

Sept. 12, 1944.

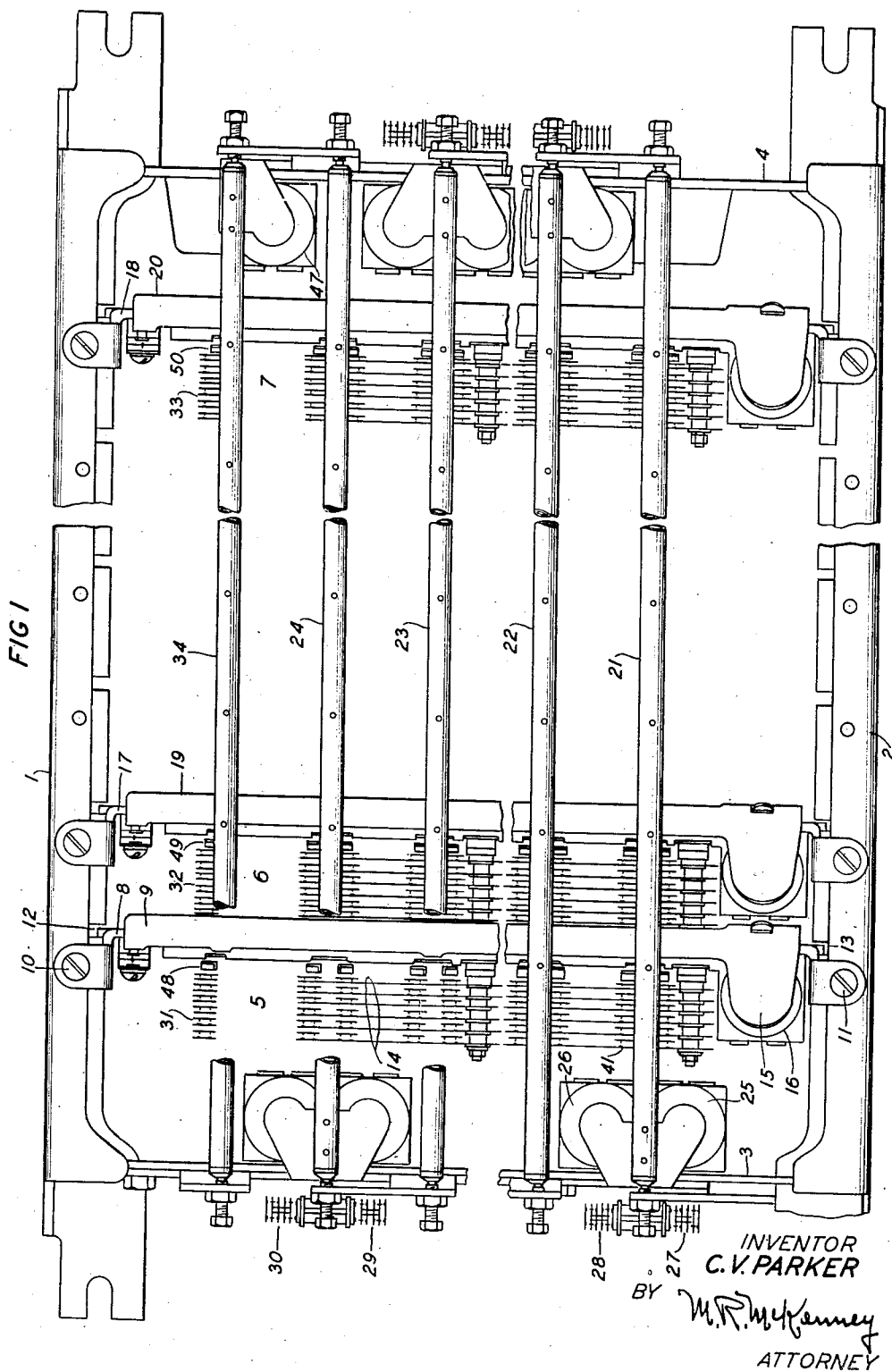
C. V. PARKER

2,358,095

SWITCHING DEVICE

Filed March 9, 1943

3 Sheets-Sheet 1



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2,358,095

SWITCHING DEVICE

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FIG. 2

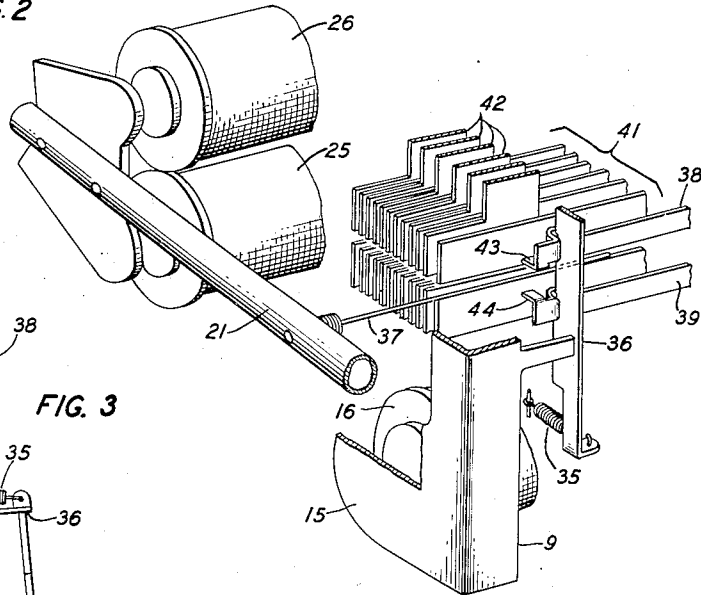


FIG. 3

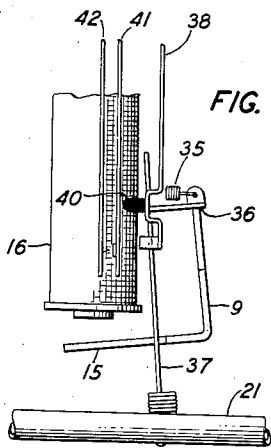


FIG. 5

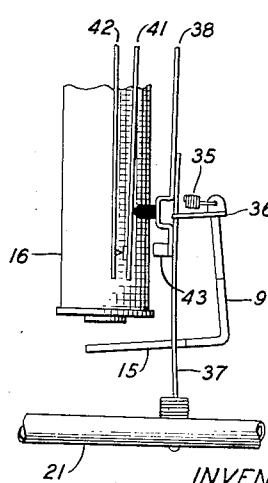
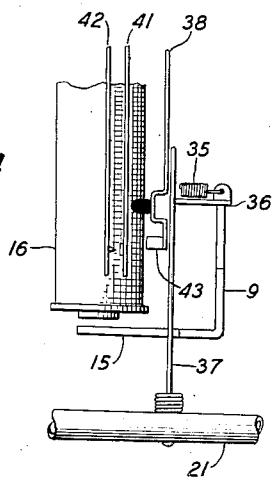


FIG. 4



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FIG. 6.

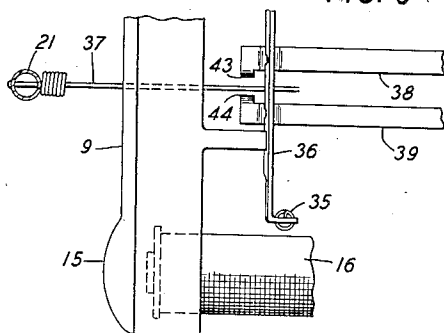


FIG. 7

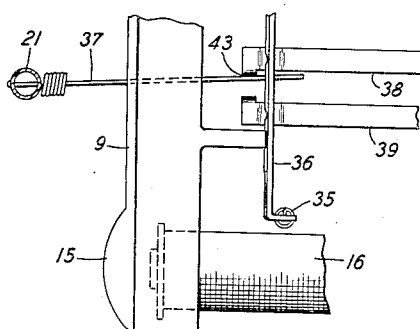


FIG. 8

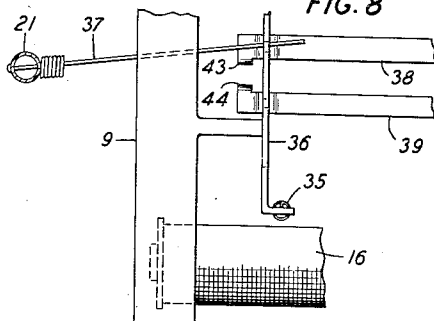
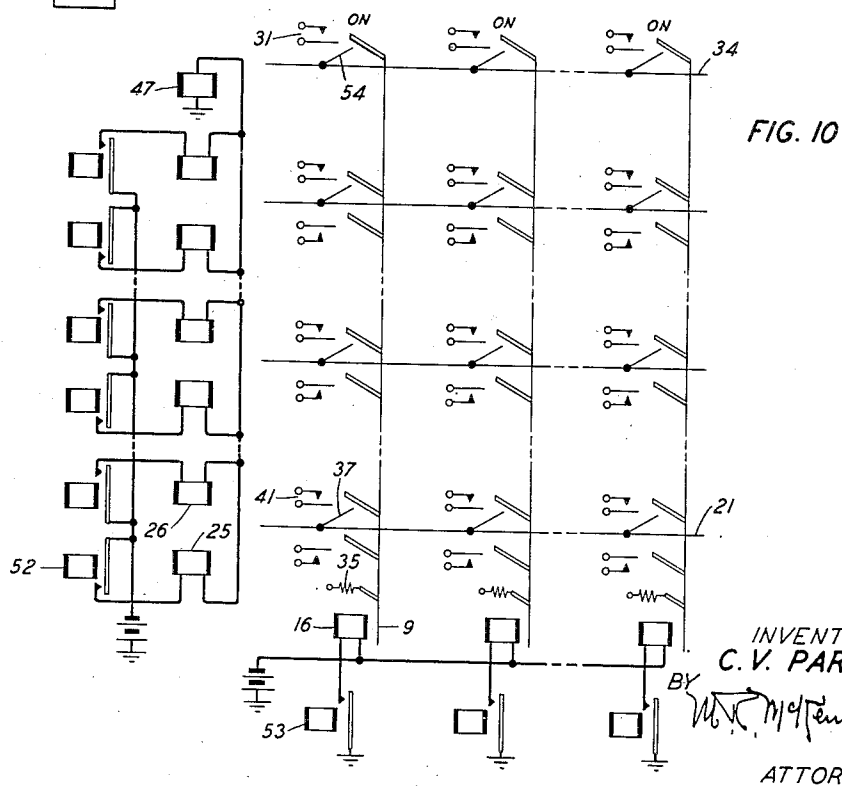
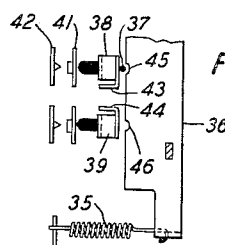


FIG. 9



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2,358,095

SWITCHING DEVICE

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Application March 9, 1943, Serial No. 478,498

8 Claims. (Cl. 179—27.54)

This invention relates to switching devices and particularly to automatic switches used in communication systems.

An object of the invention is to effect economy in the operation of automatic switches by reducing the electrical energy consumed while the switches are in their actuated condition.

Another object is to obtain a greater latitude in choosing the order or sequence of the functions performed in the operation of automatic switches.

Other objects are to effect improvements in the selection and operation of off-normal switch contacts and in other respects to obtain improvements in the structural design and operation of automatic switches.

In the conventional crossbar switch now in use in automatic telephone systems the method employed for the selection and operation of a set of contacts consists in first positioning a select bar individual to a row of contact sets in one coordinate direction, then operating a hold bar individual to a row of contact sets in the other coordinate direction to effect the closure of the desired set of contacts at the intersection of the operated bars, and finally releasing the select bar, the selected contacts being maintained in their closed condition by the continued operation of the hold bar. The subsequent release of the hold bar restores the operated contacts to normal. Switches of this type entail the expenditure of substantial amounts of energy since the hold magnets must be maintained in an operated condition as long as the selected contact sets are closed. To obviate this energy consumption during the holding time of the switch, mechanical latching devices have been proposed in the past for locking an operated set of contacts in their closed condition in order that both the select and hold magnets may be released. These latching devices, however, are objectionable in that they complicate the switch construction and increase the cost of manufacture.

In accordance with the present invention the disadvantages above mentioned are overcome by a crossbar switch structure in which each one of the hold bars is effective in its restored position, where it is normally held by a retractile spring, to close any one of the contact sets in the corresponding row, provided the appropriate select bar has been moved to its selecting position. The hold magnet, therefore, does not actuate the selected set of contacts as in the conventional switch; its purpose is to move the hold bar momentarily to its off-normal position while a select

bar is operated to move the select finger or similar device into operative relation with respect to the selected set of contacts. Thereupon the hold magnet is released, and the hold bar returns to its normal position and in so doing operates and holds the selected set of contacts. Thus it is possible to select and close any desired set of contacts in the switch by the momentary operation of the corresponding select and hold magnets, and the selected set of contacts are maintained in their closed condition as long as desired without consuming any electrical energy. To release a closed set of contacts it is merely necessary to energize momentarily the associated hold magnet.

A feature of the invention is a crossbar switch in which the conjoint operation of a select bar and a hold bar effects the actuation of the desired set of contacts and in which said bars may be operated in sequence, either one following the other, or simultaneously.

Another feature of the invention is a crossbar switch of the character above described in which individual sets of off-normal contacts are provided for the respective hold bars. These off-normal contacts are selected and operated by means of an off-normal select bar which cooperates with the hold bars in the same manner as the other select bars of the switch.

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

In the drawings accompanying the specification:

Fig. 1 is a front view of a crossbar switch in which the features of this invention are incorporated;

Fig. 2 is a perspective view showing the operating mechanism at one of the cross-points of the switch;

Fig. 3 is a detail view looking down on the contact operating mechanism and showing the hold bar and the select finger in their normal positions;

Fig. 4 is a similar view but showing the hold bar in its off-normal or attracted position and the select finger in readiness for movement into one of its selecting positions;

Fig. 5 illustrates the positions occupied by the select finger and hold bar while they are holding a set of contacts in closed position;

Figs. 6, 7 and 8 are side views showing the selecting and operating mechanism in different stages of operation;

Fig. 9 is a view of the selecting and operating

mechanism looking toward the front of the switch; and

Fig. 10 is a circuit diagram illustrating the energizing circuits for the operating magnets.

The features of the invention have been incorporated for the purpose of illustration herein in a crossbar switch of the type disclosed in the patent to J. N. Reynolds 2,021,329 of November 19, 1935. However, it will be understood that the invention is not limited in its application to this particular switch but may be applied to switches of all types in which it may be found useful.

Referring now to the drawings, first to Fig. 1, the crossbar switch herein disclosed includes a frame comprising the upper and lower channel members 1 and 2 and the end plates 3 and 4, which interconnect the members 1 and 2 and are welded or otherwise joined thereto.

The frame thus formed supports a series of vertical units 5, 6, 7 (usually ten or twenty in number). Each of these includes a mounting plate 8, which supports the several sets of contact springs forming the associated vertical row and also supports the associated operating and holding bar 9. The mounting plate 8 is detachably secured to the upper and lower frame members 1 and 2 by means of screws 10 and 11, its fixed position in the frame being determined by its engagement with the slots 12 and 13. The stationary vertical contact strips 14 extend the full depth of the vertical row 5, and the individual sets of movable spring contacts at the successive cross-points in the row are arranged to engage these stationary contact strips when selected and operated by the switch mechanism. Usually there are ten of these movable sets of spring contacts in each vertical row, and the ten horizontal rows formed by these movable contact sets may be multiplied, if desired, and connected to ten respective external circuits. The hold bar 9 is pivotally supported on the forward edge of the mounting plate 8 with its armature 15 in operative relation to the associated hold magnet 16, and a retractile spring, which will be explained hereinafter, serves normally to hold the bar 9 in its contact-operating position. In a similar manner the remaining vertical units 6, 7 include mounting plates 17, 18, which support the cooperating sets of contact strips and movable contact springs and the respective hold bars 19, 20.

The horizontal or select bars are arranged as shown in Fig. 1. Usually there are five of these bars 21, 22, 23, 24, (one being omitted in the drawings), each bar serving two horizontal rows of contacts. For example, the bar 21 may be operated in one direction by magnet 25 to rotate the select fingers into operative relation with respect to the contact sets of one horizontal row and may be rotated in the other direction by magnet 26 to position the select fingers in operative relation with the contact sets of the adjacent horizontal row.

The five select bars 21, 22, 23, 24 are provided with individual sets of off-normal spring contacts 27, 28, 29, 30, etc. Each time the bar 21, for example, is rotated in one direction it closes the off-normal contact springs 27, and each time the bar rotates in the other direction it closes the off-normal contact springs 28.

The switch is also equipped with off-normal spring contact sets 31, 32, 33, which are individual respectively to the hold bars 9, 19, 20. As will be explained hereinafter these hold bar off-normal contact sets are closed by the conjoint opera-

tion of the individual hold bar and a special or off-normal select bar 34.

To avoid unnecessary complication of the drawings, much of the details of the crossbar switch structure has been omitted. For a better understanding of the detailed construction of switches of this kind reference is made to the aforementioned patent to Reynolds 2,021,329.

As was explained hereinbefore, the switch of the present invention is capable of maintaining a selected set of contacts in a closed condition after the cooperating select and hold magnets have been deenergized and is further capable of releasing an operated set of contacts in response to the simple act of energizing the hold magnet momentarily. To this end each hold bar, such as the hold bar 9 (shown more clearly in Figs. 2 to 9) is provided with a retractile spring 35 which normally holds the bar and with it the operating plate 36 in the contact-closing position. The plate 36 is fixed to the hold bar 9 in parallel therewith as shown in Fig. 2, and the force of the spring 35 rotates the plate 36 and hold bar 9 as a unit about the vertical mounting plate 8 as a fulcrum. In this normal position the operating plate 36 engages and flexes the ten select fingers 37 of the associated vertical row.

With the bars 21 and 9 in their normal positions, each one of these fingers, such as the finger 37 shown in Fig. 2, is flexed by the plate 36 and lies in a central position between the contact-operating springs 38 and 39 without engaging either one of them. The contact-operating springs 38 and 39 are bent to form recesses (illustrated more clearly in Fig. 3) into which the plate 36 enters without disturbing said springs. Each of the contact-operating springs 38 and 39 carries an insulating stud 40 which serves, when the contact-operating spring is moved by the hold bar as explained hereinafter, to flex the movable contact springs 41 of the associated set into engagement with the respective stationary contact strips 42.

The springs 38 and 39 are also formed with integral guide portions 43 and 44. The purpose of these guides 43 and 44 is to enable the operation of the select and hold bars in either sequence. If, for example, the select bar 21 is rotated by magnet 25 while the hold bar 9 is in its normal retracted position, the select finger 37 moves up against the horizontal surface of the guide 43. Subsequently when magnet 16 is energized to rotate the bar 9, the operating plate 36 is withdrawn from the recesses in the springs 38 and 39; and the finger 37, being released, moves along the surface of the guide 43 until it escapes and advances, by reason of its own tension, into the selecting position opposite the uppermost spring 38, as seen in Fig. 8. Similarly, if the select bar 21 is rotated in the opposite direction by magnet 26, the finger 37 engages the guide 44 and moves along the surface of this guide, when the hold bar is subsequently withdrawn, until it escapes and assumes the selecting position opposite the lower contact-operating spring 39. On the other hand, if the hold magnet 16 is operated before the select magnet, the withdrawal of the operating plate 36 permits the flexed spring 37 to move freely in the horizontal plane midway between the guides 43 and 44 until it reaches the position shown in Fig. 4. Thereafter the operation of the select bar 21 causes the finger to assume a selecting position opposite either the upper spring 38 or the lower spring 39, depending upon the direction of rotation of the select bar. Finally, the re-

lease of the operated hold magnet 16 permits the retractile spring 35 to restore the hold bar 9 and the operating plate 36 to normal. The operating plate 36 in returning to normal flexes the positioned select finger 37 against either the spring 38 or the spring 39, depending upon the selection made, and urges the contact-operating spring into the contact-closing position. This position of the mechanism is clearly shown in Fig. 5.

The side view of Fig. 6 shows the mechanism in its normal position, corresponding to Figs. 2 and 3. The select bar 21 is in its normal position holding the select finger 37 midway between the contact-operating springs 38 and 39, and the hold bar 9 is rotated by the retractile spring 35 to its normal position in which the operating plate 36 flexes the resilient finger 37 between the guides 43 and 44 but without touching either of them.

The side view in Fig. 7 illustrates the mechanism with the select bar 21 in its rotated position and with the hold bar 9 at normal. The rotation of the bar 21 urges the select finger 37 up against the surface of the guide 43 on the operating spring 38. If now the hold magnet 16 is energized to rotate the bar 9 to its operated position, the withdrawal of the operating plate 36 permits the finger 37 to slide along the surface of the guide 43 until it escapes from the guide whereupon its flexure causes it to move up into the position illustrated in Figs. 8 and 9. In this select position the spring finger 37 lies opposite a small notch 45 in the plate 36. When the hold bar is subsequently released and restored by the spring 35 to its normal position, the notch 45 traps the finger 37 and moves it and the operating spring 38 into the position shown in Fig. 5 where the contact springs 41 and 42 of the associated set are closed.

In a similar manner the rotation of the select bar 21 in the opposite direction causes the positioning of the finger 37 in line with the notch 46 and opposite the lower contact-operating spring 39. With the spring finger in this position the release of the hold magnet and the restoration of the hold bar causes the closure of the lower set of contact springs of the cross-point.

As hereinbefore described, the off-normal contact springs individual to the respective hold bars are selectively operated under the joint control of the associated hold bar and the special off-normal select bar 34. The bar 34 is rotated by a select magnet 47 in a direction to position the resilient select fingers opposite the contact-operating springs associated with the off-normal contact sets. In the normal condition of the switch the retracted hold bars 9, 19, 20 flex the spring fingers on the select bar 34 to a position under but not in contact with the guiding surfaces of the respective contact-operating springs 48, 49, 50. When the hold bar is rotated for the purpose of establishing a connection through one of the switching contact sets, the corresponding spring finger on the off-normal bar 34 is unflexed and released to a position with respect to the contact-operating spring which corresponds to the position of the finger 37 illustrated in Fig. 4. Thereafter the rotation of the off-normal bar 34 tilts the spring finger to a position opposite the spring 48, whereupon the restoration of the operated hold bar closes the off-normal set of contact springs 31 associated with that hold bar. With this arrangement it will be seen that the off-normal contact springs associated with a

hold bar may be operated each time a set of switching contacts in the corresponding vertical row is operated by arranging the circuits such that the off-normal select magnet 47 is energized simultaneously with the energization of the particular select magnet that is required for selecting the desired set of switching contacts.

These off-normal contact springs, associated with the vertical or hold bars of the switch, are sometimes required for circuit reasons. For example, when the switch is used as a line switch, the off-normal contact springs may serve as the cut-off contacts for the subscriber's line. In the conventional cross-bar switch these 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.

To review the operation of the switch as a whole, assume now that it is desired to establish a connection through the upper set of contacts 41 lying at the intersection represented by the select bar 21 and hold bar 9. When contacts 41 are closed, it is desirable to close the off-normal set of contacts 31 and to maintain the off-normal contacts in a closed condition until the contacts 41 are again opened. Since the contact set 41 is controlled jointly by the select magnet 25 and the hold magnet 16, it is necessary that both of these magnets be energized concurrently for a brief interval of time. The order in which they are energized may be chosen to suit the particular circuits with which the switch is used. That is to say, the select magnet 25 may be energized followed by the energization of magnet 16, or magnet 16 may be energized first followed by the energization of magnet 25. Moreover, since the off-normal contact set 31 depends on the joint control of select magnet 47 and hold magnet 16, the magnet 47 should also be energized during some portion of the period in which the magnet 16 is energized.

While the operating circuits of the switch are subject to many variations, Fig. 10 illustrates one manner in which the magnets may be energized for operating the switch contacts. At the proper time in the operation of the system energizing circuits are closed for the control relays 52 and 53. Relay 52 closes a circuit from battery through its contact, winding of select magnet 25 and winding of off-normal select magnet 47 to ground. Relay 53 closes an obvious circuit for the hold magnet 16. Magnet 25 rotates the bar 21 to move the select finger 37 upwardly. Magnet 16 rotates the hold bar 9 against the tension of spring 35 to release the finger 37 from its normal position between the operating springs 38 and 39, permitting the finger to assume its select position opposite the upper contact-operating spring 38 as best seen in Fig. 8. Magnet 47

rotates the bar 34 to move the select finger 54 upwardly, and the rotation of the hold bar 9 also releases this finger from its normal flexed position and permits it to assume its operative position opposite the contact-operating spring 48 (see Fig. 1).

The select fingers 37 and 54 are now in their operated positions, and the next step is to apply a force to each one of these fingers for closing the associated set of contacts. This is accomplished by the deenergization of the hold magnet 16 while the select magnets 25 and 47 are being maintained in an energized condition. Upon the deenergization of magnet 16 the retractile spring 35 restores the hold bar 9 to its normal position and in so doing rotates the operating plate 36 against the positioned fingers 37 and 54, forcing these fingers against contact-operating springs 38 and 48 and in turn forcing these springs to a position where they close the associated set of contacts 41 and 31. The circuits of magnets 25 and 47 may now be opened to permit the deenergization of these magnets and the restoration of the associated bars 21 and 34 to their normal positions. Although the bar 21 restores to its normal position the finger 37 is held in its contact-closing position by the force of the spring 35 on the operating plate 36. The notch 45 in the plate 36 serves to hold the finger 37 in its trapped position and prevents it from restoring when the bar 21 is returned to its normal position. In a similar manner the select finger 54 is held by a notch in the operating plate 36 and does not restore when the off-normal bar 34 returns to normal.

Thus a set of contacts at the intersection of any vertical row and any horizontal row of the switch may be selected and operated to the exclusion of all other contact sets by the momentary energization of the corresponding select and hold magnets, and these magnets may remain deenergized throughout the interval that the contact closure is required. Furthermore, the selective operation of a desired set of switch contacts may also be accompanied by the operation of off-normal contacts by the additional energization of a select magnet concurrent with the operation of the switching contacts. The fact that all operating magnets are in a deenergized condition during the holding time of the connection is very important; it reduces to a great extent the current consumption required for the operation of the switch magnets. When the connection is no longer required, the set of contacts 41 and the off-normal set 31 may be released by the simple act of energizing the hold magnet 16 for a brief interval. The energization of this magnet rotates the hold bar 9, which releases the fingers 37 and 54 and permits them to restore to their positions corresponding to the normal positions of the select bars 21 and 34. Upon the subsequent release of magnet 16 the bar 9 returns to its normal position and in so doing flexes the fingers 37 and 54 horizontally but without affecting the associated contact springs.

It will be understood, of course, that the switch disclosed herein, like the usual crossbar switch, is capable of establishing a plurality of concurrent connections through its cross-point contacts. The flexibility of the contact select fingers permits a select bar to be operated and released repeatedly without disturbing a connection that is being held by one of the flexible fingers on said bar. Similarly the off-normal select bar 34 may be operated and released any desired number of

times while one or more of the off-normal contact sets are in their closed condition. Since the off-normal select magnet 47 is common to the other select magnets of the switch, it is convenient to operate this magnet, as illustrated in Fig. 10, in series with any one of the select magnets that may be chosen for operation.

What is claimed is:

1. The combination in a crossbar switch of a plurality of sets of separately-operable contacts, a select bar having a plurality of select elements thereon, one for each set of contacts, said select bar in its normal position serving to hold said select elements out of operative relation with the contact sets, a hold bar having a normal position and an actuated position, a magnet for said hold bar serving when energized to move the bar from its normal to its actuated position, means for actuating said select bar to position said select elements in operative relation to said contact sets while said hold bar is in its actuated position, and means acting on said hold bar to restore it to its normal position upon the deenergization of said magnet, said hold bar in its restoring movement acting upon one of said positioned select elements to operate the corresponding sets of contacts and to maintain them in an operated condition.

2. The combination in a crossbar switch of a plurality of sets of separately-operable contacts, a select bar having a plurality of select fingers thereon, one for each set of contacts, said select bar in its normal position serving to hold said select fingers out of operative relation with said contact sets, a hold bar having a normal position and an actuated position, a hold magnet serving when energized to move said hold bar from its normal to its actuated position, a select magnet for actuating said select bar to position said select fingers in operative relation to said contact sets while said hold bar is in its actuated position, and a retractile spring acting on said hold bar to restore it to its normal position upon the deenergization of said hold magnet, said hold bar in its restoring movement acting upon one of said positioned select fingers to operate the corresponding set of contacts and to maintain them in an operated condition after said select magnet is deenergized.

3. The combination in a crossbar switch of a plurality of sets of separately-operable contacts, a select bar having a plurality of select elements thereon, one for each set of contacts, said elements being movable in one direction to a select position and in a second direction to an operate position, a hold bar having a normal position and an actuated position, said hold bar in its normal position serving to hold a particular one of said select elements actuated in the operate direction, a magnet for moving said hold bar from its normal to its actuated position to release said particular element in the operate direction, means for actuating said select bar to move said particular element to the select position while said hold bar is in its actuated position, and means acting on said hold bar to restore it to its normal position upon the deenergization of said magnet, said hold bar in its restoring movement serving to reoperate said particular select element in the operate direction to operate the corresponding set of contacts and to maintain them in an operated position.

4. The combination in a crossbar switch of a plurality of sets of separately-operable contacts, a select bar having a plurality of flexible select

fingers thereon, one for each set of contacts, said fingers being movable in a selecting direction for the purpose of selecting the associated sets of contacts and flexible in an operate direction for the purpose of operating the selected sets of contacts, a hold bar having a normal position and an actuated position, said hold bar in its normal position serving to hold a plurality of said fingers flexed in the operate direction, a magnet for operating said hold bar from its normal to its actuated position to release the flexed fingers in the operate direction, means for actuating said select bar to move a particular one of the fingers released by said hold bar into the selecting position with respect to the associated set of contacts, and means acting on said hold bar to restore it to its normal position upon the deenergization of said magnet, said hold bar in its restoring movement acting upon said particular select finger to reflex it in the operate direction for the purpose of operating the associated set of contacts.

5. The combination in a crossbar switch of a plurality of sets of separately-operable contacts, a plurality of select bars individual respectively to coordinate rows of contact sets in one direction, each bar having a plurality of select fingers thereon, one for each set of contacts in the associated row, each select bar in its normal position serving to hold its select fingers out of operative relation with the contact sets, a plurality of hold bars individual respectively to rows of contact sets in the other coordinate direction, each hold bar having a normal position and an actuated position, each hold bar having an individual magnet serving when energized to move the bar from its normal to its actuated position, means for actuating any one of said select bars to position its select fingers in operative relation to the associated contact sets while any one of said hold bars is in its actuated position, and means acting on the actuated hold bar to restore it to its normal position upon the deenergization of the associated magnet, said hold bar in its restoring movement acting upon one of the positioned select fingers of said operated select bar to operate the corresponding set of contacts and to maintain them in an operated condition following the release of said select bar.

6. The combination in a crossbar switch of a plurality of sets of switching contacts, select bars individual respectively to rows of contact sets in one direction, hold bars individual respectively

to rows of contact sets in another direction, off-normal contact sets individual respectively to said hold bars, an off-normal bar common to all of said hold bars, an individual select magnet for moving each of said select bars to select the contact sets in the associated row, a magnet for said off-normal bar, means for operating the magnet for said off-normal bar each time any one of said select magnets is operated, and means for actuating any one of said hold bars while any select bar is operated and while said off-normal bar is operated to selectively operate the associated set of switching contacts and the associated set of off-normal contacts.

7. The combination in a crossbar switch of a plurality of sets of switching contacts, first operating bars individual respectively to rows of contact sets in one direction, second operating bars individual respectively to rows of contact sets in another direction, off-normal contact sets associated respectively with said second bars, an off-normal bar common to said off-normal contact sets, means for actuating any one of said first operating bars, means for actuating said off-normal bar, and means for actuating any one of said second operating bars, the actuated second bar serving to cooperate with the first bar and with the off-normal bar while in their actuated positions to close a desired set of said switching contacts and a desired set of off-normal contacts.

8. The combination in a crossbar switch of a plurality of sets of separately-operable contacts, select bars, each having a plurality of select elements thereon, said select elements being individual respectively to said sets of contacts, said select bars in their normal positions serving to hold said select elements out of operative relation with the contact sets, a hold bar having a normal position and an actuated position, magnets individual to said select bars and a magnet for said hold bar for moving a select bar and said hold bar either simultaneously or successively in either sequence to their select and actuated positions respectively to position the corresponding select element in operative relation to the associated contact set, and means acting on said hold bar to restore it to its normal position, said hold bar in its restoring movement acting upon the positioned select element to operate the corresponding set of contacts and to maintain them in an operated condition.

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