Aug. 12, 1941. H. C. HARRISON 2,251,933

SWITCHING DEVICE

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FIG. 3

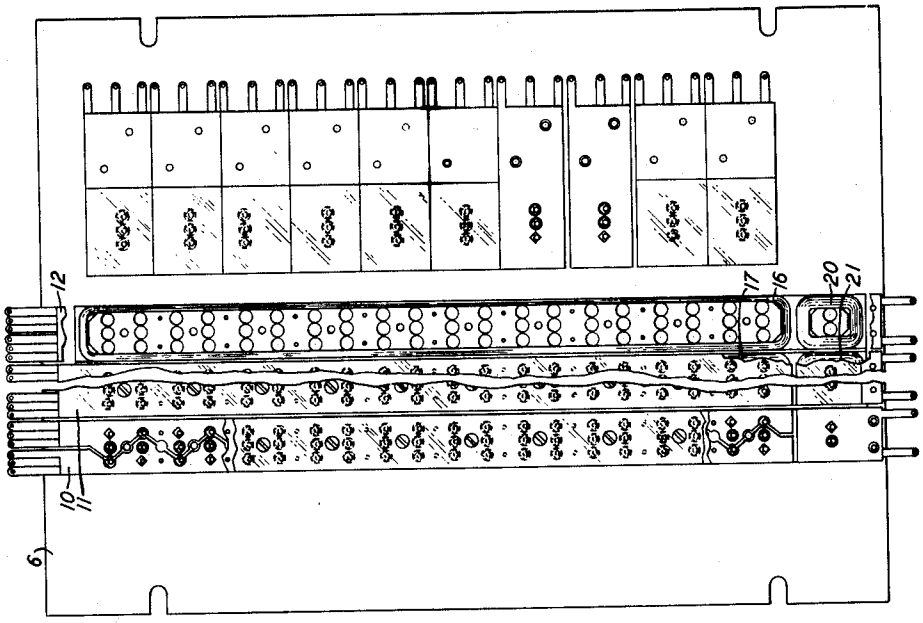

FIG. 2

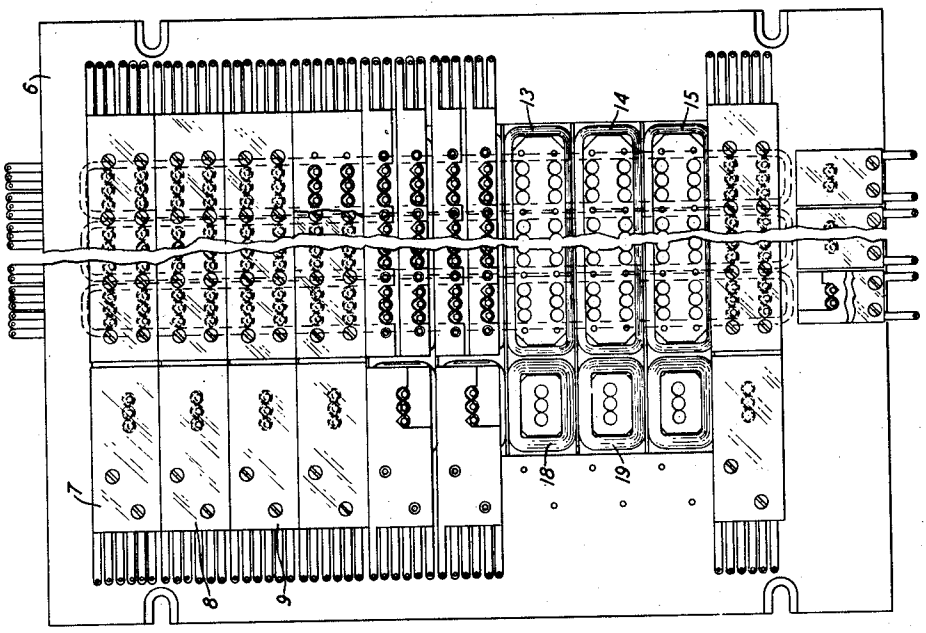

FIG. 1

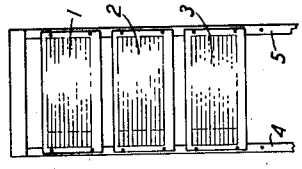

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FIG. 4

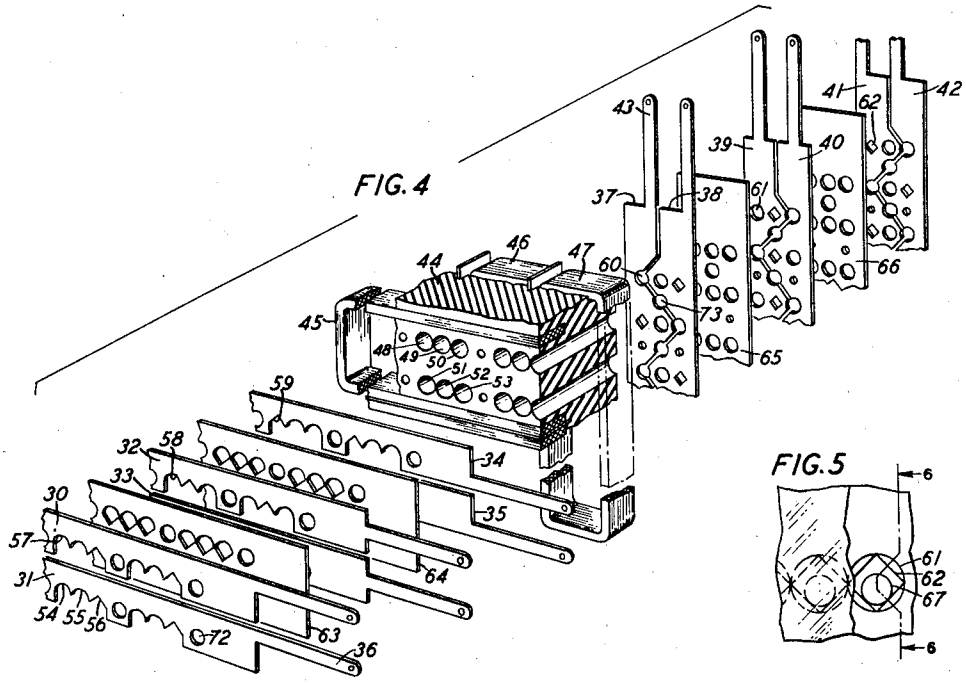


FIG. 5

FIG. 6

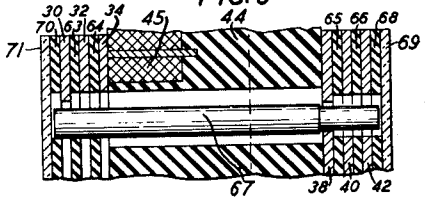


FIG. 7

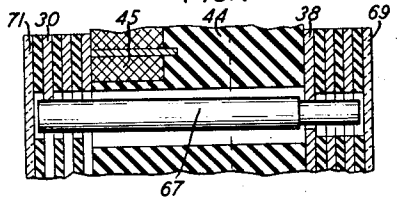


FIG. 8

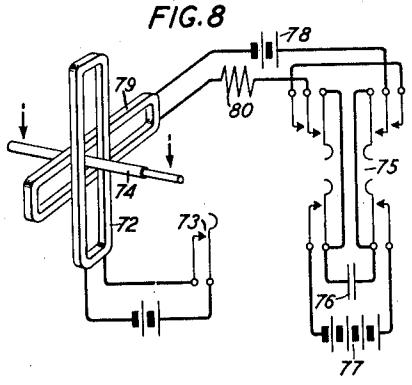
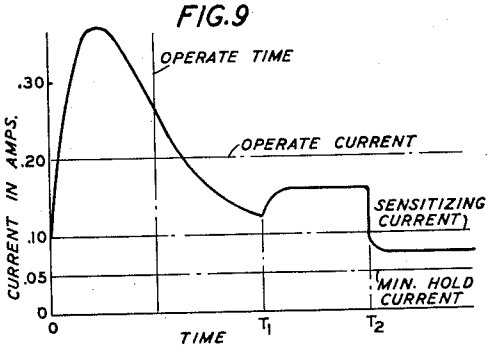


FIG. 9



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Patented Aug. 12, 1941

2,251,933

UNITED STATES PATENT OFFICE

2,251,933

SWITCHING DEVICE

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Application August 24, 1940, Serial No. 354,073

4 Claims. (Cl. 179—27.54)

This invention relates to switching means and particularly to that type of switching structure known as the cross-coil switch which may find application for instance in telephone systems.

The object of the invention is to provide switching means of a rugged and economical nature which may be assembled by mass production methods and which will require little or no adjustment either in manufacture or in service.

A feature of the invention is the use of stationary contact pieces shaped on the principle of combination locks whereby a movable contact in the form of a simple pin upon movement makes contacts with only certain ones of the stationary contacts. The switch structure comprises a plurality of rigidly assembled contact strips cut so that when assembled with the usual spacers of insulation transverse apertures are formed in which the movable contacts in the form of rollers or pins are placed. When a movable contact pin is caused to move it comes to rest against a selected plurality of these strips so that with a plurality of such movable pins at a cross-point a plurality of individual and different connections are made between such strips.

These are a plurality of what might be termed horizontal sets of contact strips and a plurality of what might be termed vertical sets of contact strips with a plurality of pins disposed in contacting relation therewith at each point where a set of the vertical strips crosses a set of the horizontal strips. There is provided an energizing coil for each said set of contact strips and when the two coils involved at any cross-point are properly energized the movable pins thereat establish the said plurality of individual and different connections between the strips of said sets. Each such individual connection involves a strip of a horizontal set and a strip of a vertical set.

In accordance with another feature of the invention the movable contact pins are constructed of magnetic material and are in the form of rollers or cylinders and may make contact with the said stationary strips at any point on the circumference of the circle defining their cross-section at the point of contact along their length.

The drawings consist of two sheets containing nine figures:

Fig. 1 is a front view of a plurality of switch units showing how they are mounted on a switch frame;

Fig. 2 is a front view of a single switch unit illustrating by broken away sections the general appearance and construction of a switch;

Fig. 3 is a similar drawing showing a rear view of the switch;

Fig. 4 is a perspective view of a small portion of the switch with the various elements moved away from each other but still placed in their proper relative positions so that the operation of the switch may be clearly visualized;

Fig. 5 is a front view of a small portion of the switch greatly enlarged to picture the normal position of a pair of movable contact pins in their proper relation to the stationary contact strips;

Fig. 6 is a sectional view taken through the switch at a single movable contact pin showing the pin in its normal or unoperated position;

Fig. 7 is a similar view showing the pin in its operated position;

Fig. 8 is a circuit diagram in conjunction with a perspective schematic representation of two cross-coils and a single movable contact pin to illustrate the method of operation; and

Fig. 9 is a graph of operating current plotted against time to illustrate one method of operation.

Fig. 1 illustrates how three switch units 1, 2 and 3 may be mounted on iron framework comprising uprights 4 and 5.

Each unit comprises a foundation or base-plate 6 on which a plurality of groups of horizontal stationary contacts 7, 8, 9, etc., are mounted and on which another plurality of groups of vertical stationary contacts 10, 11 and 12 are mounted. Coils such as 13, 14 and 15 are mounted in this base-plate and correspond to the horizontal sets of contact strips. Coils such as 16 and 17 are also mounted in this base-plate and correspond to the vertical sets of contact strips. Individual coils such as 18, 19, 20 and 21 may also be mounted to perform individual switching functions.

A clear idea of the construction of this switch may be had from the expanded view in Fig. 4. Here there is a set of horizontal contact strips 30, 31, 32, 33, 34 and 35. Each of these strips has a contact lug such as lug 36 at the right end of contact strip 31. There is also a set of vertical stationary contact strips 37, 38, 39, 40, 41 and 42 each of which is likewise provided with a contact lug such as the lug 43 associated with the strip 37. In this view the piece of insulating material 44 represents the base-plate 6 of Figs. 2 and 3 and the horizontal coil 45 corresponds to one of the coils 13, 14 or 15 of Fig. 2. The vertical coils 46 and 47 correspond likewise to the vertical coils 16 and 17 of Fig. 3. These coils, it will be noted, are mounted in recesses formed within the insulated material base-plate 44. At each point

defined by the crossing of a vertical and horizontal coil there are drilled or formed in the insulating base-plate a number of apertures 48, 49, 50, 51, 52 and 53 and corresponding to the number of contact strips in each set crossing this point.

In the contact strip 31, for instance, the semicircular formation 54 corresponds to the aperture 51, the semicircular formation 55 corresponds to the aperture 52 and the triangular formation 56 corresponds to the aperture 53.

To follow this idea out fully as shown in this Fig. 4 it will be noted that the semicircular formation 57 of contact strip 30 corresponds to the aperture 48, the semicircular formation 58 of contact strip 32 corresponds to this aperture 48 and triangular formation 59 also corresponds to aperture 48. In line with this aperture in the vertical contact strips will be found a circular formation 60 in the two strips 37 and 38, a circular formation 61 in the contact strip 39 and a square formation 62 in the vertical strip 41. When this switch is assembled, between each pair of horizontal contact strips such as 30 and 31 and such as 32 and 33, there will be found an insulating strip 63. Each insulating strip has a formation which is triangular at its bottom and semicircular at its top. This may be followed through the representation of the apertures in insulating strips 63 and 64 corresponding to the aperture 48 in the base-plate 44. In like manner there are insulating strips 65 and 66 between the vertical contact strips and here the apertures corresponding to aperture 48 are circular. A contact pin, as will be more fully explained, will rest on the bottom part of the square aperture 62 of contact strip 41 and on the triangular bottom portions of the insulating pieces 63 and 64. When the pin is energized thereafter it will make contact between the upper square portion of the aperture 62 and the upper triangular portion of the formation 59 and thus close a circuit from the contact strip 41 to the contact strip 34.

The switch as illustrated has six apertures at each cross-point, six horizontal contact strips in a set and six vertical strips in a set. When the coils 45 and 46 are properly operated, connections will be established as follows:

Movable contact in aperture	Stationary horizontal contact strip	Stationary vertical contact strip
48	34	41
49	32	39
50	30	38
51	35	37
52	33	40
53	31	42

It should be noted that arrangements may as readily be made to establish any desired number of connections at a cross-point and that the establishment of six such connections as shown is only by way of example.

In Fig. 5 the circular aperture, such as 61, may be noted, the square aperture such as 62 may be noted and the normal position of a contact pin or roller such as 67 may be noted.

In Fig. 6 a pin 67 is shown in its normal unoperated position. In this case there is a representation of the base-plate 44, the contact strip 38, insulation 65, the contact strip 40, insulation 66, the contact strip 42, another piece of insulation 68 and a piece of insulating material 69 which may be transparent and mounted over the entire face of the switch structure. At the other side of this insulating material the coil 45 is noted and then a representation of the contact strip 34, insulating piece 64, contact strip 32, insulating piece 63, contact strip 30 and an insulating piece 70 with a final cover of some transparent material 71. Comparison of this figure with the expanded view of Fig. 4 will show that the pin 67 is resting in aperture 50 for at its right-hand end it is resting on the edges of the square aperture in the vertical contact strip 38. At the right-hand end it is only the contact strip 30 which is extended downwardly by the triangular formation thereof sufficiently to allow contact to be made upon the energization of the roller pin 67. In Fig. 7 this roller pin 67 is shown in its operated position whereupon a circuit is closed between the vertical contact strip 38 and the horizontal contact strip 30.

All of these various contact and insulating strips may be assembled and secured by rivets or screws extending through the holes such as 72 in contact strip 31 and the holes such as 73 formed between contact strips 37 and 38.

The method of operation is essentially to set up a strong enough field of force at any cross-point to operate the roller pins such as 67 thereat, such pins are of magnetic material and upon operation will act also as conductors in closing the circuit such as that heretofore described. Figs. 8 and 9 illustrate one method by which a switch of this nature may be operated. First, a circuit is closed for a vertical coil 72 by the operation of switch 73. This will, of course, energize the roller pin 74 and all of the other similar roller pins in the vertical row defined by the vertical coil 72. The energization of such pins, however, is insufficient to cause them to move. The effect is shown in Fig. 9 by the horizontal line marked sensitizing current. This is insufficient to operate the pins since they require a larger current noted in Fig. 9 by the horizontal line marked operate current. Through the closure switch 73, then, all of the pins in a vertical row are sensitized and now it is necessary to select a particular set of these pins corresponding to a particular horizontal row.

For this purpose a switch 75 is operated momentarily downwardly whereupon the condenser 76 is charged to the potential of the battery 77. The switch 75 is then operated to its upper set of contacts whereupon the condenser 76 is first connected in circuit with the battery 78, the horizontal coil 79 and the resistance 80. At this instant the graph shown in Fig. 9 is created. The condenser 76 discharges into the coil 79 and creates the curve running from time zero to time T_1. Since the force created in the coil 79 by the discharge of condenser 76 is considerably above the operate current level within the time required and noted by the vertical line marked "operate time," the pin 74 will move to its operated position. As the key 75 is moved to completed its operation in the upper direction, the condenser 76 is discharged completely by a short circuit through the outer upper set of contacts of key 75. This circuit also closes a direct current circuit for the coil 79 in series with the battery 78 whereupon the current will again rise from the point T_1 and assume a steady value until the time T_2, which may be at any later convenient time when key 73 is released. When key 73 is released then the current holding the pin 74 drops to a point between the sensitizing current and the

minimum hold current and this is sufficient to maintain the pin 14 in its operated position. Other more conventional methods of operating the movable contact pins may be used.

What is claimed is:

1. A switching device comprising two groups of coils arranged to cross each other to form rectangular fields where a coil of one group crosses a coil of the other group, spaced magnetic contact elements within said rectangular fields having aligned apertures separated from each other by insulating members having apertures aligned with but eccentric to the apertures of said contact elements, and an armature roller for each group of aligned apertures normally resting on the eccentric edges of the insulation apertures and operative to contact the adjacent apertures of the contacting elements in response to electromagnetic flux produced by the energization of the two coils surrounding said armatures.

2. A switching device comprising a plurality of groups of horizontal stationary contact strips, a plurality of groups of vertical stationary contact strips, said strips being constructed and arranged to cross each other to form cross-points equal to the number of groups of horizontal strips times the number of groups of vertical strips, each said cross-point being provided with a plurality of apertures extending transversely to said strips equal in number to the number of contact strips in a group, a movable contact member in each said aperture, the said strips at the cross-points being so formed that said movable contact member in each of said apertures will establish an independent connection between the said strips of a horizontal group and the said strips of a vertical group equal in number to the number of strips in a group, and means for energizing the pins of any of said cross-points.

3. A switching device comprising a plurality of groups of horizontal stationary contact strips, a plurality of groups of vertical stationary contact strips, said strips being permanently mounted in such a manner as to provide a number of cross-points equal to the number of groups of horizontal strips multiplied by the number of groups of vertical strips, said strips being so formed that a number of transverse apertures are provided at each said cross-point equal in number to the number of strips in a group, said strips being differently formed so that each aperture presents a different contact pair between a horizontal strip and a vertical strip, a movable contact member in each of said apertures adapted upon energization to complete a connection between said contact pair and means for selectively energizing the movable contact members of said different cross-points.

4. In a switching device, sets of unmovable contacts arranged in vertical and horizontal relation to each other and forming a plurality of cross-points equal to the product of the number of sets of horizontal contacts and the number of sets of vertical contacts, a plurality of apertures formed through the composite structure formed of said contacts and the usual insulating material employed in securing said immovable relation, the individual apertures through said contacts and said insulation being of different forms whereby through different combinations of said different forms each aperture may have a different characteristic, loosely positioned pins or rollers of magnetic material in said apertures and means for selectively energizing the various sets of said pins or rollers at said cross-points whereby a plurality of independent connections between the contacts of a horizontal set are made with the contacts of a vertical set.

HENRY C. HARRISON.