Dec. 19, 1967 W. H. McKEE 3,359,529

ELECTRICAL CONNECTOR ASSEMBLY

Filed May 6, 1966

Fig.1

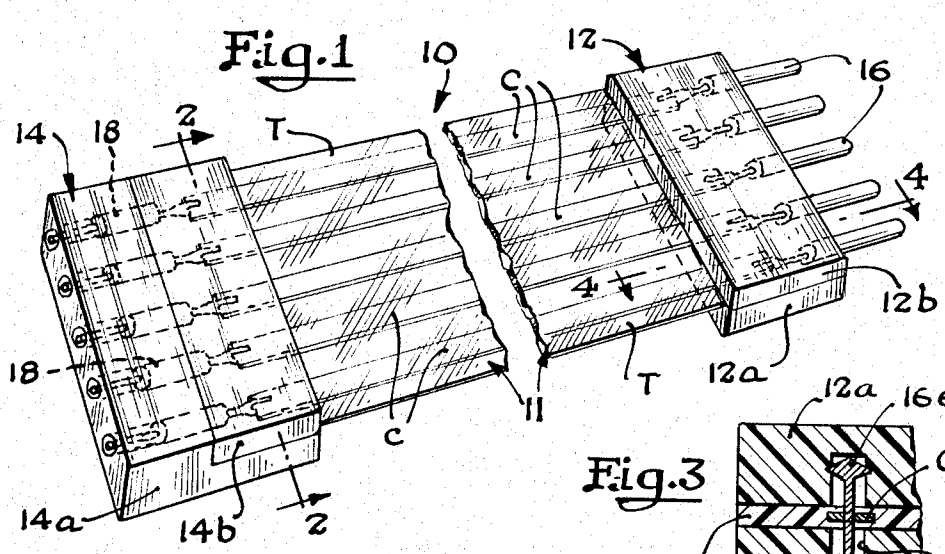


Fig.3

Fig.2

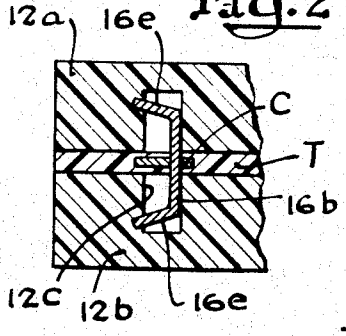


Fig.4

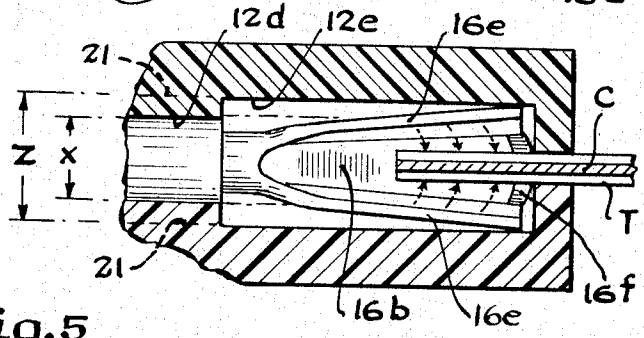


Fig.5

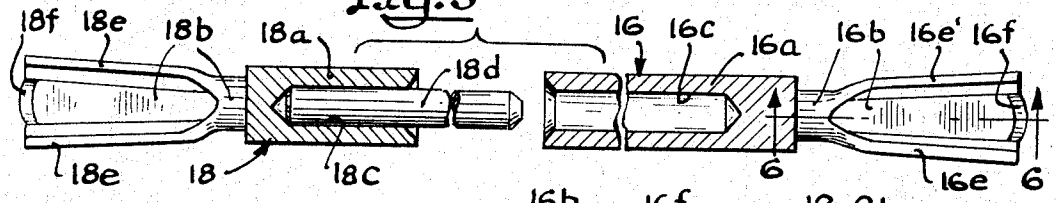


Fig.7b

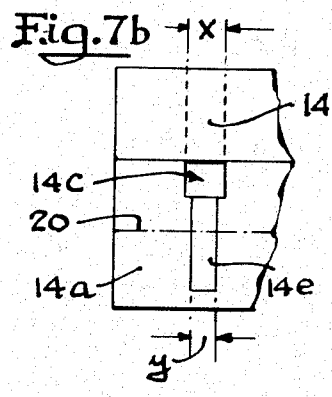


Fig.6

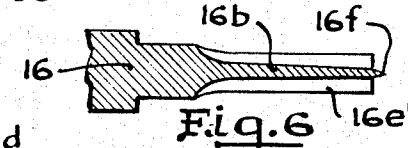


Fig.7a

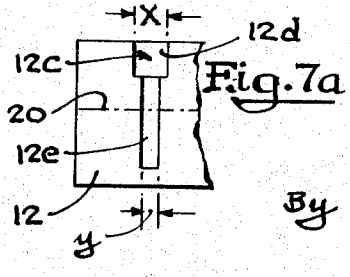
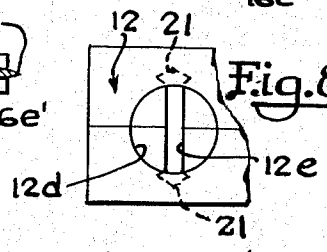


Fig.8



Inventor
William H. McKee
By John Todd
Attorneys

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ELECTRICAL CONNECTOR ASSEMBLY

William H. McKee, West Covina, Calif., assignor to United-Carr Incorporated, Boston, Mass., a corporation of Delaware

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The present invention relates to an improved electrical connector assembly and more particularly to an improved connector unit for use with flexible ribbon cable having a plurality of flat, ribbon-like conductor elements embedded therein and wherein a plurality of terminal elements are employed to maintain the respective body portions of the connector in a face-to-face relation so as to define an enclosure for the connector without the need of additional or external hardware.

In the miniature electrical connector art, especially that involving the manufacture of electrical connectors for use in printed circuit applications, or for use in aircraft, missiles, and/or other space vehicles, reliability and weight-saving are prime considerations.

The present invention is directed to the provision of an improved electrical connector unit wherein associated terminal elements are effectively utilized to retain economically formed insulating blocks in sandwiched relation so as to define a suitable protective enclosure for the connector unit. Accordingly, independent and additional means for utilizing the insulating blocks are not required. In this way a small, but perhaps significant, weight-saving may be realized without any attendant sacrifice in reliability. In the manufacture of a connector of this type, it can readily be appreciated that the small weight-saving realized in each connector may be significant when the number of connector assemblies utilized in any given aircraft or space vehicle is considered.

It, accordingly, is a general object of the present invention to provide an improved electrical connector assembly.

Another object of the present invention resides in the provision of an improved electrical connector assembly having connector units terminating respective ends of a cable wherein each of the connector units include complementary connector bodies economically formed from plastic or other suitable insulating material.

A further object of the present invention is to provide an improved electrical connector unit wherein the respective body sections of the connector in the form of preformed insulating blocks are retained in the proper sandwiched relation about the cable by associated terminal elements inserted within the connector unit.

An additional object of the present invention resides in the provision of improved electrical connector units for use with flat, flexible cables of the type having ribbon-like conductors embedded therein and wherein associated terminal elements are employed within the connector units to hold the connector bodies in the form of insulating blocks of plastic material in sandwiched protective configuration about the cable and also to cut into the ribbon-like conductors and establish electrical continuity thereto.

Still another object of the present invention is to provide an improved electrical connector assembly wherein connector units terminate the respective ends of a flat, flexible cable having a plurality of embedded ribbon-like conductors and wherein the connector units include terminal elements insertable therein with each terminal element making electrical contact with an associated one of the ribbon-like conductors and remaining electrically isolated from each of the other ribbon-like conductors.

A further object of the present invention resides in the provision of an electrical connector that is economical

to manufacture, easy to assemble and that is reliable in use as well as being relatively light weight.

The novel features which are believed to be characteristic of the present invention are set forth with particularity in the appended claims. The invention itself, however, together with further objects and advantages thereof, will best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a fragmetary view in perspective of an electrical connector assembly constructed in accordance with the present invention and which includes a multi-ribbon cable terminated in complementary electrical connectors at each end;

FIGURE 2 is an enlarged fragmentary view in cross-section taken generally along lines **2—2** of FIGURE 1;

FIGURE 3 is an enlarged fragmentary view in cross-section similar to that of FIGURE 2 and showing another embodiment of the terminal element;

FIGURE 4 is an enlarged fragmentary view in cross-section showing a detail of the terminal element and taken generally along lines **4—4** of FIGURE 1;

FIGURE 5 is a view in side elevation and partly in cross-section of the terminal elements showing the constructional details thereof;

FIGURE 6 is a top plan view in cross-section of a portion of the terminal elements taken generally along lines **6—6** in FIGURE 5;

FIGURE 7*a* is an enlarged fragmentary section of a connector body illustrated in plan view and showing a detail of the formed channel therein;

FIGURE 7*b* is an enlarged fragmentary section of another connector body illustrated in plan view and showing a detail of the formed channel therein; and

FIGURE 8 is an enlarged fragmentary section of the connector unit shown in front elevation.

Referring now to the drawings, an electrical connector assembly **10** is shown in FIGURE 1 which is constructed in accordance with the present invention. The cable employed is of the flexible multi-ribbon type, identified generally at **11**. That is, a plurality of conductor ribbons, indicated at C, are embedded in a carrier tape T of insulating but flexible material. In the preferred form, the ribbon coductors C are formed of copper strips and are laminated within the tape T (FIGURE 6) formed from a thermo-setting plastic material, which, when set, forms a tough, durable and tear-resistant protective sheath for the conductors C. With this construction, the advantage of light weight is obtained as well as optimum flexibility and durability.

In the embodiment shown in FIGURE 1, the cable **11** includes five ribbon conductors C embedded therein. It is to be understood, however, that a greater or lesser number of conductor ribbons may be employed as desired or as the particular application requirements dictate.

To maintain the characteristics of light-weight, compact-size, and reliability as exhibited by the ribbon cable **11**, the same features must necessarily be reflected in the associated connector units employed to terminate the respective ends of the cable. That is, the connector units must be constructed of a relatively light, but durable insulating material, easily formed, and which does not require any bulky, external hardware in assembling the units on the cable.

Connector units which embody the above characteristics are shown in FIGURE 1. As shown, a connector unit **12** terminates one end of the cable **11** and a connector unit **14** terminates the other end. Each of the connector units **12** and **14** are seen to include a plurality of associated terminal elements within formed channels extending longitudinally inwardly in a parallel relation from the forward edge. The connector unit **12** includes terminal

elements **16** of the female type and the connector unit **14** includes terminal elements **18** of the male type.

The connector unit **12** comprises a pair of separate but complementary connector bodies **12***a* and **12***b* of an identical, generally rectangular configuration and which are adapted to be assembled in a face-to-face, sandwiched relation about an end portion of the cable **11**. The connector unit **14** comprises a generally L-shaped connector body **14***a* and a smaller complementary cap portion **14***b*. The formed channels provided in each of the connector units **12** and **14** are identified at **12***c* and **14***c*, respectively.

As seen in FIGURE 7*a*, the formed channel **12***c* is slotted longitudinally inwardly from the forward edge of the connector unit **12** and includes a cylindrically shaped forward portion **12***d* having a diameter X and a rectangularly shaped slot or compartment **12***e* located to the rear and coaxially aligned with the cylindrically shaped section **12***d*. It will be observed that, in the plane of the connector body **12**, the width of the slot **12***e*, indicated at Y, is somewhat less than the diameter X of the cylindrical portion **12***d*. However, in the plane normal to the connector body **12**, and as best seen in FIGURE 4, the height of the slot **12***e*, indicated at Z, exceeds that of the diameter X of the cylindrical portion **12***d*. The channels **12***c* may be formed in the respective connector body portions **12** and **12***b* in any suitable manner, such as by forming the same during the molding process for the connector unit **12**. Alternatively, the channels **12***c* may be formed by cutting, drilling and/or slotting the channels subsequent to molding the respective connector bodies **12***a* and **12***b*. It has been found more economically advantageous, however, to preform the channels **12***c* during the molding process of the connector bodies **12***a* and **12***b*, and for that reason is preferred.

The formed channels **14***c* in the connector unit **14** are similar to the channels **12***c* for the connector unit **12** in that a cylindrical section **14***d* is provided in the forward part of the connector unit adjacent the front edge and a rectangularly shaped slot **14***e* is formed to the rear of and coaxially aligned with section **14***d*. For the connector unit **14**, however, the longitudinal length of the cylindrical section **14***d* is greater than that of the cylindrical section **12***d*, as seen in FIGURE 7*b*. The dimensions for the slot **14***e*, however, are the same as the dimensions of the slot **12***e* for the connector unit **12**.

It is to be noted that the connector **14** may be constructed having connector bodies of identical configurations similar to that provided for the connector unit **12**, if it is so desired. However, the embodiment as shown in FIGURES 1 and 7 has the advantage that the connector body section **14***b* may be constructed to be identical in all respects to that of the connector bodies **12***a* and **12***b*, and for that reason is preferred. The respective sections of the connector units **12** and **14** are constructed from a suitable insulating material, such as a thermo-setting plastic, for light-weight, ease of molding, and which is sufficiently elastic or deformable in the finished form so as to readily accommodate the insertion of the associated terminal elements in the manner to be described subsequently.

The terminal elements **16** and **18** are seen more clearly in FIGURE 5. It is to be understood that each of the terminal elements **16** are identical in all respects. The same, of course, is true for the terminal elements **18**. For this reason, a description of the configuration for one each of the terminal elements **16** and **18** should suffice for all others.

The terminal element **16** as shown in FIGURE 5 includes a generally cylindrical sleeve portion **16***a* and a triangularly shaped flange or fin **16***b* flaring outwardly toward the rear of the fin. The terminal element **16** may be constructed as a one piece unit, or with the sleeve **16***a* and fin **16**b provided as separate parts and subsequently assembled, as by a press fit or the like. As a matter of choice, however, the unitized, one-piece construction is

preferred. The terminal element may be constructed of any suitable conducting material, such as Phosphor bronze. The element **16** may or may not be plated with a protective material, as desired. Two or three ten-thousandths of an inch gold plating has been found to be advantageous, however.

As shown in FIGURE 5, the fin **16***b* further includes a lip or embossed ridge **16***e* along both the top and bottom edges. FIGURE 2 illustrates one embodiment wherein the embossed ridges **16***e* extend laterally from one side of the fin **16***b* approximately perpendicularly thereto. FIGURE 3 illustrates another embodiment wherein the embossed ridges, indicated at **16***e'*, extend perpendicularly from each side of the fin **16***b* at the top and bottom to define an essentially I-beam configuration when viewed in cross-section. It is to be understood that the present invention is not limited to any particular configuration for the terminal elements, either as to the embodiments as shown or modifications thereof.

From FIGURE 5 it will be seen that the terminal element **18** also includes a cylindrical sleeve portion **18***a* similar to the sleeve **16***a*, but having a somewhat shorter longitudinal length than the sleeve **16***a*. A triangularly shaped flange or fin **18***b* is provided which is identical in all respects to the fin **16***b*. A connecting pin **18***d* is fitted within the open end of the sleeve portion **18***a*, as shown. In the interconnected condition, the pin **18***d* is slidably received in the open end of the sleeve portion **16***a* of the terminal element **16** to establish electrical continuity between the associated elements **16** and **18**.

In assembling the connector unit **10**, one end of the ribbon cable **11** is clamped by a suitable temporary clamping device, as by a vise for example (not shown), between the respective connector bodies **12***a* and **12***b* of the connector unit **12**. The end of the cable **11** is positioned at approximately the dot-dash line **20** as shown in FIGURE 7*a*. Each of the terminal elements **16** are then inserted within the formed channels **12***c*. The terminal elements **16** are inserted with the fin **16***b* entering first, best seen in FIGURE 4. As shown in FIGURE 4, the height of the fin **16***b* approximates that of slot **12***e* and therefore exceeds the diameter X of the cylindrical section **12***d*. However, since the connector bodies **12***a* and **12***b* are constructed of a relatively soft plastic material, the embossed ridges **16***e* (or **16***e'*) of the fin **16***b* cut into the plastic material as represented by the dotted lines **21** in FIGURES 4 and 8. As the terminal element **16** reaches a position where the fin **16***b* enters the rectangular slot **12***e* to the rear, the sides of the embossed ridges **16***e* (or **16***e'*), being wider than the width of the slot **12***e*, again cut into the plastic material of the connector body **12** as shown in FIGURE 2 (or 3). Ths firmly secures the respective connector halves **12***a* and **12***b* together. Further, since the embossed ridges **16***e* (or **16***e'*) flare or taper outwardly toward the rear, the connector bodies **12***a* and **12***b* are subjected to clamping action by the fin **16***b* in the manner indicated by the arrows shown in FIGURE 4. When all of the terminal elements **16** are inserted into place, the clamp or vise initially clamping the connector halves **12***a* and **12***b* may be removed and the connector unit **12** is firmly secured to that particular end of the ribbon cable **11** by the action of the associated terminal elements **16** and thereby define an integral connector unit without further additional and/or external hardware being required.

As seen in FIGURES 4, 5 and 6 the end of the fin **16***b* remote from the sleeve portion **16***a* includes a knife, or cutting edge **16***f*. When the terminal element **16** is inserted within the formed channel **12***c*, the knife edge **16***f* is aligned with the edge of a ribbon conductor C, as shown in FIGURES 2, 3 and 4. When the ribbon cable **11** is firmly clamped between the connector bodies **12***a* and **12***b*, the knife edge **16***f* will cut into the cable and embedded ribbon conductor as the terminal element **16** is fully inserted into the formed channel **12***c* and thus

make electrical contact with the latter along a length thereof as shown in FIGURE 4.

In like manner, each of the remaining terminal elements **16** are assembled within an associated formed channel **12***c* in the connector unit **12** and are effective to provide a clamping action between the respective connector bodies **12***a* and **12***b* and to establish electrical contact with an associated one of the ribbon conductors C embedded in the ribbon cable **11**.

Similarly, each of the terminal elements **18** are inserted within an associated formed channel **14***c* in the connector unit **14** with the fin **18***b* providing a clamping action between the respective connector bodies **14***a* and **14***b* in the manner as above described for terminal elements **16**. The coined knife edge **18***f* on the end remote from the cylindrical sleeve portion **18***a* cuts into the clamped ribbon cable and an associated one of the ribbon conductors C to make electrical contact thereto.

With the construction as thus described an electrical connector assembly is provided which is simple and economical to manufacture and assemble, light in weight, flexible and highly adaptable so as to fit the requirements of diverse applications, yet possessing a reliability that is compatible for the most demanding circuit requirements.

In one specific construction found satisfactory, an electrical connector assembly as shown in FIGURE 1 was provided having an overall length of 5 inches as measured from the end of the connector unit **14** to the extremities of the terminal elements **16** in the connector unit **12**. The dimensions of the connector unit **12** were approximately 9/16" x 1/4" x 1/8". The dimensions of the connector unit **14** were approximately 9/16" x 1/2" x 1/8". Overall weight of the entire connector assembly as described was less than 2¼ grams.

While only one specific embodiment of the invention is shown and described herein, it will, of course, be understood that other variations and modifications may be effected without departing from the true scope and spirit of the present invention. The particular construction of the connector unit and associated terminal elements may be varied to suit the convenience of the maker or application requirements. The appended claims are intended to cover all such modifications and alternative constructions that fall within their true scope and spirit.

What is claimed is:

1. An improved electrical connector unit for connecting terminal elements to ribbon-like conductors disposed within an electrical cable comprising, in combination:

a pair of complementary connector bodies in the form of blocks of insulating material adapted to be assembled in a face-to-face relation with a portion of the cable sandwiched therebetween;

formed channels in the connector unit disposed in parallel, aligned relation in the plane of the connector unit; and

a plurality of electrical terminal elements, one insertable within each of said formed channels, said terminal elements each having block engaging means to maintain said connector bodies in assembled, sandwiched relation about the cable and provide continuous clamping action between said connector bodies, said terminal elements each having a cutting edge insertable into a ribbon conductor to establish electrical continuity when the terminal element is inserted into the formed channel.

2. An improved electrical connector unit in accordance with claim **1** wherein said complementary connector bodies forming the connector unit are constructed of a thermo-setting plastic material having sufficient elasticity in the finished state to be easily deformable by the insertion of the terminal elements.

3. An improved electrical connector unit in accordance with claim **1** wherein said terminal elements each include a central body portion having a terminal flange extending coaxially therefrom, and said block engaging means are in the form of an embossed ridge extending along the top and bottom edges of said flange portion of the terminal element, which embossed ridges protrude laterally from said flange portion to a distance greater than the width of the formed channel.

4. An improved electrical connector unit in accordance with claim **1** wherein said clamping action exerted between the connector bodies is provided by the flange extending coaxially from the central body portion of the terminal elements, said flange having a triangular shaped configuration flaring outwardly toward the end remote from the central body portion to define a diverging angle between said embossed ridges extending along the top and bottom edges of the flange.

5. An improved electrical connector unit in accordance with claim **1** wherein the cable is of the type having a plurality of parallel, aligned ribbon conductors embedded in a sheath of insulating material and wherein each of the formed channels in the connector unit is slotted longitudinally inwardly from the forward edge of the connector unit and aligned with one of the ribbon conductors.

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MARVIN A. CHAMPION, *Primary Examiner.*

J. H. McGLYNN, *Assistant Examiner.*