

May 2, 1944.

H. C. HARRISON

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SWITCHING MECHANISM

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3 Sheets-Sheet 1

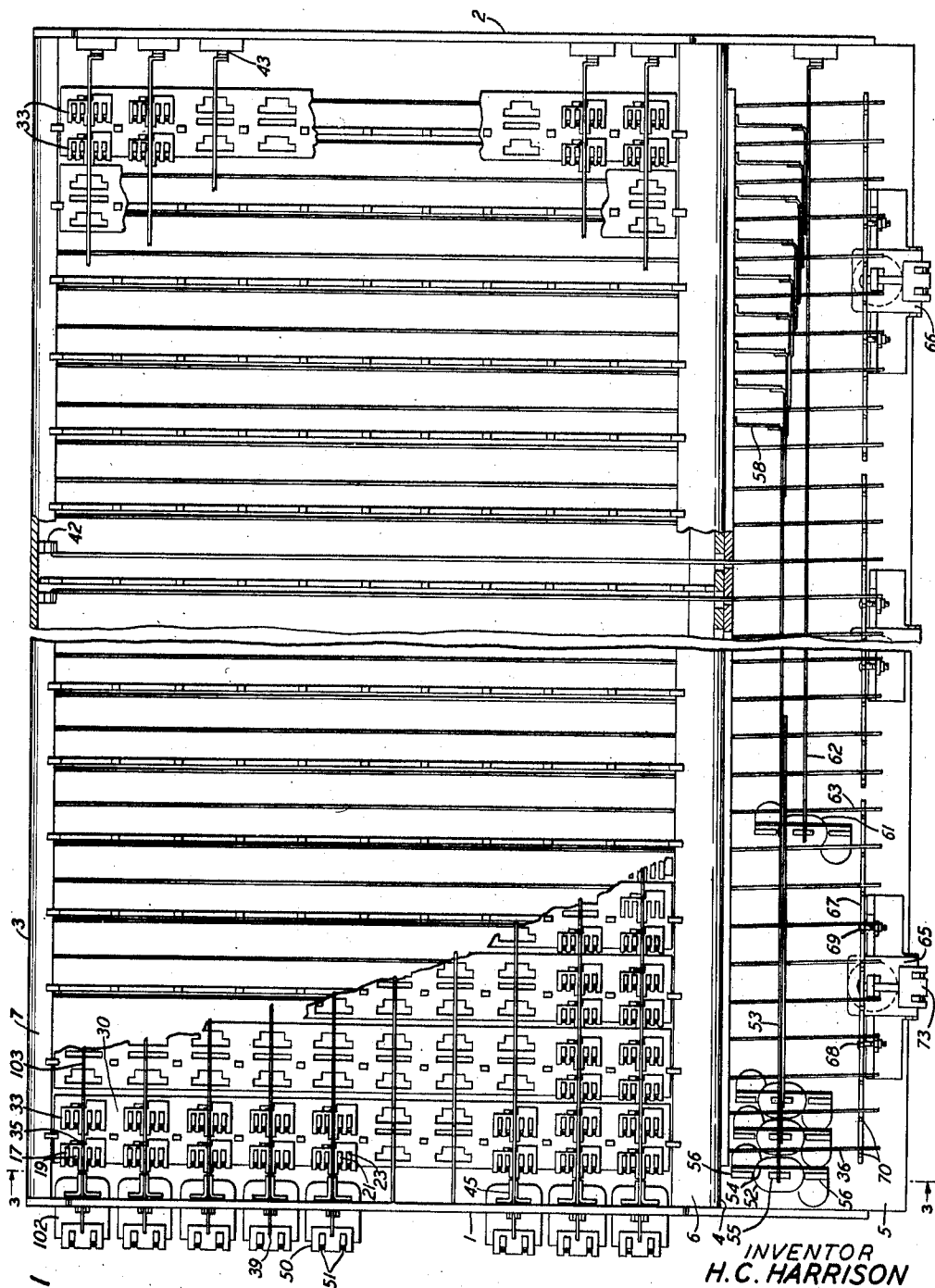


FIG. 1

INVENTOR
H. C. HARRISON
BY *M. J. McKenney*
ATTORNEY

May 2, 1944.

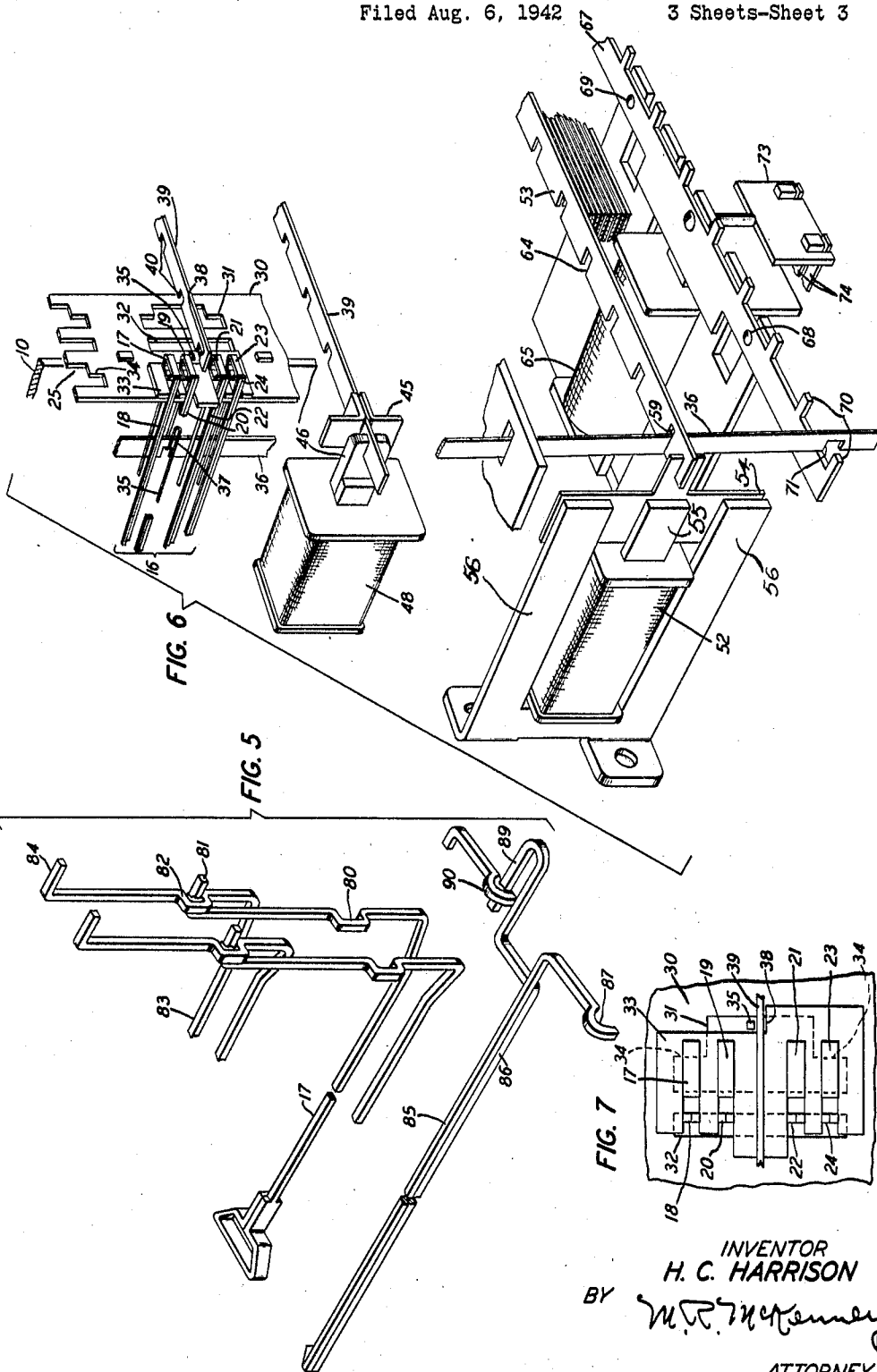
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UNITED STATES PATENT OFFICE

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SWITCHING MECHANISM

Henry C. Harrison, Port Washington, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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8 Claims. (Cl. 179—27.54)

This invention relates to switching mechanisms and particularly to mechanisms of the crossbar type as employed in automatic telephone systems to establish connections.

An object is to improve the operating characteristics and simplify the operating elements and the construction details of such switching mechanisms.

Heretofore so-called three dimensional crossbar switching arrangements have been provided, that is, crossbar switches in which connections are established by three stages of operations to first select a major group of connections, then a minor group of the selected major group and finally an individual connection in the selected minor group. Such switching systems may comprise a number of crossbar switches of the well-known type in which the operation of a select bar in one coordinate direction followed by the operation of a hold bar in the other coordinate direction, cause connections to be established between contacts at the cross-point of said two bars, these switches may be used for three dimensional operation by an arrangement including four groups of bars and three groups of magnets as shown for example in the Patent 1,528,763 to C. L. Goodrum et al. of March 10, 1925.

The applicant's invention relates to improvements in this general type of three dimensional crossbar switches and may be applied to a switching arrangement in which four sets of bars and three groups of magnets are employed, a group of single switches as mentioned above may be employed and arranged in a horizontal row with a common set of horizontal hold bars running across all of the switches and with the vertical select bars of each switch, hereinafter designated as secondary select bars, extending below the switches to be controlled by a set of horizontal primary select bars and a special horizontal tertiary select bar for each switch. To establish a connection at any cross-point in any of these switches, a magnet in a first group actuates a horizontal primary select bar to preassign one secondary vertical select bar in each switch and by operating a magnet in a second group and the associated tertiary horizontal bar to move a pre-assigned secondary select bar in the corresponding switch and finally by operating a hold magnet and the associated hold bar to cause a connection to be established between the contacts at the cross-point of this hold bar and the pre-assigned secondary select bar in the associated switch.

A special feature of this three dimensional

crossbar switching scheme is an arrangement whereby the horizontal primary select bars when actuated operate on the associated secondary select bars to flex or bend said bars, which are in the form of tapes, so that they are placed in position where they may be selected and operated longitudinally by the associated horizontal tertiary bars. Each tertiary bar is in the form of an armature controlled by an associated magnet in the corresponding group.

Another feature is an arrangement of a frame for the switches in which the frame members consist of metal plates having U-shaped cut-outs to form central projections on each of which is mounted a coil for an operating magnet and in which the central projections serve as the core while the frame member as a whole serves as the return path or pole-piece for the associated magnet. In the present case this feature has been applied to the hold magnets only but it should be understood that this may be applied to any other magnet structures without departing from the spirit of the invention.

Another feature is an arrangement of the contact means in the switch for multiple wiring by having these contact springs in the form of wires which are mounted in insulation blocks and having these wires terminate in bent portions so arranged that when one contact spring is to be multiplied to another contact spring, the bent portion of one wire will rest in a depression or hook in the succeeding wire and the joints between the succeeding wires are soldered or otherwise fused together to form the multiple.

The invention has been illustrated in the accompanying drawings in which:

Fig. 1 shows a front view of a switching arrangement embodying the applicant's invention. In this figure certain parts of the mechanism have been broken away in certain stages to more clearly illustrate the various parts thereof;

Fig. 2 is a left-hand side view of the switch shown in Fig. 1 with certain parts broken away;

Fig. 3 is a cross section taken approximately on line 3—3 of Fig. 1;

Fig. 4 is a fragmentary bottom view of the switch shown in Fig. 1 with certain parts broken away for the sake of clearness;

Fig. 5 illustrates the multiple connections for the contact springs in an exploded perspective view;

Fig. 6 is a fragmentary perspective of the switch shown in Fig. 1;

Fig. 7 is an enlarged fragmentary front view

of an operating card and contact springs at a cross-point; and

Fig. 8 is a diagrammatic representation of the general organization of the three dimensional switch structure shown in Fig. 1.

Referring now to the drawings, as shown in Fig. 1, this structure consists of a frame having side members 1 and 2, a top member 3 and a bottom member 4 welded together at the corners in any suitable manner. The bottom member 4 is at the rear of the structure bent downwardly in an angular projection 5 and in front upwardly in the angular projection 6 while the top member is bent in the front downwardly in a projection 7. Between the top member 3 and bottom member 4 are mounted vertical units each comprising a vertical plate 10, secured in front in slots in the projections 6 and 7 and at the rear in lugs 11 extending from plate 4 and lugs 12 extending downwardly from plate 3 by means of screws such as 13 and 14 to clamp the vertical plate 10 against the front projections 6 and 7. On each plate 10 are mounted in the rear two groups of individual sets of springs in the form of wires which may be secured to plate 10 by molded blocks such as 15 for one group on one side of the plate while the other group is similarly mounted on the opposite side of the plate. The individual sets of springs may be identified with the numeral 16. Each of these sets of springs 16 may consist of four pairs of springs. In the upper pair the movable spring is marked 17 and the companion stationary spring is marked 18 and below these springs 17 and 18 are similar pairs 19 and 20, 21 and 22 and 23 and 24. That is two of such groups 16 are mounted side by side in a horizontal direction as shown in Fig. 1, on opposite sides of plate 10, and there are shown ten such groups on each vertical unit. Considering the set 16, in Fig. 6 the movable springs 17, 19, 21 and 23 project through an opening identical with opening 25, in a front insulation plate 30 secured to plate 10, while the companion stationary springs 18, 20, 22 and 24 rest against the left-hand edge of this plate 30. In the corresponding right-hand set 16, not shown in Fig. 6, but shown enlarged in Fig. 7 the corresponding movable springs project through an opening 31 in the plate 30 and the stationary springs rest against a right-hand edge of another opening 32 in the plate 30. In front of the plate 30 for each group of springs 16 there is an insulation operating card 33 which has horizontal slots for the guiding of the stationary springs, while the movable springs are secured to this operating card and end in more or less triangular loops so that when the card 33 moves towards the left, the looped ends of the movable springs will come in contact with the stationary springs. The air-gap between the movable springs and the stationary springs are determined by the shape of the slots in plate 30 as all of the movable springs are tensioned toward the right, the upper and lower springs 17 and 23 will rest against the right-hand edges of the slots at the points such as 34 shown in slot 31 for example while the stationary springs 18, 20, 22 and 23 are tensioned against the left-hand edge of plate 30 for the left-hand set 16. Similarly the stationary springs of the corresponding right-hand set are tensioned against the right-hand edge of slots like 32. For each group of springs 16 there is also mounted a wire spring or finger 35 which is hooked around the associated secondary vertical select tape 36 as shown at 37 and this

finger extends forward, through the right-hand slot 31 for the associated set of springs in the plate 30, in front of a corresponding horizontal hold bar 39 and above a corresponding slot 40 in this bar, and also lies on the right-hand side of the card 33 so that when a secondary vertical select tape 36 is moved downwardly this finger 35 will slide downwardly along the right-hand edge of the card 33 until it engages the edge 38 on card 33 when the tip of this finger will enter the slot 40 in a corresponding hold bar so that when the hold bar 39 is moved towards the left, it will move this finger 35 towards the left to move the associated card in the same direction and this card then moves the movable springs 17, 19, 21 and 23 toward the left to make contact with the associated stationary springs 18, 20, 22 and 24.

The secondary vertical bars 36 are secured at the top to springs such as 42 to keep the bars in their lifted position. The horizontal hold bars 39 are secured at the right-hand side to plate 2 by means of similar springs 43 to hold these bars towards the right. The left-hand end of each hold bar 39 is provided with an armature such as 45 adjacent a core 46 which is split down the center so that the hold bar may slide easily through this core and be guided thereby when the armature 45 is moved toward the core. This core as shown in Fig. 2 in particular is formed by being cut out from the plate 1 and the coil 48 is wound around this core. When this coil 48 is energized therefore, the flux through the central core 46 will pass through the parts of the frame plate 1 outside the core 46 and thus these parts serve as return paths for the flux through the armature, back to the core. The extreme left-hand ends of these hold bars may be connected to insulation plates such as 50 which are arranged to actuate the off-normal springs as shown at 51 for example in Fig. 2 in particular.

Thus with the arrangement as shown in Fig. 1 and Fig. 8 in particular there will be twenty sets of springs 16 associated with each vertical unit plate 10 and two secondary vertical select tapes like 36, one on each side of the plate 10 and if the whole switch consists of, for example, ten groups of such vertical units with five plates 10 in each group, there would be one thousand cross-connecting points between the ten horizontal hold bars and the one hundred vertical secondary select tapes and the selections for the operation of the contacts at any one of these points could therefore be made by the operation of any one of the hundred vertical secondary select tapes and a corresponding horizontal hold bar.

On the rear portion 5 of bottom plate 4 are mounted ten magnets, the extreme left-hand one of which is marked 52. Each one of these magnets controls a horizontal primary select bar or tape such as tape 53 controlled by magnet 52 and similar tapes controlled by the succeeding magnets. The tapes are moved towards the left when the magnets are energized as for example, if magnet 52 is energized, the primary select tape 53 will be moved towards the left by the armature 54 attached to the left-hand end thereof being attracted by the core 55 and the return pole-pieces 56 of this magnet. Each tape such as 53 and the others are held in their extreme right-hand positions by means of springs such as 58 for tape 53 secured to the central portion 4 of the bottom plate. The secondary

vertical select tapes such as 36 extend downwardly through openings in the central portion of the bottom plate 4 past these primary select tapes and are engaged in slots in the tapes in the following manner. For example, the first vertical secondary select tape 36 as shown in Figs. 1 and 6 passes through a narrow slot 59 in tape 53 so as to be moved thereby towards the left when the associated magnet 52 is energized. This tape 53 also controls in the same manner the first secondary select tape in every other group of ten, that is, tape 53 controls ten secondary vertical select bars one from each switch. Similarly the succeeding nine magnets controlling the succeeding nine tapes will each control ten secondary select tapes in the ten switches to move them towards the left when the associated magnets are energized. As shown in Fig. 1, the tenth magnet 61 for the first group of ten secondary select tapes controls a tape 62 and this tape controls the last secondary vertical select tapes 63 in the first group and also the last secondary select tape in the succeeding nine groups of such tapes. As the primary select tapes lie one on top of the other, it is necessary to avoid interference between these tapes and the secondary select tapes and to this end each primary select tape is provided with nine wide slots such as 64 at each switch so that the nine secondary select tapes may move freely longitudinally and be bent sideways without encountering any interference from these nine tapes in normal or actuated positions. Below each group of ten secondary vertical select tapes there is located a tertiary magnet such as 65 for the first group and 66 for the last group. This magnet 65 controls the horizontal bar 67 which serves as an armature and is suspended by two bolts and nuts 68 and 69 and extends across the first ten secondary vertical select tapes. The armature 67 is provided with projections such as 70 one for each of the ten secondary vertical select tapes which are normally not in position to be moved by these projections. When, however, any one of these select tapes is moved by a corresponding primary magnet such as 52, for example, and its tape 53, the associated select tape 35 will be bent towards the left so that a slot such as 71 in this first tape will straddle the projection 70 on armature 67 and when this armature is attracted by the magnet 65 and moved downwardly it will move select tape 36 downwardly. This armature 67 may also be provided with a card 73 for operating corresponding off-normal contacts 74.

In regard to the multiple connections between the contact springs in this switch, the arrangement may be such that the movable springs in each group 16 are connected vertically in a row, that is the first spring 17 is connected with a corresponding spring in the succeeding lower group 16 and so on, while the stationary springs are connected in rows in a similar manner in the horizontal direction. This arrangement is illustrated in Fig. 5 in which a spring such as the movable spring 17 is bent upwardly and then is provided with a notch 80 and then with an angular rearward extension 81. This extension 81 engages a corresponding notch or bent portion 82 of the corresponding spring in the group above the group in which the spring 17 is located such as the spring 83. This spring is bent in the same manner as the spring 17 and connects by means of projection 84 to another spring above it. The connection between the exten-

sion 81 and notch 82 may be soldered or otherwise fused or bound together to establish a continuous multiple connection between the springs. On the other hand each stationary contact spring may consist, for example as shown in Fig. 5, of a pair of wires such as 85 and 86, the wire 85 is bent at the rear towards the left and provided with a vertically located hook 87 while the wire 86 is bent towards the right and then rearwardly again and formed into a horizontally located hook 89 which is engaged by a hook 90 of the next succeeding stationary contact spring corresponding to spring 85. The connection between the hooks 89 and 90 and between succeeding hooks may be established by soldering or fusing them together so that a continuous horizontal multiple is established between these stationary contact springs in succeeding horizontal groups.

The operation of this three dimensional switching mechanism is as follows: If it is assumed for example that a connection is desired between the contact springs at the cross-point 100, in the first switch, the first operation will be to preselect the secondary select tape corresponding to the vertical row in which the desired connection is located, and is, in this case, the first tape 36 in the first switch and to this end the magnet 52 is operated to attract its armature and its primary select tape 53. This tape 53 will then be moved towards the left and bend the secondary select tape 36 towards the left. This tape 53 will, of course, also bend the corresponding first select tapes in all the other nine switches. The tape 36 will thereby be placed opposite a corresponding projection 70. The magnet 65 will now be operated to attract the armature 67 and thereby move the secondary select tape 36 downwardly against the tension of its holding spring 42. The first hold magnet 102 will then be operated to attract the hold bar 103 to shift it towards the left. As there is only one secondary select tape operated the corresponding fingers 35 controlled by this bar have been moved downwardly and thus on the operation of the hold bar 103 towards the left, this bar 103 will engage the finger 35 at the cross-point of tape 36 and bar 103, and through this finger cause the operation of the associated card 33 towards the left to move the movable contact springs 17, 19, 21, 23 in contact with the stationary contacts 18, 20, 22, 24 at this cross-point. Magnets 65 and 52 may now be released while the magnet 102 maintains the established connection as long as desired. When the hold magnet 102 releases to release the hold bar 103, the card 33 and finger 35 will be returned to normal to open the connection at this cross-point. Thus it will be seen that by operating a magnet such as 52 to operate a primary select tape, a group of secondary select tapes will be preselected by bending them and one of these will then be controlled by a tertiary bar to operate in the associated switch and a hold magnet will then operate to select a desired cross-point in this switch, that is, connections may be established in this three dimensional crossbar switching arrangement by the operation in three stages of one magnet from each of three groups and one bar or tape from each of four groups.

What is claimed is:

1. In a switching device a plurality of crossbar switches, each having horizontal and vertical rows of contacts intersecting each other for the establishing of connections between the contacts

of any horizontal row and the contacts of any vertical row at the cross-point of said two rows, horizontal bars common to all switches, vertical bars in each switch, means for preselecting one vertical bar in each switch by flexing them, means associated with each switch for actuating a vertical bar in said switch operative when it has been flexed, means for actuating any horizontal bar and means responsive to the actuation of a vertical bar in any switch and a horizontal bar for establishing a connection between the contact sets at the cross-point of said two bars.

2. In a switching device, a plurality of crossbar switches each having horizontal and vertical rows of contact sets intersecting each other for the establishing of connections between the contacts of any horizontal row and the contacts of any vertical row at the cross-point of said two rows, horizontal bars common to all switches, vertical bars in each switch, a plurality of means each associated with a separate vertical bar in each switch for flexing them simultaneously, means operative when a vertical bar is flexed for shifting it longitudinally, means for shifting longitudinally any horizontal bar and means responsive to the shifting of a vertical bar and a horizontal bar in any switch for actuating the contact sets intersecting each other at the cross-point of said bars to establish connections between them.

3. In a switching device, a plurality of crossbar switches each having horizontal and vertical rows of contacts intersecting each other for the establishing of connections between the contacts of any horizontal row and the contacts of any vertical row at the cross-point of said two rows, a first set of horizontal bars in the form of flexible tapes common to all switches, a magnet for shifting each tape, vertical bars in the form of flexible tapes for each switch, a second set of horizontal bars in the form of flexible tapes common to all switches, a magnet for shifting each of said last-mentioned horizontal tapes, each said last-mentioned horizontal tape being associated with a different vertical tape in each switch so that when its magnet shifts it, the associated vertical tapes are flexed transversely, a horizontal bar for each switch, a magnet for moving each bar transversely, said last-mentioned horizontal bars and said vertical tapes being so arranged that when a vertical tape in a switch is flexed, it is placed in a position to be engaged by the associated horizontal bar in said switch for movement thereby longitudinally when said horizontal bar is moved transversely by its magnet, means responsive to the shifting of any one of said first-mentioned horizontal tapes and the longitudinal movement of any vertical tape for actuating the contacts intersecting each other at the cross-point of said two tapes.

4. In a crossbar switching device, a frame structure comprising flat members of magnetic material, horizontal and vertical rows of contacts mounted in said switch structure and intersecting each other for the establishing of connections between the contacts of any horizontal row and any vertical row at the cross-point of said rows, horizontal operating bars each in the form of a thin tape, vertical operating bars each in the form of a thin tape, a magnetic structure for moving each tape comprising a portion of a frame member, a coil wound around said portion which is cut from the frame member so as to lie flush with the wide surfaces of the frame member and surrounded on three sides with an aperture

sufficient to permit the coil to be wound around this portion and an armature attached to the associated tape and located so as to straddle the aperture between this portion and the surrounding material of the frame member, said parts being so arranged that when the coil is energized, magnetic flux will pass through the cut portion, the armature and the surrounding material of the frame back to the cut portion to attract the armature to the cut portion to move said tape and means responsive to the operation of a vertical and a horizontal tape by their respective magnetic structures for establishing a connection between the contacts intersecting each other at the cross-point of said tapes.

5. In a crossbar switching device, a frame structure comprising flat members of magnetic material, horizontal and vertical rows of contacts mounted in said structure and intersecting each other for the establishing of connections between the contacts in any horizontal row and the contacts in any vertical row at the cross-point of said two rows, horizontal operate bars each in the form of a thin tape, vertical operate bars each in the form of a thin tape, a magnet structure for moving each tape comprising a core, a winding on said core and an armature connected to the tape with the core forming an integral part of a flat frame member by cutting a U-shaped portion out of the flat member, the intermediate portion between the sides of this cut-out serving as the core, and the surrounding portion serving as a return path for the flux produced when the coil is energized and with the armature straddling the core and the surrounding portion to lie in the path of said flux and be attracted to these portions to move the connected tape, and means responsive to the operation of a vertical and a horizontal tape by their respective magnets for establishing a connection between the contacts intersecting each other at the cross-point of said tapes.

6. In a crossbar structure, horizontal and vertical rows of contact sets intersecting each other, means for selecting any row of horizontal and any row of vertical contact sets and establishing connections between said contact sets at the cross-point of said two rows, means for mounting said contact sets in said switch, the individual contacts in each horizontal row being multiplied together by being constructed of individual wires each bent with a half loop and a hook and with the hook of one wire of one set inserted in a half loop of the corresponding wire of the succeeding set, and with the hook soldered to the half loop, the individual contacts in each vertical row being multiplied together by being constructed of two parallel wires with one bent upwardly and terminating in a half loop and the other bent downwardly and terminating in a hook, and with the hook of one wire of a pair registering with a half loop in the other wire of another pair in succession and with each hook soldered to the associated half loop.

7. In a crossbar switch, horizontal and vertical rows of contact sets intersecting each other, means for selecting any row of horizontal and any row of vertical contact sets and establishing connections between said contact sets at the cross-point of said two rows, the individual corresponding contacts in each row being multiplied together by having said contacts in the form of wires bent so that a hook of one wire

engages a depression in a succeeding wire and by having these joints fused together.

8. In a switching device, a frame structure comprising flat members of magnetic material, a plurality of crossbar switching units in said frame structure, each unit having horizontal and vertical rows of contacts intersecting each other for the establishing of connections between the contacts of any horizontal row and the contacts of any vertical row at the cross-point of said two rows, and with the individual corresponding contacts in each row being multiplied together by having said contacts in the form of wires so that a hook of one wire engages a depression in a succeeding wire and by having said joints fused together, horizontal bars common to all unit, vertical bars in each unit, means for pre-selecting one vertical bar in each unit by flexing them, means associated with each unit for ac-

5 tuating a vertical bar in said unit operated when it has been flexed, a magnet structure for actuating any horizontal bar comprising a portion of a frame member and a coil wound around said portion which is cut from the frame member so as to lie flush with the wide surfaces of the frame member and surrounded on three sides with an aperture sufficient to permit the coil to be wound around this portion and an armature attached 10 to the associated horizontal bar and located so as to straddle the aperture between this cut portion and the surrounding material of the frame member for the attraction of said armature and the associated bar to said portion when the coil is energized, and means responsive to the actua- 15 tion of a vertical bar in any unit and a horizontal bar for establishing a connection between the contact sets at the cross-point of said two bars.

HENRY C. HARRISON.