March 21, 1967 M. GRUNDFEST ETAL 3,310,778

PROGRAMMING AND SWITCHING APPARATUS

Filed July 24, 1963 4 Sheets-Sheet 1

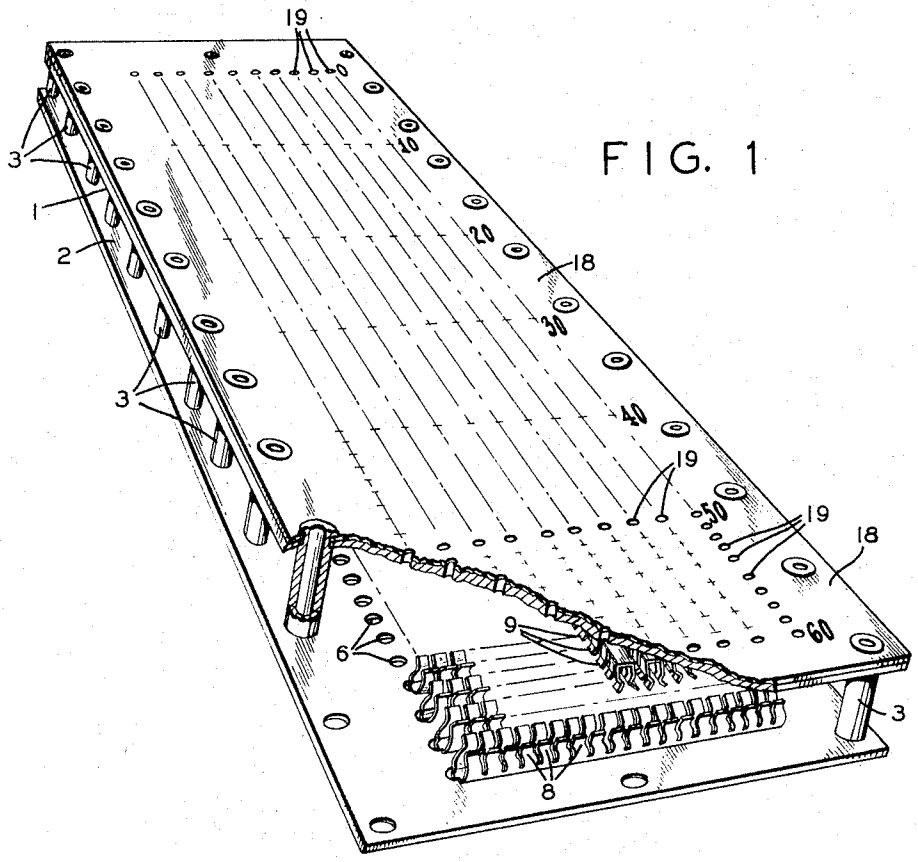
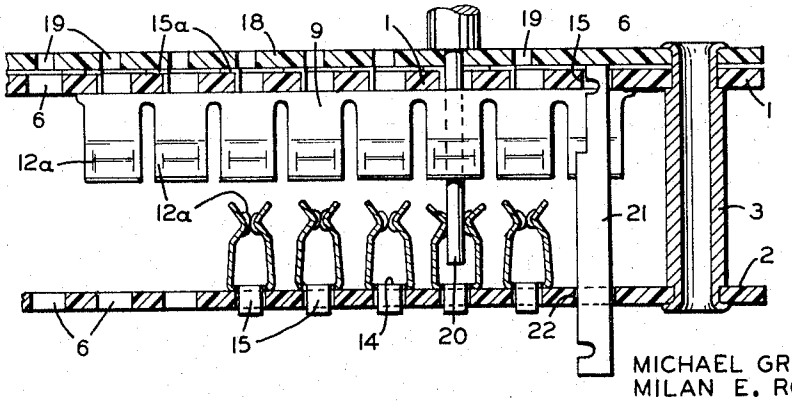


FIG. 1

FIG. 2



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PROGRAMMING AND SWITCHING APPARATUS

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FIG. 3

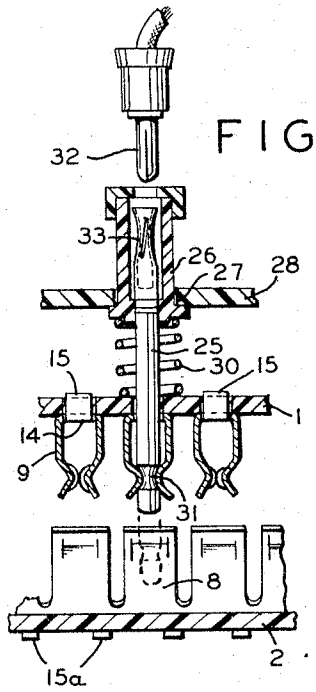


FIG. 4

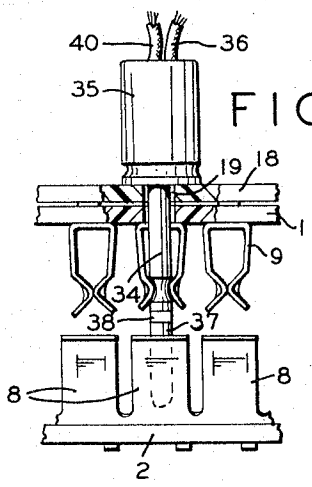
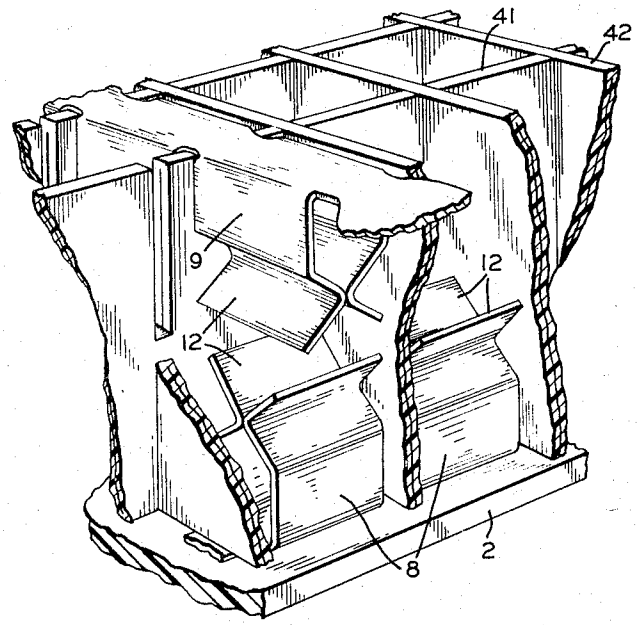


FIG. 5



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PROGRAMMING AND SWITCHING APPARATUS

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FIG. 6

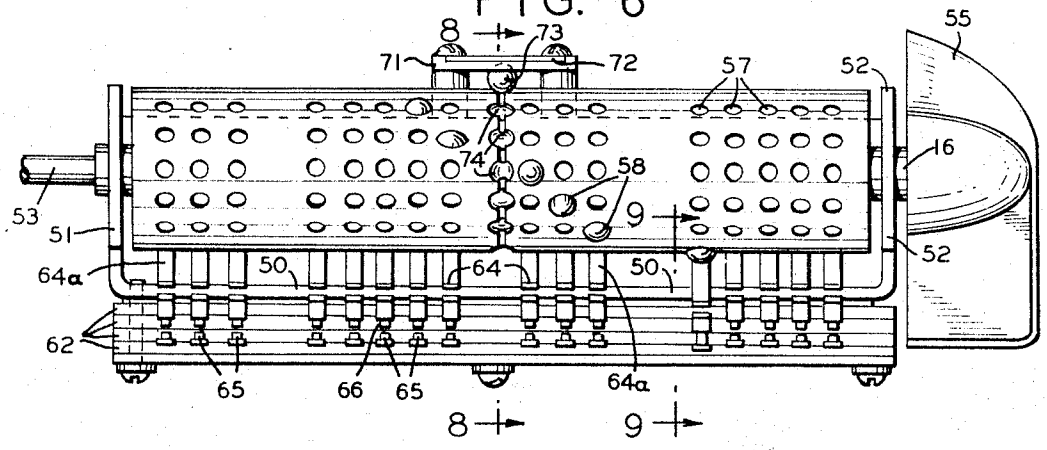


FIG. 7

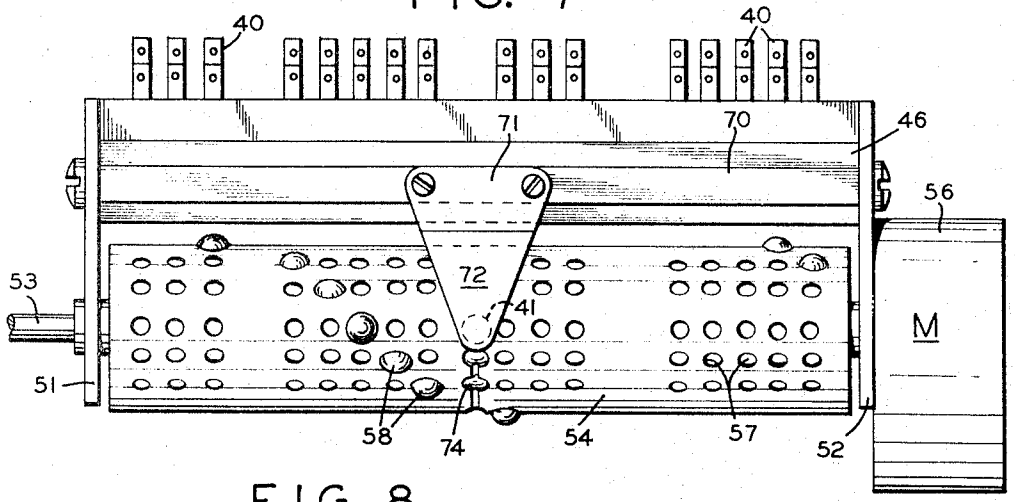
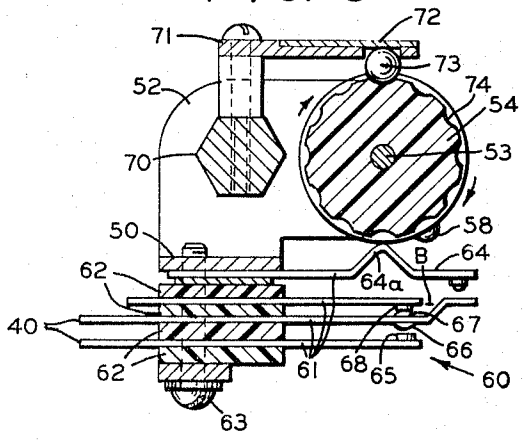


FIG. 8



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PROGRAMMING AND SWITCHING APPARATUS

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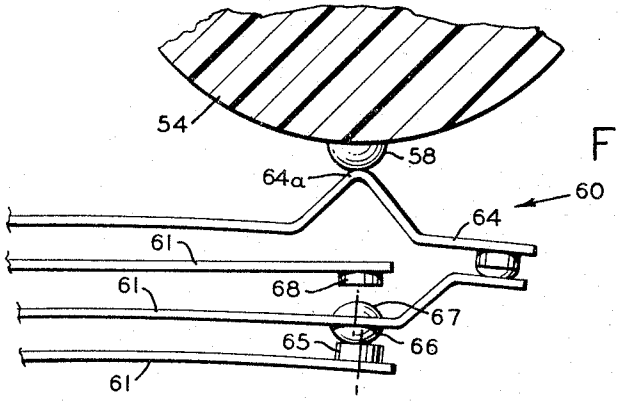

FIG. 9

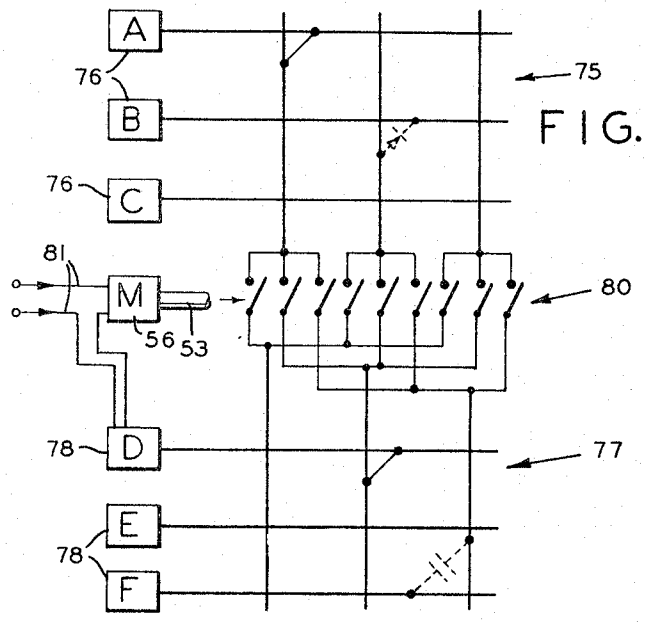

FIG. 10

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PROGRAMMING AND SWITCHING APPARATUS

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Filed July 24, 1963, Ser. No. 297,400
8 Claims. (Cl. 340—166)

This invention relates to a programming control device which includes one or more plug boards and multiple programming switch. The device is employed to control and establish a large number of predetermined circuit arrangements. The invention has particular reference to the manual or automatic change of circuitry which is made by components or sub-circuits externally connected to the plug boards.

Plug boards having multiple contact plugs are old in the art and their advantages are well-known. A plug board having ten horizontal conductors and ten vertical conductors provides a total of one hundred single switching connections and many more multiple connections. Switching mechanisms controlled by rotary contact makers are also known and have been used for operating contacts associated with many types of circuits.

The present invention combines a rotary contact switch device with two or more multiple contact plug boards to produce an unusually large number of circuit combinations. The rotary switch device can be motor operated and thereby make the circuit selection automatic. By the use of a reversing motor, the device can be used to control a preset program for a long and continuous series of events.

Since each of the rotary switch components can operate a double-throw, single-pole set of contacts, it is convenient to use three plug boards in combination.

The combination of two or more plug boards, as hereinafter described, with a rotary switch results in a multiple switching device having a large number of circuit combinations.

One of the objects of this invention is to provide an improved program control device which avoids one or more of the disadvantages and limitations of prior art control devices.

Another object of the invention is to connect a plurality of sending stations to a plurality of receiving stations in a maximum number of combinations.

Another object of the invention is to connect a number of first electrical circuits to a number of second electrical circuits in any desired combination and in a predetermined sequence.

Another object of the invention is to switch from any desired combination of electrical circuits to any other desired combination of electrical circuits by automatic means.

Another object of the invention is to preset a combination of switching connections between a first and a second series of connected conductors, said combination being automatically obtained thereafter in a predetermined sequence.

Another object of the invention is to provide a programming device with a feed-back circuit whereby the program is changed when a signal is received from a circuit connected to one of the device units.

The invention includes at least two plug boards and a rotary contact device connected to both of them. Each plug board includes a first set of contact conductors extending in parallel array in one direction and a second set of contact conductors extending in parallel array in a direction which is substantially at right angles to the first set. Means are provided for manually connecting any one of the first set of conductors to any one of the second set of conductors. The connecting means may be a simple cylindrical plug which connects the two conductors with a connection having negligible resistance or it may be a two terminal plug with connects the two conductors in series with an impedance, a diode rectifier component or any other desired electrical circuit.

The rotary contact device includes a base portion, a plurality of pairs of contacts resiliently mounted on the base portion, and a cylindrical rotatable member journaled in bearings. The cylindrical member contains a plurality of contact positions on its outside surface with provision for manually settable means for engaging the contacts when the cylinder is rotated. One feature of the invention includes an automatic motor-controlled means for turning the cylinder in predetermined steps. Connecting means are provided for connecting each of the conductors in one of the sets of each plug board to an external circuit and the other sets of conductors in each plug board are connected to the contacts controlled by the rotary contact device.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accompanying drawings.

FIG. 1 is a perspective view of a selector plug board with some of the parts broken away to show the internal structure;

FIG. 2 is a section through part of the selector board shown in FIG. 1;

FIG. 3 is a cross-sectional view taken through a portion of the plug board showing how the plug is inserted to make a double connection;

FIG. 4 is a cross-sectional view similar to FIG. 3 but showing the position of a two terminal plug when it is inserted into a connecting position;

FIG. 5 is a perspective view of an alternate form of the plug board with parts cut away to show the construction of the resilient jaws which make connections to the plug;

FIG. 6 is a side view of the rotary switch connected to a lever for manual operation;

FIG. 7 is a top view of the rotary switch shown in FIG. 6 but showing a motor connected to the shaft for automatic operation;

FIG. 8 is a cross-sectional view of the rotary switch shown in FIG. 6 and is taken along line **8—8** of that figure;

FIG. 9 is a cross-sectional view of one of the switch pairs operated by the rotary switch, shown in its operated condition, and is taken along line **9—9** of FIG. 6; and

FIG. 10 is a schematic diagram of connections showing two three-by-three plug boards and a nine hole single throw rotary switch connected to six external circuits.

Referring now to FIGS. 1 through 5, the plug board selector comprises two rectangular support plates **1**, **2** of insulating material held in spaced parallel relation by

pillars 3 at the corners of the plates and at intervals along the sides of the plates. Each of these plates is formed with parallel rows of equidistant round holes 6, the rows being parallel to the sides of the plates and the holes spaced apart along the rows by amounts equal to the separation of the rows so that the holes are at the corners of the squares, and the holes in the two plates are in perpendicular alignment to the planes of the plates.

The bottom plate 2 has a set of rows of socket contacts 8 parallel to the shorter sides of the plate and the upper plate 1 has a set of rows of socket contacts 9 parallel to the longer sides of the plate, these contacts being positioned in the space between the plates. Apart from the length of the rows of contacts they are all the same construction and only one row of contacts will be described.

Each row of contacts is constructed by bending a silver plated copper-beryllium blank to channel form (seen more clearly in FIG. 5), the side walls of the channel being divided into pairs of opposed sections, one pair for each hole in the plate. The sections are inclined inwardly and, near the mouth of the channel are deformed to V-form, as viewed along the channel, the tops 12 of the V's being directed inwardly towards one another. Furthermore, the end portions 12A are separated from the central portions and pressed inwardly to form rounded abutment surfaces which hold the central portions at a minimum separation. The central portions constitute the contact surfaces and are resiliently pre-loaded to tend to move together, even at the minimum separation.

Opposite to each pair of contact sections, the base 14 of the channel is cut to form a tongue 15 which extends lengthwise of the channel and is rounded at its end. This tongue is bent outwardly of the channel through a right angle and at about the center of its length it is again bent through a right angle to provide a limb 15A which is parallel to the base of the channel, and is directed along the channel away from hole left by the removal of the tongue.

A cover plate 18 is secured to the top plate 1 and is held by the above mentioned pillars 3. The cover plate is formed with guide holes 19 for connecting pins 20 to be inserted into the socket contacts. The holes 19 which are smaller than the holes 6 in the top and bottom plates are aligned with those holes and with the contacts, so that a pin may be inserted through any hole 19 into the contacts of the top and bottom plates which are aligned therewith. The limbs 15A are clamped between plate 1 and cover plate 18. The resultant arrangement of contacts and contact strips includes a plurality of contact pairs 8 arranged in strips which are mounted parallel to each other on a bottom insulator board. Another pluarity of contact pairs arranged in similar strips 9 are mounted directly above the first mentioned strips. The second set of strips are mounted parallel to each other in a direction which is substantially at right angles to the bottom set of strips. Inserting a plug such as that shown in FIGS. 3 or 4, connects one of the top strips with one of the bottom strips. Since each set of contacts is positioned under a hole 19, any one of the bottom strips may be connected to any one of the top strips. If there are ten contact positions on each bottom strips and ten contact positions on each top strip then there will be one hundred contact positions, each of which represents a separate and distinct switching arrangement. It is obvious that more than one plug may be used on a plug board and any bottom strip may therefore be connected to as many top strips as desired, thereby increasing the flexibility of the system considerably.

The plug arrangement shown in FIG. 3 is a push button type of contact means. A cylindrical conductor 25 is permanently mounted in a movable insulator cylinder 26 which is positioned in a hole 27 in the top insulator board 28. A spring 30 is mounted between insulator board 1 and the bottom portion of the movable cylinder 26. The bottom portion of cylinder 25 extends downwardly so that its lower end portion 31 makes permanent contact with one of the upper contact pairs 9. The cylinder 26 may be manually depressed, compressing spring 30 and moving the cylinder 25 so that the lower portion 31 makes contact with one of the lower contact pairs 8 and thereby establishing connection between the two strips. In addition, another contact means may be mounted within cylinder 26 so that an outside connection such as a plug 32 may be inserted into a cylinder and make contact with a hollow contact means 33 connected to cylinder 25. This additional contact means is an alternate connection and for many applications is unnecessary.

Referring now to FIG. 4, a double contact plug 34 is illustrated wherein the upper portion of the plug is connected to a terminal within cylinder 35 and one of the external leads 36. The lower portion of plug 34 is made of conductive material having the same outside dimensions as the upper portion and separated from the upper portion by an insulator sleeve 38. The lower portion 37 of the plug is connected to a terminal within cylinder 35 and to an external conductor 40. This type of plug is also an alternate form of the simple connecting means 20 shown in FIG. 2.

The arrangement of contact means shown in FIG. 5 is an alternate manner of attaching the contact strips to the upper and lower plates 1 and 2. In this design, the base portions of the strips pass over an arrangement of partitions 41 and 42 which are channeled so as to fit together and form a self-sustaining arrangement of square compartments. The cooperation of the two contact means 8 and 9 with an inserted plug 20 is the same as described above.

The switching device shown in FIGS. 6, 7, 8 and 9 is used as a coupling component between the plug board arrays shown in FIGS. 1 and 2. A simplified schematic diagram of such a combination is shown in FIG. 10 whereby two three-by-three plug boards are combined by means of a nine pole single throw switch to produce a large number of circuit switching combinations. Referring now to the figures, the switching device includes a base portion 50 having two turned up ends 51 and 52 for journalling a rotatable shaft 53. The shaft 53 carries a rotatable cylinder 54 which turns ϕ when the shaft is turned and may be rotated in steps either by a manual knob 55 as shown in FIG. 6 or by a motor 56 as shown in FIG. 7. Cylinder 54 is provided with a plurality of holes 57 which are adapted to accept knobs or buttons 58. Also secured to the face 50 is a plurality of contacts 60 which are formed by securing contact buttons to the ends of resilient reeds 61. The reads 61 are supported by flat insulator strips 62 all held together by a bolt 63 which is threaded to base 50.

Arrangements can be made for operating the contacts directly by means of the knobs 58 but it has been found that better results are obtained when an additional flexible reed 64 is used as an intermediate operating device. Reed 64 is also secured to base 50 and includes a bent portion 64A which is arranged to be operated by knobs 58 as they are turned with the cylinder 54. As shown in FIGS. 8 and 9, the unoperated condition of the contacts normally opens contact buttons 65 and 66 leaving contacts 67 and 68 in their operated condition. When the cylinder 54 is turned and one of the knobs 58 contacts reed 64, the central reed is moved so that contacts 67 and 68 are opened and contacts 66 and 65 are closed.

In order to insure that the cylinder 54 will be maintained in an operating position, a detent means is mounted on a cross bar 70 whose ends are secured to the turned-over pieces 51 and 52. Near the center of bar 70 a resilient bracket 71 is mounted which contains a detent means for holding the cylinder 54 in an operating position. This detent may assume various forms, the one shown in FIGS. 7 and 8 being for example, only. In this showing a triangular resilient plate 72 extends above the cylinder and holds a ball 73 in resilient contact. Depressions 74

are formed in a portion of the cylinder so that the ball **73** may be lodged therein during the operation of this portion of the switching device.

The cylinder **54** can be arranged to contain at least 16 hole positions for each of the contacts which are operated. Also, there are 16 holes provided for each of the contact pairs mounted on the base. Knobs **58** may be positioned in any of the holes in any desired arrangement.

In order to explain the flexibility and the usefulness of the above described combination, a simplified diagram of connections is shown in FIG. 10. In this figure, the upper plug board **75** has only three horizontal and three vertical strips, the horizontal strips being connected to three external circuits **76**A, B, and C. The lower plug board **77** is a similar combination of three horizontal and three vertical strips, the horizontal strips in this board being connected to three external circuits **78**D, E, and F. The vertical strips in plug board **75** are each connected to three contact strips in a switching unit **80** and the three vertical contact strips in the lower plug board **77** are also connected respectively to three contact strips in the rotary contact unit. It is obvious that for simple shorted connections there are nine possibilities in the upper plug board and nine possibilities in the lower board. If these two boards were added or connected in the usual manner, the result would be only eighteen circuit switching combinations. However, with the addition of the rotary switching unit as shown, the total number of combinations is increased from eighteen to eighty-one. It should be noted that these 81 combinations include different paths through the plug boards. That is, circuit A can be joined to circuit D in nine different path combinations, each path including two plug positions where additional circuit components may be inserted.

The combination circuit shown in FIG. 10 may be arranged for automatic program operation. When this type of operation is desired, the motor **56** (see FIG. 7) is connected to a source of supply by conductors **81** in series with a portion of one of the output circuits, such as **78**D. This circuit includes a "completed" type switch, well known in the art, which is closed only after a desired sequence of operations has been performed. When the switch is closed, the motor **56** moves the rotary cylinder to another position and another programming operation is started. The manner in which the switch is closed by external circuit **78**D is not a part of this invention and need not be described in detail.

From the above description and operation it is obvious that a novel combination of switching units has been disclosed. The total number of combinations exceeds the normally expected number by a considerable amount and thereby adds to the flexibility of this type of switching control unit.

We claim:

1. A programming and switching device comprising:

(a) a first electric circuit selector having, a first set of contact conductors extending in parallel array in one direction, a second set of contact conductors extending in parallel array in a direction which is substantially at right angles to the first set, and means for manually connecting any one of said first contact conductors with any one of said second contact conductors;

(b) a second electric circuit selector also having, a first set of contact conductors extending in parallel array in one direction, a second set of contact conductors extending in parallel array in a direction which is substantially at right angles to said first set, and means for manually connecting any one of said first contact conductors with any one of said second contact conductors;

(c) a rotary contact device having a base portion, a plurality of pairs of contacts secured to said base portion, a cylindrical rotatable member journalled in bearings secured to said base portion, a plurality of contact positions disposed on the outside surface of said cylindrical member, each position provided with manually settable means for respectively engaging said contacts and for operating the contacts when the cylinder is rotated;

(d) connecting means for connecting each of said conductors in the first set of conductors in said first electric selector to one contact in each of said contact pairs;

(e) connecting means for connecting each of said conductors in the first set of conductors in said second electric selector to the other contact in each of said contact pairs;

(f) connecting means for repectively connecting each of said conductors in the second set of conductors in both of said electric selectors to an external circuit;

(g) and means for rotating said cylinder in predetermined steps.

2. A programming and switching device as claimed in claim **1** wherein said means for connecting any one of said first contact conductors to any one of said second contact conductors is a conductive plug containing negligible resistance.

3. A programming and switching device as claimed in claim **1** wherein said means for connecting any one of said first contact conductors to any one of said second contact conductors is a plug having two terminals, one for each conductor, and an impedance connected between the terminals.

4. A programming and switching device as claimed in claim **3** wherein said impedance includes a rectifier diode.

5. A programming and switching device comprising:

(a) a first electric circuit selector having, a first set of contact conductors extending in parallel array in one direction, a second set of contact conductors extendin parallel array in a direction which is substantially at right angles to the first set, and plug means for manually connecting any one of said first contact conductors with any one of said second contact conductors, all of said conductors including a plurality of turned-over spring contact jaws for making electrical connections to a plug;

(b) a second electric circuit selector also having, a first set of contact conductors extending in parallel array in one direction, a second set of contact conductors extending in parallel array in a direction which is substantially at right angles to said first set, and plug means for manually connecting any one of said first contact conductors with any one of said second contact conductors, all of said conductors including a plurality of turned-over spring contact jaws for making electrical connections to a plug;

(c) a rotary contact device having a base portion, a plurality of pairs of contacts resiliently secured to said base portion, a cylindrical rotatable member journalled in bearings secured to said base portion, a plurality of contact positions disposed on the outside surface of the cylinder, each of said positions provided with manually settable means for respectively engaging said contacts and for operating the contacts when the cylinder is rotated, said contact positions arranged in equally spaced rows in axial alignment with the cylinder;

(d) connecting means for connecting each of said conductors in the first set of conductors in said first electric selector to one contact in each of said contact pairs;

(e) connecting means for connecting each of said conductors in the first set of conductors in said second electric selector to the other contact in each of said contact pairs;

(f) connecting means for respectively connecting each of said conductors in the second set of conductors in both of said electric selectors to an external circuit;

(g) and means for rotating said cylinder in steps, each of said steps arranged to present a row of contact positions to operate the contact pairs.

6. A programming and switching device as claimed in claim 5 wherein said means for connecting any one of said first conductors to any one of said second contact conductors is a cylindrical metallic plug arranged for resilient contact with the jaws of both conductors.

7. A programming and switching device as claimed in claim 5 wherein said rotary contact device is connected to an electric motor with means for moving one step at a time.

8. A programming and switching device as claimed in claim 5 wherein said electric motor is connected to an external circuit coupled to one of said conductors for receiving an operating pulse of electric power.

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