

[54] SWITCHING SYSTEM

[75] Inventor: Grant N. Willis, Bristol, Conn.

[73] Assignees: Frederick H. Clymer, Jr.,
Harwinton; John R. Whiting,
Bloomfield, both of Conn.; Mack C.
Jones, Longport, N.J.; Robert E.
Dallon; Warren E. Dion, both of
Bristol, Conn.; part interest to
each

[22] Filed: Mar. 9, 1972

[21] Appl. No.: 233,046

Related U.S. Application Data

[62] Division of Ser. No. 40,760, May 27, 1970, Pat. No.
3,662,301.

[52] U.S. Cl. 200/153 G, 200/6 BB, 200/67 DB,
200/166 J

[51] Int. Cl. H01h 3/00

[58] Field of Search..... 200/67 G, 68, 76,
200/6 C, 6 BB, 164, 166 J, 153 G, 67 DB

[56] References Cited

UNITED STATES PATENTS

2,550,623 4/1951 Teruzzi 200/153 G

3,030,479	4/1962	Ehrlich et al.	200/67 G
3,582,589	6/1971	Best	200/67 DB
3,643,053	2/1972	Grundig	335/113
3,305,650	2/1967	Duffield	200/67 G

FOREIGN PATENTS OR APPLICATIONS

721,690	1/1955	Great Britain	200/6 BB
---------	--------	---------------------	----------

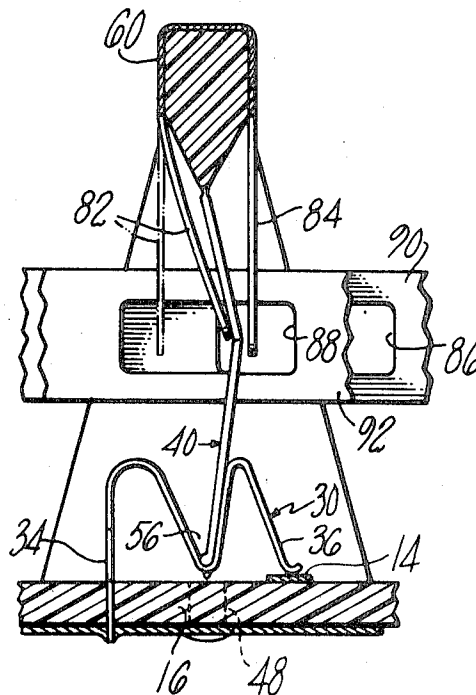
Primary Examiner—David Smith, Jr.

Attorney—R. William Reinsmith

[57] ABSTRACT

The switching system of this invention includes a plurality of coordinate contact sets arranged in rows and columns, actuating means corresponding to each column for selectively actuating a contact selector bar corresponding to each row when the contact selector bar has been operated to transmit contact closing and opening forces thereto, and a contact operator at each coordinate operable by the selector bar to effect movement and an automatic latching of a selected contact set.

16 Claims, 15 Drawing Figures



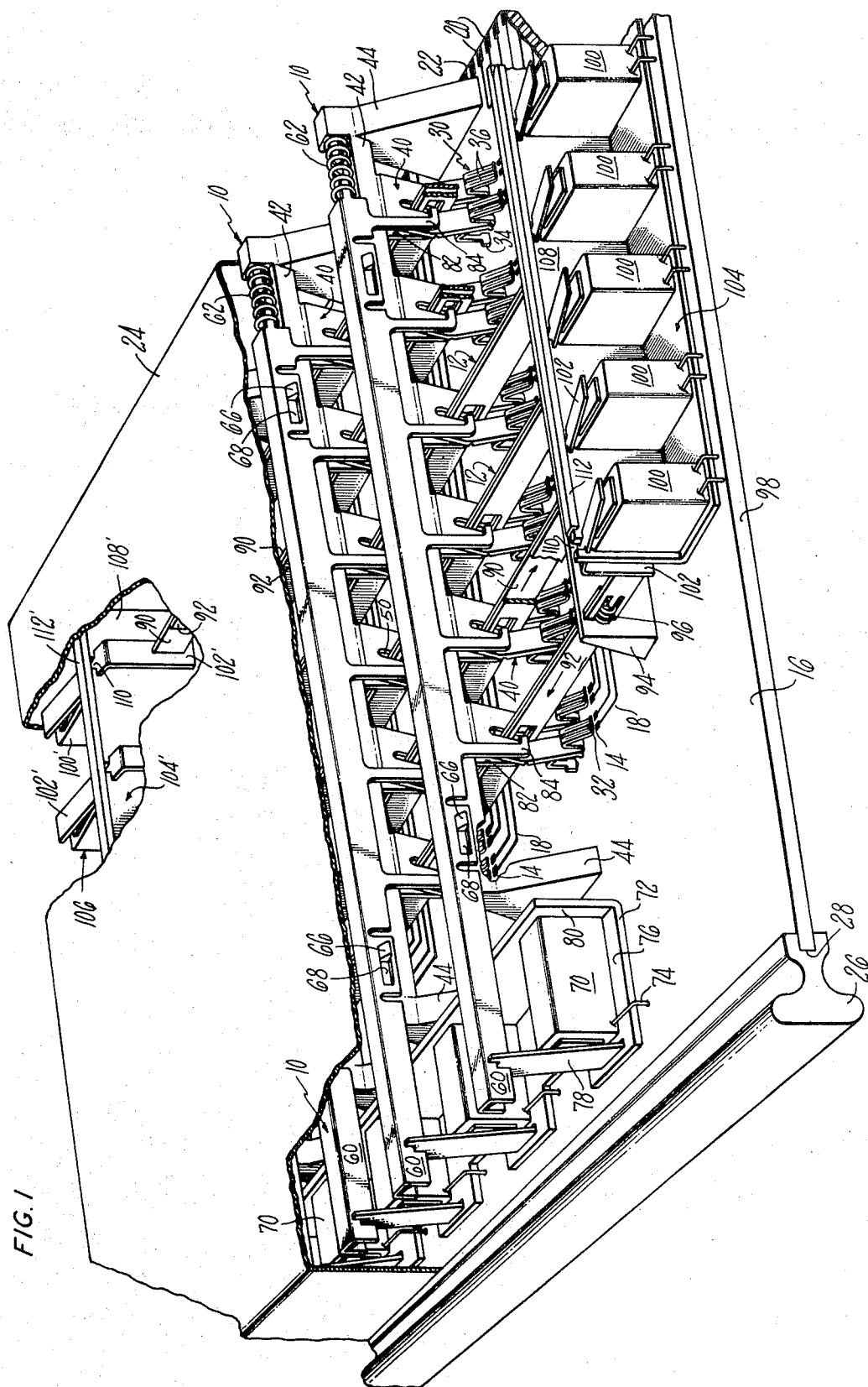


FIG. 2

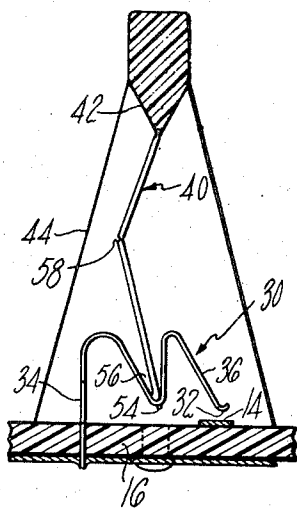


FIG. 3

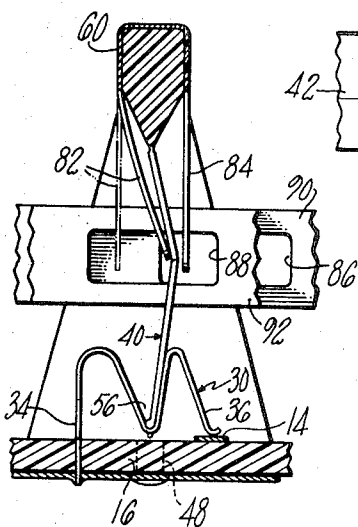


FIG. 4

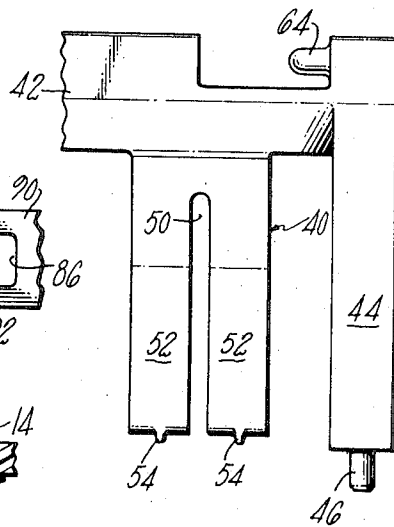
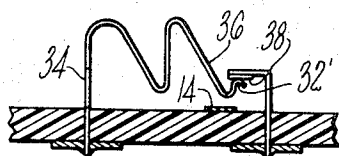


FIG. 5

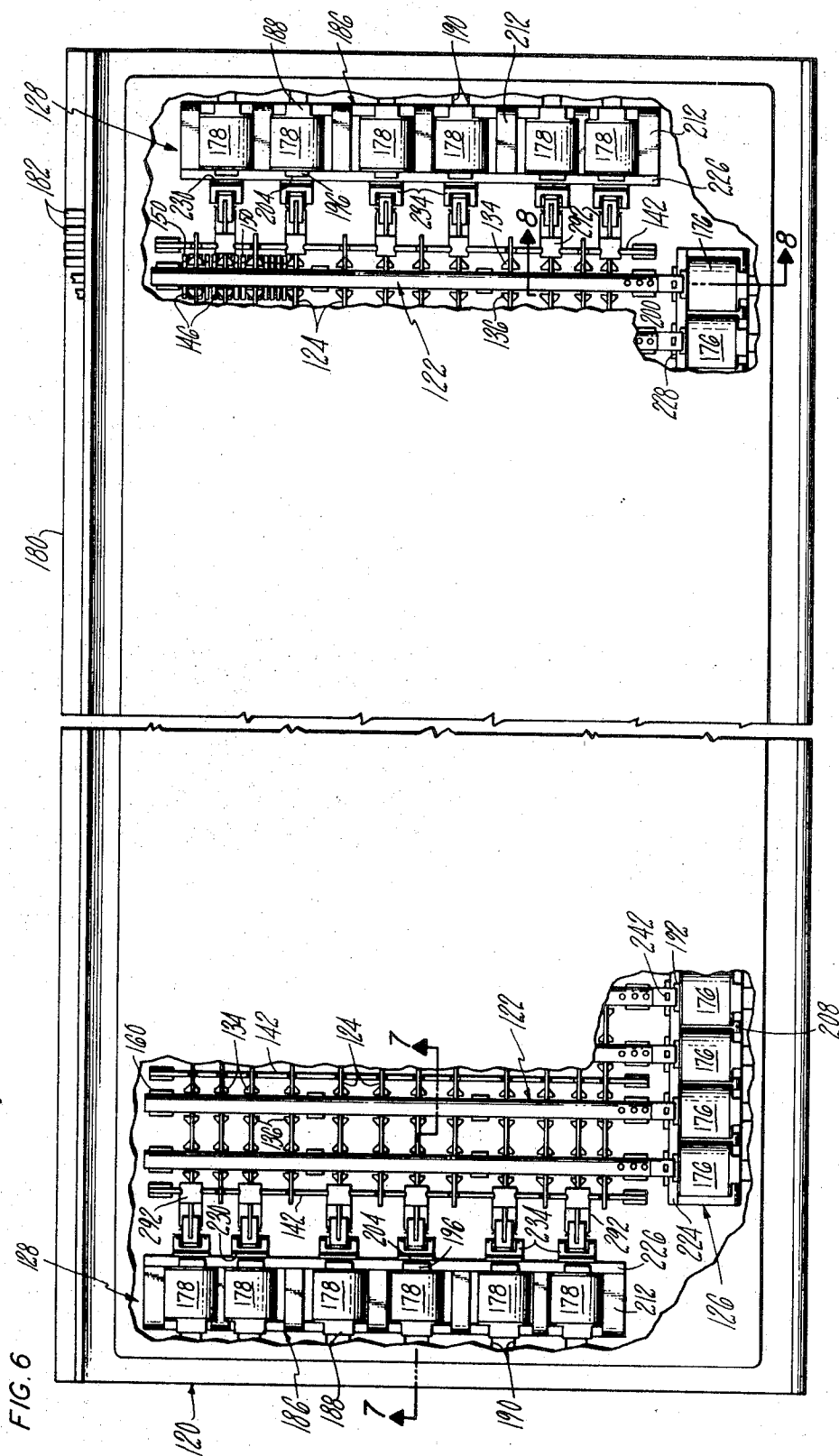


FIG. 7

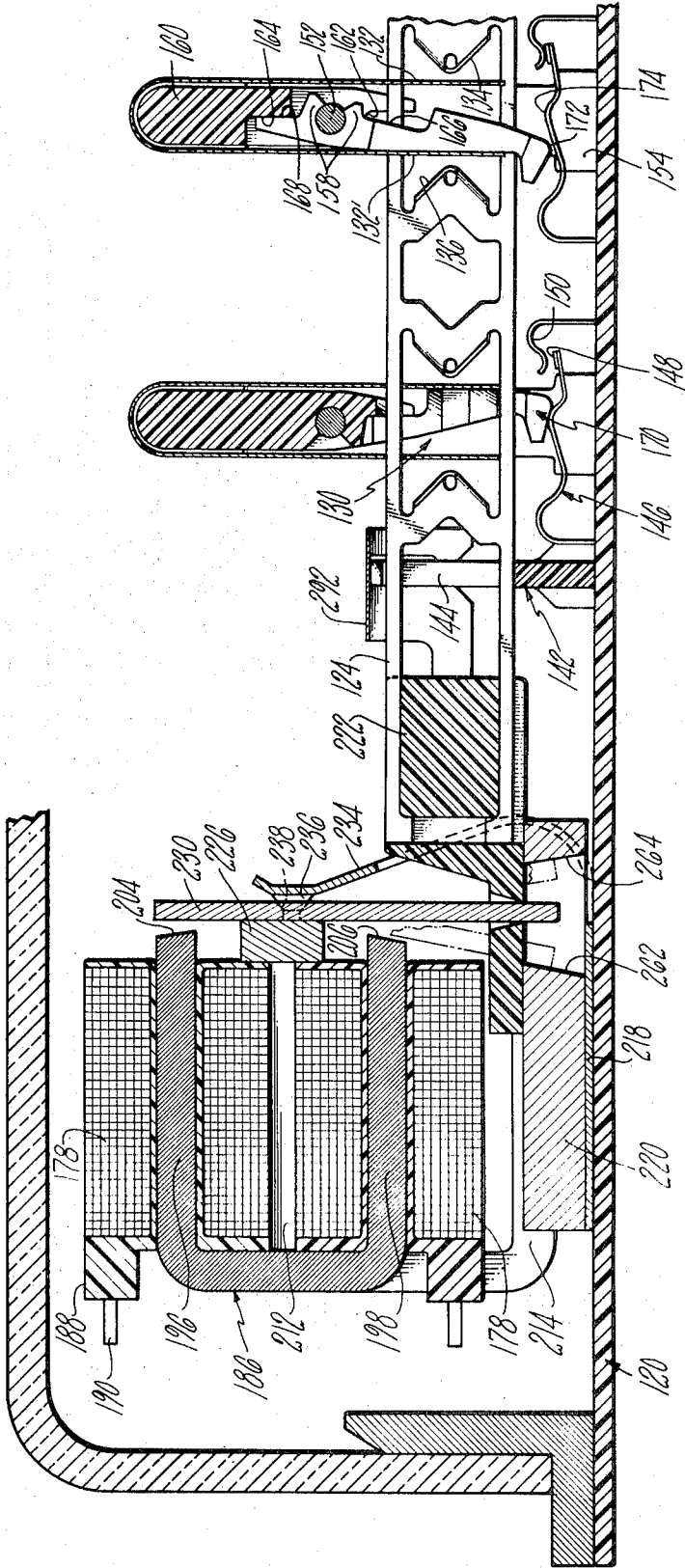
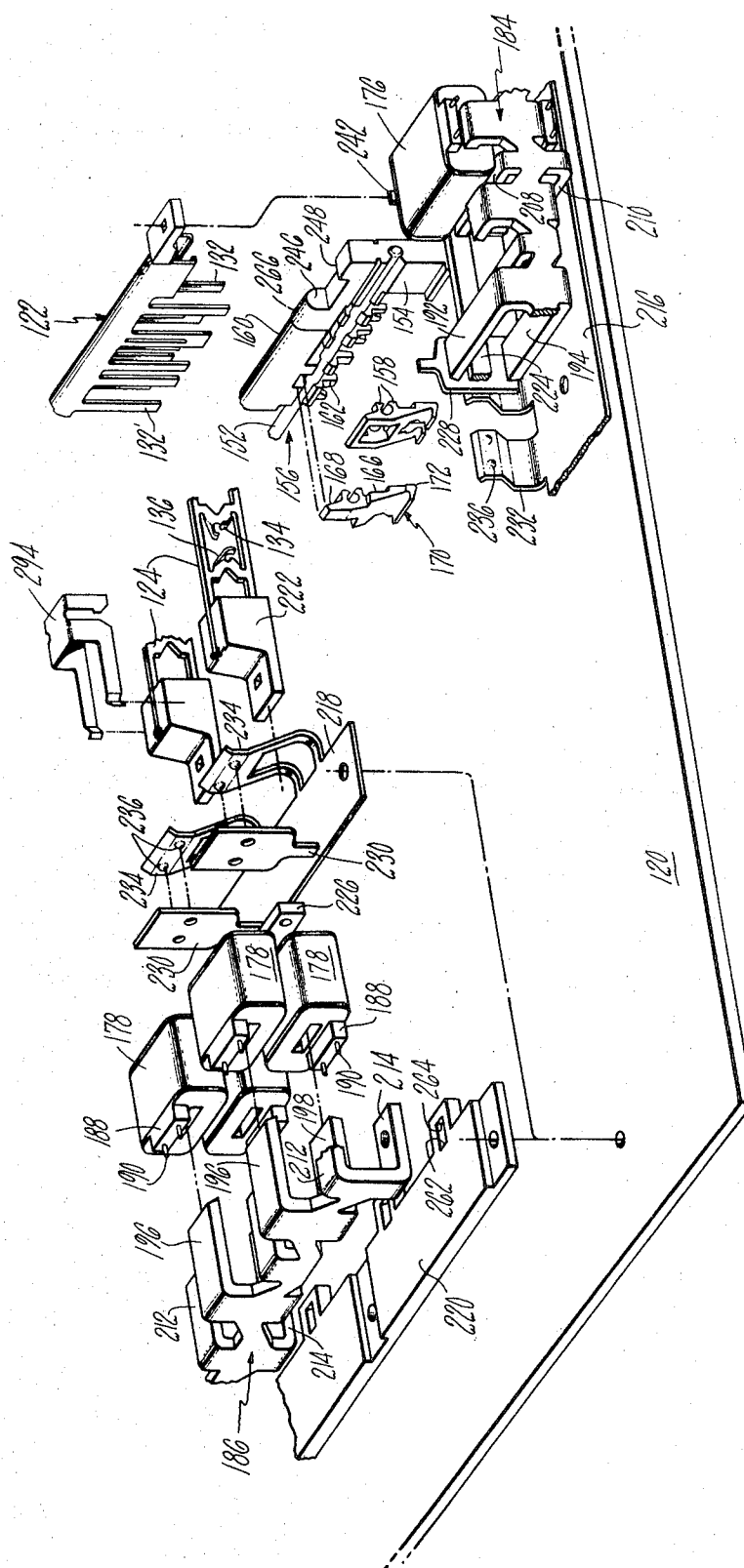


FIG. 9



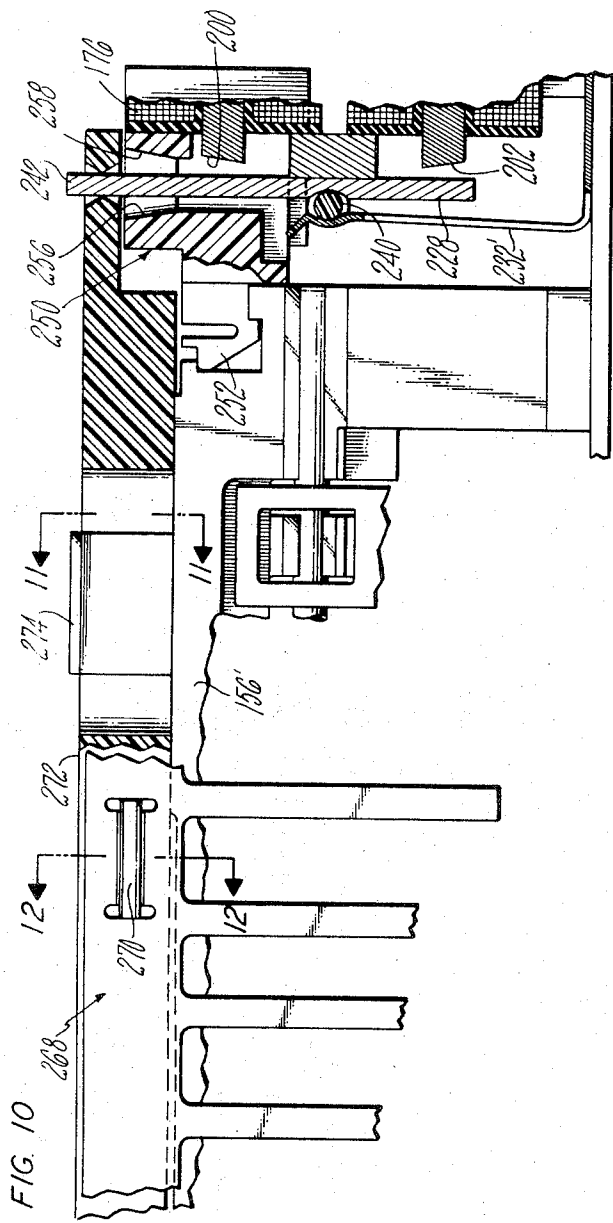
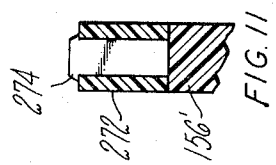
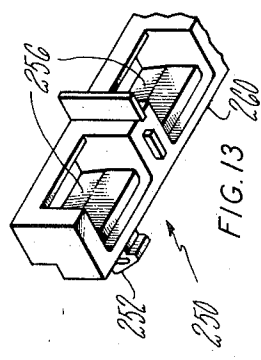
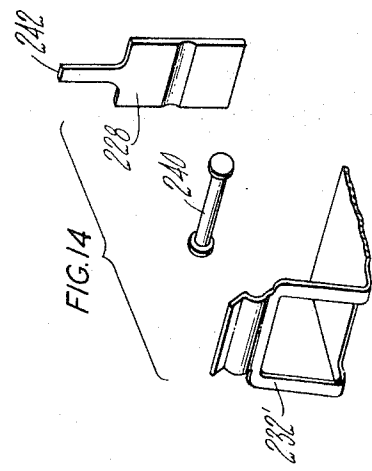
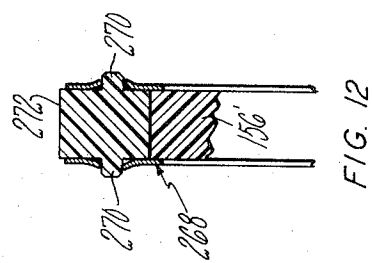
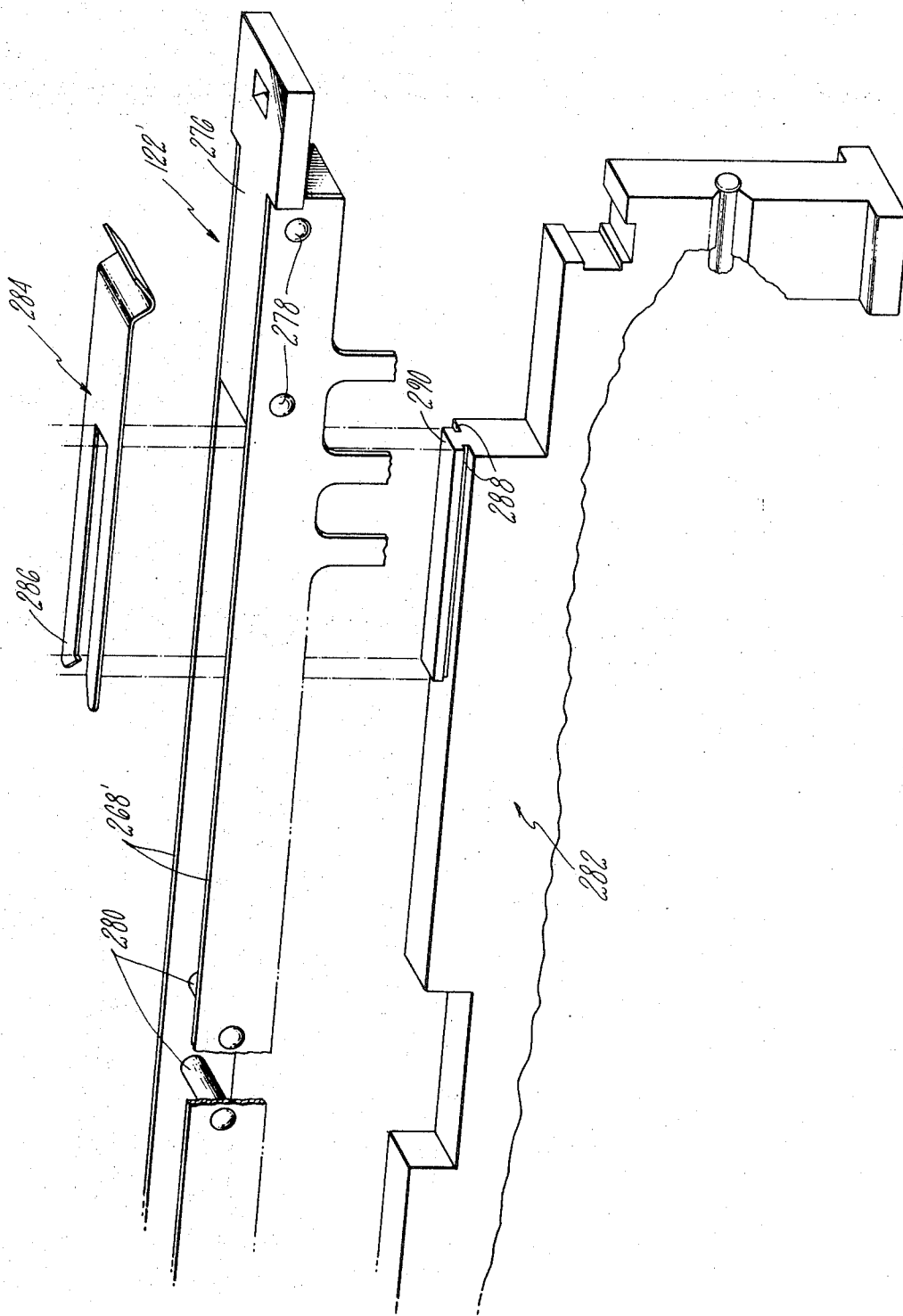


FIG. 15



SWITCHING SYSTEM

This application is a division of applicant's prior co-pending Pat. application Ser. No. 40,760 filed May 27, 1970, granted May 9, 1972 as Pat. No. 3,662,301 and assigned to the assignee of this invention.

This invention generally relates to electrical switching systems and particularly concerns crossbar or coordinate contact switching systems.

A primary object of this invention is to provide a new and improved switching system featuring compact modular units each of which is identical and comprised of a minimum number of different parts designed for low cost mass production and automated assembly.

Another object of this invention is to provide an improved switching module of rugged and simplified construction particularly suited for assembly on a printed circuit panel.

A further object of this invention is to provide an improved coordinate contact switching system wherein no electrical power is required to maintain a set of coordinate contacts in the position to which it was last moved.

A still further object of this invention is to provide an improved coordinate contact switching system wherein each set of coordinate contacts can be operated and latched at any time so that its selector and actuating means can be used for operating another set of coordinate contacts.

Another object of this invention is to provide an improved switching system which is quick and easy to assemble without precision contact adjustment and which is particularly suited for facile replacement of parts without disassembling the system.

Still another object of this invention is to provide a new and improved switching mechanism automatically effecting both contact movement and latching and which has a minimal amount of structure.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth.

In the drawings:

FIG. 1 is an isometric view, partly broken away and partly in section, showing a switching system incorporating this invention;

FIG. 2 shows a switch module incorporating an over-center hinge constructed in accordance with this invention and viewed in a first switch position;

FIG. 3 shows the hinge of FIG. 2 in a second switch position, together with portions of its associated actuating means shown partly broken away;

FIG. 4 is a partial side view of the hinge of FIG. 2;

FIG. 5 is another embodiment of a switch module similar to that of FIG. 2;

FIG. 6 is a plan view, partly broken away, showing another embodiment of a switching system incorporating this invention;

FIG. 7 is a view, partly broken away and partly in section, taken generally along line 7—7 of FIG. 6;

FIG. 8 is a view, partly broken away and partly in section, taken generally along line 8—8 of FIG. 6;

FIG. 9 is an exploded isometric view, partly broken away and partly in section, showing details of the mounting arrangement of the switching system of FIG. 6;

FIG. 10 is a view similar to FIG. 8, partly broken away and partly in section, showing another embodiment of a contact selector of this invention;

FIG. 11 is a section view, partly broken away, taken generally along line 11—11 of FIG. 10;

FIG. 12 is a section view, partly broken away, taken generally along line 12—12 of FIG. 10;

FIG. 13 is an isometric view, partly broken away, showing a snap-in armature locator provided in the embodiment of FIG. 10;

FIG. 14 is a disassembled isometric view showing a mounting arrangement for an armature in the embodiment of FIG. 10; and

FIG. 15 is an exploded isometric view of another embodiment of a contact selector similar to that shown in FIG. 10 and incorporating a damping device for the selector.

Referring to the drawings and that embodiment of this invention illustrated in FIGS. 1—5, a switching system is shown suited for multiple contact, selective switching applications as, for example, in computer or automatic telephone switching apparatus.

A multitude of coordinates are formed by spaced parallel rows of selector units 10 in perpendicular intersecting relation to spaced parallel columns of actuator units 12 shown mounted at right angles and at regular intervals along the length of each selector unit 10. While each coordinate at the crosspoints of the selector units 10 and the actuator units 12 is shown comprising a group of four fixed contacts 14 arranged in generally aligned underlying relation to its respective selector unit 10, the number of coordinates and the number of such contacts at each coordinate may be varied depending upon the selected number of crossbars and the associated circuitry.

In accordance with one feature of this invention, the switching components are designed to be mounted on a compact, plug-in type modular panel 16 having circuitry 18 formed on the panel by any conventional printed circuit technique. Each modular panel 16 may be used as an independent switching unit or in conjunction with any number of similar panels depending on the applications to which the switching system is directed. Suitable terminals 20 shown provided along a side edge 22 of the panel 16 are electrically connected with switch contacts through the printed circuitry 18 whereby the panel 16 and its associated components may be bodily plugged into an edge connector, not shown, as a unit for connection to associated external circuitry. The panel 16 is shown provided with a protective cover 24 and a carrying handle 26 extending along its side edge 28 opposite the terminals 20.

The basic module of the switching system of this invention is provided by a switch and contact operator which will be seen to be of significant use in a variety of switching applications. Each group of fixed contacts 14 is provided a set of switch arms 30 having a corresponding number of moving contacts 32. The switch arms 30 are readily manufactured to close tolerances by a stamping operation, e.g., to form a continuous ribbonlike strip to be shaped, preferably in the form of an M, with each switch arm 30 having a leg 34 suited to be pressed directly into the panel 16 in a subsequent automatic assembly operation. The switch arms 30 are cut apart after assembly to form individual switch arms. Each switch arm 30 has a bifurcated portion providing a pair of resilient legs 36 carrying the movable contacts

32 for establishing a connection at each coordinate. The movable contacts 32 come into electrical contact in unison with their respective fixed contacts 14 on the panel 16 in a limited pivotal movement relative to the fixed leg 34 which effectively precludes undesired movements in other directions. Such construction assures good contact operation without requiring delicate adjustments. While the switching action shown is a four pole single throw, a set of back contacts 38 could be added and the movable contacts 32' could be modified as shown in FIG. 5 to provide a double throw switching action if desired.

To automatically retain the switch arm 30 in the position to which it was last moved while eliminating the usual holding bars and additional structure normally required in crossbar switching systems, a contact operator or overcenter hinge 40 is provided in accordance with another feature of this invention to effect a mechanical stabilizing action in two switch positions. The overcenter hinge 40 is of a tough, nonconductive, resilient material and is preferably suspended for pivotal movement from a fixed bridge 42 of its overlying selector unit 10.

Each end of the bridge 42 has a pedestal 44 provided with a downwardly projecting stud 46 formed for receipt within preformed panel openings 48 to anchor the bridge 42 upon upsetting the stud 46. Such construction is particularly suited for a low cost mass production operation wherein each bridge 42 and its depending overcenter hinges 40 may be simultaneously formed as a one piece construction of molded nonconductive material and readily assembled on the panel 16 with the use of automatic assembly equipment while additionally ensuring that each set of coordinate contacts is insulated from the others.

In the specific illustrated embodiment of this invention, each overcenter hinge 40 is shown having a longitudinal center slot 50 defining a pair of downwardly extending fingers 52 each of which preferably has a tang 54 firmly wedged between adjacent switch legs 36 in a channel 56 of the switch arm 30 to ensure that all movable contacts 32 are moved coincidentally with movement of the hinge 40. By virtue of a lateral articulation across each hinge finger 52 near its midpoint providing a joint 58, movement of the hinge 40 moves the movable contacts 32 into and automatically holds them in a stable open position (FIG. 2) or closed position (FIG. 3) depending on the direction of hinge movement. Good contact engagement in closed position is further ensured by dimensioning and configuring the cooperating switch legs 36 and the hinge 40 to provide surface-to-surface engagement between the same when the movable legs 36 are brought into contact with their fixed contacts 14. In both embodiments, it will be noted the contacts 32 and 32' act as stops.

Such overcenter hinge movements effect additional advantages in providing a positive throw of the hinge 40 from one position of stable equilibrium to the other while minimizing the structure required to maintain a set of contacts in operated position in contrast to the complex structural arrangements associated with conventional mechanical latch mechanisms. Moreover, the overcenter action of the hinge 40 provides relative movement between the contacts 14 and 32 to provide a "wipe" ensuring that they are maintained in clean condition thereby ensuring positive contact closure.

Mounted lengthwise of each bridge 42 is a selector 60 adapted for reciprocable longitudinal sliding movement. A return spring 62 positioned between an end of each selector 60 and its adjacent bridge pedestal 44 continuously urges the selector 60 toward its illustrated normal inoperative position. Suitable spring guides are preferably provided such as that shown at 64 integrally formed on the bridge 42. Longitudinal movement of the selector 60 on the bridge 42 is limited by two pairs of laterally protruding retaining ears 66 (only one pair shown in the drawings) wherein the ears 66 are formed on the bridge 42 to extend through elongated slots 68 in the selector 60. In addition to limiting selector travel, the ears 66 retain the selector 60 on its bridge 42 and readily provide for snap-locking the selectors 60 on the bridges 42 during assembly.

To operate the selectors 60, an electromagnet 70 is associated with each selector 60 and which, upon being energized, moves each selector 60 against its spring bias. The electromagnets 70 are attached to a common magnetic frame 72 of soft steel, and their leads 74 will be understood to be connected to a source of electrical power through the terminals 20. The magnetic frame 72 is of L-shaped configuration having a base leg 76 secured to the panel 16 with armatures 78 associated with each electromagnet 70 supported on the base leg 76 for pivotal movement about an axis perpendicular to the selectors 60. Each of the armatures 78 cooperates with the frame 72 to complete a magnetic circuit path, upon energization of its electromagnet 70, and is secured to an end portion of its respective selector 60 to drive it against the selector return spring bias each time the electromagnet 70 is operated.

Each selector 60 carries plural pairs of depending flexible L-shaped fingers 82 and 84 positioned adjacent opposite faces of each overcenter hinge 40 in the row of coordinate contacts underlying their respective selector 60. When one of the selectors 60 is operated, its fingers 82, 84 are correspondingly shifted and positioned within aligned windows 86 and 88 formed in a pair of actuators 90 and 92 associated with each set of coordinate contacts in the row of the operated selector 60.

Each pair of actuators includes a set actuator 90 and a reset actuator 92 which are reversely positioned back-to-back, to extend in overlying relation to a column of contacts through the aligned slots 50 formed in the overcenter hinges 40 of each column. Common bearing plates 94 are secured to the panel 16 and provide bearing support for sliding movements of the actuators 90, 92 in a direction perpendicular to that of the selectors 60.

To further minimize the number of different working parts, each pair of actuators 90, 92 are of identical structure. Return springs such as at 96 are provided at each end of each pair of actuators 90, 92 to urge actuators 90 and 92 against their respective armatures 102' and 102.

To operate the reset actuators 92 in each column of contact sets, a bank of identical electromagnets 100 and associated armatures 102 are mounted on a common L-shaped magnetic frame 104 along the panel side edge 98 for respectively driving the individual reset actuators 92 in opposition to their spring bias. An identical bank of electromagnetic operators 106 is provided on the opposite panel edge for driving the set actuators

90 against their spring bias and toward side panel edge 98.

Such construction not only minimizes the number of different parts to ensure manufacturing cost reductions, but also provides for quick and easy parts replacement and panel rigidity. The panel rigidity is effected by the added stability contributed by the handle 26 and the common magnetic frames 72, 104, 104' of the electromagnet banks along each side edge of the panel 16 which would otherwise be unsupported. Up-
standing legs 108, 108' of the magnetic frames 104, 104' are provided suitable slots such as at 110 for pivotally supporting a reduced portion of each of the armatures 102, 102' and a retainer 112, 112' is preferably snap-locked in position on the top edge of each magnetic frame 104, 104' to maintain the armatures 102, 102' against unintended displacement.

To close a switch arm 30 of any particular coordinate, a selector electromagnet 70 of the selected row is operated to move the selector 60 into operated position and the selector fingers 82, 84 into the windows 86, 88 of the actuators 90, 92 along the selected row of contacts in interfering relation to the path of travel of the actuators. Then, an electromagnet 100' of a selected column is energized causing its set actuator 90 to be driven into engagement with the selector finger 82 which in turn applies force to the corresponding overcenter hinge 40, causing it to thrust and latch the movable switch contacts 32 into closed position as seen in FIG. 3 (which additionally depicts the set actuator 90 at the end of its throw).

The electromagnets 100' and 70 are then deenergized, permitting the return springs 96 and 62 to return the set actuator 90 and selector 60 to their illustrated inoperative positions while the movable contacts 32 remain closed under the latching action of the overcenter hinge 40. The selector fingers 82, 84 are thus entirely disengaged from the actuators 90, 92 to condition the same to be used to operate another set of coordinate contacts while the operated set of contacts remain in latched position, without requiring any pawls, holding springs, permanent magnets, holding coils or the like commonly utilized in conventional crossbar switching apparatus.

A lightweight panel construction and electromagnetic coils of a minimum size are readily permitted by virtue of the previously described overcenter latching action which requires only a minimal energizing force without creating undesired vibration or any need for mass damping techniques. In addition to ensuring maximum utilization of the full coordinate capacity of the switching system, further advantages reside in the switch latching which is maintained even though an electrical circuit connection were to be interrupted, e.g., due to a power failure which might otherwise prematurely reset the closed switch if it were dependent on a holding current.

To reset the closed contacts, the selector electromagnet 70 corresponding to the selected coordinate row is energized to again position the selector fingers 82, 84 within the actuator windows 86, 88 of the selected coordinate column, and the reset electromagnet 100 of that coordinate column is then operated to pivot its armature 102, driving the reset actuator 92 into engagement with the selector finger 84 which is operable entirely independently of its mating finger 82. The selector finger 84 engages the overcenter hinge 40 which is

tripped to move the switch 30 into open position. The electromagnets 100 and 70 are then once again deenergized to permit the reset actuator 92 and corresponding selector 60 to be returned under their return spring bias into inoperative positions, conditioning the coordinate contacts for another switching cycle, while the resiliency of the switch arm 30 maintains the contacts 32 in an open position.

While the coordinates and coordinate contacts may be modified as previously suggested and may be varied in number and easily arranged in separate switching groups as desired for maximum flexibility of design in network applications, the minimum number of different component parts of the described switching system provides significant manufacturing cost advantages. The design of this invention, characterized by linear movements of the working parts, and the simplicity of the structure and its operation ensures reliable performance over an extended period of time and quick and easy parts replacement in a rugged, compact switching system particularly suited for the low cost, automatic assembly.

Referring now to FIGS. 6-15 wherein another embodiment of a switching system and modifications thereof incorporating this invention is illustrated, a supporting modular panel 120 is shown of the general type previously described and which will be understood as having printed circuit type base wiring. The switching components are particularly suited for automatic assembly on the panel 120 by special assembly machines for the purpose of minimizing one of the longstanding basic problems in cross-bar switching: the cost associated with each crossbar switching unit.

To significantly increase the crosspoint capacity of the system while also providing simultaneous access to more circuits wherein each of the crosspoints can be independently operated at any one time without any electrical holding power requirements while yet providing a simplified, compact and reliable switching system which is economical to manufacture and assemble, each selector 122 and actuator bar 124 of the embodiment of FIGS. 6-15 provides double-acting operation and double magnet assemblies 126, 128 are respectively utilized to operate each selector 122 as well as each actuator bar 124 in opposite linear directions.

As seen in FIGS. 7-9, the selectors 122 for each contact row and also the actuator bars 124 for each contact column are selectively movable in opposite linear directions from an inoperative neutral position by their respective double magnet assemblies 126, 128. Each selector 122 and each actuator bar 124 moves in its respective path of movement to either of two operative positions relative to adjacent contact operators or hinges 130 in the same contact row at the crosspoints of each contact column.

Upon operating a double-acting selector 122 to either side of its illustrated full line inoperative neutral position shown in FIG. 8, e.g., alternate pairs of opposed selector fingers 132 will shift into an operative position in the path of movement of the actuator bars 124 for engagement with one of two pairs of actuating members or actuators 134, 136. Each double-acting actuator bar 124 carries a series of double pairs of actuators 134, 136 corresponding to each selector 122 to provide an individual set actuator 134 and an individual reset actuator 136 for each contact set 138 in the contact column of the actuator bar 124. More specifi-

cally, each actuator bar 124 is shown as extending through aligned cutout portions 140 of the hinges 130 in each column. The actuator bars 124 are supported for reciprocating sliding movement on a series of common cross members 142 fixed to the panel 120 and providing bearing support for the actuator bars 124. Members 142 have upstanding portions 144 (FIG. 7) forming guide openings for the actuator bars 124 to maintain them in alignment relative to the cutout portions 140 of the hinges 130 in each column. The double pairs of actuators 134, 136 for each selector 122 are provided on the actuator bars 124 to extend in opposite directions laterally of each bar 124. As seen in FIG. 7, the individual set and reset actuators 134, 136 of each actuator pair are disposed in opposed relation longitudinally of their actuator bar 124 on opposite sides of their respective selector 122. To reduce wear on the selector fingers 132, each of the set and reset actuators 134, 136 are smoothly contoured for engaging the selector fingers 132, 132' respectively with a wiping motion upon reciprocation of the bar 124 to selectively set and reset the hinge 130.

The basic module of the switching system is provided by a switch and contact operator similar to that described above in connection with the first embodiment. Again, while different types of switching actions may be provided and while each contact set 138 may include one or more pairs of fixed and movable contacts, FIGS. 7 and 8 illustrate the use of a normally closed set of contacts which are opened by switch actuation. The illustrated contact sets 138 effect precise and accurate control of the contact pressure throughout the life of the switch by the use of permissive lift-off contacts wherein the contact force is effectively built into the switch arm 146 and is established by the resiliency of its spring material while reducing mechanical wear of the engageable contact interfaces.

To operate each switch arm 146 to position its movable contact 148 relative to its fixed contact 150 independently of any other contact set 138 and without disturbing their position, each contact set 138 is provided with an individual hinge 130 suspended for pivotal movement from a pin 152 preferably snap locked in the pedestals 154 of each selector supporting bridge 156 to extend over its respective contact row for supporting the hinges 130 in aligned relation to one another. Each hinge 130 in turn is provided with resilient jaws 158 which may be yieldably fitted over its hinge pin 152 for suspending the hinge 130 for pivotal movement to an extent limited by a configured backbone 160 of the bridge 156 fixed to the panel 120. As best seen in FIG. 7, the backbone 160 is an integrally molded portion of the bridge 156 extending between its pedestals 154, 154 and which provides vertical stop surfaces 162, 164 respectively engageable with complementary hinge faces 166, 168 for limiting pivotal movement of the hinges 130 toward and away from the fixed contacts 150.

A contact engaging foot 170 of each hinge 130 is dimensioned and configured in relation to its cooperating switch arm or arms 146 such that upon movement of the hinge 130 toward the fixed contact 150, responsive to actuation of its operated selector finger 132' by the reset actuator 136, an arcuate toe portion 172 of the hinge foot 170 rides over unraised arcuate portion 174 of each switch arm 146 to move its movable contact 148 away from its fixed contact 150, and upon engage-

ment of the lower flat hinge face 166 with the lower stop surface 162 of the bridge backbone 160, the foot 170 of the hinge 130 is positioned in overcenter relation to the apex of the switch arm 146 which continuously urges the hinge foot 170 toward the fixed contact 150 to maintain the contact set 138 in an open position of stable equilibrium until its hinge 130 is once again repositioned in a contact closing direction. Such repositioning occurs upon operation of the selector 122 which is then actuated by the set actuator 134 to drive the hinge 130 in the opposite angular direction overcenter of the switch arm 146 to permit contact closure with a controlled force established by the resiliency of the switch arm 146.

The illustrated hinge 130 is formed of a tough non-conductive material, preferably of a suitable plastic material, and is particularly suited for operation under extreme ambient temperature ranges over extended periods of time without malfunction in view of its rigid, rugged construction of substantial cross-sectional dimension. As seen in FIG. 8, the hinges 130 are of varying form depending on the number of crosspoint contacts which are to be served and the purpose to which the hinge 130 is to be applied. For example, the two hinges 130A shown adjacent the bridge pedestal 154 are used as steering circuit hinges each having four crosspoint contacts whereas the hinges 130B in the same contact row are each shown for illustrative purposes as being split for actuating three crosspoint contacts.

To minimize the requirements for different parts of varying structure, the double magnet assemblies 126 and 128 for the selectors 122 and the actuator bars 124 are both designed to be substantially similar while further facilitating automated assembly at reduced cost in accordance with this invention.

More specifically, both the selectors 122 and the actuator bars 124 are provided with aligned stacked pairs of identical electromagnetic windings or coils 176, 178 for individually positioning each of the series of bars 122, 124 in either of their two operative positions. As seen in FIG. 6, the actuator bars 124 in successive contact columns are operated by double magnet assemblies 128, 128 which are in staggered relation to one another on opposite longitudinal ends of the panel 120. The selector double magnet assembly 126 extends along a longitudinal side edge of the panel 120 opposite the edge 180 which carries the printed circuit terminals 182 to be plugged into an edge connector, not shown. By virtue of the above described arrangement, not only is the capacity of the panel 120 significantly increased but the rigidity and stability of the panel is maintained.

As best seen in FIG. 9, the coils 176, 178 each are respectively mounted on common frames or brackets 184, 186 which provide for quick and easy mounting and replacement of the coils while also serving as a circuit path for the magnetic flux. The coils 176, 178 are provided with a suitable boss 188 located at the rear of each coil to which terminal pins 190 are secured for connection to external leads, not shown.

The brackets 184, 186 for each series of coils 176, 178 are fabricated and formed to provide an interconnected series of laterally spaced pairs of upper and lower coil supporting cores 192, 194 and 196, 198, respectively, in vertically spaced parallel relation to each other. Each pair of electromagnet cores 192, 194 and 196, 198 are preferably of U-shaped cross section

(FIGS. 7 and 8) and are dimensioned to project beyond their coils to respectively provide reversely beveled magnetic pole faces 200, 202 and 204, 206. Adjacent pairs of coil supporting cores 192, 194 and 196, 198 are respectively interconnected by a pair of mounting lugs 208, 210 and 212, 214 which are also of U-shaped cross section in vertically offset relation to their respective electromagnet cores.

The selector bracket 184 is shown supported on an elongated stabilizing mounting plate 216 fixed in position by suitable fasteners, not shown, removably secured to the lower mounting lugs 210 of the bracket 184 to maintain the same in rigid assembly with the panel 120. The bracket 186 for the actuator bars 124 is mounted on a similar mounting plate 218 although a bearing platform 220 is shown interposed between the bracket 186 and the mounting plate 218 for supporting an enlarged driven end portion 222 of each actuator bar 124.

By the above construction, a minimum number of different parts are required which not only effects the desired quick and easy assembly but also facilitates the replacement of parts without disturbing the other components of the switching system since all magnets in a given line are mounted on a common bracket. Moreover, the disclosed double magnet arrangement is particularly suited to significantly simplify the drive to the selectors 122 and the actuator bars 124 by virtue of a mechanical "neutral" provided by elongated armature positioning rails 224 and 226, respectively of generally rectangular cross section extending along the double magnet assemblies 126 and 128 in spaced relation between the pole faces of their cores. The rails 224, 226 for each magnet assembly 126, 128 are preferably secured directly to their upper mounting lugs 208, 212.

To selectively move each selector 122 and actuator bar 124 in either of two opposite linear directions, their respective double magnet assemblies 126 and 128 are each provided with a separately mounted armature 228 and 230 fulcrumed about the exposed corners of their positioning rails 224 and 226 for pivotal movement toward and away from each of the pole faces of the electromagnets responsive to energization of alternate electromagnets of each pair. Each armature 228, 230 is substantially identical although the selector armatures 228 will be seen to be mounted in inverted position to that of the actuator bar armatures 230. Each armature 228, 230 is continuously urged toward a normally inoperative "neutral" position in engagement with a flat exposed face of their positioning rails 224, 226 by means of a resilient arms 232, 234 integrally formed with the base plates 216, 218 of the respective magnet assemblies 126, 128. The arms 232, 234 extend upwardly from each base plate 216, 218 into clamping engagement with their armatures 228, 230 and provide for automatic return of the armature upon deenergization of its electromagnets. In FIGS. 7 and 8, a pair of projecting beads 236 are shown formed on the arms 232, 234 received within a pair of recesses 238 formed in the armatures 228, 230 to maintain each armature in an operable condition during energization and deenergization of the magnet assemblies. FIGS. 10 and 14 show a cylindrical roller 240 clamped between arcuate bearing surfaces formed in the spring arm 232' and the armature 228. Such an arrangement has been found to be satisfactory for eliminating undesired relative movement between the armature and its arm while further

minimizing wear over extended periods of time. If desired, the roller 240 may be formed of nylon or any similar tough self-lubricating material and is desirably provided with radially enlarged self-positioning end portions.

As seen in FIG. 8, a tang 242 at the upper free end of each selector armature 228 projects through an aperture 244 in a plastic driven end portion 246 of the selector 122 to establish a driving connection between the selector and its operating magnets, the bridge 156 providing stop surfaces 246, 248 for limiting selector travel. To minimize undesired armature overtravel, say, even over millions of cycles, so as to continuously maintain a desired air gap between the armature and each of its pole faces and assured return of the armature to its neutral position, the selector 122 shown in FIG. 10 is particularly suited to ensure that dimensional integrity is maintained between drivingly engaged parts by the provision of a separate snap-in armature locator 250 such as that shown in FIGS. 10 and 13. The locator 250 further minimizes any tendency of panel flexure and armature bottoming on its pole faces upon energization of the electromagnets. The locator 250 has a resilient locking device 252 which may be snap fitted into locking engagement within a complementary configured opening 254 formed in the selector bridge 156 with the locator 250 engaging the upper coils 176 of the selector magnet assembly 126 and in bearing engagement with a vertical wall portion 260 of the bridge pedestal 154. If desired, the snap-in locator 250 may be formed of plastic as a continuous piece having longitudinally spaced openings for receiving a series of selector armature tangs 242. Each of the openings are provided with forward and rear stop surfaces 256, 258 tapering downwardly toward one another at an angle corresponding respectively to the bevel of the lower and upper electromagnet pole faces 200, 202 to provide a fixed stop for each selector armature 122 in both angular directions while at the same time eliminating any possibility of armature overtravel and continuously maintaining an air gap between the armature 122 and its pole faces 200, 202.

The armatures 230 for the actuator bars 124 are similarly limited against undesired overtravel by the provision of stop surfaces 262, 264 formed by suitable apertures in the bearing platform 220 for establishing extreme limit positions of armature movement in opposite angular directions to assure that no direct contact is established between the armature 230 and its pole faces 204, 206.

Any possibility of selector binding under extreme ambient temperature conditions is also minimized by the provision of limited raised bearing surfaces 266 formed adjacent each bridge pedestal 154 (FIGS. 8 and 9) for providing limited bearing support for its selector 122. Any tendency of the plastic molded parts to bend due to their inherent camber is virtually eliminated, and the selector fingers 132 may also be formed from a sheet of suitable metal to further minimize any possibility of undesired selector malfunctioning.

FIG. 10 shows a two-piece skirt-type arrangement of selector fingers 132 wherein each skirt 268 is formed of metal for minimizing any undesired spreading of opposed pairs of spring fingers 132. This construction has the further advantage of being adapted to quick and easy assembly by merely snap locking each skirt 268 over laterally projecting studs 270 integrally formed on

opposite sides of a plastic selector slide 272 supported for reciprocable movement on its bridge 156'. The slide 272 in turn is simply mounted by fitting an apertured portion of the slide 272 over upstanding retaining posts 274 having enlarged beveled heads for quick and easy assembly and retention of the selector slide 272 on the bridge 156'.

FIG. 15 shows driven selector end portions 276 preferably formed of plastic and secured by fasteners 278 to metallic selector finger supporting skirts 268' having suitable spacers 280 fixed between the skirts 268' in noninterfering relation to the bridge 282. The bridge 282 shown in FIG. 15 is of a unitary molded construction. To maintain the selector 122' in operative assembly with the bridge 282 while further minimizing rebounding and time delay between sequential operations of the selector 122', a one-piece combination spring clip and frictional damping device 284 is provided. The combination spring clip 284 is preferably formed of a flat strip of resilient material having a bifurcated end 286 suited to be secured within longitudinally extending channels 288 on opposite sides of an upstanding retaining shoulder 290 formed on the top of the bridge 282 for holding the selector 122' in assembly with the bridge 282 for reciprocable sliding movement. The opposite end of the combination spring clip 284 is formed with a generally V-shaped arcuate end portion for engaging the movable selector with a light frictional loading to minimize rebounding and to promote rapid conditioning of the selector 122' for reoperation in a shortened period of time upon deenergization of its electromagnets and return of the selector to its neutral position under the bias of its clamping arm 232.

The actuator bars 124 shown in FIGS. 6 and 7 are also preferably provided with a damping or snubbing device 292 which is fitted over the cross members 142 adjacent the double magnet assemblies 128, 128, and a pair of projecting spring legs 294 of the snubbing device 292 are provided for frictionally engaging opposite side faces of the driven end portions 292 of the actuator bars 124 for minimizing time delay between switching operations, undesired rebound and so-called switch "chatter."

The bi-directional or double-acting selector and actuator bar arrangement of the above described embodiment is particularly suited to provide a compact switching system of significantly increased capacity which is not only quick and easy to assemble with special purpose assembly machines for reducing the cost of each crossbar switching unit but is particularly suited for facile disassembly and replacement of parts. Moreover, a minimum of different working parts are required to further facilitate both the assembly and servicing of the switching system of this invention.

As will be apparent to persons skilled in the art, various modifications, adaptations and variations of the foregoing specific disclosure can be made without departing from the teachings of the present invention.

I claim:

1. A switching module having particular utility in a coordinate or crossbar type switching system having at least one crosspoint and comprising a printed circuit panel having fixed contact means secured to the printed circuit panel, movable contact means mounted for movement relative to the printed circuit panel toward and away from the fixed contact means, a pivotable contact operator supported for swinging move-

ment in opposite angular directions about a pivot axis in fixed relation to the printed circuit panel for moving the movable contact means toward and away from the fixed contact means, the contact operator being engageable with the movable contact means for latching the movable contact means in at least one contact position to which it has been moved responsive to actuation of the contact operator in a selected angular direction, and a selectively operable actuator mounted on the printed circuit panel for reciprocable movement along an axis of movement parallel to the printed circuit panel for moving the contact operator in opposite angular directions.

2. The switching module of claim 1 wherein the fixed contact means includes a contact engageable with the movable contact means upon movement thereof to an unlatched position.

3. The switching module of claim 1 wherein the fixed contact means includes a contact engageable with the movable contact means upon movement thereof to a latched position.

4. The switching module of claim 1 wherein the movable contact means itself serves as a stop upon engagement with the fixed contact means.

5. The switching module of claim 1 wherein the movable contact means is of resilient material and continuously biased by the resiliency of its own material toward engagement with the fixed contact means to establish a controlled contact engagement force in closed switch position.

6. The switching module of claim 1 wherein the contact operator comprises a rigid overcenter hinge engageable with the movable contact means for effecting operation thereof and cooperating therewith to provide an overcenter latching action of the movable contact means in said one contact position.

7. The switching module of claim 5 wherein the contact operator comprises a rigid pivotable hinge engageable with the movable contact means for applying contact operating forces thereto, the hinge effecting an automatic overcenter latching of the movable contact means in open switch position relative to the fixed contact means.

8. The switching module of claim 1 wherein the contact operator has a pivotally supported end portion and a free swinging end portion, the free swinging end portion being engageable with the movable contact means, and wherein the actuator is mounted in generally overlying relation to the movable contact means for engagement with the contact operator intermediate said end portions.

9. The switching module of claim 1 wherein the movable contact means comprises a contoured switch arm formed of conductive spring material having an apex on a raised intermediate portion of the arm, and wherein the contact operator has a free swinging end portion in overlying relation to the raised intermediate portion of the switch arm and which is engageable with the switch arm, the free swinging end portion of the switch arm being disposed in overcenter relation to the apex of the raised intermediate portion of the switch arm in said one contact position and being latched therein by the resiliency of the spring material of the switch arm.

10. The switching module of claim 9 wherein said one contact position is an open contact position with the switch arm engaging the fixed contact means, and

13

wherein the contact force in said a contact position is established by the resiliency of the spring material of the switch arm.

11. The switching module of claim 1 further including a pivot pin mounted on the printed circuit panel in spaced overlying relation to the movable contact means and establishing the pivot axis for supporting the contact operator for pivotal movement, and wherein the actuator is disposed between said pivot pin and the movable contact means for engagement with an intermediate portion of the contact operator for selectively operating the movable contact means.

12. A switching module having particular utility in a coordinate or crossbar type switching system having at least one crosspoint and comprising a support having fixed contact means, a resilient strip in the form of an M having one leg secured to the support with an opposite leg movable toward and away from the fixed contact means and constituting movable contact means, a channel being formed between the legs, a pivotable contact operator movable in opposite angular directions and received in the channel between the legs of the movable contact means for moving the movable contact means toward and away from the fixed contact means and for latching the movable contact means in at least one contact position to which it has been moved responsive to actuation of the contact operator in a selected angular direction, and a selectively operable actuator mounted on the support for moving the contact operator in opposite angular directions, said opposite movable leg being bifurcated to provide a pair of movable leg portions each carrying a movable con-

14

tact, and the contact operator being formed of nonconductive material and provided with a tang wedgingly engaged between the movable leg portions to maintain the movable contacts spaced apart and to ensure coincident movement thereof with the contact operator.

13. The switching module of claim 12 wherein the contact operator comprises a resilient overcenter hinge continuously engaging the movable contact means for effecting operation thereof and providing an overcenter latching action by the resiliency of its own material for retaining the movable contact means in said one contact position.

14. The switching module of claim 12 wherein the contact operator comprises a resilient hinge supported at one end for pivotal movement relative to the support and having an opposite free end provided with said tang continuously engaging the movable leg portions of the movable contact means, the hinge having a laterally extending articulation across an intermediate portion thereof providing an overcenter movement for operating the movable contact means.

15. The switching module of claim 12 wherein contact opening and closing movements of the movable contact means additionally effects wiping of the fixed contact means.

16. The switching module of claim 12 wherein the contact operator is of resilient material and is continuously urged by the resiliency of its own material toward surface-to-surface engagement with said opposite movable leg when the latter is in contact engagement with the fixed contact means.

* * * * *

35

40

45

50

55

60

65

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,763,341 Dated October 2, 1973

Inventor(s) Grant N. Willis

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 31, cancel "emergization" and substitute therefor --energization--.

Column 7, line 66, cancel "an" before "raised" and substitute therefor --a--.

Column 13, line 1, cancel "said"; insert --closed-- before "contact".

Signed and sealed this 1st day of January 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,763,341 Dated October 2, 1973

Inventor(s) Grant N. Willis

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 31, cancel "emergization" and substitute therefor --energization--.

Column 7, line 66, cancel "an" before "raised" and substitute therefor --a--.

Column 13, line 1, cancel "said"; insert --closed-- before "contact".

Signed and sealed this 1st day of January 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents