.

2. The combination in a switching device of a plurality of crossbar switch units each including a plurality of separately-operable sets of contacts, contact actuating elements individual respectively to said contact sets, said contact sets and actuating elements being arranged in horizontal and vertical rows, hold bars individual respectively to the horizontal rows of actuating elements, first select magnets individual respectively to the vertical rows of actuating elements, each of said vertical rows comprising actuating elements in all of said switch units, the energization of any one of said first select magnets serving to prepare the associated actuating elements, second select magnets individual respectively to said switch units, the energization of any one of said second select magnets serving to prepare the hold bars of all of the horizontal rows of the corresponding switch unit, operate magnets, each serving a hold bar for each of said switch units, the energization of any operate magnet in conjunction with said select magnets serving to move a particular one of the prepared hold bars into operative relation with the cor-

responding prepared actuating elements, and means acting on said hold bar for returning it to its normal position when said operate magnet is deenergized, said hold bar on its return movement acting upon the prepared actuating element to operate the associated set of contacts and to maintain said contacts in an operated condition following the deenergization of said select and operate magnets.

3. The combination in a switching device of a plurality of crossbar switch units, each unit having a plurality of separately-operable sets of contacts, contact actuating fingers individual respectively to said contact sets, said contact sets and actuating fingers being arranged in horizontal and vertical rows, hold bars individual respectively to the horizontal rows of actuating fingers, each hold bar having notches for engagement by the respective fingers in the horizontal row, first select magnets individual respectively to the vertical rows of actuating fingers, the energization of any one of said first select magnets serving to move in all of said switch units the actuating fingers of the corresponding vertical row into prepared positions with respect to the corresponding hold bars, second select magnets individual respectively to said switch units, the energization of any one of said second select magnets serving to prepare for operation all of the hold bars associated with the corresponding switch unit, operate magnets each serving a hold bar for each of said switch units, the energization of any operate magnet in conjunction with said select magnets serving to move a particular one of the prepared hold bars into a position where the prepared actuating finger engages the associated notch thereof, and retractile means acting on said hold bar for returning it to its normal position when said operate magnet is deenergized, said hold bar on its return movement acting upon the finger engaging the notch therein to operate the associated set of contacts and to maintain them operated after the release of said select and operate magnets, the reoperation of said hold bar by the associated operate magnet serving to restore the operated set of contacts to their normal condition.

4. The combination in a switching device of a plurality of separately-operable contact sets, contact actuating elements individual respectively to said contact sets, said contact sets and actuating elements being arranged in coordinate rows, select bars individual respectively to the rows of actuating elements in one coordinate direction, hold bars individual respectively to the rows of actuating elements in the other coordinate direction, off-normal contact sets, one for each of said hold bars, off-normal bars individual respectively to said off-normal contact sets and operatively associated with corresponding hold bars, means for operating any one of said select bars to move each one of the associated actuating elements into operative relation with respect to the associated hold bar and off-normal bar, and means for operating any one of said hold bars to move the positioned actuating element and the contacts of the associated set into their closed position, the movement of said actuating element serving to move the associated off-normal bar to close the corresponding set of off-normal contacts.

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