Aug. 29, 1944. R. V. L. HARTLEY 2,357,108

SWITCHING MECHANISM

Filed July 4, 1942

FIG. 1.

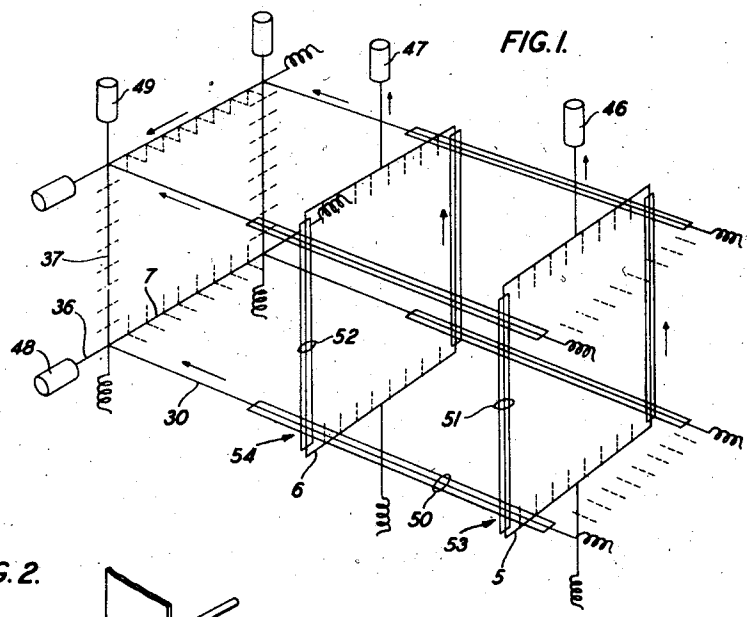


FIG. 2.

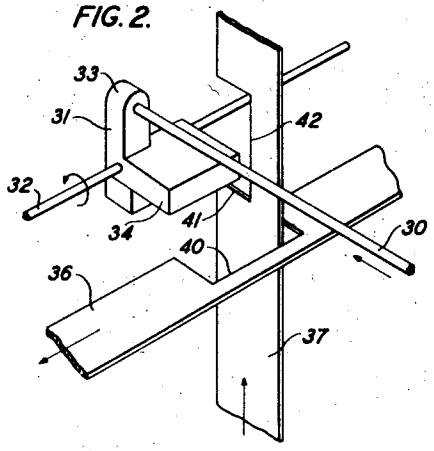


FIG. 3.

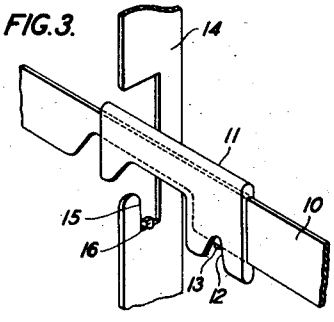


FIG. 4.

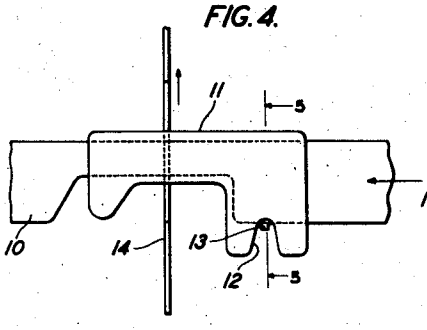


FIG. 5.

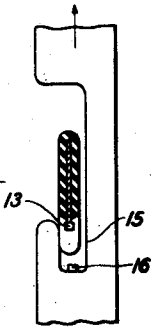


FIG. 6.

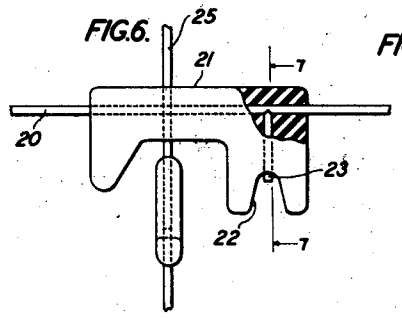
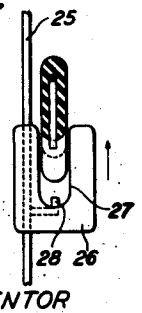


FIG. 7.



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SWITCHING MECHANISM

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Application July 4, 1942, Serial No. 449,741

6 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 for the establishing of connections.

An object is to simplify the construction details and increase the utility of such switching mechanisms.

Heretofore so-called three-dimensional crossbar switching arrangements have been provided, that is, arrangements of a group of crossbar switches in which connections are established by three stages of operation to select first 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 causes connections to be established between contacts at the crosspoint of said bars. Such 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 of March 10, 1925 to C. L. Goodrum et al. Individual single crossbar switching units are also known in which the selections are accomplished by arranging bare wires coordinately with one group of coordinate wires provided with cup-shaped contact devices and the other group of wires provided with cooperating resilient springs secured to the wires at each crosspoint and whereby connections are established by movement of the wires in the two coordinate groups to have cooperating resilient springs in one group hooked into cup-shaped contacts of the other group.

The applicant's invention relates to improvements in single individual crossbar units using bare tapes or wires arranged coordinately and in three-dimensional switching arrangements employing modified individual crossbar units of this kind. One feature of the applicant's invention is the construction of individual switching units if used individually and not in combinations for three-dimensional operation, consisting of bare tapes or wires arranged coordinately with insulation members attached to the wires at the crosspoints so shaped that on the longitudinal movement of a wire in one coordinate direction followed by the longitudinal movement of a wire in the other coordinate direction, said members hook into each other at the corresponding crosspoint and bring said wires together to establish an electrical connection between them.

Another feature of the applicant's invention is a three-dimensional switching arrangement including modified forms of the individual bare wire switching units. To this end a plurality of these types of units may be arranged so that groups of wires will run in one direction across the face of the individual units in one plane, and the units are located one behind the other. Common cooperating groups of wires are then arranged so that each of said groups extends in a direction perpendicular to all of said units with each group crossing a corresponding group of wires in the different units. These perpendicularly running common groups of wires are then arranged to be moved longitudinally by rods which are actuated by a common crossbar switch in which two coordinate bars when moved will actuate a corresponding rod at the crosspoint of said bars in a longitudinal direction perpendicular to the face of the individual units. The movement of one of these perpendicular bars and associated group of wires and the movement of the groups of wires in one of the units running across the face of said unit will therefore establish a connection between corresponding wires in said two groups of wires. Thus if 10 x 10 individual crossbar units are considered, with ten such first units arranged side by side, selections may be made to connect the wires in any one of these ten units at 100 different crosspoints to any one of one hundred groups of common wires and these connections may be maintained simultaneously.

This invention has been illustrated in the accompanying drawing in which:

Fig. 1 shows in diagrammatic form a three-dimensional switching arrangement in accordance with the applicant's invention;

Fig. 2 shows the details of the mechanism at any crosspoint of the common crossbar switch;

Fig. 3 shows in perspective the arrangement at the crossbar point of two coordinate tapes of an individual crossbar unit;

Fig. 4 is a front view of the tapes shown in Fig. 3 and Fig. 5 is a side view of Fig. 4;

Fig. 6 shows a crosspoint at an individual unit in which wires are employed instead of tapes and Fig. 7 is a side view of Fig. 6.

If reference is now made to these figures, the arrangement in general may be such that a group of individual crossbar switching units which have been indicated at **5** and **6** in diagrammatic form are arranged side by side, these units may be arranged to cooperate with a common switching unit shown at **7**. The details of these units and their operation will be described hereinafter in detail. However, if a single unit such as **5** is merely employed as an individual crossbar switch, the coordinate wires or tapes may be arranged to cross each other in the same plane. If tapes are employed the arrangement may be as shown in Figs. 3, 4 and 5 at each crosspoint. For example the horizontal tape **10** may be provided with an insulation member **11** shaped as shown with

a depression 12 to bare the tape at the bottom of this depression. To the tape at this point may be attached a contact 13 preferably of precious metal to establish proper electrical connection or the tape itself may be employed without the contact 13, if so desired. The other coordinate tape 14 is provided with a hooked-shaped depression 15 at the bottom of which may be placed a precious metal contact 16 for the establishing of connections with the contact 13.

The operation of this switching arrangement is as follows: If the horizontal tape 10 is moved towards the left looking at Fig. 4, it will be moved so that the contact 13 in the opening 12 will be placed in line with the tape 14. Then the tape 14 may be moved upwardly until the contact 16 comes in contact with a contact 13. Now as the tape 14 is flexible, tape 10 may be returned to normal position, but the connection between contacts 15 and 13 will be maintained as long as tape 14 is in operated position as tape 14 cannot be released from the member 11 on tape 10 until tape 14 is released to normal condition. The purpose of releasing tape 10 is so that any other vertical tape like 14, when operated, will not make connection with this tape while it is engaged by tape 14.

If instead of tapes 10 and 14 individual bare wires are employed, the arrangement will be as shown in Figs. 6 and 7, that is the horizontal wire 20 is provided with an insulation member 21 having a depression 22 in the bottom of which an extension contact 23 is located and connected with the wire 20. The vertical wire 25 is provided with a similar insulation member 26 which also has a depression 27 at the bottom of which an extension contact 28 is located and connected to the wire 25. In this case the operation is the same as described in connection with Figs. 3 to 5, that is, the horizontal wire 20 may be moved toward the left until the contact 23 is opposite or in line with wire 25 and wire 25 is moved upwardly until the contact 28 connects with contact 23 after which wire 20 may be returned to normal condition as the wire 25 is flexible, the same as tape 14.

In employing individual switching units of this general type as described in connection with Figs. 3 to 7, in a three-dimensional switching arrangement as disclosed in Fig. 1, the arrangement of the wires is somewhat different. The vertical tapes or wires in the individual units 5 to 6 and others are the same, that is, they will run vertically from top to bottom across the face of the individual units. On the other hand the horizontal tapes or wires do not run horizontally across the face of the individual units, but there is one wire at each cross point where a horizontal wire would cross a vertical wire which runs perpendicular to the face of the unit and these horizontal perpendicular wires then run through all of the switching units so that each horizontal wire is common to all of the units, at the same crosspoints. Of course, such wires as cross each other may be gathered in groups of three for example at each crosspoint if more than one individual connection is desired. Ordinarily three of such connections are desired for the tip, ring and sleeve connections and to this end in Fig. 1, these horizontal and vertical wires have been shown in groups of three. Thus if the individual units such as 5 and 6 are placed side by side, and in each switch there are ten vertical groups of wires there will be running through these switches one hundred horizontal groups of wires. These hundred groups of wires will then terminate in the rear in individual rods that terminate in switch 7 perpendicularly to the face of this switch. The construction of this individual switch 7 at a crosspoint where such a rod terminates is shown in Fig. 2. In this figure one of these rods is marked with the numeral 30. As shown rod 30 terminates in a crank lever 31 secured for rotation to a shaft 32. This lever 31 extends upwardly in a lever arm 33 to which rod 30 is connected and horizontally in a lever arm 34. In front of each horizontal shaft 32 there is a horizontal tape 36 and at each crosspoint associated with this tape and the perpendicular rods 30 is a vertical tape 37. Thus each one of the rods extending from the individual units terminates perpendicularly in the common switch 7. The tapes in this switch 7 will be operated by corresponding magnets and if a connection is desired at the crosspoint shown, the tape 36 will be moved towards the left and thus will, through its slot 40 engage the side of tape 37 and bend this tape 37 towards the left so that the lower edge 41 of a slot 42 in this latter tape will be placed under the lever arm 34. Now if the vertical tape 37 is moved upwardly, the edge 41 will engage the lever arm 34 of the lever 31 and thus cause this lever to rotate on the shaft 32 and move the lever arm 33 so as to shift the connected rod 30 in a longitudinal direction as shown by the arrow. As the rod 30 is connected to a group of horizontal wires in the individual units these wires will be correspondingly moved in a longitudinal direction across all of the units.

If reference is now made particularly to Fig. 1, the operation of the three-dimensional switching arrangement as shown in this figure will be described. It should be observed that in each individual unit 5 and 6 all the vertical wires in each switch are connected together and are movable upwardly by an individual magnet 46 for switch 5 and an individual magnet 47 for switch 6 so that when a magnet such as 46 operates all of the vertical groups of wires will be moved upwardly. With this in mind if the common switch 7 is operated by first selecting a horizontal tape such as 36 by the operation of a corresponding magnet 48, for example, this tape will be moved toward the left. If then a vertical tape such as 37 is moved upwardly by the operation of a corresponding magnet 49 the rod 30 will be moved towards the left in the direction of the arrow and thus move a corresponding group of three wires 50 in a corresponding direction across the faces of the switches 5 and 6. Thus the crosspoint corresponding to this group of wires 50 in the switches 5 and 6 for the first vertical groups of wires 51 in switch 5 and 52 in switch 6 are prepared for operation for connection to either of these groups of wires in switches 5 or 6. Depending now on whether magnet 46 or 47 is operated, the corresponding vertical groups of wires will be raised. For example if magnet 46 is operated, the wires 51 and all the other associated groups will be raised and thus a connection will be established at the crosspoint 53 between the group of wires 50 and the group of wires 51 in switch 5. Had magnet 47 been operated, a similar connection would have been established between the group of wires 50 and 52 at the crosspoint 54. The magnets 48 and 49 may now be released to release rod 30 and the associated group of wires 50 but the connection at the point 53 will be main-

tained between the wires 50 and 51 as long as the magnet 46 is maintained operated. Similarly other connections may be established at other points in the switches 5 or 6 by the operation of other horizontal and vertical tapes in the common switch 7. If it is considered that in addition to these individual units 5 and 6 for example, eight other units are provided to make a group of ten, it is readily seen that a total of ten connections may be established through these units, that is one connection in each of the individual units between the vertical groups of wires in these units and any ten groups of horizontal wires in the total of one hundred groups strung across those units.

What is claimed is:

1. In a switching device, a plurality of crossbar switching units arranged with a plurality of longitudinal movable groups of bare wires running across the face of each unit, means in each unit for longitudinally moving all of the groups of wires therein simultaneously a plurality of longitudinally movable groups of bare wires with each group running perpendicular to the faces of said unit and each group crossing a corresponding group of wires of said first-mentioned groups in each of said units, means at each crosspoint of two groups of wires for establishing electrical connections between the individual wires in one group and corresponding individual wires of the other group on the movement of said two groups of wires in their assigned directions, another crossbar switch comprising horizontal and vertical bars longitudinally movable, means at each point where a horizontal bar crosses a vertical bar operative on the movement of said bars to move a particular group of said second-mentioned wires longitudinally so that on such movement of a group of said second-mentioned wires followed by the longitudinal movement of said first-mentioned wires in one of said units corresponding electrical connections are established between said moved groups of the second-mentioned wires and one of the moved groups of said first-mentioned wires in the corresponding unit.

2. In a switching device, a crossbar switch comprising a plurality of groups of longitudinally movable bare wires running parallel to each other in one plane, and a plurality of groups of longitudinally movable bare wires running in parallel planes perpendicular to said first-mentioned planes with an equal number of groups in each of said planes and with each of the groups in a plane crossing a perpendicular group of wires in said first-mentioned plurality of groups, means at each crosspoint of two groups of wires for establishing electrical connections between individual wires of one group and corresponding individual wires of the other group on the longitudinal movement of said groups of wires, a magnet for moving the first-mentioned plurality of groups of wires simultaneously, a crossbar switch operative to select and move longitudinally any one of the groups of wires in the second-mentioned plurality of groups to establish an electrical connection on the operation of said switch between the group of wires selected and moved thereby and a corresponding group of wires on the subsequent operation of said magnet.

3. In a crossbar switch, groups of longitudinally movable bare wires, arranged coordinately with an equal number of groups in each coordinate direction, hook shaped insulation members on said wires with the wires exposed inside the hooks, said hooks being so arranged that the longitudinal movement of a group of wires in one coordinate direction followed by the longitudinal movement of a group of wires in the other coordinate direction, causes hooks of one of said groups to be moved to engage hooks on the other of said groups in pairs so that electrical connections are established between the exposed wire portions of each pair of engaged hooks.

4. In a crossbar switch, a series of vertical conductors, a series of horizontal conductors arranged coordinately, means for moving said conductors longitudinally, and means located at each point where a vertical conductor crosses a horizontal conductor comprising an insulation member enclosing each conductor and having a hooked shaped portion with a part of the enclosed conductor exposed in the bottom of the hook, said hooks being so located that on the longitudinal movement of a horizontal conductor followed by the longitudinal movement of a vertical conductor the two hooks at the crosspoint of said conductors engage each other so that the exposed portions of the two conductors inside of said hooks make electrical connection with each other and said hooks being so shaped that one of the engaged conductors may be restored to normal position without disturbing the said established electrical connection.

5. In a crossbar switch, a series of vertical metal bands, a series of horizontal metal bands arranged coordinately, means for moving said bands longitudinally and insulation strips covering the horizontal bands at the points where they cross the vertical bands, said strips having V-shaped cuts therein so shaped as to expose a part of the band at the bottom of said cuts, each of said vertical bands having hook shaped cuts in its side, one at each point where it crosses a horizontal band, said cuts being so arranged that on the longitudinal movement of a horizontal band, the cut in the strips thereon are placed opposite the cuts in the vertical bands and that on a subsequent longitudinal movement of a vertical band, it will engage the moved horizontal band with the associated cuts registering to establish an electrical connection means between the exposed part of said cuts and said registering being such that the horizontal bar may be returned to normal without disturbing the established connection.

6. In a crossbar switch, a first group of longitudinally movable bare wires arranged in one plane, a second group of longitudinally movable wires running perpendicular to the plane in which said first-mentioned wires are located, with each wire in said second group crossing a separate wire in said first group, means for selecting and moving longitudinally any wire in said second group, and means responsive to the longitudinal movement of one wire in each group for establishing an electrical connection between them at the point where these wires cross each other.

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