Nov. 14, 1944. H. C. HARRISON 2,362,551

SWITCHING MECHANISM

Filed Dec. 10, 1943 5 Sheets-Sheet 1

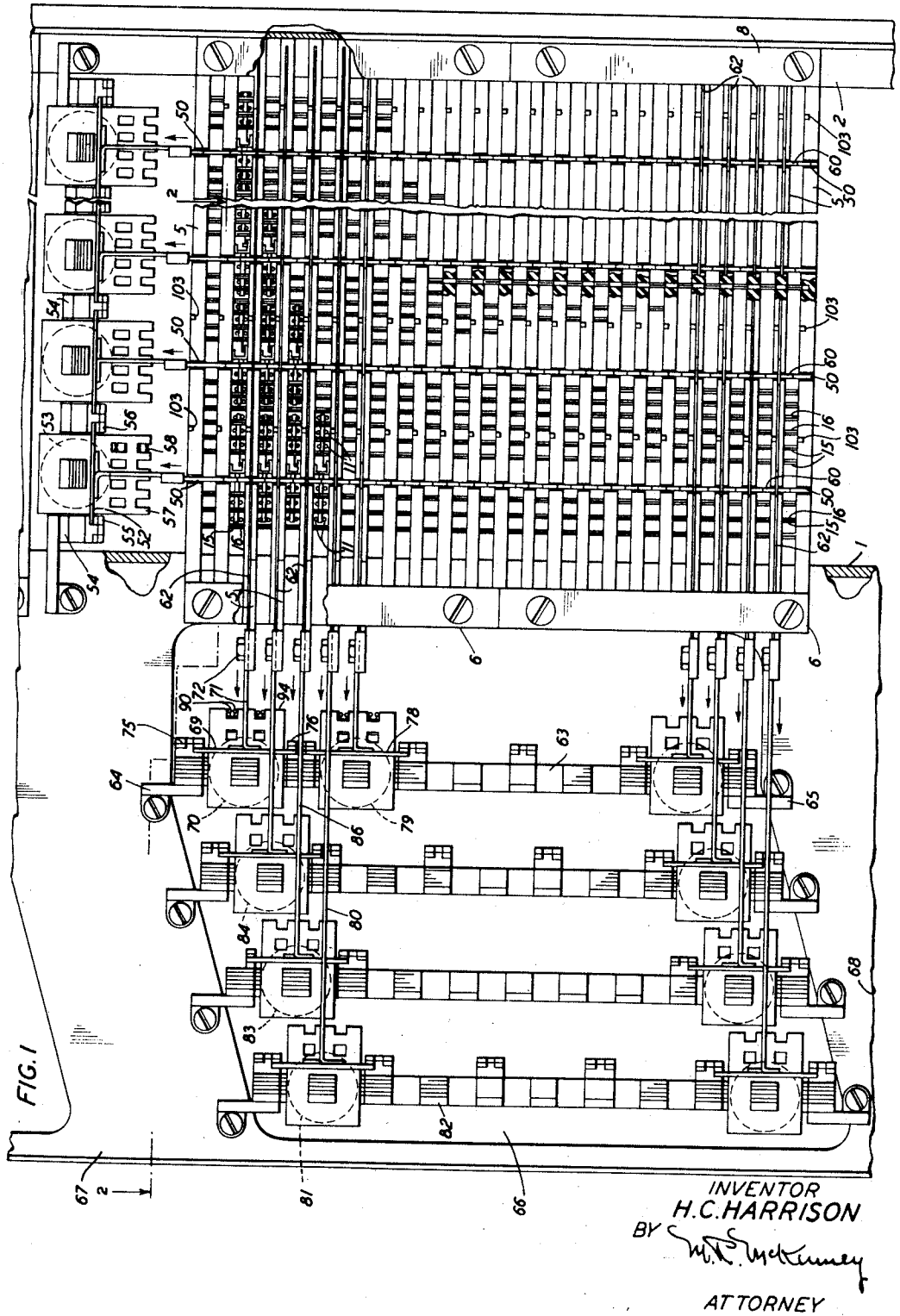

FIG. 1

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SWITCHING MECHANISM

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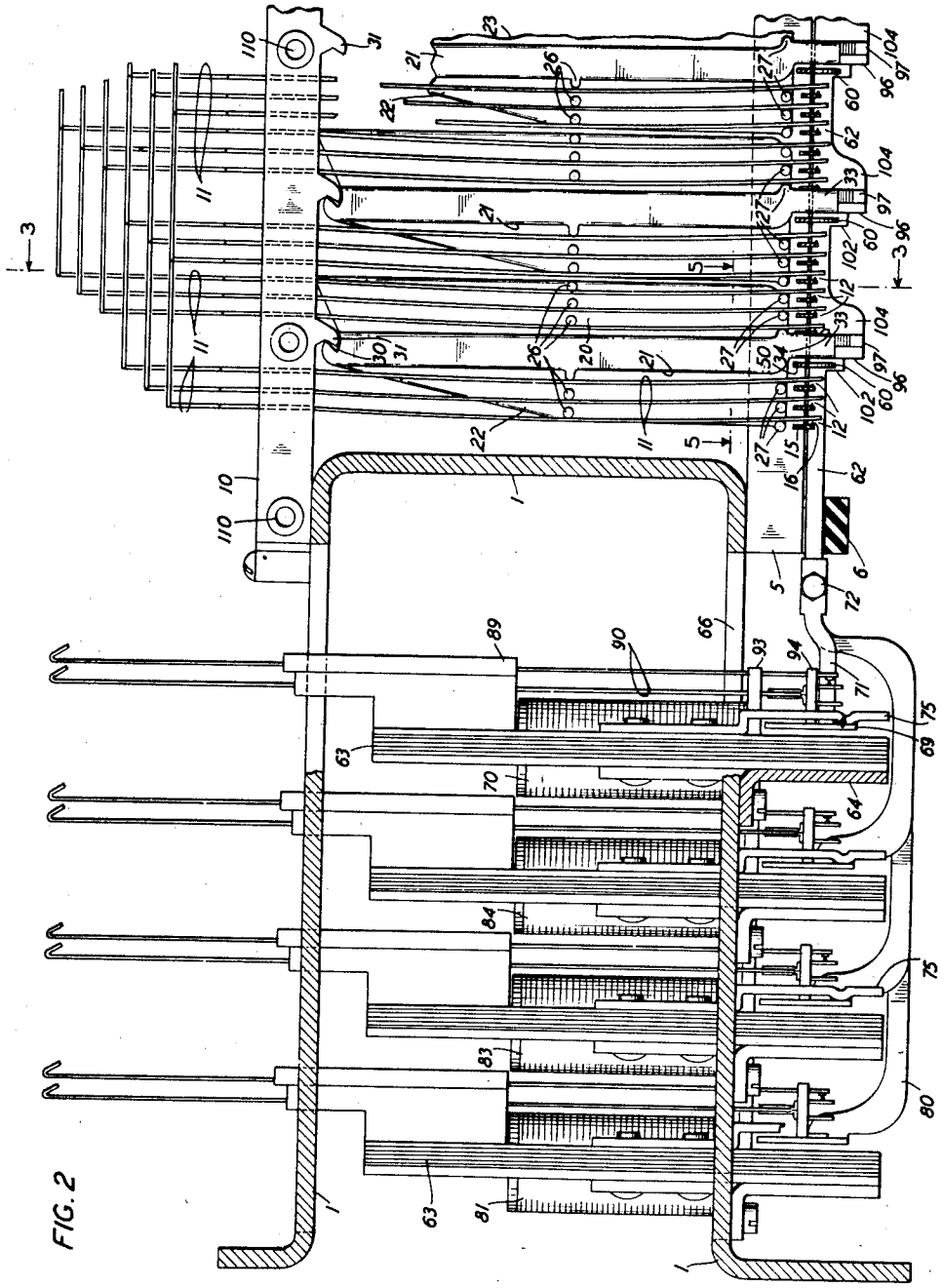

FIG. 2

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SWITCHING MECHANISM

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FIG. 3

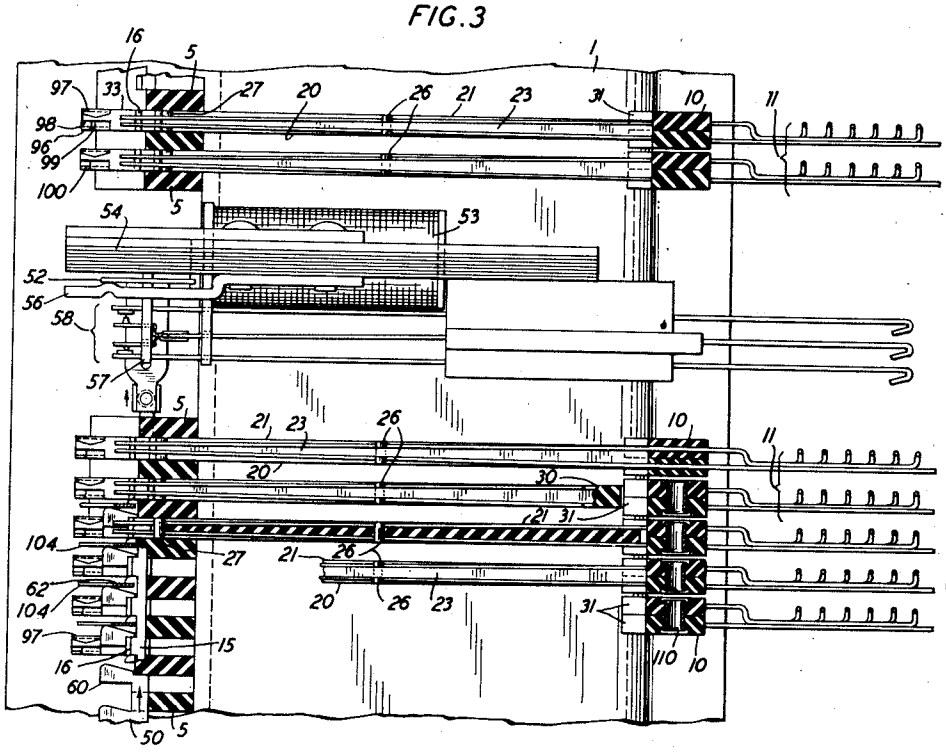


FIG. 4

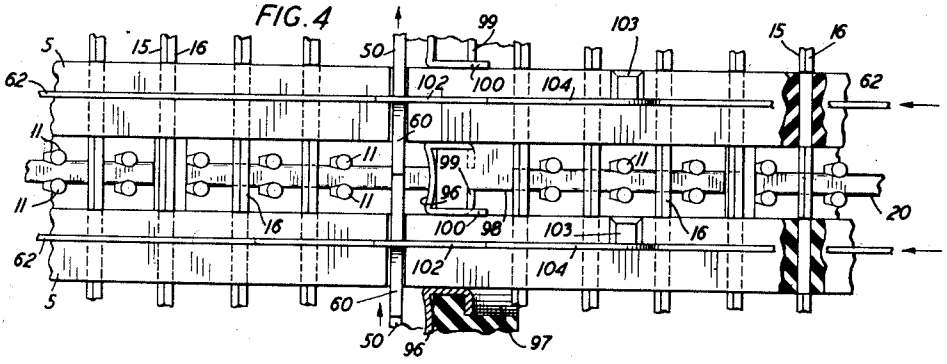
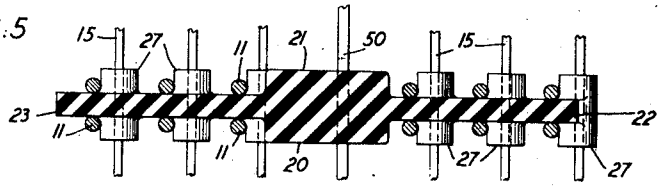


FIG. 5



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SWITCHING MECHANISM

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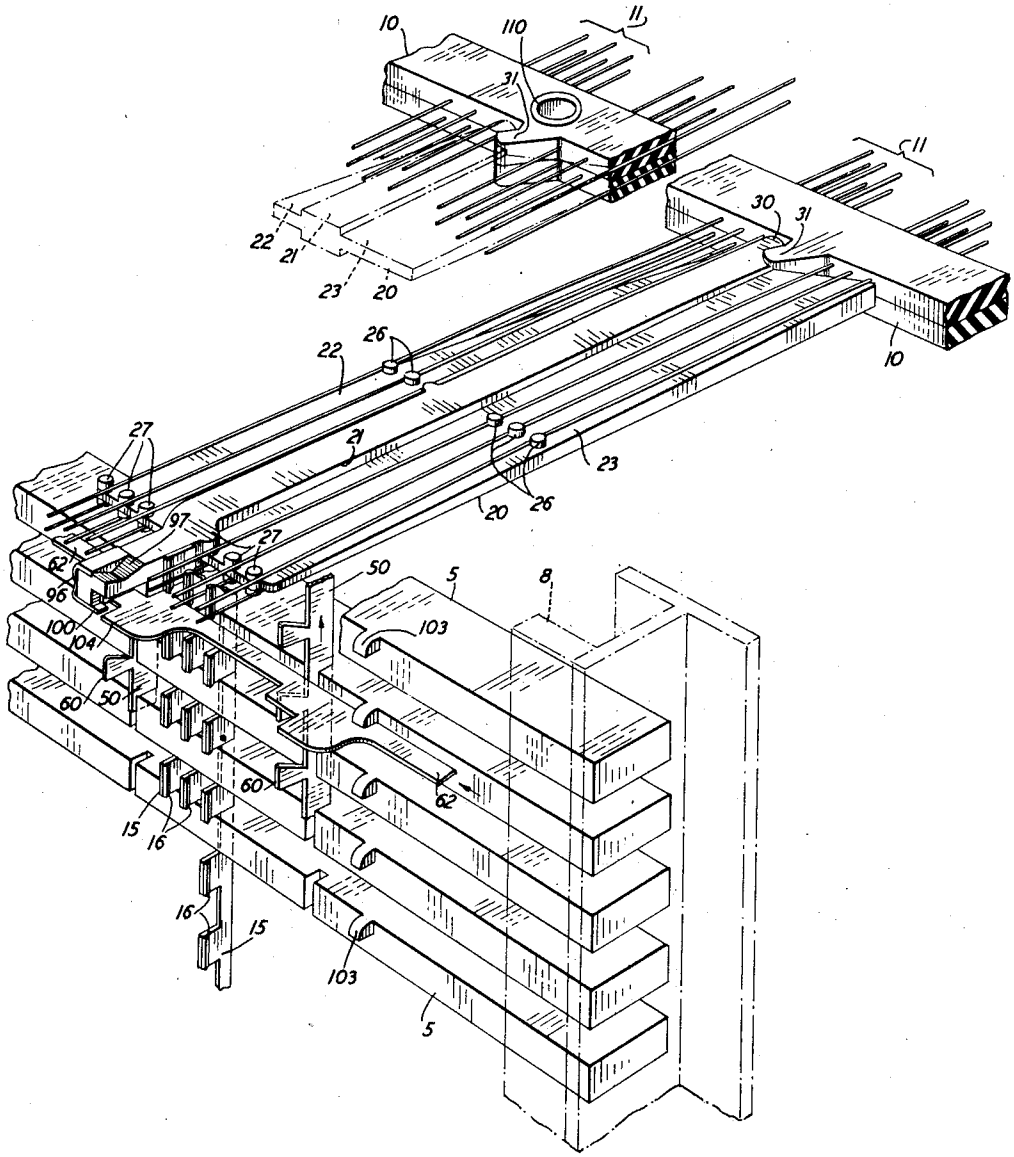
FIG. 6



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SWITCHING MECHANISM

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FIG. 7

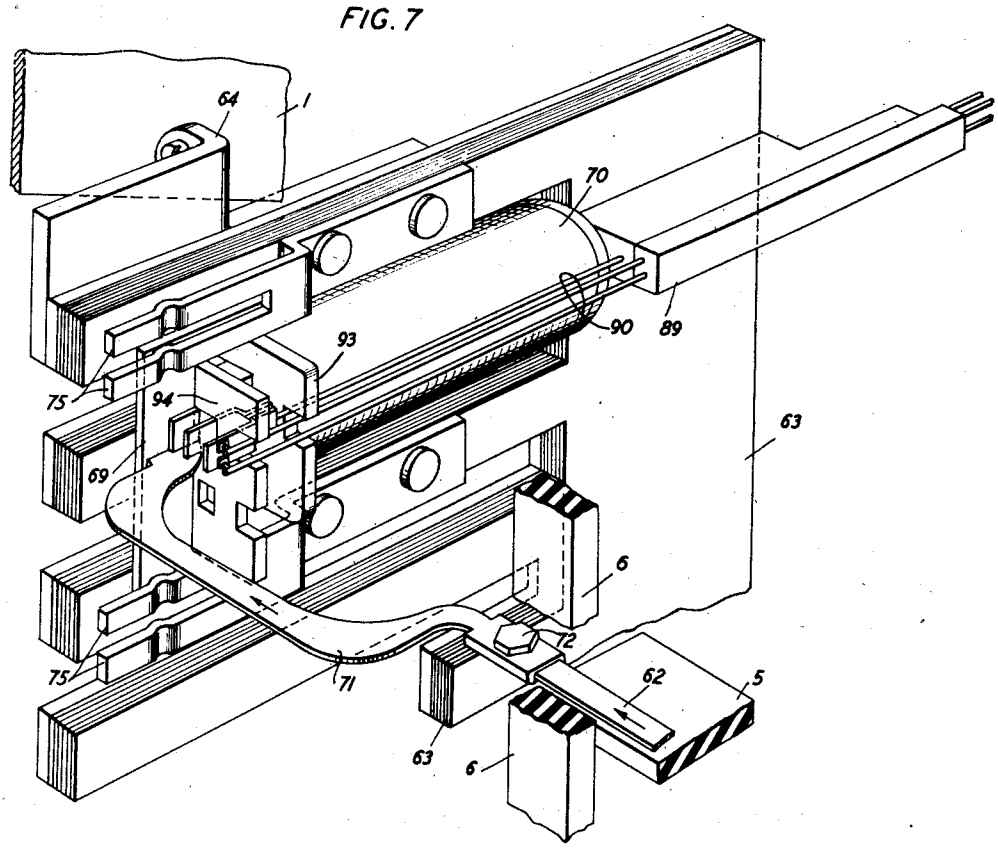


FIG. 8

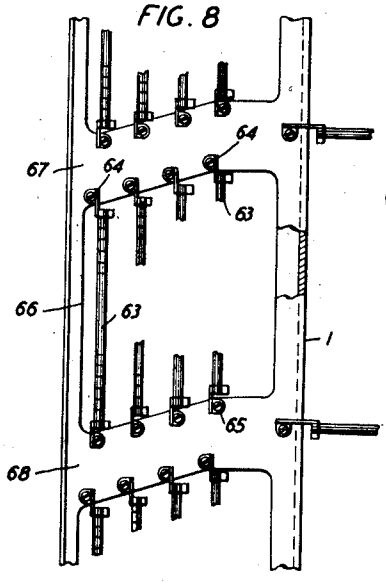
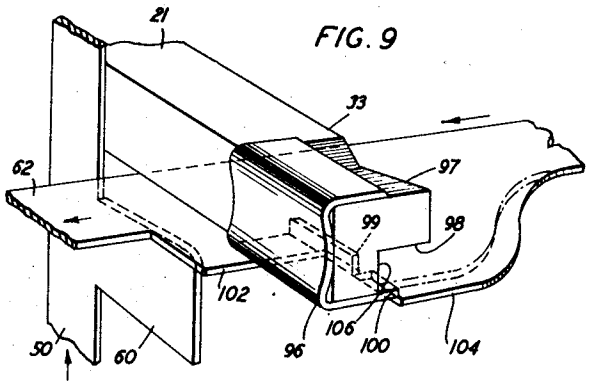


FIG. 9



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Patented Nov. 14, 1944 2,362,551

UNITED STATES PATENT OFFICE

2,362,551

SWITCHING MECHANISM

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Application December 10, 1943, Serial No. 513,793

5 Claims. (Cl. 179—27.54)

This invention relates to switching mechanisms and particularly to improvements in cross bar switching mechanisms employed in telephone systems for establishing electrical connections.

An object is to reduce the size and weight of cross bar switching structures.

Another object is to improve, simplify and reduce the number of detail parts employed in such structures and to provide for greater interchangeability of such detail parts.

A further object is to construct the detail parts of the mechanism so as to make them self-aligning and self-adjusting with regard to air-gaps between electrical contact members in particular.

Heretofore cross bar switching mechanisms have been used in which coordinate contacting members were controlled for selection at intersecting points to establish electrical connections by means of longitudinally movable horizontal and vertical intersecting control bars or tapes.

The present invention relates to cross bar switches of this general type in which vertically located contact strips and horizontally located rows of contact springs are arranged for establishing of connections at intersecting points between groups of vertical strips and horizontal springs.

A feature thereof is the provision of a series of horizontally located narrow insulation plates across the front of the switch structure and at the front edges of which are embedded the vertical contact strips with contact members projecting forwardly between the insulation plates. Each horizontal row of contact springs is embedded in a horizontally located supporting plate of insulation material at the rear of the structure and is divided in groups one at each point where they are crossed by an equal number of vertical strips. Each group of springs is divided in two horizontal layers with the springs appearing vertically opposite each other in pairs, each pair constituting a single contacting means. A card is provided at each cross-point inserted between the two layers of contact springs. These cards have oppositely located projections on which the contact springs are tensioned or sprung in such a manner that the cards will at the rear of the structure be held to pivot on a knife edge on the associated rear supporting plate while the forward end of each card extends between two adjacent front insulation plates and rests on or is tensioned by the springs against one side of one of the associated vertical contact strips so that when the card is moved laterally away from this contact strip, each pair of springs will make yielding connection with its companion vertical strip. Thus the springs are aligned and self-adjusting to control the normal air-gap between themselves and the associated vertical strips.

Another feature is the arrangement and construction of the horizontal and vertical operating bars which are in the shape of thin flexible tapes. The vertical select tapes are slidably and partially embedded in the horizontal front insulation plates and are moved longitudinally or lifted by means of magnets arranged side by side at the upper ends of the tapes in an upper frame member of the switch structure. The horizontal hold tapes are so arranged in relation to the vertical select tapes and the forward projections on the card at each cross-point that when a select tape is lifted, it will flex upwardly the hold tapes at the point where these hold tapes cross the lifted select tape and so that later when one of the hold tapes is shifted longitudinally by its hold magnet, the flexed portion thereof will engage the projection on the card at the cross-point of these two tapes, and move the card away from the vertical strip against which it is normally resting or tensioned and thus cause the associated pairs of contact springs to make contact respectively with the corresponding vertical strips at this cross-point.

Another feature relates to the arrangement of the hold tapes and the magnets for operating these tapes. The thickness or vertical measurements of the horizontal front insulation plates may be equal or less than the vertical distance between them, which latter distance is determined by the required thickness of the operating card to give it strength and rigidity and by the space required for the contact springs on opposite sides of the card. As this required width is exceedingly small, it is readily seen that the hold magnets must be placed quite close together. Hence the hold magnets must be arranged to meet these conditions. To this end therefore the hold magnets for the whole switch structure have been mounted in minor vertical groups on individual vertical brackets. These brackets in turn are arranged side by side in a staggered relation at one side of the frame structure and connected at top and bottom to the bottom member of a U-shaped upright frame member. This bottom member for that purpose is partially cut out to accommodate the brackets and the coils of said hold magnets. This enables the hold tapes to be connected to the armatures of the hold magnets by various extension pieces that are curved in one direction so as not to interfere with each other or

with the magnet coils and armatures in the adjavent vertical groups. These brackets are comb-shaped and of magnetic material so that each hold coil may be wound on one of the comb members of the bracket serving as a core while the adjacent comb members serve as return pole-pieces for the associated armatures. One comb member is provided between each two coils and serves as a return pole-piece for these two adjacent coils and the armature for each coil is loosely mounted on the return pole-pieces on either side thereof.

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

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

Fig. 2 is a top view taken on line 2—2 of Fig. 1;

Fig. 3 is a cross-section taken on line 3—3 of Fig. 2.

Fig. 4 is an enlarged fragmentary front view of the switch mechanism at a cross-point;

Fig. 5 is an enlarged cross-section on line 5—5 of Fig. 2 taken through one of the cards;

Fig. 6 is a fragmentary perspective of a card and other adjacent parts of the switch structure;

Fig. 7 is a fragmentary perspective of one of the hold coils and the associated mechanisms and part of the bracket on which it is mounted;

Fig. 8 shows in part the arrangement of the brackets for the hold magnets and the U-shaped left-hand supporting member of the frame; and

Fig. 9 is a partial perspective view of the mechanism at a cross-point for moving a card.

Referring now to the drawings in general, a number of cross bar switches, made in accordance with the applicant's invention, may be mounted on top of each other and between a left-hand U-shaped frame member 1 and a right-hand T-shaped frame member 2. Each switch consists of a series of horizontally located supporting plates 5 of insulation, supported on the left-hand side on the U-shaped member 1 to which they are clamped by means of bars such as 6 and clamped on the right-hand side to the T-shaped member 2 by means of bars such as 8. The distance vertically between these plates is approximately equal to the thickness of the plates. Between members 1 and 2 at the rear of the structure are mounted insulation mounting plates such as 10. In each of these are embedded or clamped a series of rows of horizontal contact springs in groups of six. The first one of these groups is shown at Fig. 2 marked with the numeral 11. Associated with these horizontal groups of contact springs are six vertical contact strips such as group 12 for group 11 and others in the same corresponding positions in the vertical direction. The switch illustrated may have a capacity of ten groups of six contact springs each in each horizontal row and having twenty such horizontal rows, so that, each vertical row of six contact strips such as 12 may be associated with twenty groups of contact springs in twenty different horizontal rows, thus making it possible to establish two hundred connections in a switch of this type. The vertical strips are embedded in the front insulation plates and are provided with forwardly extending portions such as 15, each having a contact 16 in a vertical direction secured on the right-hand side thereof. These extensions 15 are located between the horizontal insulation plates 5 and are as wide in a vertical direction as the distance between the plates with the contacts 16 of the same width. Each group of six contact springs besides being anchored or embedded in a plate 10 is also mounted on an individual operating card such as 20. One of these cards is shown in cross-section in Fig. 5 and is provided with a central longitudinal rib 21 and flat opposite sides 22 and 23 which are narrower than the rib 21. From these flat sides protrude on opposite sides and approximately the middle thereof, circular knobs, such as 26, one for each spring, and similar knobs, such as 27, located towards the front of the card. The rib 21 ends at the rear in a V-shaped portion as shown at 30 engaging a knife edge portion 31 on the associated rear plate 10, and this rib 21 extends forwardly beyond the sides 22 and 23 and past the vertical strips 12 into a portion 33 of substantially square cross-section. Springs 11 are so tensioned and arranged on these knobs 26 and 27 on a card that they will hold the portion 30 against the knife 31 to be rotated thereon and the front portion 33 pressed against the nearest right-hand vertical strip as shown, for example, in Fig. 2 where the portion 33 engages the strip 34 and so that the forward contacting ends of the contact springs will be positioned a certain definite distance away from their associated contact strips. The required air-gap between the springs and the strips is thereby provided without any undue or elaborate arrangements for adjusting these air-gaps. In fact, these air-gaps are determined practically automatically by having the forward portion 33 engage the strip 34 and thus locating all the springs in the proper distance from their associated contact springs. To establish the connections between the springs and the associated contact strips, the forward ends of the cards 20 need therefore merely be moved towards the left for a short distance. The cards and the springs mounted thereon occupy extremely small spaces. They are merely wide enough to provide the necessary strength and as the springs are located in pairs on opposite sides of the flat sides 22 and 23, the actual distance occupied vertically by each card is comparatively small. This determines the vertical distance between the horizontal front plates 5 and allows sufficient room for the rear plates 10 to be mounted one on top of the other as shown for example in Fig. 3. The vertical space occupied by the twenty horizontal rows of contacts is therefore small, compared with ordinary standard cross bar switches of this capacity. In fact, the vertical over-all dimension may be reduced to two-thirds or more than the corresponding dimension in prior switches. On the other hand the horizontal width of the card 20 is only that required for a central rib and the flat sides to provide strength and a sufficient distance between the pairs of contact springs to mount the associated contact strips and provide the necessary air-gaps, thus the horizontal width of the switch may also be reduced perhaps to one-third less than the standard switches. The groups of six pairs of springs at each cross-point will as is evident make six separate connections, each pair of springs making one electrical connection with the associated contact member 16.

The arrangement for operating these cards to establish connections at cross-points between contact springs and associated contact strips will now be described. The vertical select bars which are in the form of tapes such as 50 are each located centrally between two adjacent vertical rows of contact strips and are partially embedded

for slidable movement in slots across the front insulation plates as shown clearly in Fig. 6, for example. Each of these bars is connected to an armature such as 52 controlled by an associated magnet 53. There are ten of these magnets mounted on a common horizontally located comb-shaped member 54 at the top of the switch, every other comb-tooth of which is surrounded by the winding of a separate magnet. The intermediate comb-teeth serve as return pole-pieces for adjacent windings. The armatures 52 are loosely suspended between adjacent pole-pieces by means of brackets such as 55 and 56 secured to said pole pieces. Each bracket serves as a suspension means for the adjacent armatures and is for that purpose bifurcated or slit through the center. Each armature is provided with a downwardly extending insulation card such as 57 which controls a series of off-normal springs 58. It should be noted that each vertical select bar is provided with forwardly extending projections such as 60, one for each horizontal hold bar, the purpose of which will be described hereinafter.

In the present switch there is provided as stated twenty horizontal rows of contact strips and a hold bar is provided for each row such as for example 62 for the first row. These hold bars, which are in the form of flexible tapes, must of necessity be mounted close together to fit in between the rows of springs and are slidably mounted on the U-shaped bracket 1 and the T-shaped bracket 2 in slots in the associated members 6 and 8. It is further seen that there will not be room to mount the hold magnets for these bars one above the other as is the usual practice. They are therefore mounted in groups of five in staggered relation as shown for example in Fig. 1 on individual vertical mounting brackets such as bracket 63 for the first group of five magnets and three other brackets for the remaining three groups of five magnets each. These mounting brackets 63 are mounted by means of angle pieces such as 64 and 65 on the forward bottom member of the U-shaped frame member 1 which for that purpose is cut out to form openings as indicated for example in Fig. 8 at 66. The upper pieces 64 are mounted on one connecting portion 67 of the forward bottom member and the lower pieces 65 are mounted on a lower connecting portion 68 as shown in this Fig. 8. These brackets are mounted side by side and being four in number will accommodate the twenty hold magnets. It should be noted that they are mounted in a staggered relation on the connecting portions 67 and 68 to shift the magnets on the succeeding brackets a short distance downwardly looking at Fig. 1 so that the first magnet on the first bracket will control the first hold bar, the first magnet on the second bracket the second hold bar, the first magnet on the third bracket the third hold bar and the first magnet on the fourth bracket the fourth hold bar and so on so that the succeeding magnets on succeeding brackets will control succeeding hold bars of the group of twenty. Each hold bar is connected to an armature such as 69 for the first magnet 70 on the first bracket by means of an intermediate connecting link 71 which connects at 72 to the first bar 62. It should be noted, of course, that the brackets 63 are of the same design as the bracket 54 for the select magnets, that is, these brackets are provided with comb-members on every other one of which is mounted the winding of the associated select magnet. The intermediate comb-members serve as return pole-pieces for the adjacent magnets and the member on which windings are located serve as the cores. The armature 69 straddles the three adjacent members and is mounted loosely by means of brackets such as 75 and 76 connected to the adjacent pole-pieces on opposite sides of the armature. These brackets serve also the purpose of mounting adjacent armatures such as bracket 76 serving as a mounting means for the armature 69 for the first magnet 70 and for the armature 78 for the second magnet 79. In order that the connecting links between the armatures of the hold magnets and the hold bars shall not interfere with each other, they are of course of different corresponding lengths to reach from the hold bars to the armatures for the succeeding brackets and also bent or formed in a U-shaped formation towards the front to avoid the intermediate magnets. For example, the connecting link 80 for the first magnet 81 on the last bracket 82 will have to be bent or formed in a U-shaped formation to avoid the magnet and armatures of the intermediate hold magnets such as 83, 84 and 70, while, for example, the connecting link 86 for the armatures of the first magnet 83 on the second bracket is bent to another U-shaped formation to avoid magnets 84 and 70 and their associated parts. This formation of a connecting link is clearly illustrated in Fig. 7. On the rear portions such as, for example, 87 of the bracket 63 is mounted for each hold magnet an insulation block 89 in which is embedded a series of off-normal springs such as 90. These springs extend rearwardly towards the rear of the structure for terminal connections and forwardly to cooperate with stationary contacts 82 connected to the front spool head 93 of magnet 70 when the armature 69 is attracted and released under control of an insulation plate 94 attached to the armature 69. This arrangement is similar to the off-normal spring arrangement for the select bars.

A description will now be made of the function of the select bars and hold bars at each cross-point to cause a card 20 to be moved when the corresponding select bar and hold bar are actuated. The mechanism for this purpose is as follows. If special attention is given to Figs. 6 and 9 it will be noted that the card 20 at its forward end 33 is provided with a U-shaped metal clip 96, securely fastened thereto by having the upper side of clip 96 bent downwardly into a V-shaped depression 97 and the lower side of slip 36 bent upwardly into a cut-out 98 as shown at 99. This clip 96 is also provided with a lip 100 that extends forwardly towards the right looking at Fig. 9. Just below the end of the tip 33 is located the associated hold tape 62 and on the left-hand side of it is located the associated select tape 50. If the select tape 50 is lifted by its associated magnet, it will be observed that the projection 60 thereon will engage an enlarged portion 102 on the hold tape 62, and thereby due to the flexibility of the hold tape 62 causes this tape to bend upwardly and also with a slight twist in the upward direction. This upward bending of the hold tape 62 is limited to the particular intersecting area at which this select tape is actuated due to projections such as 103 on the opposite side of this intersecting area. The remainder of the hold tape 62 will be unaffected at any other intersecting area by this bending action. This bending and twisting of the hold tape now causes a further forward extension 104 to be raised to a position above the lip 100 on the clip 96, as shown in dotted lines in Fig. 9.

When the hold tape 62 is then moved toward the left by its associated hold magnet, this projection 104 will therefore engage the tip 33 in the cut-out portion 98 at point 106, and thereby cause the card 20 to be rotated on its pivotal point at 30. The movement of the card in this manner will shift the contact springs 11 toward the left looking at figures such as 2 and 6 and permit these contact springs to contact with the associated contact strips 12. This movement of the card 20 toward the left need not be particularly accurate as long as it is sufficient to make the springs contact with the strips as the springs are movable away from the hubs 27 so that they will, if the movement of the hold tape 62 is excessive nevertheless yielding contact with the strips. The select tape 50 may now be returned to normal while the hold tape with its projection 104 will be held above the lip 100 on the clip 96 at this particular intersecting point and the connection will be maintained by this hold tape in actuated position as long as desired. When the hold magnet releases, the tape 62 will return to normal and release the card 20 for return to normal, and the projection 104 slip off the lip 100 and assume its normal straight position.

From this description of the applicant's invention as embodied in a cross bar switch, it is readily seen that a good many of the detailed parts are interchangeable such as the magnetic structures in the supporting brackets and easily removed individually for repair if necessary. The required distances between the coordinated contact strips and contact springs are exceedingly small and thus the associated parts of the mechanism are adapted for these smaller dimensions so that the over-all size of the switch mechanism is considerably reduced. The size vertically and horizontally may therefore be reduced to approximately one-third less than standard switches of this general type. As all the detail parts of this mechanism are extremely small and light, flexible and narrow in construction, the weight of this switch may also be considerably reduced to approximately one-quarter of the weight of standard switches of this general type known in the art. Parts of this mechanism are also easily manufactured as it will be noted that the card 20, for example, may be molded in one piece with the clip 96 easily attached to the end 33. The insulation plates are simple, easily molded and standardized while the contact strips, select bars and hold bars may be punched out of very light flexible material in simple forms. The contact springs may also be easily assembled in horizontal holding strips such as 10 and clamped together by eyelets such as 110 shown in Figs. 3 and 6 in particular.

What is claimed is:

1. In a cross bar switch, coordinately arranged cross bars in which the hold bars are flexible and located horizontally while the select bars are located vertically, horizontally located insulation plates, vertical contact strips secured to the plates, horizontally located sets of contact springs at each cross-point of the coordinate bars, an operating card secured to each set of contact springs and controlled by said springs so as to normally engage one of the associated vertical strips under tension of said springs to regulate the normal air-gap between the springs and the corresponding contact strips and further so arranged that when the card is moved away from said vertical strip, said springs will yieldingly make contact with the respective vertical contact strips, a magnet for each select bar for shifting it longitudinally, a magnet for each hold bar for shifting it longitudinally, means on said select bars and hold bar for flexing all hold bars by any select bar when shifted at the cross-points where the shifted select bar crosses the hold bars, means on any hold bar operative after it has been flexed and when it is shifted for engaging the card at the point where this hold bar crosses the shifted select bar and for moving it to shift the associated springs into engagement with the associated vertical strips.

2. In a cross bar switch, coordinately arranged cross bars in which the select bars run in a vertical direction and the hold bars in a horizontal direction and in which the hold bars are in the form of flexible tapes, vertically running contact strips arranged in sets, one for each vertical row of cross-points of said bars, horizontally running contact springs arranged in sets, one set for each cross-point, each set extending in the horizontal plane at right-angles to the associated set of vertical strips, a stationary support for one end of said springs while the opposite ends of said springs are free to move in contact with corresponding vertical strips at corresponding cross-points, a card for each set of springs so controlled and arranged as to be held by said springs in a position where the card rests at one end against said stationary support as a pivotal point, while the other end of the card is held against an associated vertical contact strip so that when the card is moved away from said contact strip, the free ends of said springs will yieldingly contact with the associated strips and means associated with said select bars and hold bars and said cards whereby when a select bar is moved it lifts the hold bars in a position so that when any one of said hold bars is subsequently moved it will engage the card at the cross-point of said moved select bar and hold bar and move it to cause the springs thereon to connect with the associated strips.

3. In a cross bar switch, a frame, a group of horizontally mounted insulation plates in said frame, vertically mounted contact strips on said plates, another group of horizontally mounted insulation plates in said frame, a horizontal row of sets of springs mounted in each of said last-mentioned plates, each row extending between two of said first-mentioned plates with each set adjacent a particular corresponding set of contact strips, an operating card mounted on each set of springs, each card having a projection tensioned by the springs to engage one of the associated contact strips to fix the air-gap between the associated springs and the corresponding contact strips, said card being so mounted on said springs that when the card is moved away from said contact strip each spring thereon will make flexible contact with a corresponding associated contact strip, a horizontally mounted magnetic core on said frame, select magnet coils and associated armatures mounted on said core, a vertically located select tape attached to each armature and associated with a corresponding vertical row of cards, a series of vertically mounted cores on said frame, a group of hold magnet coils and associated armatures mounted on each core in said series, a horizontally located flexible hold tape attached to each of said last-mentioned armatures, one of said hold tapes associated with each horizontal row of cards, means integral with said select tapes and hold tapes and cooperating at each cross-point with an associated card to

move it to cause its attached springs to engage the associated strips in response to the shifting of the corresponding select tape and hold tape by the attached armatures when attracted by the associated coils and cores.

4. In a cross bar switch, a group of horizontally located insulation plates one on top of the other and spaced apart a distance approximately equal to their thicknesses, two vertical frame members, means for mounting said plates between said frame members towards the front of the switch, contact strips vertically mounted across said plates partially embedded therein and having forwardly extending contacting projections between each two adjacent plates, another group of horizontally located insulation plates one on top of the other, means for mounting said last-mentioned plates at the rear of the switch between said vertical frame members with each of said rear plates occupying a position vertically corresponding to the space between two adjacent front plates, rows of springs embedded in said rear plates and extending with their free ends through the openings between adjacent front plates in sets, each set comprising an upper and a lower layer of springs and extending past vertical contact strips in pairs, each pair comprising a spring from the associated upper and lower layers of a set and each pair arranged for movement into contact with the corresponding extension on a vertical strip, an operating card between the two layers of each set of springs, having a knife edge at one end resting in a depression in the associated rear plate and having its opposite end resting against one of the associated vertical strips and having means engaging the associated springs to tension said springs so as to press said card against said vertical strip and when said card is moved with its knife edge remaining as a pivot away from said vertical strip, said set of springs may yieldingly make contact with the associated respective vertical strips, a horizontally located magnetic core secured between said frame members above the upper insulation plates, a plurality of select magnets and associated armatures mounted on said core, a vertically located select tape attached to each armature, one select magnet, armature and select tape being provided for each vertical row of cards, a plurality of vertical magnetic core brackets arranged in parallel relation and attached to one of said frame members, a plurality of hold magnets on each bracket, an armature for each magnet, a horizontally located flexible hold tape attached to each armature for movement thereby in a longitudinal direction, one hold magnet, armature and hold tape being provided for each horizontal row of cards, each select tape and each hold tape being provided at each cross-point with a projection each select tape adapted to lift the hold tapes at the cross-points of said tapes when the associated select magnet is actuated and the projection on a hold tape at the cross-point of said hold tape and an actuated select tape operative when this hold tape is actuated by its hold magnet to engage the associated card and move this card to cause its associated set of springs to connect with the associated vertical contact strips at said cross-point.

5. In a cross bar switch, coordinately arranged cross bars in which the hold bars are flexible and located horizontally while the select bars are located vertically, horizontally located insulation plates, vertical contact strips embedded in said plates, horizontally located sets of contact wires at each cross-point of the coordinate bars, an operating card of insulation material secured to each set of contact wires and controlled by said wires so as to normally engage one of the associated vertical strips under tension of said wires to regulate the normal air-gap between the wires and the corresponding contact strips and further so arranged that when the card is moved away from said vertical strip, said wires will yieldingly make contact with the respective vertical contact strips, a magnet for each select bar for moving it longitudinally, a magnet for each hold bar for moving it longitudinally, a projection on each said select bar and a projection on each said hold bar at each cross-point of said bars, said projections on a select bar when moved being in position to engage the corresponding projections on all the hold bars where these bars cross and flex said hold bars at said cross-points, an additional projection on each hold bar at each point where it crosses the select bars, said last-mentioned projections on a hold bar operative after said hold bar has been flexed by a select bar at the corresponding cross-point to engage said associated card when said hold bar is moved for moving said card to shift the associated wires in engagement with their associated strips and means on said card for maintaining the shifted hold bar in flexed position after the corresponding select bar is returned to normal to maintain the established connection until said hold bar is released.

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