

ELECTRICAL CONNECTORS

The present invention generally relates to the field of electrical connectors. More particularly, the present invention relates to electrical connectors whereby the base section of male terminals associated with conductive plates (usually called 'bus bars') may be positionally captured, and hence securely retained, by a tubular housing member for the male terminals and the means that couple the same to the base. In such a manner, deformation and/or positional skewing of the male terminals can be minimized (if not eliminated entirely).

Electrical connectors having a connector housing and capable of establishing electrical connection with external circuits are known, for example as disclosed in Japanese Utility Model publication no. 58-10306. The conventional connector structure described in this publication comprises a connector housing capable of accommodating a plurality of female terminals which may respectively be coupled to a plurality of parallel male terminals. The connector housing of the type described in Japanese Utility Model publication 58-10306 includes an insulating wall disposed perpendicular with respect to the housing's side

walls that are formed in the longitudinal direction of a frame. The resulting terminal accommodating chambers that are formed thereby are open-ended.

Furthermore, slanted guide surfaces are formed at a lower end portion of the insulating wall at positions on the inside and outside thereof which do not coincide with the lower open end of the frame. The above-described conventional structure may be fastened to the circuit board using a separate cover plate by means of screws that extend through holes formed in flanges associated with the lower portion of the housing.

The cover plate must be prepared and mounted separately of the electrical connector. Thus, increased complexity of the work needed for fabricating the connector ensues. Therefore, one problem that arises with the prior art electrical connector described above is that the overall cost of the connector increases. In addition, since the housing is fixed to the circuit board separately via screws, tools (e.g. screwdrivers) are needed which may not always be accommodated easily (if at all) in the close confines of a particular circuit board layout. As a result, fabrication efficiencies and/or productivities decrease.

A further problem with the above-described conventional electrical connector is that the base section of the male terminals cannot be retained by the lower surface of the housing. Therefore, the upper surface of the circuit board positioned away from the base is pressed towards the circuit board by the lower portion of the

inside surface of the housing flange. As a result, the base portions of the male terminals and/or the male terminals themselves can be easily deformed and/or positionally skewed.

It would be desirable to be able to provide an electrical connector which overcame the aforementioned problems associated with the prior art.

According to the present invention there is provided an electrical connector comprising an electrically insulating base member, a retaining wall extending upwardly from said base member, said retaining wall having a forward face thereto, at least one electrically conductive plate having a base portion disposed adjacent the forward surface of the retaining wall and a male terminal extending from the base portion forwardly of the retaining wall, a tubular housing positioned forwardly of the retaining wall and having a rear wall defining an opening into the housing through which the or each male terminal extends to be received within said housing, and resilient coupling means for coupling the tubular housing to the base member in such a manner that the rear wall of the tubular housing exerts a force against the base portion of the or each conductive plate so as to capture said base portion between the retaining wall and the tubular housing whereby the male terminal thereof is rigidly fixed within the tubular housing.

Thus it will be appreciated that the or each male terminal is protectively housed within the interior of the tubular housing, while the resilient coupling means prevent

the housing from being uncoupled from the base member whereby a positional restraint is maintained upon the base section of the or each terminal and deformation and/or skewing of the male terminal or terminals is minimised, if not eliminated.

Preferably the coupling means include a pair of guide rails formed on one of the base member and the tubular housing and a corresponding pair of grooves formed in the other of the base member and the tubular housing and adapted to slidably mate with respective ones of said guide rails.

In one embodiment of the invention, the guide rails are formed on the base member, the forward end of each guide rail comprising a resilient tongue member which, on sliding movement of the tubular housing along the base member, are sprung apart, and which, on completion of said sliding movement, engage a forward portion of the tubular housing to couple the housing to the base member.

Alternatively, the coupling means may comprise a resilient tongue element associated with one of the base member and the housing, and a recessed surface defined in the other of the base member and the housing, coupling of the housing to the base member being determined by engagement of the tongue element with the recessed surface.

In a still further arrangement, the coupling means may comprise a resilient tongue element associated with one of the base member and the housing, and an upstanding wall defined on the other of the base member and the housing, coupling of the housing to the base member being determined

by engagement of the tongue element with the upstanding wall.

Such arrangements enable the electrical connectors to be assembled without the use of tools and in a snap-action, one-touch manner. That is, by simply sliding the tubular housing into engagement with the base member until its final, coupled position is achieved, the tubular housing will be securely mounted to the base member so that it cannot readily be uncoupled therefrom. At the same time, the male terminals are protected due to the surrounding presence of the housing, and the increased mechanical support that the housing provided thereto.

By way of examples only, embodiments of the invention will now be described in greater detail with reference to the accompanying drawings wherein like reference numerals denote like structural elements and of which:

Figs. 1A-1F are each perspective views of respective electrical connectors according to the present invention, the electrical connectors being shown in a disassembled state thereof whereby the base, tubular housing, and female plug body are separated one from the other;

Figs. 2A-2F are each vertical cross-sectional views of the respective electrical connectors shown in Figs. 1A-1F taken along respective section lines therein, and thus are likewise shown in a disassembled state thereof;

Figs. 3A-3E are each respective perspective views of the electrical connectors shown in Figs. 1A-1E, but illustrated in a state in which the tubular housing is coupled to the base thereof;

Figs. 4A-4F are each vertical cross-sectional views of the connectors shown in Figs. 2A-2F, respectively, and illustrated in a state whereby the female plug body is inserted into the tubular housing (and thereby coupled electrically to the male terminals housed thereby);

Figs. 5A-5F are each cross-sectional views of the connectors shown in Figs. 2A-2F, respectively, and illustrated in a state whereby the base is separated from the tubular housing.

Figs. 6A-6F are each elevational cross-sectional views taken along respective sectioning lines in each of Figs. 4A-4F;

Fig. 7A is a side cross-sectional elevational view similar to Fig. 4A, but illustrated in a state whereby the female plug body is separated from the tubular housing;

Fig. 8A is a top cross-sectional view of the connector shown in Fig. 7A;

Fig. 9 is a collective cross-sectional view of the various electrical connector embodiments shown in Figs. 4A-4F as taken along section line 8-8 therein;

Fig. 10 is a collective lateral cross-sectional view of the various electrical connector embodiments shown in Figs. 4A-4F as taken along section line 10-10 therein;

Figs. 11A-11B are each perspective views of other embodiments according to the present invention showing the electrical connectors thereof in an assembled state;

Figs. 12A-12B are each perspective views of the respective electrical connectors shown in Figs. 11A-11B but shown in a disassembled state thereof; and

Figs. 13A-13D are perspective views showing alternative embodiments of the base according to the present invention.

The basic structures according to a particularly preferred embodiment of an electrical connector according to the present invention is shown in accompanying Figs. 1A-8A. As is shown especially in Figs. 1A and 2A, the electrical connector generally includes an electrically insulating base member 1 to which a tubular housing 11 of an electrically insulating and heat resistant plastic such as nylon 6,6 may be coupled (as will be described in greater detail below). A female plug member 13 may then be inserted into the tubular housing 11 so as to establish electrical communication with, for example, an external circuit.

The base 1 itself defines an opening in its upper surface 1 that, in turn, establishes an opposing, separated pair of longitudinally extending rail edges 41. These rail edges 41, moreover, form an upper integral portion of a pair of opposing, but mirror-imaged, L-shaped slots 31 that are defined in a front wall of the base member 1. The pair of slots 31 thus establish therebetween a vertically extending stop plate 21 which is an integral part of the front wall of base member 1.

The base member 1 may be fabricated from virtually any electrically insulating material. However, it is presently preferred to fabricate the same from a plastics material which is electrically insulating and which provides the necessary mechanical strength properties required of electrical connectors generally.

An upright (substantially vertical) retaining wall 5 is integrally provided on the upper surface 1 of the base member 1 at the rearward extent of the opening formed in the upper surface of the base member 1. Elongated metal conductive plates 6 are supported on the base 1 and include forward bent portions which lap over the forwardmost surface of the retaining wall 5. Each of the elongated conductive plates 6 includes a relatively narrower male terminal 7, these terminals 7 projecting forwardly parallel to one another (and to the parallel rail edges 41). Moreover, these terminals 7 are separated from one another by a dimension which is less than the lateral separation dimension between the opposing rail edges 41.

As shown perhaps more clearly in Fig. 2A, the tubular housing 11 defines openings 8 in its distal end wall. These openings 8 are sized and configured so as to closely conform to the size and shape of the forwardly extending male terminals 7 and thereby allow the male terminals 7 to extend therethrough - i.e. so that the male terminals 7 are positioned within and housed by the interior of the tubular housing 11 when the latter is coupled to the base 1 (see Figs. 7A and 8A, for example). The tubular housing 11 also includes an opposing mirror-imaged pair of generally L-shaped mounting legs that establish longitudinally extending guide grooves 9. The guide grooves 9 are sized and configured to accept a respective one of the rail edges

41 so as to allow relative sliding movements to occur between the tubular housing 11 and the base 1.

The tubular housing 11 is also provided with a resiliently deformable tongue element 101 that extends downwardly from the bottom wall thereof. The resilient tongue element 101 is, moreover, slanted downwardly and forwardly relative to the tubular housing 11 and terminates in a forwardmost edge.

As is shown particularly in accompanying Figs. 4A and 7A, the forwardmost edge of the tongue element 101 is engaged with the rear surface of the stop plate 21 when the housing 11 is coupled to the base 1 (i.e. in a state as shown in Fig. 3A, for example). Because of this engagement between the stop plate's rear surface and the forwardmost edge of the tongue element 101, the tubular housing 11 will be retained in its coupled relationship with base 1 - i.e. it cannot normally be withdrawn away from the male terminals 7.

In order to assemble the tubular housing 11 onto the base 1, the mounting legs of the latter are aligned with the similarly configured slots 31 so that the rail edges 41 mate with the guide grooves 9. The housing 11 may then be slidably moved rearwardly (i.e. in a direction towards the retaining wall 5) so that the male terminals 7 begin to enter the respective openings 8 formed in the rear wall of the housing 11. Continued rearward sliding movement of the housing 11 will cause the upper edge of stop plate 21 to engage the forwardly and downwardly slanted resilient tongue element 101, causing the latter to be urged upwardly

towards and into the recess 19 formed in the bottom wall of the housing 11.

With the housing 11 is in its 'seated' position - i.e. with the rear wall of the housing 11 abutting those bent portions of the conductive plates 6 on the forward face of the retaining wall 5 as shown in Fig. 3A - the tongue element 101 will have cleared the rearward surface of stop plate 21. As a result, the inherent resiliency of the tongue element 101 will thereby urge it to return to its 'normal' position (i.e. where it is slanted downwardly and forwardly). Upon returning resiliently to its normal position, the forwardmost edge of the tongue element 101 will thus abut against the rearward surface of the stop plate 21. The housing 11 will thereby be retained in its coupled relationship to the base 1 by virtue of this engagement between the tongue element 101 and the stop plate 21.

The rear wall of housing 11 will moreover exert a rearwardly directed force against the base sections of male terminals 7 which is maintained due to the inter-engagement of the tongue element 101 and the stop plate 21. Thus, the housing structure of the present invention not only protects the male terminals 7 due to the male terminals 7 being housed within the tubular housing 11, but also imparts structural rigidity to the male terminals 7 (and the conductive plate 6 associated therewith) due to the base sections 7 of the male terminals 7 being forcibly captured between the rear wall of housing 11 and the forward surface 5 of retaining wall 5. In this manner,

the conductive plates 6 do not necessarily need to be attached physically to the base 1 via separate fasteners - e.g. screws, rivets, etc - since the tubular housing 11 provides these fastening functions.

It will be appreciated, therefore, that the tubular housing 11 can be coupled to the base 1 in a so-called 'one touch' mounting manner (usually without the need of any tools) due to the snap-fitting relationship between the tongue element 101 and the stop plate 21. The housing 11, when coupled to the base 1, will therefore protectively house the forwardly projecting parallel male terminals 7.

With the housing 11 coupled to the base 1 as described above, the female plug body 13 (having female connecting terminals 12 corresponding in number to the male terminals 7) may then be inserted operatively within the opening defined at the forward end of housing 11. In such a manner, the male terminals 7 are each electrically coupled to the female terminals 12, as shown more specifically in accompanying Fig. 4A.

The female terminals 12 include a fastening claw 17 for securing the same within the female plug body 13 (the latter being formed of an electrically insulating plastics material,) as shown more clearly in Figs. 7A and 8A. Conductive wires 14 coated with an electrically insulating material are respectively connected to the female terminals 12 at a press connection portion 18 thereof (see Figs. 7A and 8A). The elongated conductive plates 6 or bus bars may be connected to an external circuit (not shown) due to electrical communication that is

established via the male terminals 7, female terminals 12, and conductive wire 14.

In order to ensure correct alignment of the female plug body 13 relative to the tubular housing 11 (e.g. so as to ensure that correct polarity of the established electrical connection ensues), the tubular housing 11 and female plug body 13 are provided with co-operating tongue and groove elements 15,16, respectively. Thus, when the female plug body 13 is slidably inserted into the tubular housing 11, the tongue and groove elements 15,16, respectively, will likewise mate. As such, only one coupling orientation of the female plug body 13 (and hence a single coupling orientation for the pairs of male/female terminals 7/12) relative to the tubular housing 11 is allowed.

Although the embodiment of the present invention discussed above has been described in terms of a pair of male connecting terminals 7 which are formed from a pair of conductive plates 6, more or less numbers of male terminals 7/conductive plates 6 may be provided without departing from the scope of the present invention. In this regard, the number of female terminals 12 that are provided in the female plug body will usually coincide with the number of male terminals 7. Moreover, the precise external shape of the tubular housing 11 will be determined in large part by the numbers of male/female terminals 7/12, respectively, that are provided. Hence, the use of a square tubular form of the housing 11 and a mateably configured female plug body 13 are merely preferred for the embodiments of the

present invention, and are thereby representative of the other geometric forms that the electrical connectors according to the present invention may take.

Another embodiment according to the present invention is shown in Figs. 1B-6B. In this regard, the reader will note that many of the structures associated with this embodiment (and the other embodiments of the invention to be discussed below) are essentially the same as those described above with reference to Figs. 1A-8A. Hence, these similar structures will not be described again in detail here. Instead, the discussion that follows will emphasize the structural and functional differences as between the various embodiments. Suffice it to say that similar structures as between all of the embodiments of this invention to be discussed herein bear the same reference numerals throughout the various Figures.

As is seen particularly in Fig. 1B, a pair of separated parallel rail edges 42 are formed in the insulating base 1. Each of the rail edges 42 integrally includes, at the forwardmost end thereof, a laterally resilient tongue element 42A. The tongue elements each include an interior engagement surface that is substantially aligned (i.e. co-planar) with the forward edges 22 of base 1. A relief slot defined in the base 1 laterally of each of the fastening members 42A creates a longitudinally extending arm parallel to the guide rails 42 that imparts lateral resiliency to the tongue element 42A. As a result, each of the tongue

elements 42A may be flexed resiliently outwardly relative to the other of the tongue elements 42A (i.e. so as to enlarge the separation dimension therebetween).

The tubular housing 11 may thus be coupled to the base 1 by aligning the rail edges 42 and the respective grooves 9 formed by the mounting legs. In this regard, it will be observed from Fig. 1B that a pair of outwardly divergent surfaces are also defined on the tongue elements 42A. These surfaces serve as cam surfaces of sorts so as to assist in the spreading of the tongue elements 42A during mounting of the tubular housing 11 onto the base 1. That is, when the rearward end of the tubular housing 11 contacts the cam surfaces, said surfaces will serve to assist in resiliently spreading the tongue elements 42A apart - i.e. due to the presence of the relief slots and the arms as described above. This state of coupling the housing 11 to the base 1 is perhaps more clearly shown in Fig. 5B. As a result, the housing 11 may be slidably moved into its final position - i.e. with the male connecting members being contained within the housing 11 - as is shown in Fig. 3B and 4B.

It will be observed that, with the tubular housing 11 in its seated position on the base 1, the tongue elements 42A will each return to their 'normal' condition by virtue of their inherent resiliency. As a result, the engagement surfaces thereof are brought into engagement with a portion of the forward face of the tubular housing 11 (see Fig. 3B, for example). In such a manner, the base sections of the male terminals 7 are each securely captured between

the rear wall of the tubular housing 11 and the vertically extending retaining wall 5 in a manner similar to that as described above.

A modified embodiment of an electrical connector according to the present invention is shown in accompanying Figs. 1C-6C. As shown particularly in Fig. 1C, the electrically insulating base 1 is provided with a raised platform section 23 which defines an upper supporting surface 23A. A centrally located recess 43 is defined in the supporting surface 23A near the forward edge of base 1.

The base 1 is also provided with opposing pairs of upright claw posts 33 which collectively establish a planar space above the surface 23A sized to closely accept the laterally projecting flange 9' of the tubular housing 11. The flanges 9' of the tubular housing 11 will thus be held securely against the bottom surface 23A of base 1 by means of the claw posts 33. A forwardly and downwardly projecting resilient tongue element 101 is provided on the bottom wall of the tubular housing 11 as is perhaps best seen in Fig. 4C.

The tubular housing 11 is coupled to the base 1 by aligning the laterally extending flanges 9' with the planar space established by the claw posts 33 and by sliding the flanges 9' thereunder. The portion of the supporting surface 23A forwardly of the recessed surface 43 will thus engage the tongue element 101 during initial sliding movements of the tubular housing 11 onto the base 1, causing the tongue element 101 to be resiliently displaced upwardly into the recess 19 formed in the bottom wall of

the tubular housing 11. However, once the tongue element 101 has cleared this forward portion of the supporting surface 23A, it will return to its 'normal' condition under the influence of its inherent resiliency as shown particularly in Fig. 4C. As a result, the forwardmost edge of tongue element 101 will engage the forwardmost edge of the recessed surface 43 in the support surface 23a. As a result, the tubular housing 11 is prevented from being withdrawn from the base 1. In addition, the base sections of the male terminals 7 will be securely captured between the rear wall of the tubular housing 11 and the vertical retaining wall 5 in a manner similar to that described previously.

A further embodiment of an electrical connector according to the present invention is shown in accompanying Figs. 1D-6D, respectively. The embodiment depicted in Figs. 1D-6D is essentially similar to the embodiment of the present invention described above with respect to Figs. 1C-6C. One principal difference, however, is that a resilient tongue element 44 is provided integrally with the supporting surface 23A associated with the base 1 and is upwardly and rearwardly inclined. A recessed surface 104, on the other hand, is defined in the bottom wall of the tubular housing 11 so as to receive the tongue element 104 therein. The rearwardmost edge of the tongue element 44 (see Fig. 2D) will thus enter the recessed surface 104 and will prevent withdrawal of the tubular housing 11 from its position when coupled to the base 1 (e.g. as shown especially in Figs. 3D and 4D).

Figs. 1E-6E depict a further embodiment according to the present invention. As shown, the base 1 is provided with a support surface which is an integral extension of the upper surface 25 thereof. A recessed surface 43 is centrally defined within the support surface near the forward edge of base 1. A pair of opposing upright flanged walls 35 each terminating in an inwardly turned flange member are provided and extend continuously from the forwardmost edge of the base 1 to adjacent the vertically extending retaining wall 5.

The tubular housing 11 of this embodiment of the invention is provided with a downwardly and forwardly slanted resilient tongue element 101 which engages the recess 43 when the tubular housing 11 is in its final coupled position with respect to base 1. In this regard, the tubular housing 11 is capable of being slidably received within the space established by the walls 35 and their respective flanges, the latter engaging the upper wall of the tubular housing 11. It will be noted that the flanges associated with the flanged walls 35, together with the interengagement of tongue element 101 and recessed surface 43 will securely couple the tubular housing 11 to the base 1.

A further embodiment of this invention is depicted in Figs. 1F-2F and 4F-6F, and is somewhat similar to the embodiment described above in connection with Figs. 1D-6D. Note also that the perspective view of this embodiment of the invention would be essentially identical to Fig. 3E). However, the principal differences therebetween are that

the embodiment of Figs. 1F-2F and 4F-6F includes an upwardly and rearwardly slanted tongue element 44 associated with the support surface 25 of the base 1, and a recessed surface 104 is defined in the bottom wall of the tubular housing 11. The resilient tongue element 44 will thus extend upwardly into the recessed surface 104 when the tubular housing 11 is coupled to the base 1, thereby preventing uncoupling of the same and capturing the base portions of the male connecting members 7 in a manner similar to that described above.

As the reader will appreciate, a variety of modifications may be made to the electrical connectors according to the present invention without departing from the scope thereof. Some of the modifications are shown in accompanying Figs. 11A-12A and 11B-12B. For example, the electrical connector shown in Figs. 11A-12A is similar to that described above with respect to Figs. 1C-6C. However, in the electrical connector of Figs. 11A-12A, a vertical stop plate 4 is provided at a forward edge of the base 1 and against which the resilient tongue element 10 (see Fig. 12A) associated with the tubular housing 11 is engaged when the tubular housing 11 is in its coupled position (See Fig. 11A).

The embodiment of the invention shown in Figs. 11B-12B is similar to the electrical connector described above with reference to Figs. 1D-6D. However, in the electrical connector shown in Figs. 11B-12B, a stop plate (not shown) extends downwardly into the channel defined in the bottom wall of the tubular housing 11. The upwardly and

rearwardly slanted resilient tongue element 44 associated with the bottom surface of base 1, will thus engage the stop plate to prevent uncoupling of the tubular housing 11 for the base 1.

Figs. 13A-13D each show alternative forms of the base 1 that may be incorporated into the electrical connectors of the present invention. More specifically, Figs. 13A-13D each shows an alternative embodiment of the base 1 whereby the upright retaining wall 5 includes a centrally located column member 5a that separates a pair of horizontally disposed male terminals 7. In these embodiments, the conductive plates or bus bars 6 are laterally disposed so that the housing (not shown in Figs. 13A-13D) will capture the base sections 7A of the plates 6 against the retaining wall 5 in a manner similar to that described above.



1. An electrical connector comprising an electrically insulating base member, a retaining wall extending upwardly from said base member, said retaining wall having a forward face thereto, at least one electrically conductive plate having a base portion disposed adjacent the forward surface of the retaining wall and a male terminal extending from the base portion forwardly of the retaining wall, a tubular housing positioned forwardly of the retaining wall and having a rear wall defining an opening into the housing through which the or each male terminal extends to be received within said housing, and resilient coupling means for coupling the tubular housing to the base member in such a manner that the rear wall of the tubular housing exerts a force against the base portion of the or each conductive plate so as to capture said base portion between the retaining wall and the tubular housing whereby the male terminal thereof is rigidly fixed within the tubular housing.

2. A connector as claimed in claim 1 in which the coupling means include a pair of guide rails formed on one of the base member and the tubular housing and a corresponding pair of grooves formed in the other of the base member and the tubular housing and adapted to slidably mate with respective ones of said guide rails.

3. A connector as claimed in claim 2 in which the guide rails are formed on the base member, the forward end of each guide rail comprising a resilient tongue member which, on sliding movement of the tubular housing along the



base member, are sprung apart, and which, on completion of said sliding movement, engage a forward portion of the tubular housing to couple the housing to the base member.

4. A connector as claimed in claim 1 in which the coupling means comprises a resilient tongue element associated with one of the base member and the housing, and a recessed surface defined in the other of the base member and the housing, coupling of the housing to the base member being determined by engagement of the tongue element with the recessed surface.

5. A connector as claimed in claim 1 in which the coupling means comprise a resilient tongue element associated with one of the base member and the housing, and an upstanding wall defined on the other of the base member and the housing, coupling of the housing to the base member being determined by engagement of the tongue element with the upstanding wall.

6. A connector as claimed in any one of claims 1 to 5 and further comprising a female plug member received within the tubular housing, said female plug member incorporating, for the or each male terminal, a corresponding electrically conductive female terminal coupled to the male terminal within the housing.

7. A connector as claimed in claim 6 in which the tubular housing and the female plug member include co-operating engagement means which determine the orientation of the plug member in the housing.

8. An electrical connector substantially as described with reference to and as illustrated by the accompanying

drawings.

