Dec. 15, 1942. R. F. MALLINA 2,305,316

SWITCHING MECHANISM

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FIG. 2

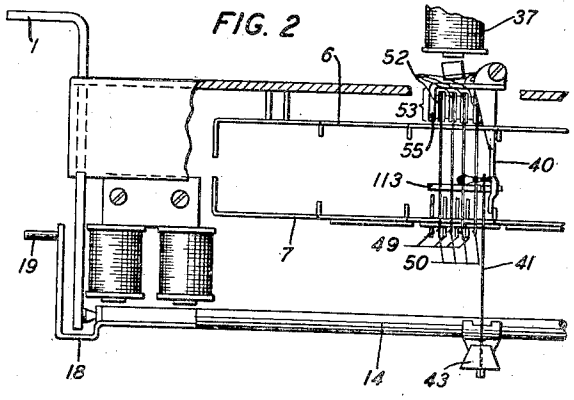


FIG. 3

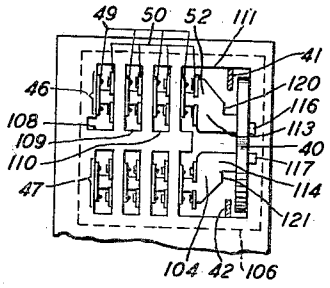
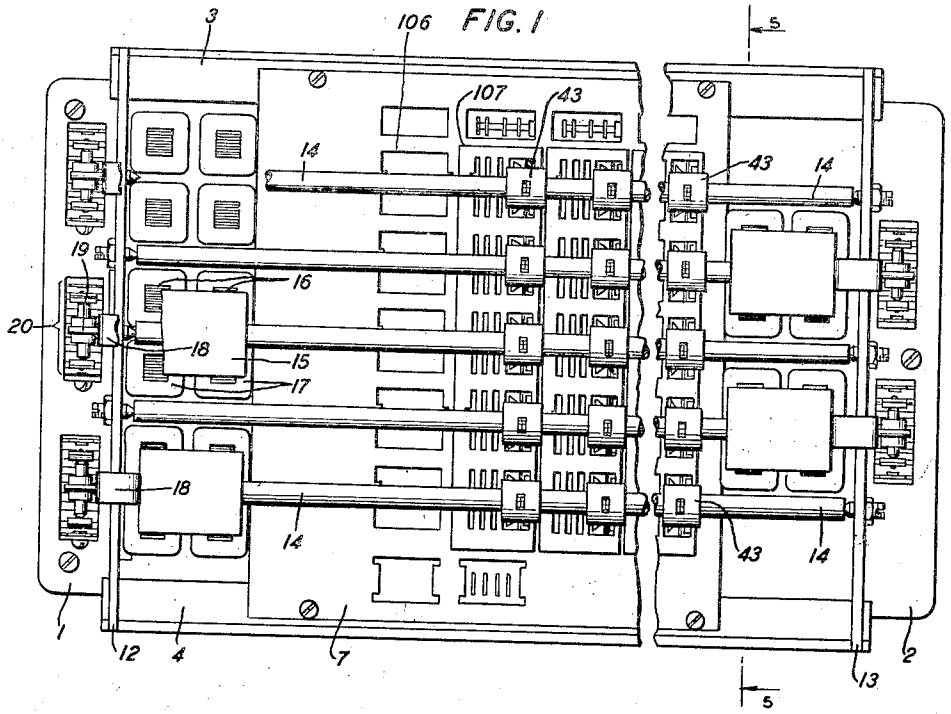


FIG. 1



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SWITCHING MECHANISM

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FIG. 4

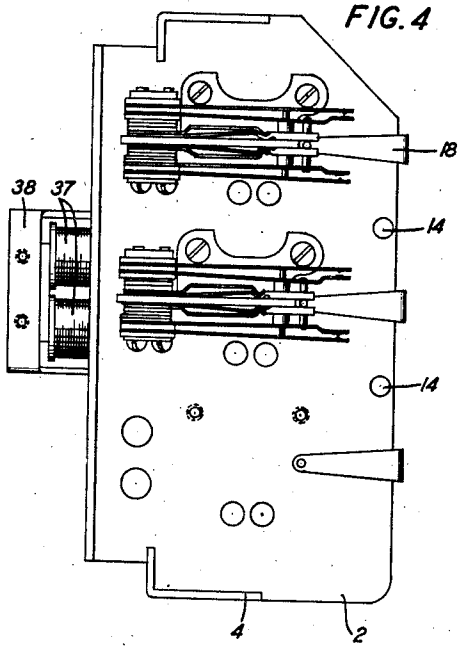
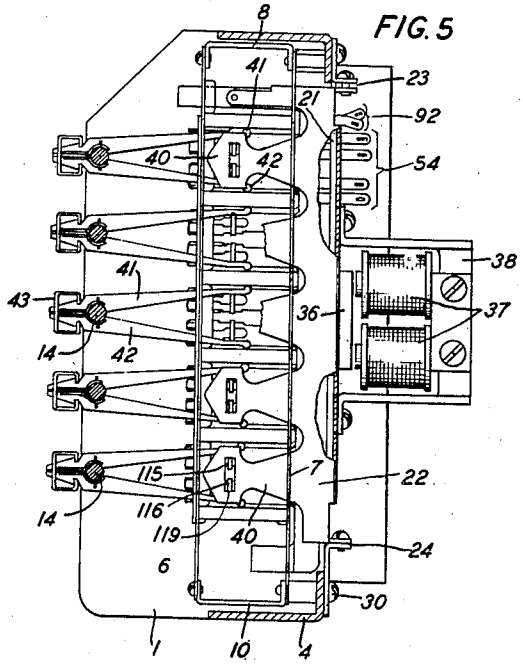


FIG. 5



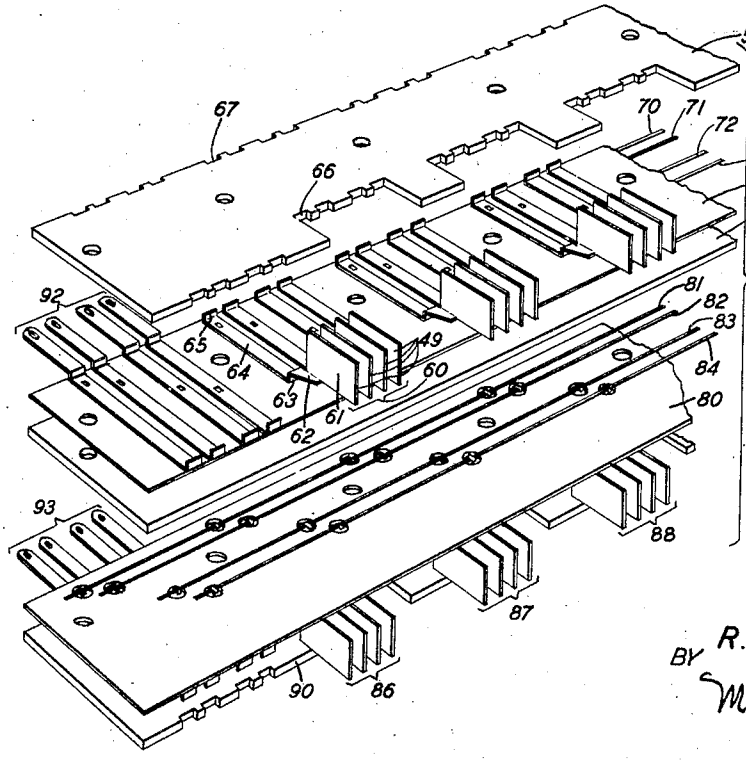


FIG. 6

FIG. 7

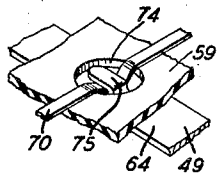


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FIG. 9

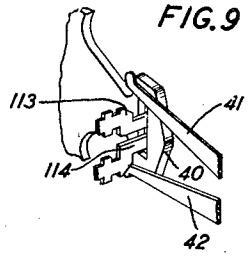


FIG. 10

FIG. 11.

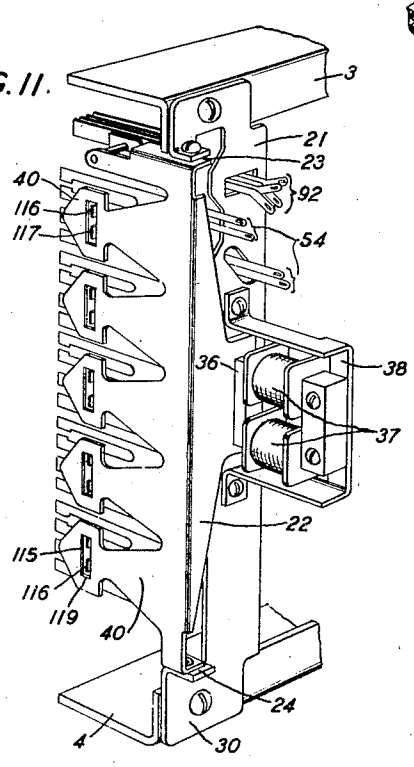
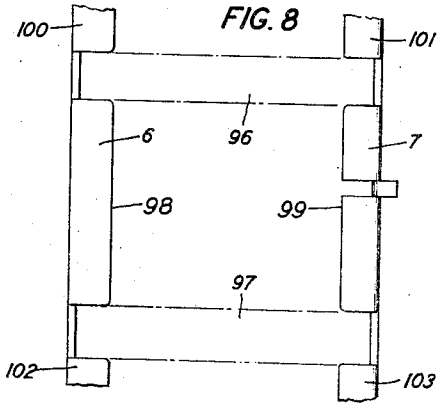


FIG. 8



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Patented Dec. 15, 1942 2,305,316

UNITED STATES PATENT OFFICE

2,305,316

SWITCHING MECHANISM

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Application August 6, 1941, Serial No. 405,581

8 Claims. (Cl. 179—27.54)

This invention relates to improvements in switching mechanisms and particularly to switches of the crossbar type for use in establishing connections in telephone systems.

It is an object of the invention to provide an improved, simplified, and compact switch structure of this type easily assembled from simple parts.

Crossbar switches of the particular type on which the present invention is an improvement are well known in the art. Such switches consist essentially of a number of contact sets arranged in coordinate rows with the contacts associated with each other for the establishing of connections at the crosspoints of said rows and means including one group of operating members intersecting another group of operating members controlled by magnets. Connections may be established between the contacts at any intersecting point by the operation of one corresponding intersecting member of each group. Switches of this type have also been provided where the number of intersecting members of one group is half that of the intersecting members of the other group. In this case the rotation of a member of the smaller group in either of two directions controls the selection of one or the other of two adjacent rows for operation by a single movement of the member in the larger group. A switch of this latter type is disclosed in the patent to John N. Reynolds 2,021,329 of November 19, 1935.

It is in connection with this latter type of switches that the present invention is disclosed as far as it relates to the general operating characteristics thereof. However, the improved switch structure in accordance with the applicant's invention is such that a switch built on the principles thereof would occupy a considerably smaller space than crossbar switches of the type disclosed in the prior art. To this end the switch in accordance with the applicant's invention is built with a considerably lesser number of parts and the features thereof relate to the construction, arrangement and assembling of such parts.

The crossbar switch illustrated herein consists of an outside frame structure comprising side members and an upper and a lower cross member. Between and secured to these cross members is mounted an inner frame structure having a front plate and a back plate and top and bottom members. Horizontal and vertical intersecting rows of contact springs are arranged in a group of pairs at each crosspoint of said rows and each pair comprises a horizontal and a vertical contact spring. A series of horizontal conductors are arranged for each row of horizontal contact springs. Each conductor in a horizontal row is connected to an individual horizontal contact spring in a horizontal row at each crosspoint. These horizontal contact springs and associated conductors in a horizontal row are arranged on insulation plates between the front and back plates of said inside frame. A series of vertical contact strips for each row of vertical contact springs is located outside of the back plate of the inside frame assembled on a vertical member secured to the upper and lower cross members of the outside frame structure. Each strip in a vertical row is integral with one individual vertical contact spring of each group of contact springs at each crosspoint. Each group of contact springs protrude through an aperture in the front plate outside thereof and insulation members are secured to the front plate of this inner frame structure having apertures therein so located and shaped that each pair of contact springs protrude through a corresponding aperture and engage the opposite sides of the latter aperture at a tension so as to be held normally a definite distance apart determined by the distance between said opposite sides. Means is also provided for selecting and operating the pairs of contact springs at any crosspoint of said rows to have one of the contact springs selected to move towards the other to establish an electrical connection between them. This means comprises the usual members, for example, ten vertical operating bars each controlled by a magnet to rotate in one direction and five horizontal operating bars each controlled by magnets to rotate in opposite directions.

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

Fig. 1 shows a front view of a switch structure in accordance with the applicant's invention;

Fig. 2 shows a partial top view of this switch structure shown in Fig. 1;

Fig. 3 shows an arrangement of two groups of contacts at a crosspoint of horizontal and vertical operating bars;

Fig. 4 is a left-hand side view of the structure shown in Fig. 1;

Fig. 5 is a cross section taken on the line 5—5 of Fig. 1;

Fig. 6 is an exploded perspective view of the arrangement of two associated rows of horizontal sets of contacts;

Fig. 7 is a fragmentary view of the connections for these horizontal contacts;

Fig. 8 is a part of the inner frame structure for holding the horizontal rows of contacts;

Fig. 9 is a partial perspective view of operating fingers and a vertical operating bar and part of the operating cards controlling the contacts;

Fig. 10 is a partial perspective view of the mechanism shown in Fig. 1 as shown from the front; and

Fig. 11 is a partial perspective view of this mechanism as shown from the rear.

Referring now to the drawings, the mechanism is enclosed in an outside frame structure consisting of the left-hand and right-hand members 1 and 2, top member 3 and bottom member 4. Secured to this frame is an inner frame structure consisting of a back plate 6 and a front plate 7 connected at its top with an angle piece 8 and at the bottom by a similar angle plate 10. Between the front and back members 7 and 6 are mounted the contact spring arrangements for the horizontal rows of contacts which will be described hereinafter in more detail. The side plates 1 and 2 have forwardly extending sections or angular projection plates 12 and 13 between these and mounted on bearing screws are horizontal operating bars 14. Five of these bars are provided in this switch structure. On the left and right-hand sides of alternate bars are mounted armature wings such as 15 for the rotation of the bars 14 in opposite directions by magnets mounted on the left and right-hand side members 12 and 13 of the structure as shown in Fig. 1. The magnet 16, for example, operates on the armature 15 to rotate a bar 14 in a clockwise direction and magnet 17 operates on the armature 15 to operate this bar in a counter-clockwise direction. To each armature and magnet is secured a bracket 18 bent back towards the back of the structure shown in Figs. 1 and 2 and this bar is provided with a pin 19 that operates on off-normal contacts 20. When the horizontal bar is rotated in a clockwise direction, pin 19 operates on the lower group of springs and when the horizontal bar is rotated in the counter-clockwise direction, it acts on the upper group of springs. On the rear of the outer frame between the top and bottom members 3 and 4 are mounted a plurality of vertical plates 21. On each plate 21 is mounted a vertical operating bar such as 22 shown in Figs. 5 and 11 on bearings such as shown at 23 and 24. Each of these vertical bars 22 may be rotated by having an armature 36 attached thereto in front of an individual set of coils or operating magnets 37. Each magnet 37 may be mounted on a U-shaped bracket 38 which in turn is mounted on the associated vertical plate 21. Each vertical bar 22 is provided with forwardly extending projections such as 40 for controlling two sets of contact springs at the crosspoint where these projections cross the horizontal bars as will be hereinafter described. A set of two select fingers 41 and 42 is provided for each crosspoint. Each of these sets is mounted in its proper position on the bars 14. The fingers 41 and 42 are mounted on opposite sides of the bar 14 in slots and are held apart as shown, for example, in Figs. 5 and 10 by a clamping spring 43 engaging the left-hand end of these fingers looking at Fig. 5. If reference is made to Fig. 3, it will be noted that each set of select fingers 41 and 42 operate in conjunction with a projection 40 to control two sets of contact springs, an upper set marked 46 and a lower set marked 47. Each of these sets, for example, 46, consists of four stationary springs of a horizontal row such as springs 49 and four movable springs of a vertical row such as 50. The four movable springs 50 are tied together by means of an operating card 52 for movement towards the left looking at Fig. 3 to contact with the stationary springs 49 under control of the finger 41 and the extension 40 of the corresponding horizontal and vertical bars. This operation to establish a connection at a crosspoint will be described hereinafter.

Referring now to the arrangement of the horizontal and vertical rows of contact springs, it will be noted that the vertical movable springs such as 50 for each vertical row are extended from the front of the structure towards the rear and are connected together by vertical strips 52 assembled in a corresponding vertical bank assembly 53. These strips 52 are suitably insulated from each other and provided with outlet terminals as shown at 54. Each vertical assembly 53 of such vertical strips 52 are mounted on an angular extension 55 on a corresponding vertical plate 21 as shown in Figs. 2, 5 and 11. In Fig. 6 has been shown the arrangement for assembling the horizontal rows of stationary springs such as 49. This figure indicates that two adjacent horizontal rows of springs are assembled together as follows: At 53 is shown an insulation plate that serves as a top plate for the assembly shown in this figure and below this plate is another insulation plate 59 on which are mounted on the upper side thereof a horizontal row of springs 49 in groups of four as shown, for example, at 60. Each one of the springs in the group 60 consists of a forwardly extending upright portion 61 which is then bent and formed into a narrow extension at right angles toward the left as shown at 62, then again bent downwardly transversely for a short distance as shown at 63, then backwardly into a narrow strip as shown at 64 and finally bent upwardly for a short distance as shown at 65. The upper insulation plate 58 normally fits over the extension 64 so that the corner portions 63 and 65 register with slots 66 and 67 at the front and the rear of the plate 58. Below this insulation plate 59 are located four conductors or flat strips 70, 71, 72 and 73 running parallel to each other in a horizontal direction. These are not visible under plate 59 but are visible as extending toward the right end of the broken-off plate 59. These conductors or strips may be connected each one with a separate horizontal stationary spring 49 as shown in Fig. 7, for example, in the following manner. Fig. 7 is drawn to show the under-side of plate 59. That is, a hole 74 is provided for each strip 70 to 73 and a projection or tongue 75 is cut out from the portion 64 of each spring 49 and bent upwardly and around the associated strip 70 etc. which is slightly bent downwardly into the hole 74 so that the upper surface of the tongue 75 lies flush with the upper surface of the insulation plate 59, that is, strip 70, for example, is thereby connected to the left-hand spring 49 in each group 60 of four springs in the horizontal row and the other springs 71, 72 and 73 are connected in the same manner to a corresponding spring 49 in this group of springs 60 in this horizontal row. Underneath the insulation plate 59 is another insulation plate 76 and below this is another assembly consisting of an insulation plate 80 on top of which is placed another row of four conductors or strips 81, 82, 83 and 84 connected (in the same manner as were the strips 70 to 73) to a corresponding set of stationary springs 49 of a second horizontal row such as the sets 86, 87, and 88 shown. Below the plate 80 is another insulation plate 90, similar to plate 58, which fits over this lower horizontal row of springs 86, etc., in the same manner as plate 58 fits over the horizontal row of

springs 60 and others. On the left-hand end of plates 59 and 80 are four transverse contact strips 92 and 93 connected in the same manner to the horizontally running multiple connecting strip 70, etc., and 81, etc., to establish outside connections to these multiple connections. All of these parts shown in this Fig. 6 are assembled together in a compact unit to form a bank assembly containing two rows of horizontal stationary springs. In the switch structure shown there will be five of these units as shown in Fig. 6 mounted between the frame members 6 and 7. In Fig. 8 two of these units marked 96 and 97 have been indicated by dash and dot lines and they are mounted between these plates 6 and 7 by having these plates provided with projections such as 98 and 99 bent inwardly toward each other and similar projections 100 and 101 above, and 102 and 103 below projections 98 and 99. That is, unit 96 is mounted to fit at the left between projections 98 and 100 and at the right between projections 99 and 101, while unit 97 is mounted to fit between projections 98 and 102 at the left and between projections 99 and 103 at the right.

Referring now again to Fig. 3, it will be noted that the four forwardly extending springs 49 of a horizontal row are, as stated, located adjacent to correspondingly forwardly extending springs of a vertical row such as the springs 50 forming the group 46 projecting through an opening 106 in the front plate 7. This opening 106 is large enough to include also the group 47 and the associated select fingers 41 and 42. It should now be observed that on the front plate 7 is mounted in front of each row of vertical groups of springs an insulation plate 107 which also is provided with openings. There is provided openings such as 108, 109 and 110 for each of the first three pairs of springs counting from the left, Fig. 3, each pair including a horizontal and a vertical spring. The horizontal springs in these openings are tensioned to rest on the left-hand edge of associated openings and the associated vertical springs are tensioned to rest against the right-hand edge of the associated openings. The distance between these sides is such that the air-gap between the pair of springs in each opening is accurately determined. Consequently the springs in each opening need not be specially adjusted when assembled to enter it but merely tensioned sufficiently apart so that the springs will rest against the opposite sides of the associated opening. The insulation plate 107 is also provided with other openings such as 111 associated with each group of openings 108, 109 and 110. These openings are larger than the openings on the left thereof and through each of these latter openings protrudes the fourth pair of springs. The left-hand spring of this pair is tensioned against the left-hand side of this opening while the right-hand spring is tensioned against the associated operating card such as 113, for example, for the group 46. This opening is large enough to permit a pair of select fingers 41 and 42 to protrude therethrough from the front of the structure. Adjacent these fingers 41 and 42 on the right-hand side thereof looking at Fig. 3 is located an extension 40 of the associated vertical bar 22. The card 113 for the upper group of springs 46 and card 114 for the lower group of springs 47 are secured respectively to the movable vertical springs of the associated groups of springs 46 and 47 and cut so that the movement of these cards towards the left will shift the associated movable springs to make contact with their companion stationary horizontal springs. These cards 113 and 114 have projections 116 and 117 extending respectively through opening 119 in the extension 40 for the free movement of the extension 40 towards the left without normally disturbing these cards. However, these cards 113 and 114 have cut-in portions 120 and 121 respectively so located that when select finger 41 is lowered or finger 42 raised, between these cut-in portions and the extension 40, the extension 40 will, when moved towards the left, move the associated card towards the left through the medium of the finger 41 or 42 as will be described hereinafter in more detail.

The operation of selecting a particular set of contact springs such as 46 to cause the movable springs 50 to connect with the associated stationary springs 49 will now be described in connection with Figs. 1, 3, 9 and 10, in particular. It may be assumed that the upper horizontal bar 14 is rotated in a clockwise direction by having the magnet 16 therefor energized to attract the armature 15. This will move the contact finger 41 downwardly while the associated finger 42 will not be moved but will remain at rest against the lower edge of the opening 111. It will be noted that finger 41 will thereby enter between the extension 40 and the cut-in portion 120 on the card 113 and if the magnet 37 for the associated vertical bar 22 is then energized this vertical bar 22 will cause the projection 40 to be moved toward the left looking at Fig. 3, and through the medium of finger 41, cause the card 113 to move toward the left and operate the associated movable springs 50 to connect with corresponding stationary springs 49 in the group 46 and thus establish a connection at this crosspoint of the vertical bar 22 and the first horizontal bar 14. Had this horizontal bar 14 been operated in the opposite direction by the armature 15 being attracted by the energization of magnet 17, the finger 42 would have been moved upwardly and on the operation of the corresponding vertical bar 22, the associated card 114 would have been operated toward the left in the same manner as card 113 to move the associated movable springs to establish a connection with the stationary springs in group 47. Similarly, connections may be established between the springs controlled by other cards at other crosspoints by the rotation of other horizontal bars 14 and other vertical bars 22.

1. In a crossbar switch, a frame having a front plate and a back plate and side members, horizontal and vertical rows of contact springs arranged in a group of pairs at each crosspoint of said rows with each pair comprising a horizontal and a vertical contact spring, a series of horizontal conductors for each row of horizontal contact springs located between the front and back plates of said frame, each conductor in a row connected to an individual horizontal contact spring at each crosspoint, a series of vertical contact strips for each row of vertical contact springs located outside of the back plate of the frame, each strip in a vertical row being integral with one individual vertical contact spring of each group of contact springs at each crosspoint, said groups of pairs of contact springs protruding through apertures in said front plate outside of said front plate, members secured to the front

plate of the frame having apertures therein so located and shaped that each pair of contact springs protrudes through a corresponding aperture and engages the opposite sides of the aperture at a tension so as to be held apart normally a definite distance determined by the distance between said opposite sides, and means for selecting and operating the pairs of contact springs at any crosspoint of said rows to have one of the contact springs in each selected pair moved toward the other to establish an electrical connection between them.

2. In a crossbar switch, a frame having a front plate and a back plate and side members, horizontal and vertical rows of contact springs arranged in a group of pairs at each crosspoint of said rows with each pair comprising a horizontal and a vertical contact spring, a series of horizontal conductors for each row of horizontal contact springs between the front and back plates of said frame, each conductor in a row connected to an individual horizontal contact spring at each crosspoint, an insulating plate between each row of horizontal conductors and the connected row of horizontal contact springs, means for securing said insulating plates between and to said front and back plates, a series of vertical contact strips for each row of vertical contact springs located outside of the back plate of the frame, each strip in a vertical row being integral with an individual vertical contact spring of each group of contact springs at each crosspoint, said groups of pairs of contact springs protruding through apertures in said front plate outside of said front plate, an insulating plate secured to the front plate having apertures therein so located and shaped that each pair of contact springs protrudes through a corresponding aperture and engages the opposite sides of the aperture at a tension so as to be held apart normally a definite distance determined by the distance between said opposite sides, and means for selecting and operating the pairs of contact springs at any crosspoint of said rows to have one of the contact springs in each selected pair moved toward the other to establish an electrical connection between them.

3. In a crossbar switch, a frame having a front plate and a back plate, horizontal and vertical rows of contact springs arranged in a group of pairs at each crosspoint of said rows with each pair comprising a horizontal and a vertical contact spring, series of horizontal conductors for each row of horizontal contact springs located between the front and back plates of said frame, each conductor in a row connected to an individual horizontal contact spring at each crosspoint, an insulating plate between each row of horizontal conductors and the connected row of horizontal contact springs, said series of horizontal conductors and associated contact springs being arranged in groups of two with the conductors of one series below the associated insulation plate and the conductors of the other row above the associated insulation plate, an insulating plate between the two rows of horizontal conductors comprising each group, projections on said front and back plates arranged to hold each group of conductors, contact springs and insulation plates between said front and back plates, and means for selecting and operating the pairs of contact springs at any crosspoint of said rows to have one of the contact springs in each selected pair move towards the other to establish an electrical connection between them.

4. In a crossbar switch, a frame having a front plate and a back plate, horizontal and vertical rows of contact springs arranged in a group of pairs at each crosspoint of said rows with each pair comprising a horizontal and a vertical contact spring, a series of horizontal conductors for each row of horizontal contact springs located between the front and back plates of said frame, each conductor in a row connected to an individual horizontal contact spring at each crosspoint, a series of vertical connecting strips for each row of vertical contact strips located outside of the back plate of the frame, each strip in a vertical row being integral with one individual vertical contact spring of each group of contact springs at each crosspoint, horizontal operating bars located outside the front plate of the frame, each bar in line with two adjacent horizontal rows of contact springs, vertical operating bars located outside of the back plate of the frame, each bar in line with each row of vertical contact springs, two operating magnets for each horizontal bar for rotating it in opposite directions, an operating magnet for each vertical bar for rotating it in one direction, a pair of operating fingers on each horizontal bar at each crosspoint of the horizontal and vertical bars, an operating card at each crosspoint of the horizontal and vertical rows of contact springs, each card associated with all of the vertical contact springs at the corresponding crosspoint, said bars, operating fingers and operating cards so arranged that the rotation of a horizontal bar in one direction or the other followed by the rotation of a vertical bar causes a corresponding finger to cooperate with a corresponding operating card to actuate the associated vertical contact springs in each pair to engage the corresponding horizontal contact springs at the corresponding crosspoint, members secured to the front plate of the frame having apertures therein so located and shaped that each pair of contact springs protrude through a corresponding aperture and engage the opposite sides of the aperture at a tension so as to be held apart normally a distance determined by the distance between said opposite sides.

5. In a crossbar switch, a frame having a front plate and a back plate, horizontal and vertical rows of contact springs arranged in a group of pairs at each crosspoint of said rows with each pair comprising a horizontal and a vertical contact spring, a series of horizontal conductors for each row of horizontal contact springs located between the front and back plates of said frame, an insulation plate between each series of horizontal conductors and the associated row of horizontal contact springs, a projecting tab on each horizontal contact spring, each conductor in a row connected to an individual horizontal contact spring at each crosspoint, through the medium of the associated tab protruding through an individual aperture in the intermediate insulation plate, a series of vertical connecting strips for each row of vertical contact springs located outside of the back plate of the frame, each strip in a vertical row being integral with one individual vertical contact spring of each group of contact springs at each crosspoint, horizontal operating bars located outside the front plate of the frame, each bar in line with two adjacent horizontal rows of contact springs, vertical operating bars located outside of the back plate of the frame, each bar in line with each row of vertical contact springs, two operating

magnets for each horizontal bar for rotating it in opposite directions, an operating magnet for each vertical bar for rotating it in one direction, a pair of operating fingers on each horizontal bar at each crosspoint of the horizontal and vertical bars and projecting through apertures in said front plate between said front and back plates, an operating card at each crosspoint of the horizontal and vertical rows of contact springs located between the front and back plates and each card associated with all of the vertical contact springs at the corresponding crosspoint, said bars, operating fingers and operating cards so arranged that the rotation of a horizontal bar in one direction or the other followed by the rotation of a vertical bar causes a corresponding finger to cooperate with a corresponding operating card to actuate the associated vertical contact springs in each pair to engage the corresponding horizontal contact springs at the corresponding crosspoint, an insulating plate secured to the front plate of the frame having apertures therein so located and shaped that each pair of contact springs protrude through a corresponding aperture and engage the opposite sides of the aperture at a tension so as to be held apart normally a distance determined by the distance between said opposite sides.

6. In a crossbar switch, horizontal and vertical rows of contact springs arranged so that horizontal contact springs are connectible to vertical contact springs at each crosspoint of said intersecting rows, a row of terminals in line with and for each row of horizontal contact springs, a row of bare horizontal conductors for each horizontal row of contact springs and associated terminals, an insulation plate between each row comprising horizontal contact springs and associated terminals and the associated row of horizontal conductors, projecting tabs on each horizontal contact spring and each terminal, each conductor in a row connected to an individual horizontal contact spring at each crosspoint and to an associated individual terminal in the same row through the medium of the associated tab protruding through an intermediate aperture in the intermediate insulation plate, said rows of horizontal contact springs, terminals, horizontal conductors and insulation plates being arranged in groups of two with the bare conductors of one row below the associated insulation plate and the bare conductors of the other row above the associated insulation plate, an insulation plate between the two rows of bare horizontal conductors, an insulation plate above the upper row of horizontal contact springs and associated terminals, another insulation plate below the lower row of horizontal contact springs and associated terminals, projections on the horizontal contact springs and terminals registering with notches in the said upper and lower insulation plates so that when these parts are assembled the contact springs and terminals will be accurately located and spaced in relation to each other, and means for selecting and operating vertical contact springs at any crosspoint of said rows to connect them with the associated horizontal contact springs.

7. In a crossbar switch, a frame having a front plate and a back plate, horizontal and vertical rows of contact springs arranged in a group of pairs at each crosspoint of said rows with each pair comprising a horizontal and a vertical contact spring, series of horizontal conductors for each row of horizontal contact springs located between the front and back plates of said frame, each conductor in a row connected to an individual horizontal contact spring at each crosspoint, an insulating plate between each row of horizontal conductors and the connected row of horizontal contact springs, said series of horizontal conductors and associated contact springs being arranged in groups of two with the conductors of one series below the associated insulation plate and the conductors of the other row above the associated insulation plate, an insulating plate between the two rows of horizontal conductors comprising each group, two insulation plates for each group, one above the upper row of contact springs and the other below the lower row of contact springs, projections on said front and back plates arranged to hold each group of conductors, contact springs and insulation plates between said front and back plates, and means for selecting and operating the pairs of contact springs at any crosspoint of said rows to have one of the contact springs in each selected pair move towards the other to establish an electrical connection between them.

8. In a crossbar switch, a frame having a front plate and a back plate, horizontal and vertical rows of contact springs arranged in a group of pairs at each crosspoint of said rows with each pair comprising a horizontal and a vertical contact spring, a series of bare horizontal conductors for each row of horizontal contact springs, an insulation plate between each row of horizontal conductors and the associated row of horizontal contact springs, a projecting tab on each horizontal contact spring, each conductor in a row connected to an individual horizontal contact spring at each crosspoint through the medium of the associated tab through an individual aperture in the intermediate insulation plate, said series of horizontal conductors and associated horizontal contact springs and intermediate insulation plate being arranged in groups of two with the conductors of one series below the associated insulation plate and the conductors of the other row above the associated insulation plate, insulation plates one above the upper and another below the lower row of contact springs, each of said insulation plates having notches therein registering with bent portions on the associated horizontal contact springs to accurately space the contact springs in relation to each other, an insulation plate between the two rows of horizontal conductors comprising each group, projections on said front plate of the frame bent toward the back plate of the frame, projections on said back plate of the frame bent toward the front plate of said frame, said projections arranged to hold each group of conductors, contact springs and insulation plates between said front and back plates of the frame, and means for selecting and operating the pairs of contact springs at any crosspoint of said row to have one of the contact springs in each selected pair moved toward the other to establish an electrical connection between them.

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