

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO ELECTRICAL CONNECTORS

(71) We, WESTERN ELECTRIC COMPANY, INCORPORATED, of 222 Broadway, New York City, New York State, United States of America, a Corporation organized and existing under the laws of the State of New York, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to electrical connectors for terminating a cord.

So-called modular plugs are designed to permit a subscriber, as well as an installer, to insert a plug into a jack and/or to remove the plug from the jack. This provides the customer with the capability of changing cords and/or connecting newly obtained telephones with existing wall terminals. Because of the ease with which telephone handsets may be connected to and disconnected from wall terminals, handsets become portable. Still further, the customer may disconnect a retractile cord, which connects a telephone handset to a base, in order to remove kinks, and then reconnect the cord.

Modular plugs for terminating telephone cords are known for example from U.K. patent 1347166 and U.S. patent 3,761,869.

Modular plugs must be constructed to avoid a reduction in dielectric strength with an accompanying decrease in breakdown voltage which could lead to a loss in service. In order to meet the dielectric strength requirements between adjacent conductors and/or terminals, a plug housing has been constructed with individual ducts or cells for receiving individual ones of the cord conductors with the cells being separated from each other by partitions which extend the height of the cells. This differs from previous modular plugs in which the conductors were disposed side-by-side, generally in contiguous relation to one another in open-topped troughs.

While the use of individual conductor-receiving cells is beneficial from the standpoint of dielectric strength, their use causes at least one problem. Terminals that are supported in the housing extend between the cells

and channels which open to an outside surface of the plug to make connections between the cord and jack wires disposed in a predetermined spacing and received in the aligned channels when the plug is inserted into a jack. However, the thickness of the floor-to-ceiling partitions of the cells causes the spacing of the cells to differ from that of the jack wires. Hence, the terminals must extend between the channels, which have the same centre line spacing as the jack wires, and the cells, which have a centre line spacing different from that of the jack wires.

An alternative to a solution in which the plug connects conductors at one spacing to jack wires at a different spacing is to change the spacing of the jack wires and the spacing at which the terminals are inserted, to that of the conductors. This is not an attractive alternative since it would require modification or replacement of all the existing machinery used in the production of modular plugs and jacks at an outrageous expense.

A further problem that manifests itself is the moulding of a plug of this size with individual cells for the conductors. Minimizing the lengths of the partitions which form the individual cells would be of help in the moulding of the plug by permitting the use of a more compact, stronger core pin; however, in order to avoid a reduction in dielectric strength, any reduction in length of the individual cells must be off-set by other features of the plug which enhance its dielectric strength.

The dielectric strength and hence the breakdown voltage may also be reduced because of a portability feature of modular systems in which the cavities of unused modular jacks are at times exposed to corrosive atmospheres. Then, when a plug is inserted into the jack cavity, metal contact wires in the jack which have become corroded engage terminals in the plug, thereby initiating a corrosive attack upon the terminals. Corrosion of the terminals is prevented by plating the exposed portions of the terminals with a corrosion-resistant material.

Previously, the terminals were constructed with side edges interrupted by cutouts used as pilot holes during the forming of the terminals

in a continuous strip. Unfortunately, a portion of the side edges of the terminals adjacent the jack contact wires did not engage the plastic housing when the terminals were seated within the housing. Since only the cutouts of the side edge surfaces of the terminals were plated, the exposed portions adjacent the jack wires were susceptible to corrosion.

A still further problem relates to the support of the terminals within the housing so that unintended movement of the terminals is prevented. Previous terminals relied on side edge barbs for their support, or on the previously described side edges with intermediate cutouts. The barbs were not wholly satisfactory in preventing pivotal movement of the seated terminals, while the side edges of cutout types of terminals were subject to corrosion.

According to this invention an electrical connector for terminating a cord having a plurality of insulated conductors includes a dielectric housing having a plurality of conductor-receiving channels spaced apart a first distance, and a plurality of terminal-receiving slots associated with the channels, each of the slots being aligned with its associated channel, the slots communicating with the exterior of the connector through openings which are spaced apart a second distance less than the first distance, the portions of the housing that define each opening including at least one camming surface which serves to guide a terminal inserted into that opening to enter the associated slot, and an electrically conductive terminal at least partially inserted into each of the terminal-receiving slots and having an internal contact portion for piercing the insulation of and making electrical contact with a conductor in the associated channel, an external contact portion for permitting electrical contact external to the connector, and oppositely disposed edge portions in compressive engagement with material of the housing to resist unintended movement of the terminal.

The housing may include a closed free end and an open cord-input end, the conductor-receiving channels each including a substantially laterally enclosed cell, and an aligned trough formed in a chamber, the cells extending from the closed end to the chamber. The connector may include at least one rib depending from a surface of the chamber opposite a floor of the chamber and extending from the conductor-receiving cells toward the cord-input end along the longitudinal centre line of the housing. The said rib may extend from said surface to the floor of the chamber.

The chamber may include spaced ribs which extend from a floor of the chamber toward the terminal-receiving slots to form the troughs.

Each terminal-receiving slot may communicate with its associated conductor-receiving channel through a restricted opening, whereby insertion of a terminal through the restricted opening causes material forming that opening

to engage the side surfaces of the terminal to substantially seal that channel from that slot.

Each terminal-receiving slot may be separated from its associated conductor-receiving channel by a frangible web of material which is penetrable by a terminal upon seating of that terminal in the slot, material of the web engaging surfaces of the terminal to substantially seal that channel from that slot.

Each of the terminals may include tangs formed along one edge surface thereof for electrically contacting the conductor, a top surface having curved end portions for engaging a component external to the connector, and opposed side edge surfaces which are indented adjacent the curved portions of the top surface, the top surface and the indented portions being coated with a corrosion-resistant material.

The invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a telephone base and handset connected together by a retractile cord which is terminated at each end with a modular plug embodying the invention;

Figure 2 is an enlarged elevational view partially in section showing a modular plug embodying the invention inserted into a jack of a telephone set to connect a flat cord having conductors arranged in a planar array with components in the jack;

Figure 3A is a perspective view of a plug housing and a cord aligned for assembly with the housing;

Figure 3B is an elevational view of a portion of a strip of partially formed earlier type terminals;

Figure 3C is an elevational view of a portion of a strip of partially formed terminals;

Figure 4 is an elevational view partially in section and showing a housing of the modular plug prior to insertion of terminals;

Figure 5 is a plan view of the plug housing of Figure 4;

Figure 6 is an end view of the plug housing of Figure 5 taken along lines 6-6 thereof;

Figure 7 is a cross-sectional end view of the housing of Figure 5 and taken along lines 7-7 thereof;

Figure 8 is a cross-sectional end view of the housing of Figure 5 and taken along lines 8-8 thereof;

Figure 9A and 9B are partial cross-sectional views of variations of the plug of Figure 5 and taken along lines 9A-9A and 9B-9B thereof;

Figure 10 is an enlarged perspective view of a portion of the housing in the vicinity of the terminal-receiving slots;

Figure 11 is an elevational view partially in section of the plug of Figure 4 with a terminal in an armed, partially inserted position and showing strain-relief facilities in an actuated position to hold the cord within the plug housing;

Figure 12 is an end view of the plug housing

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of Figure 4 and showing terminals aligned with openings in the plug housing just prior to insertion;

Figure 13 is an end view of the plug housing of Figure 12 and showing the terminals being inserted into the housing and shifted laterally into planes aligned with the jack components;

Figure 14 is an end view of the plug of Figure 13 after the terminals have been seated fully therein;

Figure 15 is an enlarged perspective view showing one of the terminals seated in the plug housing with a portion of the housing broken away to show one of the conductor receiving cells with the conductor removed therefrom for purposes of clarity;

Figure 16 is an enlarged detail view of the engagement of one of the terminals with a conductor; and

Figure 17 is an enlarged perspective view of a modular plug assembled to an end of a telephone cord.

The phrase 'modular cord system' is intended to describe a system which includes the use of devices mounted in equipment and assembled to ends of cords to permit customer connection of the cords to the equipment. Modular devices also reduce the amount of work required of installers. The economic advantage of modular systems together with the convenience afforded the customer have resulted in widespread acceptance of such systems.

Modular cord systems typically include retractile cords 30-30 and line cords 35-35 (Figure 1), each having a plurality of individually insulated flexible conductors 31-31 and terminated with modular plugs 33-33. The flexible conductor 31 may be stranded wire or, preferably, a filamentary core 41 (Figure 2) having a plurality of tinsel ribbons 42-42 wrapped helically thereabout and enclosed with a suitable insulative covering 43 such as, for example, described in co-pending U.K. application No. 16520/77 (Serial No. 1582021). The insulated conductors 31-31, preferably, are disposed side-by-side in a planar array and are enclosed in a common jacket 44 made of a suitable plastics material. The final cord configuration has a cross-section with parallel sides and semi-circular ends, and is referred to as a 'flat cord'.

The cord 30 is connected to a telephone handset 34 (see Figure 1) or base 36, while the cord 35 is connected to a wall terminal 37 or to the base 36, by inserting a plug 33 into a jack 38 (see also Figure 2). The jack 38 is typically that shown in U.S. patent 3,990,764 and includes a plurality of wire-like contact elements 39-39 spaced on 0.040 inch centres.

A modular plug 33 having a dielectric strength of at least 1000 volts includes a housing 51 (see Figures 2 and 3A) which is made from a dielectric material, and a plurality of terminals 52-52. The terminals 52-52 connect electrically the conductors 31-31 of the cord

end held within the plug 33 and electrical components of telephone apparatus such as, for example, the wire-like contact members 39-39 of the jack 38. The terminals 52-52 are mounted within the housing 51 to be engageable by the contact wires 39-39 in the jack 38.

Portions of the housing 51 and the terminals 52 are described in U.K. patents 1445270, 1448811 and 1559572, and co-pending application no. 50239/77.

The terminal 52 is made from a sheet stock of an electrically conductive material such as, for example, brass or Phosphor-bronze alloy. As can best be seen in Figure 3A, the terminal 52 has flat faces 53-53 spaced apart by an edge surface 54 from which internal contact portions in the form of tangs 56-56 protrude. When the terminals 52 are seated fully within the housing 51, the tangs 56-56 pierce through the insulation of an engage electrically the conductors 31-31 (see Figure 2).

The terminals 52-52 include external contact portions which are exposed to an outer surface of the housing 51 and which engage the wire-like members 39-39 (see Figure 2) in the jacks 38-38 to complete electrical paths from the conductors 42-42 to the external components. Each terminal 52 has an external contact portion in the form of an edge surface 57 having crowns 58-58 of predetermined radii formed at the ends thereof. The crown 58 adjacent a free end 59 (see Figure 2) of the housing 51 functions to engage the wire-like component 39 of the jack into which the plug 33 is inserted.

As can be seen in Figure 3A, each terminal 52 is formed with side edge surfaces 61 and 62 and with side edge surfaces 63 and 64. Each terminal 52 has an overall height of about 0.166 inch with the side surface 61 being about 0.068 inch long and the side surface 63 being about 0.045 inch in length. The edge surfaces 61 and 62 of the terminal 52 are designed to co-operate with the plastics housing 51 to support the terminals in both an armed, i.e. partially inserted, position, and in a final position.

When the terminal 52 is in the fully seated position, the tangs 56-56 extend through the conductors 31-31 and are embedded slightly in the bottoms of the conductor-receiving facilities of the housing 51 (see Figure 2). This supplements the side edge support of the terminals 52-52 in the housing 51 to prevent unintended movement of the terminals.

Selected surfaces of the terminal 52 are plated with a metal such as, for example, gold, to prevent corrosion. The selected surfaces include the crowns 58-58 since they are exposed and since one of the crowns of each terminal is engaged by a contact wire 39 (see Figure 2), and further includes the edge surface 57.

Previous terminals were formed with spaced

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side edges having a cutout for indexing purposes when forming the terminals in a continuous strip (see Figure 3B). The strip of partially formed terminals was plated and sheared to form the terminals. Portions of the side edges along the shear line were not in engagement with the plastics housing, and since these portions were not plated, they were highly susceptible of becoming corroded.

By constructing the terminal 52 as shown in Figure 3A, all the edge surfaces not in engagement with plastics when the terminal is seated in the housing 51, are capable of being plated when interconnected together in strip form (see Figure 3C). These include the surfaces 57, crowns 58-58 and the indented edges 63 and 64.

The plug housing 51 is unipartite rigid housing (see Figures 4 and 5) designed to be constructed from a plastics material, by using conventional injection moulding techniques. Plastics material must provide suitable mechanical strength as well as adequate electrical insulation and may be, for example, a polycarbonate, a polyester, a polyamide or related polymer material such as ABS resins. The housing 51 includes the closed free end 59, a cord-input end 72, a terminal-receiving side 73 and a side 74 opposite to the terminal-receiving side 73.

As may be observed from Figure 4, the cord-input end 72 of the housing 51 is formed with a cord-input aperture 75 designed to circumscribe generally the outer periphery of the largest cord expected to be terminated with the plug 33. The unipartite housing 51 is constructed in one piece with no assembly of sub-parts required and with the aperture 75 formed entirely therewithin. The aperture 75 has a flared entrance 76 which prevents, advantageously, sharp bends in the cord 30 or 35 during customer use. The flared entrance 76 also facilitates insertion of an end portion of the cord 41 after ones of the conductors 31-31 have been inserted.

The aperture 75 opens to a cavity 77 which terminates adjacent a transition section 78. The transition section 78 includes a wall 79 which is tapered along the top and sides as viewed in Figure 4 to connect the cavity 77 to a plurality of conductor-receiving channels, designated generally at 80-80.

The conductor-receiving channels 80-80 of the housing 51 are constructed to provide a plurality of individual duct-like compartments or cells 82-82 disposed in one tier (see Figures 4 and 6) for receiving the conductors 31-31 of a cord 30 or 35. Each of the cells 82-82 is of sufficient size to accept one of the conductors 31-31 of the new 'flat' cord. The cell cross-section is generally slightly smaller than the cross-section of the largest expected conductor 31. As can be seen in Figure 4, the cells 82-82 terminate in a portion 81 of the housing 51.

Further, the housing 51 is constructed to prevent voltage breakdown between adjacent ones of the conductors 31-31 and the terminals 52-52. A voltage breakdown may result for example, from the ingress of moisture or other contaminants through the free open end of previous plugs which corrodes the terminals. The construction of the housing 51 with the free end 59 being closed by the portion 81 prevents the ingress of moisture or other contaminants and contributes to the 1000 volt dielectric strength of the plug 33.

As can best be seen in Figure 4, the cells 82-82 extend longitudinally of the housing 51 from the free end 59 to terminal-receiving openings, designated generally by the numeral 83. The cells 82-82 are disposed in one tier and are accessible from the terminal-receiving side 73. It should be understood that this arrangement is designed to accommodate a cord 30 or 35 having a planar array of conductors 31-31. As described in co-pending application No. 50239/77 (Serial No. 1596310), the plug 33 may also be constructed with two tiers of conductor-receiving cells to accommodate cords having old style 'round' cords having a non-planar array of conductors.

Each of the cells 82-82 is enclosed laterally throughout the length thereof and may have a generally square cross-sectional configuration formed by opposing walls 85-85, side walls 86-86 and partitions 87-87 (see Figures 5 and 6). The orthogonal intersection of each two adjacent walls which define each cell is replaced with a beveled surface 89 to provide more effective support for the conductor 31 therein during the insertion of the terminal. Also, the entrance to each cell 82, which is oriented toward the cord-input end 72 of the housing, is chamfered along side surfaces 88-88 (see Figures 6 and 8). The chamfering of the entrance portion of the cells 82-82 facilitates the insertion of the conductors 31-31.

In addition to the cells 82-82, the conductor-receiving channels 80-80 include a plurality of conductor-receiving troughs 98-98 which are aligned with associated ones of the cells and which are formed in a chamber 90 common to all the conductors 31-31. The troughs 98-98 are formed by a plurality of parallel, longitudinally extending ribs 91-91, which may have a generally triangular cross-sectional shape (see Figures 4-5, 8 and 10), which project from a floor 92 of the chamber 90, and which are aligned with the partitions 87-87 of the cells. The ribs 91-91 co-operate with the floor 92 to act as guideways for the conductors 31-31 and thus assist an installer who will insert conductors 31-31 into the channels 80-80.

The chamber 90 is configured to further improve the dielectric strength of the plug 33. At least one additional rib 93 (see Figures 4, 6, 8 and 9A) is formed along and depends from a ceiling 94 along the centreline of the housing 51. The rib 93 lengthens the dielectric path be-

tween the two centremost conductors 31-31 which have been found to be the most frequent source of breakdown.

In another embodiment in Figure 9B, a floor-to-ceiling partition 96 aligned with the partition 87 along the longitudinal centreline of the plug housing 51 is continued from the cells 82-82 to the transition section 78. In a further embodiment, the housing is constructed with the centre partition 96 and with ribs 97-97 on each side thereof depending from the ceiling 94 thereof.

An assembler removes a sufficient length of the cord jacket 44 to permit insertion of the conductors 31-31 into predetermined ones of cells 82-82 (see Figure 3A). Then the assembler inserts the jacketed portion of the cord 30 or 35 to abut the beveled surface 79 of the transition section 78 (see Figure 11), with the conductors 31-31 extending further along the guideways between the ribs 91-91 and into the cells 82-82.

The housing 51 is also constructed with jacket strain-relief facilities which are actuated after the leading end portion of the jacketed cord 30 or 35 is inserted into the cavity 77. These facilities, which contribute to the feasibility of the unipartite, as opposed to a two piece, housing 51, are described in U.K. patent No. 1558811.

The strain-relief facilities are disposed within an opening 101 (see Figures 4 and 5) which opens to the terminal-receiving side 73 of the housing 51. A jacket anchoring member 102 is disposed within the opening 101 and includes surfaces 103 and 104 which intersect along an edge 106. The anchoring member 102 extends generally across the width of the opening 101 and is connected to a portion 108 of the housing 51 through a plastics hinge 109 oriented toward the free end 59 of the housing, and at its other end, is connected temporarily by a fragile web 111 to a wall 112 adjacent the cord input end 72 the housing. The web 111 supports the anchoring member 102 in the as-manufactured, unoperated position as shown in Figure 4 to permit insertion of the end portion of the cord into the cavity 77. The surface 103 of the anchoring member 102 is moulded to include a stop 113 disposed centrally thereof.

After having inserted an end portion of a cord into the cavity 77, the assembler applies forces to the anchoring member 102 to break the web 111 and to move the anchoring member about its plastics hinge 109. As described in co-pending application no. 40728/76 (Serial No. 1558811) the stop 113 co-operates with surfaces 112 and 118 to maintain the anchoring member 102 locked engagement of the cord 30 in the housing 51. This arrangement permits the jacket strain-relief capability of the plug 50 to continue to be effective during customer use when retrograde forces are applied to the cord 41.

The plug 33 also includes conductor strain-relief facilities designated generally by the numeral 120 (see Figures 4 and 11). The conductor strain-relief facilities 120 are generally of the type shown, for example, in U.K. patent 1445270 and co-pending application no. 40728/76 (Serial No. 1558811).

Further, the plug 50 includes a tab 115 for locking the plug within a jack 38 (see Figures 4, 6 and 11). The tab 115 and its operation are disclosed in U.K. patent 1445270.

In order to mount a plurality of the terminals in the housing 51, the housing is constructed with a well 121 opening to the surface 73 (see Figures 3A, 4 and 7). The well 121 has a plurality of spaced, longitudinally extending dielectric separators in the form of fins 122-122 which project from an inner surface 123 of the well 121 toward a plane 124 of the terminal-receiving side 73. The fins 122-122 are spaced apart on 0.040 inch centres in order to correspond to the spacing of wire-like contact members 39-39 of the jack 38. When a plug 33 is inserted into a jack 38, each wire-like contact member 39 is received between two adjacent ones of the fins 122-122 (see Figure 14).

The housing 51 includes a plurality of terminal-receiving slots 132-132 (see Figures 4 and 7), each of which opens to the surface 123 and connects the well 121 with an associated one of the conductor-receiving channels 80-80. The terminal-receiving slots 132-132 extend parallel to the cells 82-82 and include end walls 136-136 and 137-137, which are oriented toward the free end 59 and the cord-input end 72, respectively. The rib 93 depends from the ceiling 94 of the cavity 80 between the two terminal-receiving slots 132-132 which are adjacent the longitudinal centreline of the housing 51.

The conductor-receiving channels 80-80 and the associated terminal-receiving facilities must be constructed within certain restrictions consistent with the dimensions of the associated jacks 38-38 and cords 30 or 35. The 0.040 inch spacing of the external contact elements 39-39 and the size of the jack 38 into which the plug 33 is inserted are standard dimensions used throughout the industry. The external dimension of the insulated conductors 31-31 is fixed. Since partitions adjacent the free end 59 of the housing 51 are used between the conductors 31-31 to provide optimum dielectric strength, the lateral spacing of the conductors held between the ribs 91-91 in alignment with the terminal-receiving slots 132-132 is greater than that between the centrelines between adjacent ones of the fins 122-122.

The terminal-receiving slots 132-132 are designed in order to accept the terminals 52-52 and to reorient the terminals by shifting them laterally. The reorientation is necessary because each of the terminals 52-52 is fed into an insertion position between two of

the fins 122-122, or between one of the fins 122 and the side walls of the well 121, on 0.040 inch centres. The lateral spacing between the terminals 52-52 in the pre-insertion position is slightly less than that in the fully seated position. The construction of plug 33 results in increased dielectric strength while maintaining compatibility with existing standard jacks 38-38 and jack wire spacing.

In order to shift the terminals 52-52 laterally upon insertion, the terminal-receiving slots 132-132 communicate with the terminal-receiving side 73 of the housing 31 through associated openings 134-134 (see Figures 7 and 8) which are specially formed to connect the vertical walls thereof with the top surfaces of the plug housing. As can best be seen in Figure 7, each of the two centremost slots 132-132 opens to opposed camming surfaces 141-141 formed on the fins 122-122. The openings 134-134 spaced farthest from the centreline of the housing 51 each include only one camming surface 142 formed along the surface of a fin 122. Since there is only one camming surface 142 associated with each of the outermost slots 132-132, these must be larger than the camming surfaces 141-141.

The function of the camming surfaces 141 and 142 in reorienting the terminals 52-52 can best be described by viewing Figures 12 and 13. A plurality of insertion rams 144-144 engage priorly fed terminals 52-52 and urge the terminals downwardly into a fully seated position. In Figure 12 it will be observed that the insertion rams 144-144 are aligned perfectly on a one-to-one basis with the terminals 52-52. As the terminals 52-52 are moved downwardly, the inner two terminals 52-52 engage the camming surfaces 141-141, pivot slightly and resume a generally vertical path of travel (see Figure 13). The outer two terminals 52-52 engage the camming surfaces 142-142 and are shifted laterally, but moreso than the inner two terminals. In the fully seated position (see Figure 14), the terminals 52-52 engage electrically the tinsel conductors 31-31 although they have been shifted laterally from their original position.

The camming surfaces 141 and 142 are effective in reorienting the terminals 52-52 which are fed to an insertion position in apparatus (not shown) at a predetermined spacing and in causing the terminals to be seated within the housing so as to be engageable by external components spaced apart the predetermined distance and to engage insulated conductors 31-31 spaced apart a distance other than the predetermined distance. This capability permits the use of a combination of individual cells 82-82 and rib extensions 91-91 which contribute to the dielectric strength of at least 1000 volts of the plug 33. At the same time, the continued use of a 'standard' spacing of external components, i.e. the jack wires 39-39, is permitted, thereby obviating the

need for expensive changes to assembly apparatus and to jacks already in use.

The terminals 52-52 must be supported within the housing 51 to ensure against unintended movement. The support of the terminals 52-52 in the plug 33 may be two-fold. First, since this plug 33 is destined for field assembly to a cord 30 or 35, the terminals 52-52 are assembled to the plug in a manufacturing facility in a partially assembled stage (see Figure 13) and then shipped to users in the field. This temporary support must be sufficient to prevent the terminals 52-52 from inadvertent canting, laterally or longitudinally, or drop-out. Secondly, permanent support must be provided for the terminals 52-52 when the terminals have been seated fully within the housing 51 (see Figures 2 and 14).

When all of the cord conductors are disposed in a planar array, such as, for example, the 'flat' cords commonly manufactured today, the terminal support function had been accomplished by the use of side edge barbs as in U.K. patent 1445270. The above-mentioned side edge barbs gouge away portions of the end walls which define the terminal-receiving slots and generally provide only point support with the plastics material. It has been found that this arrangement may render the terminal 52 subject to some pivotal movement which may be troublesome to field personnel using hand tools for the final seating. Also, it may not be possible to extend portions of the housing adjacent the terminal-receiving slots toward the terminal-receiving side of the plug in order to provide additional support for the terminal.

Terminals 52-52 constructed in accordance with the configuration shown in Figure 3 mitigate these difficulties and provide substantial surface support for the terminals. Turning now to the present housing 51, the width of each terminal-receiving slot 132 is about 0.014 inch while each of the terminals 52-52 is made from 0.012 inch thick sheet stock. Hence, there is insufficient proximity between the flat faces of terminals 52-52 and the side walls of the terminal-receiving slots 132-132 to support the terminals in the housing without risking undesired canting of the terminals.

The terminals 52-52 are configured along side edges for engaging the plastics material of the housing to support the terminals against unintended movement. The terminal-receiving slots 132-132 are dimensioned lengthwise between the end walls 136-136 and 137-137, respectively, to provide an interference fit with the terminals 52-52 received therein (see Figure 15). In order to provide the interference fit, each terminal 52 has an overall length of about 0.134 inch while each terminal-receiving slot 132 has an overall length of about 0.126 inch.

The co-operation of the edge surfaces of the terminals 52-52 and the end surfaces 136 and 137

137 of the terminal-receiving slots 132-132 provides suitable support for the terminals in both the temporary, armed, and fully seated positions. As can be observed from Figure 15, the insertion of the terminals 52-52 into the terminal-receiving slots 132-132 causes the edge surfaces 61-61 and the edge surfaces 62-62 to deform the end surfaces 136-136 and 137-137 of the openings which may include slight shearing of the plastics. The end walls 136-136 and 137-137 reform generally into grooves, the walls of which are in clamping compressive engagement with the edge surfaces and adjacent portions of the side edge surfaces 53-53 of the terminals. This arrangement advantageously provides a longer support surface for the terminals 52-52 than previous terminals having barbs formed on the sides thereof, and is especially effective in preventing canting of the terminals in the slots 132-132.

This arrangement advantageously results in a continuous end support surface for the terminals 52-52 and is especially helpful when providing a plug 33 armed with the terminals in a temporary position for shipment to field users. When the terminal 52 is in a temporary or armed position with the tips of the tangs 56-56 spaced slightly above conductor-receiving facilities, substantial portions of the edge surfaces 61 and 62, uninterrupted by cutouts, for example, are in engagement with the end walls of the housing 51. When the terminal 52 is in an armed, partially inserted position, approximately 0.033 inch of the overall height protrudes above the housing surface, and approximately 0.078 inch protrudes above the well surface.

The configuration of the terminals 52-52 and of the terminal-receiving slots 132-132 also cooperate to protect the terminals against corrosion which could result in a reduced voltage breakdown strength. As can best be seen in Figure 3C, the indented surfaces 63 and 64 of each terminal, which are used for indexing a strip of the terminals, and the crown surfaces 58-58 used for camming the jack wires 39-39 are capable of being plated along with the top edge surface 57. Hence, those surfaces of the terminals 52-52 which are exposed during use will have been plated. The non-plated surfaces 61 and 62 which are formed when the terminals are sheared from the continuous strip of partially formed terminals engage the plastics of the slots 132-132 in an interference fit (see Figure 15). This reduces the surface area of the terminals 52-52 which is exposed to the atmosphere and hence reduces corrosion of the terminals.

To further enhance the corrosion protection of the terminals 52-52, each of the slots 132-132 may be formed with a thin, e.g. 0.005 inch divider wall 150 between the slots and the common chamber 90 and the cells 82-82 (see Figures 9B and 15). When the terminal 52 is

driven to a fully seated position, the terminal punches through the divider wall 150. This causes the separated portions of the divider wall 150 moved downwardly as shown in Figure 16 with the terminal 52 to flex upwardly into clamping engagement with the terminal side surfaces 53-53. This advantageously prevents contaminants from entering the chamber 90 from the slots 132-132 and corroding the unplated tangs 56-56 which would adversely offset the dielectric strength of the cells. This is an important consideration when building the housing with the common chamber 90.

An alternative arrangement is to form the terminal-receiving slots with a restricted area adjacent the chamber 90 so that when a terminal is inserted and seated, the plastics forming the restriction forms a seal with the surfaces of the terminal. Either this partial closing of the interior of each slot 132 or a full closing as disclosed herebefore is effective to prevent the ingress of contaminants into the chamber 90.

While this invention has been described with reference to a unipartite housing 51, the invention is not so limited. The invention could be carried into effect with a two piece plug such as that shown in U.K. patent 1347166 and U.S. patent 3761869.

WHAT WE CLAIM IS:-

1. An electrical connector for terminating a cord having a plurality of insulated conductors, including a dielectric housing having a plurality of conductor-receiving channels spaced apart a first distance, and a plurality of terminal-receiving slots associated with the channels, each of the slots being aligned with its associated channel, the slots communicating with the exterior of the connector through openings which are spaced apart a second distance less than the first distance, the portions of the housing that define each opening including at least one camming surface which serves to guide a terminal inserted into that opening to enter the associated slot, and an electrically conductive terminal at least partially inserted into each of the terminal-receiving slots and having an internal contact portion for piercing the insulation of and making electrical contact with a conductor in the associated channel, an external contact portion for permitting electrical contact external to the connector, and oppositely disposed edge portions in compressive engagement with material of the housing to resist unintended movement of the terminal.

2. A connector as claimed in claim 1, wherein the housing includes a closed free end and an open cord-input end, the conductor-receiving channels each including a substantially laterally enclosed cell, and an aligned trough formed in a chamber, the cells extending from the closed end to the chamber.

3. A connector as claimed in claim 2, including at least one rib depending from a surface of

70

75

80

85

90

95

100

105

110

115

120

125

130



137 of the terminal-receiving slots 132-132 provides suitable support for the terminals in both the temporary, armed, and fully seated positions. As can be observed from Figure 15, the insertion of the terminals 52-52 into the terminal-receiving slots 132-132 causes the edge surfaces 61-61 and the edge surfaces 62-62 to deform the end surfaces 136-136 and 137-137 of the openings which may include slight shearing of the plastics. The end walls 136-136 and 137-137 reform generally into grooves, the walls of which are in clamping compressive engagement with the edge surfaces and adjacent portions of the side edge surfaces 53-53 of the terminals. This arrangement advantageously provides a longer support surface for the terminals 52-52 than previous terminals having barbs formed on the sides thereof, and is especially effective in preventing canting of the terminals in the slots 132-132.

This arrangement advantageously results in a continuous end support surface for the terminals 52-52 and is especially helpful when providing a plug 33 armed with the terminals in a temporary position for shipment to field users. When the terminal 52 is in a temporary or armed position with the tips of the tangs 56-56 spaced slightly above conductor-receiving facilities, substantial portions of the edge surfaces 61 and 62, uninterrupted by cutouts, for example, are in engagement with the end walls of the housing 51. When the terminal 52 is in an armed, partially inserted position, approximately 0.033 inch of the overall height protrudes above the housing surface, and approximately 0.078 inch protrudes above the well surface.

The configuration of the terminals 52-52 and of the terminal-receiving slots 132-132 also cooperate to protect the terminals against corrosion which could result in a reduced voltage breakdown strength. As can best be seen in Figure 3C, the indented surfaces 63 and 64 of each terminal, which are used for indexing a strip of the terminals, and the crown surfaces 58-58 used for camming the jack wires 39-39 are capable of being plated along with the top edge surface 57. Hence, those surfaces of the terminals 52-52 which are exposed during use will have been plated. The non-plated surfaces 61 and 62 which are formed when the terminals are sheared from the continuous strip of partially formed terminals engage the plastics of the slots 132-132 in an interference fit (see Figure 15). This reduces the surface area of the terminals 52-52 which is exposed to the atmosphere and hence reduces corrosion of the terminals.

To further enhance the corrosion protection of the terminals 52-52, each of the slots 132-132 may be formed with a thin, e.g. 0.005 inch divider wall 150 between the slots and the common chamber 90 and the cells 82-82 (see Figures 9B and 15). When the terminal 52 is

driven to a fully seated position, the terminal punches through the divider wall 150. This causes the separated portions of the divider wall 150 moved downwardly as shown in Figure 16 with the terminal 52 to flex upwardly into clamping engagement with the terminal side surfaces 53-53. This advantageously prevents contaminants from entering the chamber 90 from the slots 132-132 and corroding the unplated tangs 56-56 which would adversely offset the dielectric strength of the cells. This is an important consideration when building the housing with the common chamber 90.

An alternative arrangement is to form the terminal-receiving slots with a restricted area adjacent the chamber 90 so that when a terminal is inserted and seated, the plastics forming the restriction forms a seal with the surfaces of the terminal. Either this partial closing of the interior of each slot 132 or a full closing as disclosed herebefore is effective to prevent the ingress of contaminants into the chamber 90.

While this invention has been described with reference to a unipartite housing 51, the invention is not so limited. The invention could be carried into effect with a two piece plug such as that shown in U.K. patent 1347166 and U.S. patent 3761869.

WHAT WE CLAIM IS:-

1. An electrical connector for terminating a cord having a plurality of insulated conductors, including a dielectric housing having a plurality of conductor-receiving channels spaced apart a first distance, and a plurality of terminal-receiving slots associated with the channels, each of the slots being aligned with its associated channel, the slots communicating with the exterior of the connector through openings which are spaced apart a second distance less than the first distance, the portions of the housing that define each opening including at least one camming surface which serves to guide a terminal inserted into that opening to enter the associated slot, and an electrically conductive terminal at least partially inserted into each of the terminal-receiving slots and having an internal contact portion for piercing the insulation of and making electrical contact with a conductor in the associated channel, an external contact portion for permitting electrical contact external to the connector, and oppositely disposed edge portions in compressive engagement with material of the housing to resist unintended movement of the terminal.

2. A connector as claimed in claim 1, wherein the housing includes a closed free end and an open cord-input end, the conductor-receiving channels each including a substantially laterally enclosed cell, and an aligned trough formed in a chamber, the cells extending from the closed end to the chamber.

3. A connector as claimed in claim 2, including at least one rib depending from a surface of

the chamber opposite a floor of the chamber and extending from the conductor-receiving cells toward the cord-input end along the longitudinal centre line of the housing.

- 5 4. A connector as claimed in claim 3 wherein said rib extends from said surface to the floor of the chamber.

- 10 5. A connector as claimed in claim 2, 3 or 4 wherein the chamber includes spaced ribs which extend from a floor of the chamber towards the terminal-receiving slots to form the troughs.

- 15 6. A connector as claimed in any preceding claim, wherein each terminal-receiving slot communicates with its associated conductor-receiving channel through a restricted opening, whereby insertion of a terminal through the restricted opening causes material forming that opening to engage the side surfaces of the terminal to substantially seal that channel from that slot.

- 20 7. A connector as claimed in any one of claims 1 to 5, wherein each terminal-receiving slot is separated from its associated conductor-receiving channel by a frangible web of material which is penetrable by a terminal upon seating of that terminal in the slot, material of the web

engaging side surfaces of the terminal to substantially seal that channel from that slot.

8. A connector as claimed in any preceding claim, wherein each of the terminals includes 30 tangs formed along one edge surface thereof for electrically contacting the conductor, a top surface having curved end portions for engaging a component external to the connector, and 35 opposed side edge surfaces which are indented adjacent the curved portions of the top surface, the top surface and the indented portions being coated with a corrosion-resistant material.

9. A connector substantially as herein described with reference to the accompanying 40 drawings.

10. A connector as claimed in any preceding claim and a said cord terminated thereby, the terminals being seated in their associated slots 45 and electrically contacting their respective conductors of the cord.

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