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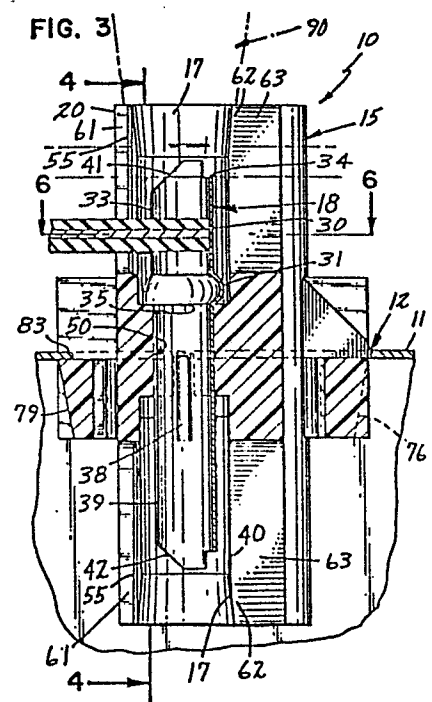
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54 **Electrical connector module with multiple connector housings.**

57 An electrical connector comprises a plurality of metal split cylinders (18) each having an axially extending slot (33) for receiving an insulated wire to form an electrical connection, and an insulating housing (20) for each cylinder, supporting the cylinder and including slots (61, 62) on diametrically opposed sides with one slot coaxially extending with the slot of the cylinder. The housings are aligned in two rows with the slots thereof aligned transversely to the rows and with the housings in each row laterally spaced apart to form a plurality of inter housing slots (63) and the housings in different rows laterally offset.



ELECTRICAL CONNECTOR MODULE WITH MULTIPLE
CONNECTOR HOUSINGS

Background of the Invention

Terminal connecting blocks or modules are widely used in the telecommunications industry to interconnect equipment and distribution lines, particularly in signal switching or distribution applications. Their primary function is the solderless connection of two or more wires.

Apart from their primary function, connecting modules of the kind the present invention is concerned with provide for a quick, mechanically secure and electrically sound connection. In addition, they provide for relatively simple and fast disconnection, as needed where frequent rewiring is necessary. Quick connection is provided by eliminating as much pre-connection and post-connection conditioning as possible. Stripping, bending or trimming operations should be unnecessary, such that connection may be accomplished with few movements. Mechanically secure and electrically sound connections are provided by interference, clamp or like connection methods in which the connection module exerts a positive grip on an installed wire conductor.

To provide a connecting module having such qualities, it is known to utilize a metal split cylinder having an axially extending narrow seam or slot. A wire is connected to the cylinder by moving it laterally of its axis into the slot so that the edges of the slot slice through the insulation and establish contact with the conductor with a positive gripping force as provided by the resilience of the cylinder cross section. It is also known to support a cylinder in an insulating housing of generally cylindrical shape with a rec-

tangular cross-section, in a coaxial orientation, to form a connector module. The housing is slotted along diagonally opposite corners and the cylinder aligned therein such that one corner slot is aligned with the wire receiving slot in the cylinder. Installation of a wire is accomplished by laying it to extend through the housing slots, over the cylinder, and using an impact tool to drive the wire down into the split cylinder, which preferably includes a cutting edge opposite the wire receiving slot to trim or sever the excess wire length. An installed wire is thus shielded from others by the housing such that shorting and interference problems are avoided. In actual practice, a plurality of housings are mounted to extend orthogonally from a planar member to form a multiple connector terminal connecting panel. An example of such a panel is disclosed in co-pending U.S. Patent Application Serial Number 321,107, to Vachhani, filed Nov. 31, 1981, and entitled "Electrical Connector Module."

Although the Vachhani panel provides for the quick and secure solderless cross connection of a large number of wires at a central location with relatively high density, it does have certain disadvantages. For one, assembly of the panel requires that individual modules be mounted one at a time, such that assembly is time consuming and correspondingly expensive. For another, the diagonal orientation of the wire slots together with the side by side orientation of the housings generally requires that wires be positioned and installed one at a time, such that a technician must continually switch between positioning and inserting operations. This has been recognized as time inefficient in the consecutive installation of large numbers

of wires. Another undesirable aspect of the Vachhani module relates to stresses exerted on the split cylinder by the wire insertion tool. It has been found that due to the impact operation of the tool and the relatively pliable housing material used for the modules that the wire receiving cylinder was susceptible to connection threatening deformation during installation of a wire. In addition, the Vachhani tool needs to be oriented with respect to a housing for proper operation, which has been also recognized as undesirable. Finally, the tool includes moving parts and is thus relatively expensive.

Summary of the Invention

The present invention provides an electrical connector panel and a tool for installing or inserting wires in the panel which alleviates or eliminates the above described disadvantages of the Vachhani apparatus. According to one aspect of the invention a plurality of metal split cylinders of the above described type are provided and mounted in a non-conductive housing to form a connector module. The housing is formed to support the split cylinders in a plurality of cylindrical sub housings formed in two rows, with each of the sub housings including slots on diametrically opposed sides with one of the subhousing slots coaxially extending with the slot in the split cylinder, and with the subhousing slots aligned transversely to the rows. The sub housings in each row are laterally spaced apart to form a plurality of inter subhousing slots and the sub housings in different rows are laterally offset so that one slot of each subhousing is aligned with one of the inter subhousing slots. According to this aspect of the invention a plurality of wires to be installed

may be laid side by side and parallel in the subhousing slots in one series of operations, and installed in another series of operations, eliminating the need to switch back and forth between wire placement and insertion operations where two or more wires are to be installed in the panel sequentially.

According to another aspect of the invention the module housing includes a snap mounting arrangement comprising one or more flexible bridges and shoulders disposed on the side of the housing and longitudinally spaced apart. The bridges include a bridge member spaced apart from the side of the housing and supported on opposite ends so that it may flex toward the housing when compressed. The panel member provided for supporting the housing includes an aperture sized to receive the housing with the aperture including one or more tabs positioned to engage the bridge or bridges and compress them inwardly as the housing is slid into the aperture, and to engage a transverse edge of the bridges when the housing is mounted. A shoulder is provided to stop the housing in the mounting position such that the housing is snapped into place and immovably retained by the shoulders on one side of the housing and the transverse edge of the bridges of the other. Thus, the present invention provides for the mounting of a plurality of connectors to a panel simultaneously, as opposed to mounting single connector modules one at a time, thus resulting in substantial time savings in panel assembly.

According to yet another aspect of the invention the housing is constructed of a relatively rigid plastic non-conducting material, and a simple wire insertion or installation tool with no moving parts is

provided to insert wires. The wire insertion tool includes a central post sized to fit inside the split cylinder and a cylindrical member coaxially extending around the post and sized to fit around the outside
5 perimeter of the cylinder between the cylinder and the housing. A shoulder is provided on the tool and is axially displaced from the tip, the shoulder being of sufficient radius to engage the end transverse edges of a subhousing with the tip of the tool extending in and
10 around the split cylinder mounted therein. Thus, wires to be installed may be laid across the top of the cylinder extending through the subhousing slots and pressed into the cylinder with the tool, which by virtue is its cylindrical configuration does not need to be
15 oriented, and which does not include moving parts. Furthermore, the operation of the tool provides that the subhousing absorbs certain stresses from the tool as the wire is being inserted to avoid deformation of the split cylinder.

20 According to still another aspect of the invention the end portions of each subhousing cylinder are funnel shaped to facilitate insertion of the tool into the ends of the sub housings, and to guide the tool into proper axial orientation with the split cylinder.
25 In addition, at least one slot of each subhousing includes arcuate axially extending lips on each side of the slot, with the width of the passageway formed between the lips being slightly less than the diameter of a wire to be installed, so that the lips provide a mechanical grip
30 and strain relief for the wire during and after installation.

Thus, the present invention provides an electrical connector panel eliminating or alleviating the

problems above-discussed with respect to the Vachhani apparatus. More specific details, aspects and salient features of the construction and operation of the invention are set forth in the ensuing drawing and specification.

Brief Description of the Drawing

FIGURE 1 is a perspective view of a connector module according to the present invention;

10 FIGURE 2 is a top plan view of the electrical connector module according to the present invention;

FIGURE 3 is a cross sectional view of the connector module according to the present invention taken along the lines 3-3 of Figure 1;

15 FIGURE 4 is a cross sectional view of a portion of the connector module according to the present invention taken along the lines 4-4 showing the installation tool according to the present invention inserted therein; and

20 FIGURE 5 is a cutaway perspective view of the installation tool according to the present invention; and

FIGURE 6 is a cross sectional view of the connector module of the present invention taken along the
25 lines 6-6 of FIGURE 3.

Detailed Description of the Invention

The electrical connector apparatus of the present invention is provided for use in an access
30 member such as the quick-cross connect panel or in a terminal block to electrically connect various electrical lead wires or circuits with certain other electrical lead wires or circuits. In actual practice, the lead

wires may be part of a communication circuit such as a telephone line or a data transmission circuit. Where the leads are telephone lines, the electrical connector module of the present invention is utilized to patch or cross-connect such lines to accommodate growth of telephone usage, changes in telephone number, relocation of users, etc.

Referring to FIGS. 1 and 2 an electrical connector module according to the present invention is illustrated, in perspective and plan views. Connector module 10 is mounted in a relatively flat panel member 11, in an aperture 12, of generally the same cross-section as connector module 10. Module 10 includes a housing 15 molded of a relatively rigid non-conductive plastic. Housing 15 includes a plurality of generally cylindrical sub housings 20, extending on either side from panel member 11 (see FIG. 3), each of which supports a centrally positioned split cylinder connector member 18. Each of sub housings 20 are formed to include funnel shaped end portions 17 as may be seen best with reference to FIGS. 3 and 4, to facilitate entry and alignment of an insertion tool, as will be described in more detail below. Although partially asymmetrical in certain detail, the module is identical on each side of the panel member with respect to the function and construction of the operative portions of sub housings 20.

With reference to FIGS. 3 and 4 it may be seen that connector member 18 includes a first end 30 including a collar 31, a wire engaging slot 33 and a wire trimming edge or blade 34. The other end of connector member 18 includes a pair of tine members 37 and 38 cut from the sidewalls of the cylinder, a wire

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engaging slot 39 and a further trimming blade 40. Each end of connector member 18 further includes wire guide sections 41 and 42 narrowing toward the respective slots 33 and 39, and a transverse cut 35 structurally isolating the cross sectional resilience of the opposite ends.

To accommodate the mounting of a connector member 18 in the cylindrical subhousing 20, the housing includes an annular retaining portion 50 extending inward from the sidewall of subhousing 20 and having a radius slightly smaller than that of connector member 18. A pair of diametrically opposed and longitudinally extending grooves 51 and 52, having a width slightly larger than that of tines 37 and 38 respectively, are provided in retaining portion 50. The mounting of connector member 18 may thus be accomplished by inserting the member tine-end first into the subhousing such that tines 37 and 38 are compressed as they pass through the upper portion of retaining portion 50, and snap into place in grooves 51 and 52. Connector member 18 is thus axially retained in place by shoulder member 31 on one side of retaining portion 50 and by tines 37 and 38 on the other side, which also provide rotational restriction. A connector is thus positioned in a subhousing 20 to provide functionally identical wire engaging slots on both ends, and both sides of panel member 11.

As may be seen best with reference to Figure 1, both ends of sub housings 20 include a pair of diametrically opposed axially extending slots 61 and 62 in the cylinder walls with one of the slots on each end aligned with one of slots 33 or 39 and the other slots on each end aligned with the recesses formed by trimming blades 34 or 40. Preferably, the subhousing slots and

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connector members slots coextend for a minimum of two or three diameters of the wire size to be connected, such that two or three wires may be connected to connector member 18 on either end thereof, as explained below.

- 5 Further inter subhousing slots 63 are provided, coaxially extending with associated cylinder wall slots 61 or 62.

As shown best in FIG. 6, slots 61, 62 and 63 have generally the same width, which is slightly greater
10 then the diameter of the wire to be installed, so as to not engage the wire during installation. Slots 61, however, are preferably formed to include relatively thin arcuate axially extending lips 55 and 56 along each opposite edge, with the width of the opening between the lips 55 and 56 being slightly less than the
15 diameter of a wire to be installed, such that when a wire is inserted transverse to its axis it is gripped by the slot 61, thereby providing a mechanical strain relief for a wire. Although the invention is not
20 limited to specific dimensions, it provides a slot (61, 62, 63) width of .045", an inter lip opening width of .025", and a lip radius of .010" for .032" to .035" insulated wire. These relative ratios of dimensions have been found to permit wires to be relatively easily
25 manually pulled or pressed in between the lips without undue force during preliminary placement, and to avoid deformation or weakening of the conductor during installation. Moreover, the arrangement provides that the wire may slide downward between the lips via the
30 force applied by the insertion tool, which force is applied on only the portion of the wire lying inside the subhousing. It shall be noted that slots 61, 62 and 63

are identical for a particular end of a housing 15 so that all strain relief slots 61 are on a common side of the sub housings 20.

Housing 15 includes four flexible bridge members 70-73 and a pair of shoulders 74 and 75 to accommodate snap-in mounting of housing 15 in aperature 12 of panel 11. Reinforcement wedges 69 may be provided integral with housing 15 to add to the structural strength of the end sub housings. Each of bridges 70-73 is supported in a spaced apart relationship with the main body of housing 15 and includes a respective ramping portion 76-79, the cross section of which may be best seen in Figure 3. Four corresponding tab members 80-83 are provided on the panel member 11 to extend into aperature 12. Installation of housing 15 in panel 11 is thus accomplished by inserting the unshouldered end of housing 15 into aperature 12, such that ramps 76-79 engage the respective tabs 80-83 and compress the bridge members 70-73 as the housing 15 is pushed down into the aperature 12, with tabs 80-83 snapping over the top edge of the bridge members as shoulder members 74 and 75 engage panel member 11. Housing 15 is thus irremovably retained in a mounted position on panel member 11.

The tool provided for and the method for installing wires in a connector member 18 will now be explained with particular reference to FIGS. 3, 4 and 5. In Figure 5, the wire installing tool according to the present invention is shown in cutaway perspective view. The tool 90 includes a shaft 91 to be connected to a handle (not shown), for example a conventional screwdriver handle. The end of shaft 91 includes a tip portion 92 including a cylindrical member 93 having an outside diameter smaller than the inside diameter of the

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extent of a subhousing 20 surrounding the connector member 18, and an inside diameter slightly greater than the outside diameter of a connecting member 18. A center post or punch member 94 is concentrically
5 disposed within cylindrical member 93, and has a radius slightly smaller than the inside diameter of the connector member 18. Punch member 94 includes a smaller diameter portion 100 which is spaced axially apart from the end of punch member 94 so that when the tool is
10 fully inserted the smaller diameter portion is axially beyond the end of connector member 18. A bored aperture 101 is provided and extends from the inside of tool 90 to the outside of both sides of tip 92. The arrangement of smaller diameter portion 100 and aperture 101
15 facilitates the movement of plastic and metal residue produced by wire trimming up between members 94 and 95 out of aperture 101, so that the tool does not jam with residue. Member 93 further includes a shoulder 95 of generally the same outside diameter of a subhousing 20,
20 such that when the tool is inserted into a subhousing the shoulder rests on the end edges thereof, and such that the tip 92 of the tool extends downwardly inside and around a connector member 18.

Installation of wires and connectors 18 may be
25 accomplished using tool 90 as follows. As for example shown in Figure 1, a wire to be installed may be layed in slots 61, 62 and 63 (leftmost wire), and manually pulled down across the top of connecting member 18 (rightmost wire) with the excess wire extending out-
30 wardly from the slot adjacent the trimming blade 34 or 40, as determined by which end of housing 15 the wire is installed in. It will be noticed that for any given

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side of housing 15 that each connector member 18 is aligned with its wire receiving slot facing in the same direction such that wires to be installed are all layed in with the excess wire extending from the same face of the housing. As explained above, each of lipped slots 61 provide a wire restriction which is preferably slightly less wide than the outside diameter of the insulation on a wire to be installed. Thus, a wire may be manually positioned for insertion by pressing or pulling it into engagement with a slots 61 across the top of a connector member 18, and retained there until fully installed with tool 90. Once fully installed, the gripping force of the lipped slots 61 provide an effective strain relief so that if wires are pulled or bumped after installation the connection with the connector member 18 is not disturbed.

With a wire or wires properly positioned in slots 61, 62 and 63 of one or more subhousings, tool 90 is inserted into the end of a subhousing, as facilitated by the subhousings reatively large funnel shaped ends 17. As the tool 90 moves into the subhousing, the funnel shape aids in axially aligning the tool 90 with respect to the connecting member 18, so that the tool 90 engages the wire and pushes it into the wire receiving slot 33 or 34. The trimming blade 34 or 40 of a connector member 18 severs the excess length of wire and as the wire slides in the slot 33 or 34 such that the insulation of the wire is pierced by the inside edges of a respective 33 or 34 slot in order to make an intimate electrical contact and a mechanical connection with the connecting member 18, as illustrated in FIG. 2. The excess length of wire sheared off by cutting edge 34 or 40 may be easily removed manually. As explained above, trimming residue may travel up the inside of tip 92 of

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tool 90 and out aperture 101. Also, it shall be seen that tool 90 pushes the wire further into lipped slot 61 so that the wire extends substantially transversely from the subhousing when installed.

5 Thus, it shall be seen then that the above-described connector module, installation tool and method of installation provides that a plurality of wires may be secured in place for installation via the wire gripping slots in a single series of operations, and
10 then fully installed in a series of installation operations such that switching back and forth between wire placement and installation with the wire installing tool is not required where two or more wires are sought to be installed sequentially. Also, it shall be seen that two
15 or three wires may be installed in a given slot either sequentially or simultaneously. Moreover, it shall be seen that the installation tool of the present invention is completely symmetrical such that the installation tool does not need to be oriented other than being axially
20 aligned with a subhousing and connector member. Significant time savings in wire installation and savings in tool costs are thus accomplished. Still further, it shall be seen that construction of the housing 15 with a rigid plastic material in conjunction
25 with the operation of the installation tool results in the absorbtion by the housing of most of the force applied via the tool, such that deformation or damage to the connector members 18 is avoided. Last, but not least, it shall be seen that the connector module of the
30 present invention may be easily mounted on a panel 11 in a snap in fashion.

I CLAIM:

1. Electrical connector apparatus comprising:

a plurality of metal split cylinder means each including a slot for receiving and engaging a insulated wire to form an electrical connection;

5 a non-conductive housing configured to provide a plurality of cylindrical sub housings each for concentrically supporting one of said split cylinder means, each of said sub housings including slots on diametrically opposed sides with one of said sub housing
10 slots coaxially extending with said split cylinder slot;

said sub housings aligned in two rows with said sub housing slots aligned transversely to said rows, the sub housings in each row laterally spaced apart to form a
15 plurality of inter sub housing slots and the sub housings in different rows laterally offset so that one slot of each sub housing is aligned with one of said inter sub housing slots whereby wires to be connected may be
20 inserted in said split cylinders.

2. Electrical connector apparatus comprising:

wire connecting means including an insulating housing, said connecting means for receiving wires to be
25 connected and engaging the wires in mechanical and electrical connection;

panel means for supporting said housing in an aperture therein;

said housing including on the sidewalls
30 thereof flexible bridge means for snap mounting and axially displaced shoulder means for slideably snap

mounting said housing in said aperature, said bridge means flexing as the housing is slid into said aperature;

said aperature sized to receive said housing
5 and including tab means for compressing said bridge means as it is slid into said aperature and for engaging a transverse edge of said bridge means when it snaps past the panel means, said shoulder means stopping said housing after said bridge means snaps past the panel
10 means so that when mounted said shoulder means retains said housing on one side of the panel means and said edge of said bridge means on the other side.

3. Electrical connector apparatus comprising:
15 metal split cylinder means including a coaxially extending slot for receiving an insulated wire and peircing the insulation to form an electrical connection with the conductor, and including a cutting blade near one end of the cylinder means diagonally
20 opposite said slot for trimming excess wire length from a wire inserted in said slot;

a generally cylindrical non-conductive housing for concentrically supporting said split cylinder means therein with the one end of said split cylinder axially
25 displaced from an end of said split cylinder means, said housing including diametrically opposed slots with one of said slots coextending with said split cylinder means slot and the other housing slot aligned with said blade;

wire insertion means including a central post
30 sized to fit inside said split cylinder means and a cylindrical member coaxially extending around said post and sized to fit around the outside perimeter of said cylinder means between the cylinder means and the

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housing, said tool means further including a shoulder axially displaced from the one end of said tool to engage the edge of said end of said housing, whereby wires may be laid across the top of said cylinder means
5 extending through said housing slots and pressed into said cylinder with said tool means, said tool means causing excess length to be trimmed on said blade and said wire to be electrically connected in said slot.

