

July 25, 1950

C. N. HICKMAN
CROSS WIRE SWITCH

2,516,772

Filed April 10, 1948

2 Sheets-Sheet 1

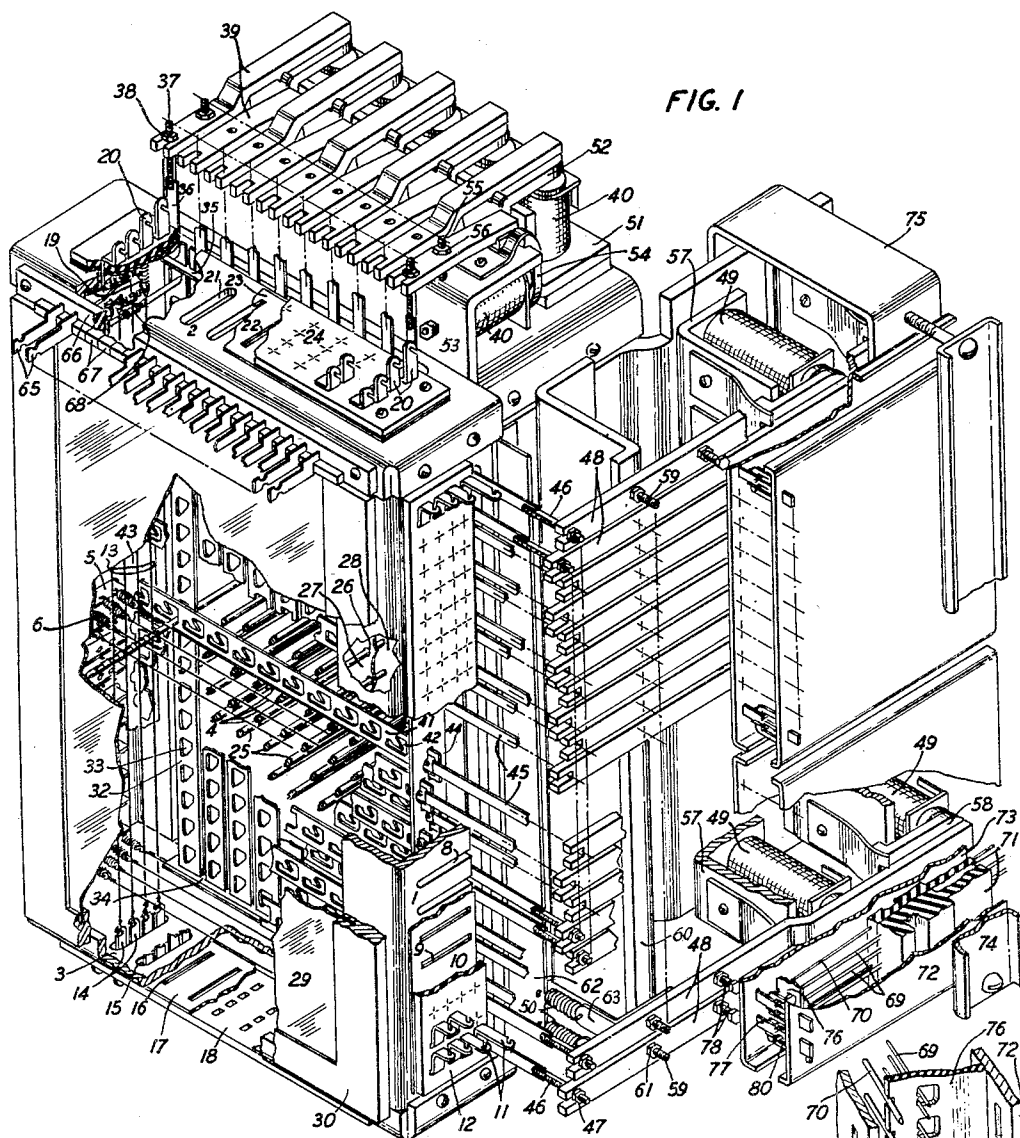


FIG. 1

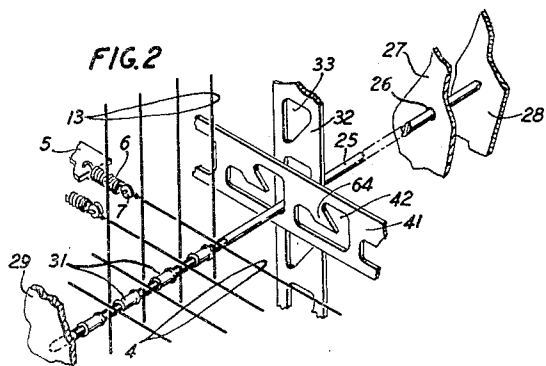


FIG. 2

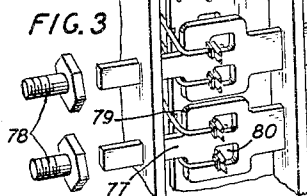


FIG. 3

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2 Sheets-Sheet 2

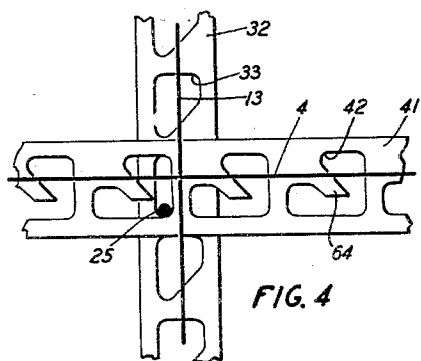


FIG. 4

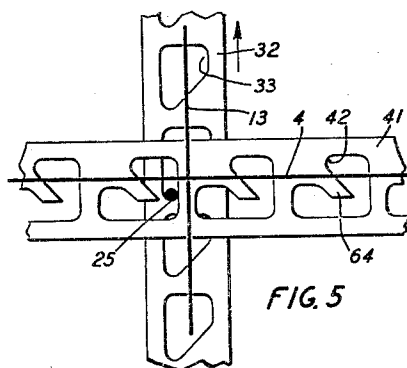


FIG. 5

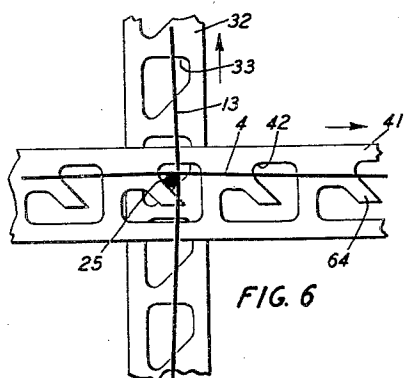


FIG. 6

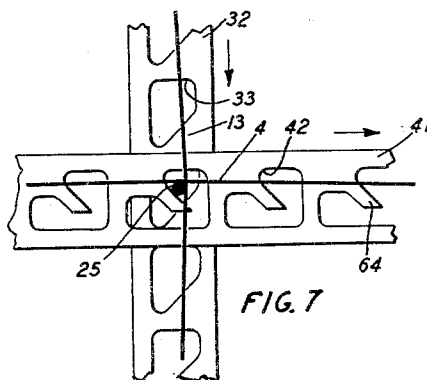


FIG. 7

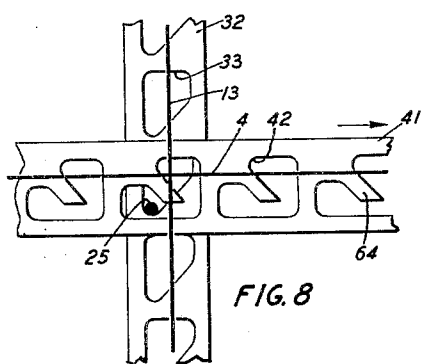


FIG. 8

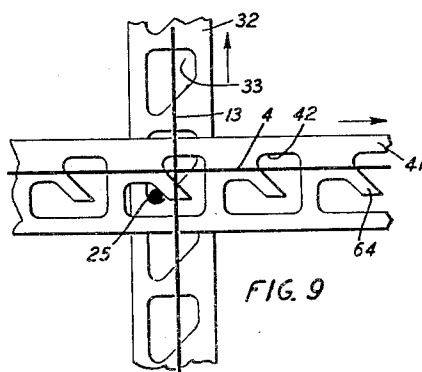


FIG. 9

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CROSS-WIRE SWITCH

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9 Claims. (Cl. 179—27.54)

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This invention relates to automatic telephone switches, and more particularly to switches of the cross bar type.

The primary object of this invention is the provision of a switch reliable in operation, economical of manufacture and compact in size.

This object has been attained through the employment of coordinately arranged conductors with a novel means for selectively establishing electrical connections therebetween.

In the preferred embodiment of the invention, a plurality of sets of line conductors are arranged in a series of parallel planes and a plurality of sets of trunk conductors are arranged in a second series of planes perpendicular to the line conductors. Each set of line conductors therefore intersects each set of trunk conductors with each line conductor being in close proximity but out of contact with a trunk conductor at the point of intersection. At each point of juncture between the sets of line and trunk conductors, there is provided a rod which carries insulated contacting media for establishing connections between the line and the trunk conductors. Means are provided to selectively operate any of the rods to bring the contacting media into position to bridge the gaps between the individual line and the trunk conductors at the selected cross-point. These means may comprise ladder-type coordinately positioned select and hold tapes which are suitably apertured to accept the individual contact rods. The configuration of the apertures in the tapes is such that upon the conjoint operation of a select and a hold tape, the selected contact rod is moved to establish the aforementioned electrical connections.

In order to meet certain circuit requirements, means have also been provided to operate auxiliary contacts upon the operation of each select or hold tape, such means comprising additional contacting media on certain of the contact rods to indicate that a certain select tape has been actuated, and wire spring pile-ups associated with the hold magnet armatures to indicate that a certain hold tape has been actuated.

The features of the invention will hereinafter be discussed in detail with reference to the accompanying drawings in which:

Fig. 1 is an isometric view of a switch constructed in accordance with the invention with certain portions broken away and with certain duplicate parts omitted for purposes of clarity;

Fig. 2 is an enlarged view of a portion of Fig. 1 showing the interrelationship of the elements at a typical cross-point;

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Fig. 3 is an enlarged view of a portion of Fig. 1 more clearly showing the auxiliary contacts associated with the hold magnet; and

Figs. 4 to 9, inclusive, demonstrate the relationship of the several elements at a cross-point with the select and hold tapes in the several possible combinations of operation and release.

Referring now particularly to Fig. 1, the switch comprises a rectangular frame having side members 1, a top member 2, and a base member 3. A plurality of line conductors 4 are arranged in sets of four in a series of horizontal planes. Each line conductor 4 is affixed to a bracket 5, mounted on one side member 1, through a tension spring 6. The bracket 5 may be of insulating material and the line conductors may be further insulated through the use of insulating discs 7 (Fig. 2) between the conductors and the tension springs 6. At the other end, each line conductor 4 is affixed to a terminal 11 which passes through a slot 8 in side member 1, through a slot 9 in insulating sheet 10 and is riveted to terminal strip 12, also of insulating material.

A plurality of trunk conductors 13 are arranged in sets of four in a series of vertical planes. Each trunk conductor 13 is affixed at its lower end to a terminal 14 which passes through a slot 15 in base member 3, through a slot 16 in insulating sheet 17 and is riveted to terminal strip 18 of insulating material. At the upper end, each trunk conductor 13 is connected through a tensioning spring 19 to a terminal 20 which passes through a slot 21 in top member 2, through a slot 22 in insulating sheet 23 and is riveted to terminal strip 24. It is evident that no insulating discs 7 will be used in connection with the trunk conductors 13. Each of the sets of terminals 11, 14 and 20 are preferably aligned so that they may be easily multiplied if such is required. As may be seen in Figs. 1 and 2, the sets of line conductors intersect the sets of trunk conductors with the individual line conductors in each set arranged in proximity to but out of contact with the individual trunk conductors with which they are

matable.

At each of the junctures or cross-points of the sets of line conductors 4 and trunk conductors 13 is located a contact rod 25. These may be of metal with an insulating material sprayed or painted upon them or they may be entirely of insulating material. The contact rods 25 are loosely supported in apertures 26 (Figs. 1 and 2) in support plate 27, and are restrained from longitudinal movement by the rear end bearing against back plate 28 and the front end bearing

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ing against front cover 29, the latter being preferably made of a transparent material mounted in a frame 30 so that the functioning of the apparatus may be observed. Contacting media 31 (Fig. 2) are properly located on each contact rod 25 so that when the contact rod is moved to its operated position, each of the contacting media will bridge the gap between an associated line conductor 4 and trunk conductor 13. These contacting media are preferably of precious metal and may be sprayed on the insulated contact rods, or may be separate tubular elements pressed on the insulated contact rods.

The contact rods 25 are loosely mounted in support plate 27 both so that the rod may be freely pivoted about this point within the requisite limits, and also to permit a rotary motion of the rod as the contacting media are rolled into contact with the trunk conductors as will be hereinafter described. Such rolling movement not only insures good electrical contact but also provides a continuously changing contacting surface which distributes the wear for a longer service life.

The contact rods 25 are selectively actuated by means of a plurality of coordinately positioned ladder-type tapes. A series of select tapes 32 are mounted in parallelism one with the other and extend vertically in the depicted embodiment. A select tape 32 is provided for each set of trunk conductors 13 and each such tape comprises a thin strip of metal or other suitable material having an aperture 33 therein for each set of line conductors 4. Each select tape 32 is slidably supported in a suitably apertured bottom select guide 34 and top select guide 35. At its uppermost end, each of the select tapes 32 is attached by means of a ribbon 36, a threaded connector 37 and a nut 38 to the armature extension 39 of its respective select magnet 40. The select tapes 32 may either be connected to springs at their lower extremes or may be gravity biased to return to their normal unoperated positions.

A series of hold tapes 41 are mounted in parallelism one with the other and extended horizontally in the depicted embodiment. A hold tape 41 is provided for each set of line conductors 4 and each such tape comprises a thin strip having an aperture 42 therein for each set of trunk conductors 13. Each hold tape 41 is slidably supported in a suitably apertured left hold guide 43 and right hold guide 44. At its right-hand end, each hold tape 41 is attached by means of a ribbon 45, a threaded connector 46 and a nut 47 to armature extension 48 of its respective hold magnet 49. Through each set of registering apertures 33 in select tapes 32 and 42 in hold tapes 41 passes one of the contact rods 25. Since the select tapes are spring- or gravity-biased to normally remain at the lower extreme of their movement, and since the hold tapes 41 are biased by means of springs 50 to normally remain at the left-hand extreme of their movement, the contact rods 25 normally rest out of contact with the associated line and trunk conductors as is depicted in Figs. 1 and 2.

The select and hold tapes are operated by means of select magnets 40 and hold magnets 49, respectively, which have been positioned for optimum efficiency and compactness. In the preferred embodiment, select magnets 40 may be arranged in two rows with the cores of the magnets in the rearmost row extending vertically and the cores in the other row extending

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horizontally. The magnetic circuit of each of the select magnets 40 in the rearmost row is from the core through L-shaped pole-piece 51, pivoted armature 52 and back to the core. The magnetic circuit of each of the select magnets 40 in the front row is from the core through L-shaped pole-piece 53, pivoted armature 54 and back to the core. In both cases, armature extensions 39 are firmly affixed to their respective armatures 52 and 54 and move therewith. The armature extensions 39 extend toward the front of the relay and their frontmost ends, which lie approximately in plane, are bifurcated to accept select-tape threaded connectors 37. The positioning of the select tapes 32 is accomplished through the adjustment of nuts 38. The length of select-tape travel is adjusted by means of studs 55 which bear against pole-piece 53 and also act as armature back stops. Lock nuts 56 may be provided. It may be seen that upon energization of one of the select magnets 40, the forward end of the armature extension 39 will be raised upwardly thus moving the associated select tape 32 through a short vertical distance.

Hold magnets 49 are also arranged in two rows and are staggered to permit armature extensions 48 to lie in plane. The magnetic circuit of each hold magnet is from the core through L-shaped pole-piece 57, pivoted armature 58 and return to the core. Armature extensions 48 are firmly affixed to their respective armatures 58 and are bifurcated at their frontmost ends to accept hold-tape threaded connectors 46. The positioning of the hold tapes 41 is accomplished through the adjustment of nuts 47. Hold tape length-of-travel is adjusted by means of studs 59 which bear against plate 60 and which may be locked in position by nuts 61. Under energization of one of the hold magnets 49, the frontmost end of the armature extension 48 will be moved to the right thus moving the associated hold tape 41 through a short horizontal distance to the right. Springs 50 tensioned between bracket 62 and bracket 63 on armature extension 48 serve to return the hold tapes 41 to their unoperated positions upon de-energization of hold magnets 49.

The function of the contact rods 25 and the contacting media 31 thereon during operation of the select tape 32 and hold tape 41 will now be described in reference to Figs. 4 to 9, inclusive. In these figures, no attempt has been made to depict the contacting media. It is to be understood that the particular configuration of the apertures in the select and hold tapes is exemplary and may be modified within the scope of the invention.

Fig. 4 depicts the interrelationship of the elements at a typical cross-point at a time at which both select tape 32 and hold tape 41 are unoperated. Upon operation of the select magnet associated with the depicted select tape, each of the contact rods 25 associated with that particular select tape will be pivoted upwardly to assume a position as shown in Fig. 5. The contact rod has thereby been raised sufficiently so that it may be engaged by the hold lug 64 upon the subsequent movement of hold tape 41.

Referring now to Fig. 6, with the select tape operated, energization of a hold magnet and the resulting operation of the hold tape 41 will cause contact rod 25 at the selected cross-point to be engaged by hold lug 64 and moved to the right. Since the lower edge of aperture 33 in select tape

32 is cut at an approximately 45-degree angle, contact rod 25 will be moved to the right and upwardly at this angle to intersect the sets of line and trunk conductors 4 and 13, respectively, and to bridge the gap therebetween. During such contacts the contact rod 25 will be rolled slightly so that good electrical contact is assured and also so that the wear on the contacting media 31 will be distributed over their surfaces. As is apparent in Fig. 6, the contact rod is moved sufficiently so that both the line and trunk conductors are deflected against the tension of their respective springs 6 and 19.

In order to release the switch for further functioning in so far as possible, it is desirable to be able to release the select tape and still maintain the previously selected contact closure. Such is possible in the present invention as is exemplified in Fig. 7. Upon the deenergization of the select magnet and the consequent release of the select tape, the contact rod 25 is retained in a stationary position and in intimate contact with the line and trunk conductors by the downward force of the tensioned line conductor 4, by the force to the left exerted by the tensioned trunk conductor 13 and by the force at 45 degrees upward and to the right exerted by the hold lug 64.

Fig. 8 demonstrates that the contact rods 25 at non-selected cross-points are not affected by operation of a hold tape. With the select tape 32 unoperated, actuation of hold tape 41 will not affect the contact rod 25 since hold lug 64 will pass above the contact rod. If, then, while hold tape 41 remains operated to hold a selected cross-point, a subsequent switching operation causes a select tape to be operated, as in Fig. 9, the contact rod 25 will be prevented from moving upwardly by its contact against the lower surface of hold lug 64. This is desirable since the fact that the hold tape is operated indicates that line conductors 4 are already in circuit with a selected set of trunk conductors 13, and an additional trunk should not be connected into this circuit nor should a contact rod be permitted to strike the line conductor for such impact might disturb the quality of conduction in the selected circuit.

Referring now to Fig. 1, provision is made for actuating a series of auxiliary contacts upon the operation of any of the select magnets 40 or hold magnets 49. Such supplementary contacts are useful in operating auxiliary circuits to indicate which sets of line conductors 4 or sets of trunk conductors 13 are being used, as an indication of the extent of traffic over a switch or series of switches, or for any other such circuit function. It is contemplated that these auxiliary contacts may also be employed to place a resistance in series with the hold magnets upon the operation thereof in order to provide rapid initial operation and still reduce the power consumption during the holding period.

The auxiliary contacts which are associated with each select magnet 40 comprise a pair of spaced terminals 65 mounted in a slotted insulating block 66 at the top of the switch and locked in place by insulating block nibs 67. The upper contact rod 25 in each vertical row thereof is provided with additional contacting media 68 which are matable with the associated pair of spaced terminals 65 upon the upward movement of the contact rod. It is apparent, therefore, that the operation of any select magnet 40 will cause auxiliary circuits to be closed through the associated pair of terminals 65.

The auxiliary contacts which are associated with each hold magnet 49 may comprise a series of mating contact springs 69 and 70 molded in insulating blocks 71. These insulating blocks 71 may be mounted between upper and lower guide plates 72 and 73 which, in turn, may be supported by brackets 74 and 75. It has been found to be preferable to provide twin contact springs 69 in the outer layer matable with single contact springs 70 in the inner layer. Referring now to Fig. 1 and to the enlarged view of Fig. 3, certain of the contact springs 69 and 70 are restrained and certain others are positioned and guided by stationary cards 76, of insulating material, which are fixedly supported between guide plates 72 and 73. Others of the contact springs are actuated and guided by movable cards 77, of insulating material, which are slidably supported between the guide plates 72 and 73 and which engage apertures therein. As may be seen in Fig. 1, upon the actuation of a hold magnet 49 and the consequent movement of the armature extension 48 to the right, adjustable bolt 78 will operate its respective movable card 77. Referring again to Fig. 3, it will be noted that the inner single contact springs 70 are preformed so as to be pretensioned outwardly to engage notches along the inner edge of the stationary cards 76 and to pass around the inner edges of extended portions 79 of movable cards 77. The outer twin contact springs 69 pass through apertures in stationary cards 76 to engage apertures 80 in movable cards 77, and are pretensioned inwardly. Whether the inner single contact springs 70 are fixed and rest against the stationary card 76 or whether they are movable and rest against the inner edge of movable card 77, and whether the outer twin contact springs 69 are fixed and rest against the edges of the apertures in a stationary card 76 or whether they are movable and rest against the inner edges of the apertures 80 in a movable card 77 depends upon the configuration of those two cards, which is determined by whether it is desired that the contacts close or break auxiliary circuits upon energization of the associated hold magnets 49. In the embodiment as depicted in Fig. 3, the contacts are arranged to break auxiliary circuits upon operation of the hold magnet, and, therefore, the configuration of the cards is such that the inner single contact springs 70 are fixedly restrained by the lower edge of the stationary card 76. The outer twin contact springs 69, which are pretensioned inwardly so as to normally be in contact with their mating contact springs 70, are normally out of contact with both of the operating cards; but upon operation of the movable card 77, the inner edges of the apertures 80 therein will force the twin contact springs 69 outwardly and cause the associated circuits to be broken.

The sets of line and trunk conductors which have been described as comprising four conductors per set may, in practice, have either more or fewer conductors as the circuit requirements may dictate. It is also contemplated that additional sets of conductors may be placed in the area behind the actuating select and hold tapes, connection between such additional sets of conductors being accomplished by additional contacting media on the contact rods. It is evident that many possible embodiments may be made of the above-described invention, and that many changes may be made in the embodiment above set forth, and it is to be understood that all matter hereinbefore set forth, or shown in the ac-

companying drawings, is to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In an automatic telephone switch, sets of line conductors and sets of trunk conductors arranged coordinately but out of contact one with the other, a select tape associated with each set of trunk conductors and having a plurality of openings therein, one for each set of line conductors, a hold tape associated with each set of line conductors and having a plurality of openings therein, one for each set of trunk conductors, sets of contacting media each associated with one of the crossing points of said sets of line and trunk conductors and operable through the conjoint operation of one select tape and one hold tape, and means to move said tapes to effect electrical connection between said sets of line and trunk conductors.

2. In an automatic telephone switch, sets of line conductors and sets of trunk conductors arranged coordinately but out of contact one with the other, a select tape associated with each set of trunk conductors and having a plurality of openings therein, one for each set of line conductors, a hold tape associated with each set of line conductors and having a plurality of openings therein, one for each set of trunk conductors, a plurality of contact rods, one associated with each crossing point of said sets of line and trunk conductors, arranged to pass through the associated openings in said select and hold tapes, and operable through the conjoint operation of one select tape and one hold tape, and means to move said tapes to effect electrical connection between said sets of line and trunk conductors.

3. In an automatic telephone switch, sets of line conductors and sets of trunk conductors arranged coordinately but out of contact one with the other, a select tape associated with each set of trunk conductors and having a plurality of openings therein, one for each set of line conductors, a hold tape associated with each set of line conductors and having a plurality of openings therein, one for each set of trunk conductors, a plurality of contact rods each having sets of contacting media associated therewith, each of said contact rods passing through the associated openings in said select and hold tapes at a crossing point of said sets of line and trunk conductors and operable through the conjoint operation of one select tape and one hold tape, and means to move said tapes to cause said contacting media to effect electrical connection between said sets of line and trunk conductors.

4. In an automatic telephone switch, sets of line conductors and sets of trunk conductors arranged coordinately but out of contact one with the other, a select tape associated with each set of trunk conductors and having a plurality of openings therein, one for each set of line conductors, a hold tape associated with each set of line conductors and having an opening therein for each set of trunk conductors, each of the openings in said hold tape being so shaped as to form a depending lug, a plurality of contact rods having sets of contacting media thereon, one of said contact rods being associated with each crossing point of said sets of line and trunk conductors and passing through the associated openings in said select and hold tapes, means to move a selected one of said tapes to move a selected one of said contact rods, and means to move a selected one of said hold tapes to cause the depending lug thereof to further move the selected

one of said contact rods to effect an electrical connection between the selected associated sets of line and trunk conductors.

5. In an automatic telephone switch, sets of line conductors and sets of trunk conductors arranged coordinately but out of contact one with the other, a select tape associated with each set of trunk conductors and having a plurality of openings therein, one for each set of line conductors, a hold tape associated with each set of line conductors and having a plurality of openings therein, one for each set of trunk conductors, a plurality of contact rods each having sets of contacting media associated therewith, each of said contact rods passing through the associated openings in said select and hold tapes at a crossing point of said sets of line and trunk conductors, and operable through the conjoint operation of one hold tape and one select tape, means to move said tapes to effect electrical connections between said sets of line and trunk conductors, pairs of spaced terminals mounted adjacent certain of said contact rods, and additional contacting media on said certain contact rods engageable with said spaced terminals upon operation of said certain contact rods to establish auxiliary electrical circuits.

6. In an automatic telephone switch, sets of line conductors and sets of trunk conductors arranged coordinately but out of contact one with the other, a select tape associated with each set of trunk conductors and having a plurality of openings therein, one for each set of line conductors, a hold tape associated with each set of line conductors and having a plurality of openings therein, one for each set of trunk conductors, sets of contacting media each associated with one of the crossing points of said sets of line and trunk conductors and operable through the conjoint operation of one select tape and one hold tape, means to move said tapes to effect electrical connection between said sets of line and trunk conductors, and further means associated with and operable by said last-mentioned means to control auxiliary electrical circuits.

7. In an automatic telephone switch, sets of line conductors and sets of trunk conductors arranged coordinately but out of contact one with the other, a contact rod at each crossing point of said sets of line and trunk conductors, a select tape associated with each set of trunk conductors and having an opening therein for each associated contact rod, an edge of each of said openings serving as a camming surface for its associated contact rod, a hold tape associated with each set of line conductors and having an opening therein for each associated contact rod, each of the openings in said hold tape so shaped as to form a depending lug one edge of which serves as a camming surface for said contact rod, means to move a selected one of said select tapes to move a selected one of said contact rods, and means to move a selected one of said hold tapes to cause the depending lug thereof to further move the selected one of said contact rods to effect an electrical connection between the selected associated sets of line and trunk conductors.

8. In an automatic telephone switch, sets of line conductors and sets of trunk conductors arranged coordinately but out of contact one with the other, a contact rod at each crossing point of said sets of line and trunk conductors, a select tape associated with each set of trunk conductors and having an opening therein for each associated contact rod, one edge of said opening being

at an angle with the direction of movement of said select tape and serving as a camming surface for said contact rod, a hold tape associated with each set of line conductors and having an opening therein for each associated contact rod, each of the openings in said hold tape so shaped as to form a depending lug the sides of which extend at an angle to the direction of movement of said hold magnet and serve as camming surfaces for said contact rod, means to move a selected one of said select tapes to move a selected one of said contact rods to a position wherein it may be engaged by the associated depending lug, and means to move a selected one of said hold tapes to cause the camming surfaces of said select tape and of said hold tape depending lug to force the selected one of said contact rods into rolling contact with the selected associated sets of line and trunk conductors to effect an electrical connection therebetween.

9. In an automatic telephone switch, sets of line conductors and sets of trunk conductors arranged coordinately but out of contact one with the other, a contact rod at each crossing point of said sets of line and trunk conductors, a select tape associated with each set of trunk conductors and having an opening therein for each associated contact rod, an edge of said opening serving as a camming surface for said contact rod, a hold tape associated with each set of line con-

ductors and having an opening therein for each associated contact rod, each of the openings in said hold tape so shaped as to form a depending lug the opposite edges of which serve as camming surfaces for said contact rod, means to move a selected one of said select tapes to move a selected one of said contact rods, and means to move a selected one of said hold tapes to cause the depending lug thereof to further move the selected one of said contact rods to effect an electrical connection between the selected associated sets of line and trunk conductors, further engagement of other contact rods with said selected line and trunk conductors being prevented upon the subsequent operation of a select tape by the hold tape depending lug.

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