

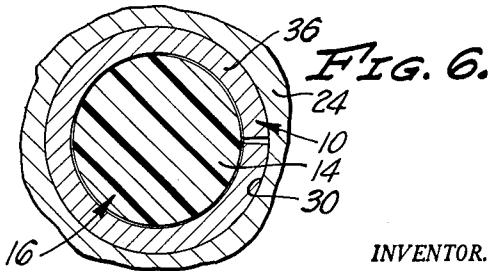
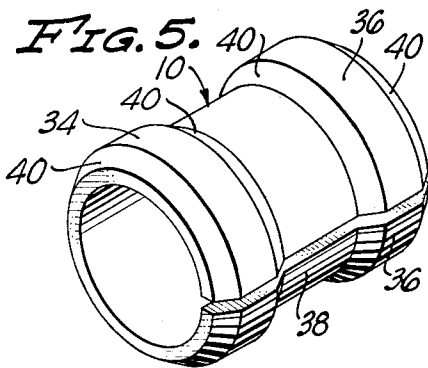
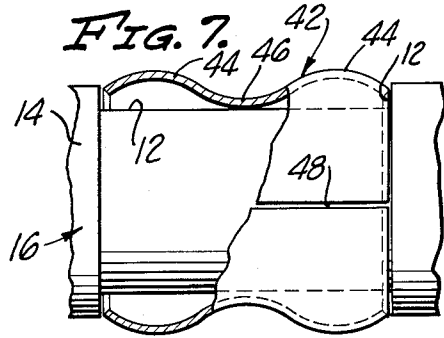
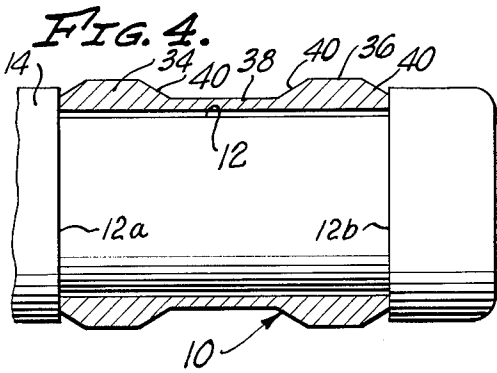
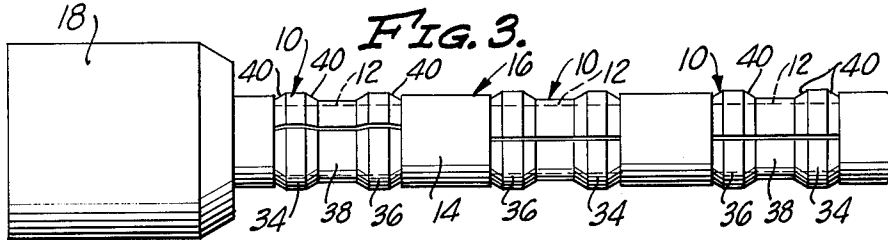
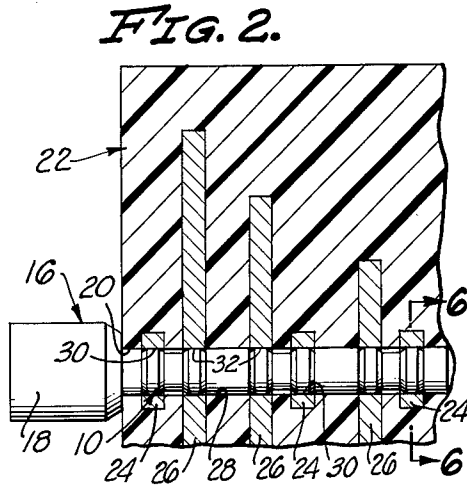
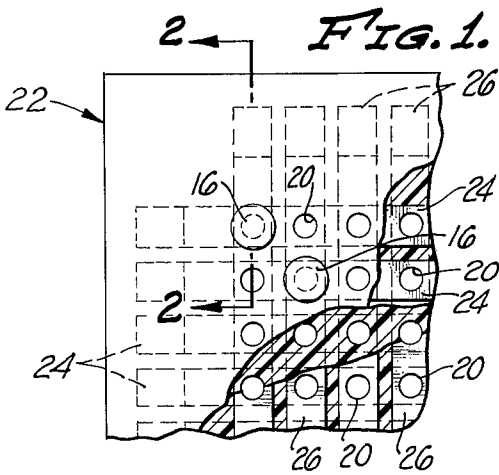
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ELECTRICAL CONNECTOR

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ELECTRICAL CONNECTOR

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The present invention relates to an electrical connector for internal switching in crossbar switching blocks.

Switch boards, pin boards and the like, herein broadly referred to as switch blocks, are widely employed to provide a means for connecting together particular conductors of a great plurality of conductors. Such switch blocks customarily incorporate superposed layers of insulated conductors which extend longitudinally all of the conductors of one layer extending in the same direction, but with the conductors of adjacent layers usually arranged at right angles to each other. The ends of the various conductors are adapted to be connected to leads for carrying a switching action to be provided to communication circuits, programming circuits, and the like, the switching action being provided by interconnection at the switch block of certain of the conductors.

The switch block connections of particular conductors are provided by electrical pin connectors which are disposed within sets of registering openings provided in the block and the conductors. The pin connectors include electrically conductive portions which bridge adjacent conductors in superposed layers of conductors. By appropriate indicia on the switch block, a connector pin can be inserted in the proper set of registering openings to switch, that is, make, break, or change, the connections in an electrical circuit which may be associated with the conductors within which the pin is disposed.

Heretofore, difficulty has been encountered in providing good electrical contact between the conductive portions of the connector pin and the conductors, particularly where the openings in the conductors for receipt of the pin are of slightly different diameters. For example, one prior art arrangement employs threaded openings in the switch block and the conductors, and a threaded connector pin is disposed within these openings. It will be apparent that the threads must have a certain amount of tolerance, and the degree of contact of the pin threads with the threads of the adjacent conductors is not uniform. Further, inadvertent breakage of such a pin makes it difficult to remove the pin from the registering openings of the switch block and the conductors. In addition, the expense of providing precision threads upon the pin and the conductors and switch block, and the awkwardness of having to thread the pin in and out of the openings, will be apparent.

Other prior art methods for achieving good electrical contact between adjacent conductors of the switch block incorporated separate resilient elements permanently mounted in the registering openings of the conductors, the connector pin being inserted to complete the connection between the resilient elements. Such an arrangement requires the provision of resilient elements for each conductor in each of the sets of registering openings in the switch block, and the great number of such resilient elements needed, together with the manufacturing complexities involved in their installation, undesirably increases the cost of such switch blocks. In addition, it will be apparent that only certain portions of the connector pins were conductive, and these portions had to be individually fitted to connector pins made of non-conductive material.

Therefore, it is an object of the present invention to provide an electrical connector which is adapted to be mounted upon a connector pin for slidable insertion into the registering openings of a switch block and the con-

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ductors incorporated therein, thereby providing a rapid and easy means for electrically connecting a selected pair of conductors.

Another object of the invention is to provide an electrical connector adapted to be mounted upon a connector pin made of non-conductive material, and which includes resilient sections (sometimes called "extreme portions") for engaging a plurality of conductors, including at least one intermediate section (sometimes called a "medial portion") which maintains adjacent pairs of sections in predetermined spaced relationship during operation of the connector pin, but which permits the sections to flex substantially independently of each other. With this arrangement, the end sections accommodate themselves to the particular diameters of the openings in the conductors, even though these openings are slightly different in size.

A further object of the invention is the provision of an electrical connector pin for a switch block incorporating superposed conductors, in which the switch block and the conductors include sets of registering openings, the connector pin including a non-conductive shank to which is mounted a resilient cylindrical sleeve made of conductive material and engageable at its extreme portions with a pair of the conductors, the extreme portions being connected by a resilient medial portion which has a thin wall to permit the extreme portions to flex substantially independently of each other. The registering openings in the switch block and the conductors therein are cylindrical and smooth-walled to slidably receive the pin connector whereby the pin connector may be quickly and easily inserted or removed, as desired.

Another object of the invention is to provide an electrical connector pin having one or more reduced diameter portions for receiving a corresponding number of split, cylindrical sleeves made of conductive material and compressible upon insertion into registering openings of conductors to provide good electrical contact therebetween.

It is another object of the present invention to provide a connector pin mounting one or more electrical connectors, and insertable in registering openings in a switch block and a plurality of conductors incorporated therein, in which said pin, electrical connector, switch block, and conductors are relatively inexpensive to manufacture, and reliable in operation.

Other objects and features of the invention will become apparent from consideration of the following description taken in connection with the accompanying drawing, in which:

FIG. 1 is an elevational view of a portion of a switch block having pin connectors therein, portions of the switch block being cut away for clarity;

FIG. 2 is a view taken from the line 2-2 of FIG. 1, on an enlarged scale;

FIG. 3 is an enlarged elevational view of a pin connector;

FIG. 4 is a detail, cross-sectional view of an electrical connector according to the present invention, mounted in position upon the pin connector;

FIG. 5 is a detailed perspective view of the electrical connector of FIG. 4;

FIG. 6 is an enlarged view taken from line 6-6 of FIG. 2; and

FIG. 7 is a detail, cross-sectional view of another embodiment of the present invention, mounted in position upon a pin connector.

Referring now to the drawing, and particularly to FIGS. 1 and 2 thereof, I show three electrical connectors 10 mounted within three reduced diameter portions or annular recesses 12 formed in an elongated shank 14 (sometimes herein called a "spindle") of a pin 16 which

includes a locating head 18 at one end of the shank 14, the head 18 being substantially larger in diameter compared to the shank 14. Recesses 12 are bounded by axially spaced-apart shoulders 12a and 12b, which face each other. Although three connectors 10 are illustrated, it will be apparent that less than or more than three may be mounted upon the pin 16, if desired.

Each of the electrical connectors 10 which is located in the spaced-apart and elongated recesses 12 is made of electrically conductive material, such as copper or brass or the like. The pin 16 is made of electrically non-conductive material, such as plastic or the like.

The shank 14 of the pin 16 is adapted to be disposed through one of a plurality of sets of registering openings 20 provided in a switch block 22 and in a plurality of pairs of conductors 24 and 26 incorporated therein. For convenience, the numeral 24 is applied to all of the conductors in one layer, and the numeral 26 is applied to all of the conductors in the adjacent layer, three pairs of conductor layers being illustrated by way of example.

More particularly, the switch block 22, which term is intended to include switch boards, pin boards, and the like, incorporates superposed layers of the conductors 24 and 26 insulated from each other by the material of the switch block 22. The conductors 24 are elongated, juxtaposed to each other, and extend in the same direction parallel to each other and in substantially the same plane. The adjacent layer of the conductors 26 is spaced from the layer of the conductors 24, the conductors 26 being elongated and mutually parallel to each other, and extending in the same direction but in a direction at right angles to the direction of the conductors 24.

The ends of the conductors 24 and 26, FIG. 1, constitute terminals to which leads (not shown) may be attached for connection of the conductors 24 and 26 to a computer, tabulator, accounting machine or the like (not shown). With this arrangement an interconnection at the switch block 22 of a pair of the conductors 24 and 26, by insertion of the pin 16 within a particular set of registering openings 20, completes an electrical switching operation which is carried by the above-mentioned leads to the external equipment with which the switch block 22 is associated.

Although a pair of the pins 16 are illustrated in a pair of registering openings 20 in FIG. 1, it will be apparent that any number of the pins 16 may be inserted in the various sets of openings 20 to connect a corresponding plurality of conductors 24 and 26.

The switch block 22 is preferably constructed by suitably supporting the layers of conductors 24 and 26 in the positions illustrated, enclosing the whole in a mold (not shown) and filling the mold with a suitable dielectric or insulating material, such as one of the well known "potting" plastics, and removing the composite body from the mold after the plastic material has hardened. In this manner, the conductors 24 and 26 are embedded in the material of the block 22 in insulated relationship.

The plurality of sets of registering openings 20 are molded into the switch block 22 in alignment with the already formed openings in the conductors 24 and 26, it being noted that the openings 20 are cylindrical, smooth-walled, and adapted to closely and slidably receive the pin shank 14 and the connectors 10 mounted thereon. For this purpose the length of each of the recesses 12 on the pin shank 14 is made such that it bridges the plurality of conductors 24 and 26 to which the recess 12 is adjacent.

Since the pin shank 14 is slidably received in the registering openings 20, electrical connection between the associated plurality of conductors 24 and 26 is quickly effected by insertion of the pin 16. Further, this slidable connection permits a tool to be inserted in the registering openings 20 for driving out the pin shank 14 should the locating head 18 become broken off for some reason.

Each of the sets of registering openings 20 is constituted by an elongated opening 28 in the switch block 22 which registers with openings 30 and 32 in intersecting conductors 24 and 26, respectively. Although it is important that good electrical contact be present between the walls of the openings 30 and 32 and the associated electrical connector 10, often the diameters of the openings 30 and 32 are not identical, and the present conductor 10 is adapted to accommodate itself to this difference in diameters.

For this purpose, each connector 10 constitutes a longitudinally split and cylindrical sleeve whose wall thickness and material is such that the connector 10 is resiliently compressible. Its inner diameter is preferably made approximately the same as the diameter of the associated reduced diameter portion 12 of the pin shank 14. When the connector 10 is sprung apart at its split for mounting upon the reduced diameter portion 12, the connector 10 tends to remain sprung slightly outwardly. Thus, when the connector 10 is inserted within the openings 30 and 32, the connector 10 is compressed slightly and exerts a continuous bias against the walls of the openings 30 and 32 by reason of the resilience of the material of which the connector 10 is made. A half-hard brass has been found to be satisfactory in this regard, both from the standpoint of high modulus of elasticity and the standpoint of good electrical conductivity.

To permit the connector 10 to accommodate itself to the particular diameters of the openings 30 and 32, it will be apparent that the extreme portions of the connector 10 must flex differentially. This is accomplished in the embodiment of FIGS. 1-6 by providing a pair of spaced-apart extreme portions or rings 34 and 36, constituting contact members or sections for the conductors 24 and 26, respectively. These rings 34 and 36 are connected together by a medial portion 38 which has a wall thickness substantially less than that of the rings 34 and 36. The medial portion 38 maintains the rings 34 and 36 in predetermined spaced relationship during the operation of the pin 16, and yet yields upon differential flexing of the rings 34 and 36, during accommodation of the rings 34 and 36 to the openings 30 and 32 in the conductors 24 and 26. Because of this yielding of the portion 38, the rings 34 and 36 do not flex identically, and the closure of a ring 34 is not followed by an equal closure of the ring 36. Thus, there is accommodation to the different diameter openings 30 and 32. It will be apparent that more than two sections or rings 34 or 36 could be provided to interconnect more than a pair of conductors, in which case a medial portion 38 would be provided between each adjoining pair of such rings.

One successful embodiment of the connector 10 includes a medial portion 38 having a wall thickness of 0.0035", and rings (extreme portions) 34 and 36 having a wall thickness of 0.010". The wall thickness of the portion 38 is thus approximately 30% of the wall thickness of the rings 34 and 36, although, of course, the invention is not intended to be limited to this particular difference in wall thickness.

The extremities of each of the rings 34 and 36 are preferably provided with beveled portions 40 to facilitate the insertion and removal of the rings 34 and 36 from the openings 30 and 32. Further, the external diameter of the rings 34 and 36 is preferably slightly larger than the diameter of the shank 14, and the inherent resilience of the rings 34 and 36 further tends to spring them apart to a diameter slightly greater than the diameter of the pin shank 14. The lesser diameter of the medial portion 38, as compared to the rings 34 and 36, eliminates engagement between the medial portion 38 and any portion of the set of registering openings 20, so that the differential flexings of the rings 34 and 36 is unimpaired.

Referring now to FIG. 7, a different form of electrical connector is illustrated in which the wall thickness is uniform throughout. More particularly, the connector,

designated generally by the numeral 42, is constituted by a pair of end contact sections or rings 44 (sometimes called "extreme portions") connected by an integral, intermediate section 46 (sometimes called a "medial portion").

The connector 42 includes a longitudinally extending split 48, and is made of a resilient material, such as the half-hard brass of connector 10, so that the connector 42 may be radially expanded for fitting upon the reduced diameter portion 12 of the pin shank 14. As will be apparent, insertion of the pin shank 14 within one of the registering sets of openings 20 tends to radially compress the contact sections 44 and the bias of the resilient material thereof tends to urge the contact sections 44 radially outwardly into firm contact with the openings of the conductors 24 and 26.

The mode of operation of the connector 42 is slightly different from that above described in connection with the connector 10. Where the intermediate section 38 of the connector 10 was made thin and yieldable to enhance differential flexing of the end rings 34 and 36 of the connector 10, the intermediate section 46 of the connector 42 acts as a pivot area for transmitting radial movement of one of the contact sections 44 to the other of the contact sections 44. That is, upon compression of one of the contact sections 44, the intermediate section 46 will engage the pin shank 14 so that radial compression of one contact section 44 springs apart or radially expands the other contact section 44, the intermediate section 46 acting as a form of "see-saw" or pivot point. Thus, the connector 42 provides differential radial expansion or compression of the contact sections 44 for accommodation to openings of different sizes in the conductors to be electrically coupled.

In one successful embodiment of the connector 42, the wall thickness of the half-hard brass was 0.003" and, the split 48 was 0.003" when the connector 42 was fully compressed upon the pin shank 14, and 0.015" when the connector 42 was unconstrained against radial expansion. The maximum diameter of the cylindrical contact sections 44 was 0.098" with the connector 42 fully expanded, and 0.094" with the connector 42 fully compressed. The length of the connector 42 was 0.130", the maximum diameter of the contact sections 44 being located 0.02" inwardly of the ends of the connector 42. It is important to note that the outer ends of the contact sections 44 are never in contact with the reduced diameter portion 12 of the pin shank 14, the clearance therebetween being needed to allow a pivotal action to better occur at the intermediate section 46.

Thus, an electrical connector 10 has been provided which is adapted to be mounted upon a pin 16 for insertion within a switch block 22 for connecting together a selected plurality of conductors 24 and 26, the connector 10 being characterized by contact sections or rings 34 and 36 adapted to differentially flex for accommodation to different diameter openings 30 and 32 in the associated conductors of the switch block 22. The connectors 10 are quickly mounted on the pin 16, and the manufacture of the pin 16 and the provision of plain cylindrical sets of openings 20 in the switch block 22 all constitute relatively simple and straightforward production operations, thereby greatly reducing the cost of manufacture of the switch block 22, the conductors incorporated therein, the pin 16, and the connectors 10 mounted thereon.

While the invention has been described by means of specific embodiments, the invention is not limited thereto since obvious modifications and variations will occur to those skilled in the art, without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. A switch pin for a crossbar switching block of the

class having a plurality of layers of conductors held in and spaced apart by an insulating matrix, there being a plurality of cylindrical holes through the matrix and conductors, the switch pin being adapted to enter and engage at least a portion of the inside wall of one of said holes so as conductively to connect a pair of said conductors, said pin comprising: an unpierced unitary spindle made entirely of insulating material and having a longitudinal axis; a pair of axially spaced-apart shoulders on the spindle facing each other and extending around the peripheral surface and axis thereof; a conductive sleeve mounted on said spindle between said shoulders, said sleeve having an axis, two extreme and one medial peripheral portions, and an axial slit extending for the full length thereof, the extreme portions each having an outer transverse dimension greater than any outer transverse dimension of the medial portion, the medial portion having a length such as to permit slight changes in the lateral dimension of one extreme portion without appreciably changing the said lateral dimension of the other extreme portion, the extreme portions being axially spaced apart to correspond to the spacing of the conductors to be connected, whereby the switch pin may be inserted into one of said holes, and the extreme portions will engage respective conductors and compensate for slight differences between hole diameters therein, and the medial portion will leave a clearance between its outer surface and the wall of the hole in the insulating matrix so as to leave the contact between the conductors and the extreme portions unimpeded, the sleeve being made of inherently springy material, and lying inherently laterally free of the spindle so as to permit a lateral compression to provide for spring-back thereby to engage the wall of said hole, the sleeve being of axial length substantially equal to that of the axial spacing between the shoulders so as to be axially restrained thereby.

2. A switch pin according to claim 1 in which the inner diameter of said sleeve is initially of uniform diameter, but deformed out of round, and in which the farthest removed-apart ends of the extreme portions are sloped to permit easier insertion and removal of the switch pin in said block.

3. A switch pin according to claim 2 in which the radial thickness of the sleeve at the extreme portions is greater than that at the medial portion whereby to strengthen the portions where electrical contact is to be made.

4. A switch pin according to claim 1 in which the sleeve is made of material of uniform thickness having an undulating axial cross-section to form said extreme and medial portions.

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