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ELECTRICAL CONNECTOR

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Fig. 1

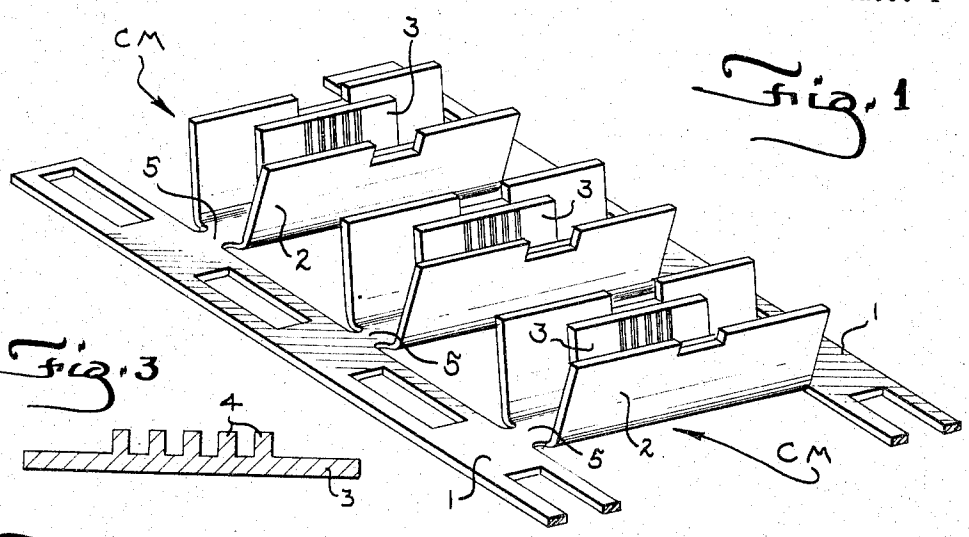

Fig. 3

Fig. 4

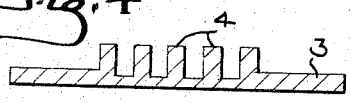

Fig. 2

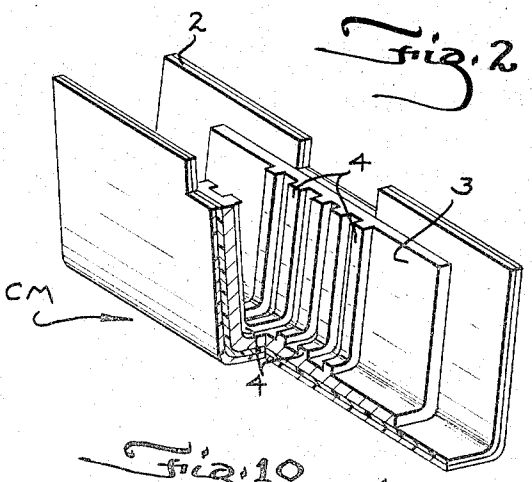

Fig. 5

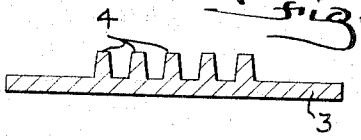

Fig. 6

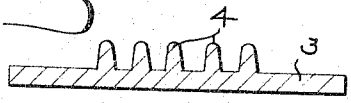

Fig. 7

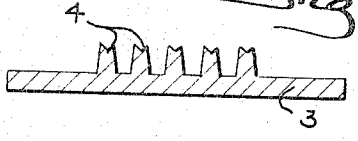

Fig. 10

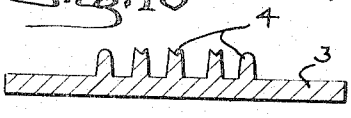

Fig. 8

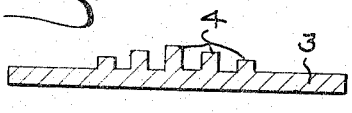

Fig. 11

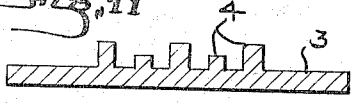

Fig. 9

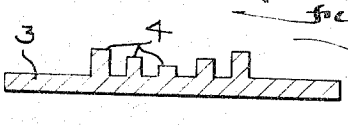

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Fig. 12

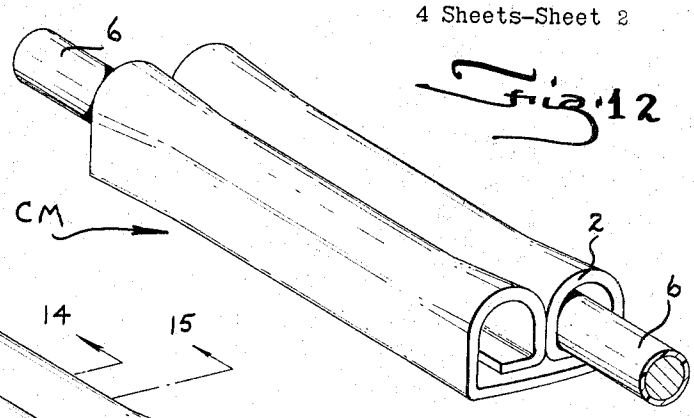
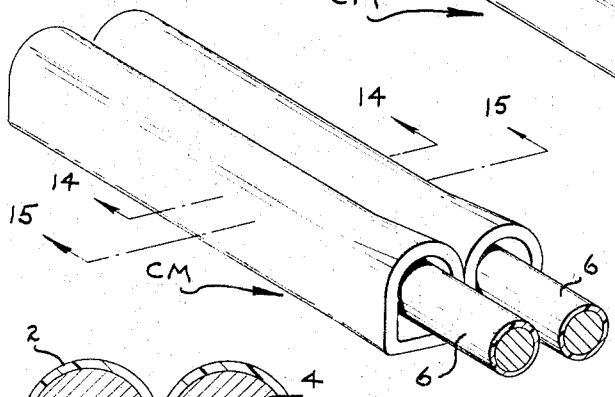


Fig. 13



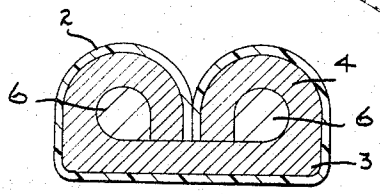


Fig. 15

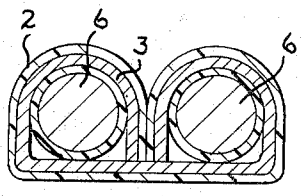


Fig. 14

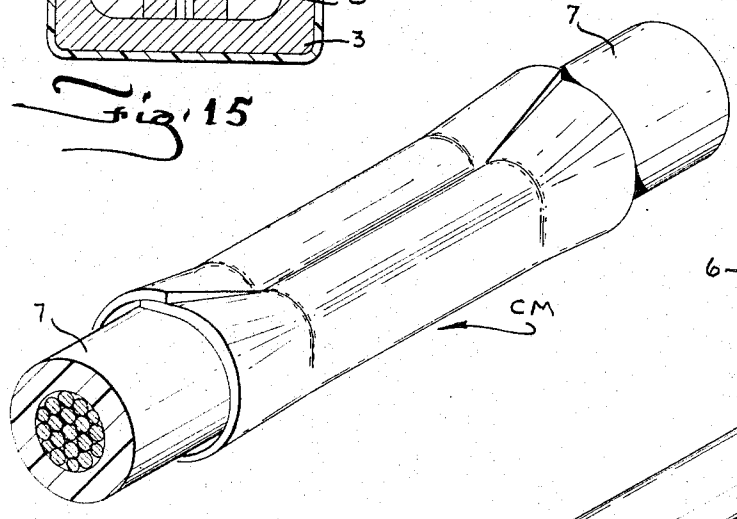
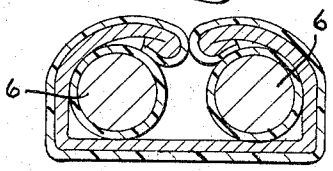


Fig. 16

Fig. 18



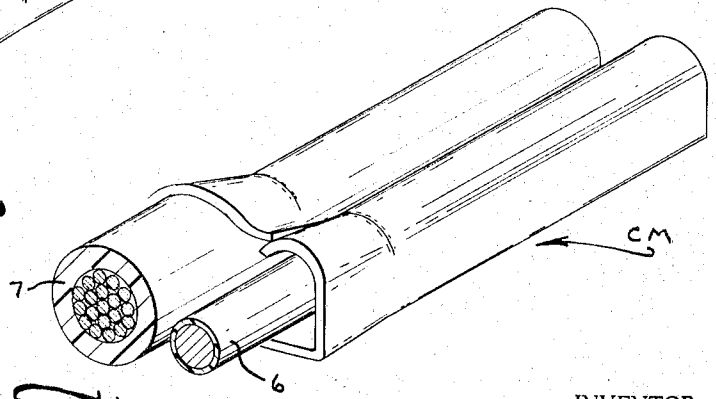


Fig. 17

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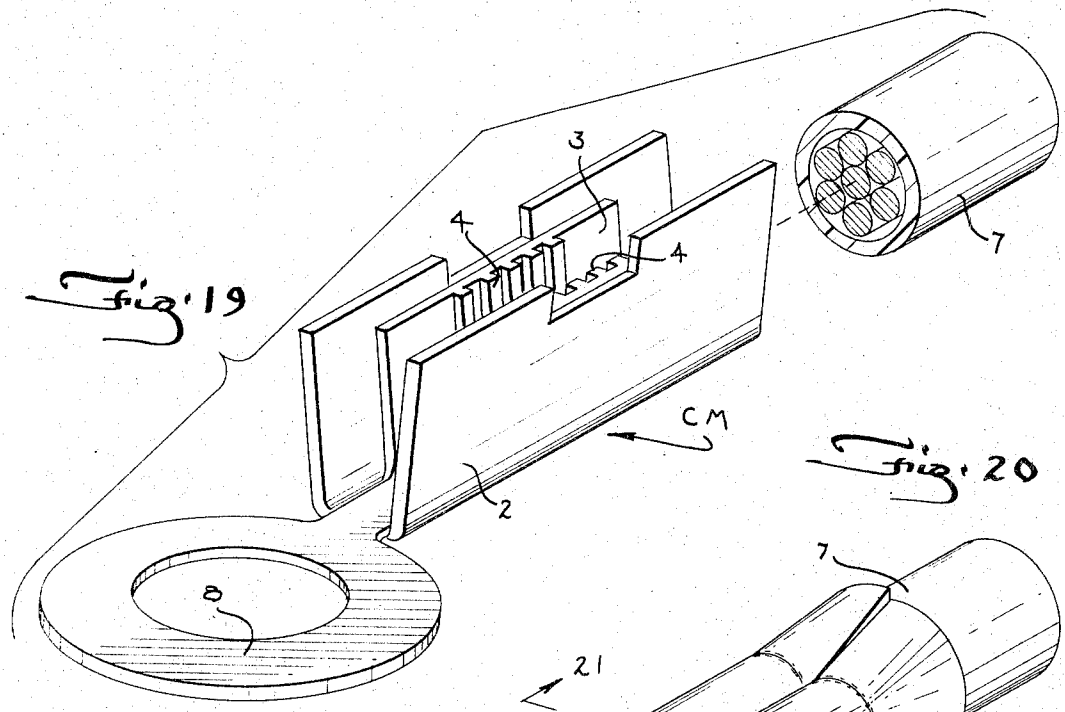

Fig. 19

Fig. 20

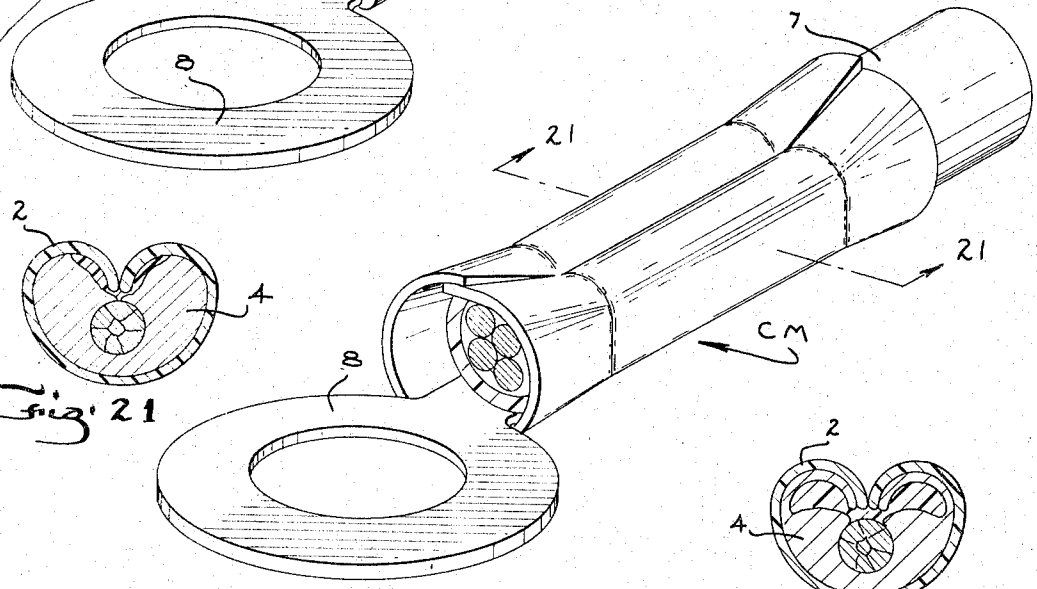

Fig. 21

Fig. 21a

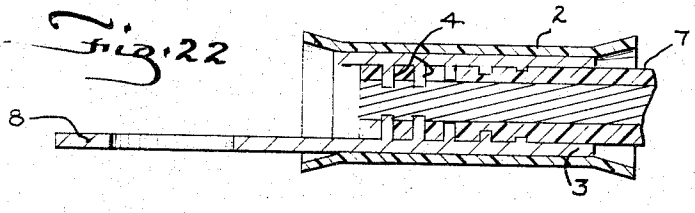

Fig. 22

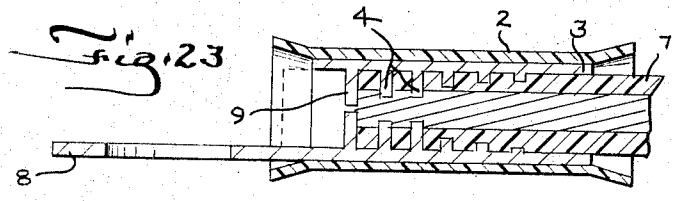

Fig. 23

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Fig. 24

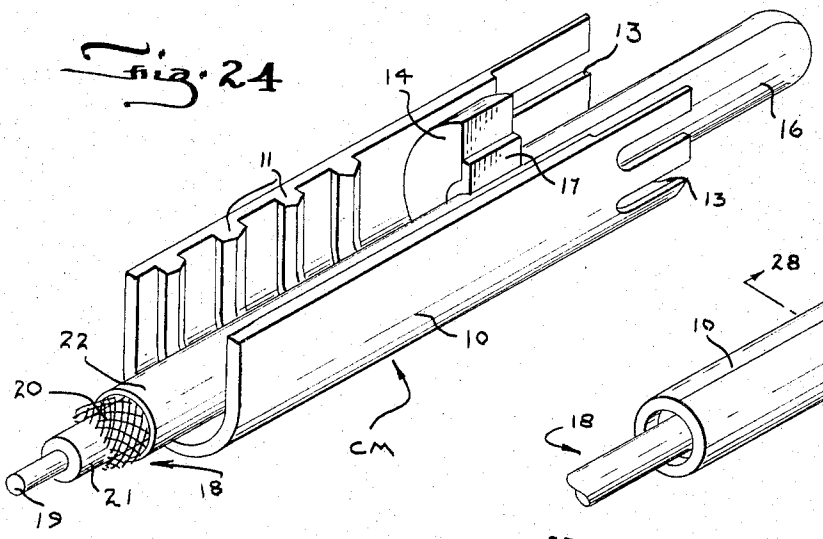

Fig. 26

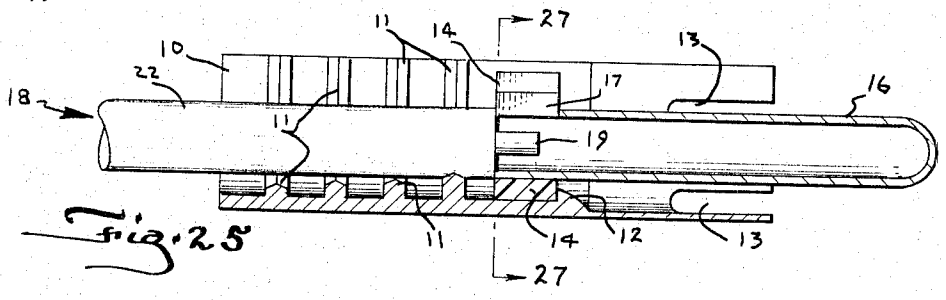

Fig. 25

Fig. 29

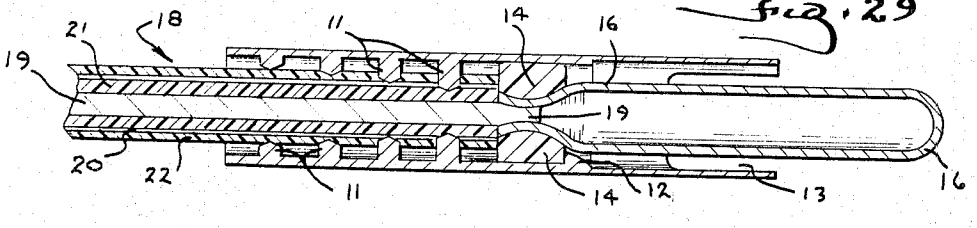

Fig. 28

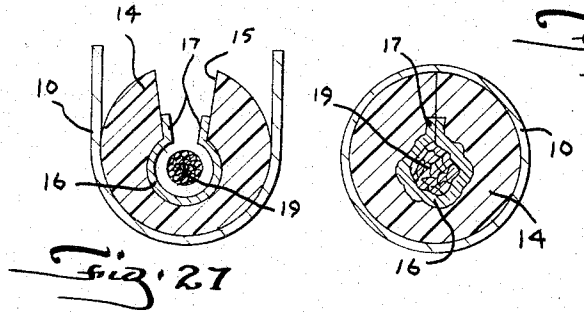

Fig. 27

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United States Patent Office 3,355,698 Patented Nov. 28, 1967

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ELECTRICAL CONNECTOR

Joseph Richard Keller, Harrisburg, Pa., assignor to AMP Incorporated, Harrisburg, Pa.

Filed Apr. 28, 1965, Ser. No. 451,394
13 Claims. (Cl. 339—97)

This invention relates to electrical connectors and more particularly to electrical connectors of the type crimpable onto conductor means.

An object of the invention is to provide an electrical connector that is crimpable onto the conductive portion of conductive means.

Another object of the invention is the provision of an electrical connector having ribs disposed transversely to the direction of the axis of the electrical connector.

A further object of the invention is to provide an electrical connector having ribs that can take various forms.

An additional object of the invention is the provision of an electrical connector having ribs extending outwardly from an interior surface and insulation disposed on an exterior surface.

A still further object of the invention is to provide a pre-insulated connector for engaging the conductive portion of conductive means.

Still another object of the invention is the provision of a pre-insulated connector having transverse ribs or pressure-relieving means for engaging the conductive portion of conductive means.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there is shown and described illustrative embodiments of the invention; it is to be understood, however, that these embodiments are not intended to be exhaustive nor limiting of the invention but are given for purposes of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the conditions of a particular use.

The foregoing objects are achieved in the present invention through the provision of an electrical connector means having a U-shaped metal member provided with rib members extending outwardly from the inside surface of the U-shaped member and transverse to the axis thereof. Insulation means is disposed on the exterior surface of the U-shaped member. The connector means is crimpable onto insulated conductor means for electrical and mechanical engagement with the conductive portion of the conductor means.

In the drawings:

FIGURE 1 is a perspective view of connector means in feed strip form;

FIGURE 2 is a perspective view partially in section of the connector means of the present invention;

FIGURES 3 through 11 are cross sectional views of the metallic portion of the connector means illustrating various forms of the rib members extending outwardly from the surface thereof;

FIGURES 12 and 13 are perspective views of the connector means crimped onto conductor means;

FIGURE 14 is a view taken along lines **14—14** of FIGURE 13;

FIGURE 15 is a view taken along lines **15—15** of FIGURE 13;

FIGURES 16 and 17 are perspective views of the connector means crimped onto conductor means;

FIGURE 18 is a cross sectional view of the connector means crimped onto conductor means;

FIGURE 19 is a perspective exploded view of an embodiment of the present invention;

FIGURE 20 is a perspective view of the connector means in FIGURE 19 in its crimped condition onto a conductor means;

FIGURE 21 is a view taken along lines **21—21** of FIGURE 20;

FIGURE 21*a* is a view similar to FIGURE 21 except that the rib members do not extend to the ends of the sides of the metallic member;

FIGURE 22 is a longitudinal sectional view of FIGURE 20;

FIGURE 23 is a view similar to FIGURE 22 but is directed to another embodiment;

FIGURE 24 is a perspective view of a further embodiment of the present invention;

FIGURE 25 is a longitudinal cross-sectional view of FIGURE 24;

FIGURE 26 is a perspective view of the embodiment of FIGURES 24 and 25 in its crimped condition;

FIGURE 27 is a view taken along lines **27—27** of FIGURE 25;

FIGURE 28 is a view taken along lines **28—28** of FIGURE 26; and

FIGURE 29 is a view taken along lines **29—29** of FIGURE 26.

Turning now to the drawings, there is illustrated a series of connector means CM integrally connected to slotted feed strip members **1** via insulation **2** of the connector means. Connector means CM, in feed strip form as illustrated in FIGURE 1, are appropriately fed into a crimping area of an applicator completely disclosed in Ser. Number 451,601 filed Apr. 28, 1965, now Patent No. 3,292,236 and assigned to the present assignee for successively crimping the connector means onto conductor means. Of course, the connector means may be fed into the crimping area of a crimping machine or crimping tool in any suitable manner as well as being individually placed within the crimping areas of a crimping machine or crimping tool.

Connector means CM comprises a metallic member **3** formed into a U-shape having rib members **4** extending outwardly from the interior surface thereof. The rib members extend transversely with respect to the axis of U-shaped metallic sheet **3**; the rib members are preferably spaced from each other with the rib members covering about half the length of metallic member **3**. As can be discerned, the portions of metallic member **3** from the outermost rib members **4** to each end of metallic member **3** contain no rib members so that the rib members are disposed inwardly from each end of the metallic member.

As can be perceived from FIGURES 3 through 11, rib members **4** take various forms. The rib members in FIGURE 3 are of the same height and are rectangular shaped in cross section. In FIGURE 4, the thickness of metallic member **3** between rib members **4** is less than that of the outermost portions beyond the rib members. Rib members **4** in FIGURE 5 are of the same height and have a wedge shape in cross section. The rib members in FIGURE 6 are similar to those in FIGURE 5 except that the tops are rounded. Likewise in FIGURE 7, rib members **4** are similar to those of FIGURE 5 except that the top of each rib member is provided with sharp edges. Rib members **4** in the embodiment of FIGURE 8 increase in height from outermost rib members **4** to the center, while in FIGURE 9, the rib members increase in height from the center to the outermost rib members. The rib members in FIGURE 10 are a combination of the rib members of FIGURES 6 and 7. In FIGURE 11, the rib members are of alternate heights. The thin por-

tion of metallic member 3 between rib members 4 as illustrated in FIGURE 4 can of course be applied to the other embodiments. While there have been disclosed various configurations of rib members 4, other configurations of rib members can, of course, be utilized as well as combinations thereof. It is also to be understood that the number of rib members extending outwardly from the interior surface of the sheet metal member depends upon many factors such as, for example, the length of the connector member, the distance between rib members, the thickness of the rib members, etc. The height of the rib members is determined by the type of conductor means to be terminated.

A suitable insulation material 2 is disposed on the exterior surface of U-shaped metallic member 3 and is preferably adhered thereto by means of a suitable adhering substance. As can be discerned from FIGURES 1 and 2, insulation 2 extends outwardly from the ends and sides of metallic member 3. The insulation material for use in conjunction with the present invention must be yieldable, must have a good coefficient of friction relative to the crimping members and must be tough. It has been found that Mylar fulfills the foregoing requirements and is therefore the insulation material that is preferably used in conjunction with the present invention; however, any other material fulfilling the foregoing requirements may be used. Insulation material 2 is preferably in laminated form with two sheets of Mylar glued together by means of a rubber based glue.

One reason for laminating the insulation material is to obviate any possibility of the insulation material having any discrepancy since any discrepancy occurring in the insulation material precludes the connector means from performing its intended function of providing a preinsulated connector means for terminating conductor means. Therefore, in the event that one of the thin sheets of laminated plastic has a discrepancy therein, it is an extreme remote possibility that the other thin sheet of plastic material will have a discrepancy at the same location; whereas, if the insulation material was nonlaminated and comprised a single sheet of material of equal thickness as that of the laminated material, a discrepancy occuring in this single sheet of insulation material would impair the insulation properties of the connection when the connector means is crimped onto a conductor means. Another reason for laminating the insulation material is that the rubber based glue allows the insulation material to flow more evenly with the metallic member during formation of the preinsulated connector means and during the crimping operation of the conector means onto the conductor means. Thus, the inside sheet of the laminated insulation material may be impaired during the crimping operation but the outside sheet of the insulation material will not be impaired at the location of impairment of the inside sheet thereby providing an insulated connection which is highly reliable. If a single sheet of insulation material is used in place of the laminated insulation material and if the single sheet of insulation material is impaired during the crimping operation, this impairs the insulation properties of the connection thereby decreasing its reliability.

The following procedure sets forth the desirable mode for manufacturing the connector means in strip form as illustrated in FIGURE 1. A strip of metal such as, for example, brass is subjected to a milling operation to form a strip of ribbed material. Of course, the strip of metal can also be subjected to a rolling, skiving, extruding or any other suitable operation to form a strip of ribbed material. A profiling operation is performed on the strip of ribbed material by conventional tooling to form the profile of metallic member 3 in its desired form. Insulation means 2 is formed as a laminated structure by gluing two thin sheets of insulation material such as, for example, Mylar together to form a strip of insulation material about twice the width of the metallic strip

of ribbed material. The laminated strip of insulation material is adhered to the metallic strip of ribbed material with the strip of ribbed material disposed centrally of the strip of insulation material. The combined strip of metallic ribbed material and insulation material is profiled by conventional tooling to form the sides of the insulation material into slotted feed strip members and the profiled metallic members along with the insulation material are formed into U-shaped connector means with the ends of insulation 2 being connected to feed strip members 1 via portions 5. Thus, there is formed a strip of open barrel connector means as illustrated in FIGURE 1 ready to be used in the applicator mentioned hereinbefore.

The connector means described in conjunction with FIGURES 1 through 11 can be used on various types of conductor means such as for example, conventional stranded or solid wire surrounded by an insulating sheet, film insulated wire, i.e., solid wire having a thin film of insulation therearound such as for example Formvar (polyvinyl formal resin) or other suitable insulating material, or combinations of conventionally insulated conductor means. FIGURES 12 and 13 illustrate connector means CM crimped onto conductor means 6 having a thin film of insulating material thereon. FIGURE 16 illustrates connector means CM crimped onto the ends of conductor means 7 which is of the type having stranded wires surrounded by an insulating sheath, and the connector means in FIGURE 17 is crimped onto the ends of conductor means 6 and 7 to interconnect same.

It is desirable when crimping the open barrel connector means of the present invention to use crimping dies of the type disclosed in U.S. Patent Nos. 2,600,012 and 2,818,632, which are assigned to the present assignee. In use, the connector means are fed or placed within the crimping area of the crimping dies, the conductor means being placed within the connector means. The crimping die of the crimping dies is operated causing the free ends of the connector means to be folded inwardly and downwardly toward the bottom of the connector means as illustrated in FIGURES 12 through 17 with each free end of the connector means circling or attempting to circle around the respective conductor means as illustrated in FIGURES 12 through 14 and 17. During the crimping operation of the connector means by the die members, the crimping pressure during a large portion of the crimping operation is on the rib members with the greatest amount of crimping pressure located at the center of the connector means, the crimping pressure decreasing from the center of the connector means outwardly toward each end thereof. Thus, at the outer ends of the connector means, i.e., where no rib members are located, the crimping pressure does not exceed the compressive strength of the insulation material; however, at the center of the connector means or the area where the rib members are located, the crimping pressure is many times the allowable compressive strength of the insulation material, but this high crimping pressure does not rupture the insulation material in this area because the resultant crimping pressure is restrained longitudinally along the connector means by friction between the crimping dies and the connector means which prevents the insulation material from being impaired during the crimping operation.

Due to the fact that friction is an essential ingredient which prevents impairment of the insulation material during the crimping operation, the surface finish and fit of the dies must be correct and the surfaces of the connector means and dies must be substantially free of foreign material in order to perform most satisfactorily. The length of the connector means is dependent upon the abovementioned parameters and its own cross section.

Since the metallic member of the connector means is elongated during the crimping operation and since the

insulation material is laminated, it is believed that the metallic member and the sheets of the laminated material undergo laminar flow thereby obviating rupture of the insulated material during the crimping operation.

In the case of film insulated wire in FIGURES 12 and 13, the top edges of the rib members other than the rounded rib members are sharp thereby allowing the rib members to shear through the insulation during crimping thus permitting contact between the conductive portion and the sides of the rib members. In the case of rounded rib members, these conductor means undergo elongation during the crimping operation causing the thin film of insulation on the conductor means to open in the areas of the rib members thereby allowing the rounded top rib members to engage the conductive portions of the conductor means as illustrated in FIGURE 15. In between the rib members, the insulation on the conductor means remains intact as illustrated in FIGURE 14. This is also true with respect to the portions of metallic member 3 from the outermost ribs to the ends thereof. An important feature of the present invention is the fact that insulation material **2** extends beyond the corresponding ends of metallic member **3** and the area of engagement along the insulation material where the free ends are folded inwardly thereby providing an insulated connection that more than adequately insulates the connection.

In terminating conductor means **7** in FIGURE 16, the non-striped ends of these conductor means are abutted in a central location of the connector means then the connector means is crimped in the same manner as that of FIGURES 12 and 13 thereby causing conductor means 7 to be electrically spliced together via connector means CM. Rib members **4** penetrate through the insulating sheaths of conductor means **7** and they electrically engage a conductive portion thereof in the same manner that the rib members engage the conductive portions of conductive means **6** in FIGURES 12 and 13. The engagement of the rib members with the conductive portion of conductor means **7** is illustrated in FIGURE 21. Between the rib members, the metallic member of the connector means engages the insulating sheaths of conductor means **7** in the same manner as that illustrated in FIGURE 14. FIGURE 17 merely illustrates the fact that conductor means **6** and **7** can be interconnected via connector means CM with the connector means engaging the conductive portions of conductor means **6** and **7** in the same manner as that illustrated in FIGURES 12 through 16. FIGURE 18 illustrates the free ends of the connector means being bent back upon themselves which occasionally happens mainly because of the size of the wire; however, this does not prevent the connector means from being effectively crimped onto the conductor means to form an excellent mechanical and electrical connection.

Some of the advantages of using the connector means of the present invention are as follows:

Crimp height control problems are reduced, crimping pressure requirement is less, more economical, longer applicator tooling and die life, crimping dies are of simplified construction and are not complicated and existing die designs can be utilized, conductor means need not be stripped prior to terminating, retention of connector means on the conductor means does not depend upon plastic under a compressive load, solid or stranded wire can be terminated, a controlled pressure gradient in the crimp allows crimping so that the wire barrel may be deformed through insulation material without damaging the insulation material. Thus, as can be discerned, the connector means of the present invention has a number of advantages that render the connector means highly desirable.

FIGURES 19 through 22 illustrate an embodiment of the connector means which is similar to that illustrated in FIGURE 2 except that a ring tongue **8** or some similar means for connecting the connector means to a mounting post or other connector means extends outwardly from metallic member **3** and beyond one end of insulation material **2**. Rib members **4** preferably take the form illustrated in FIGURE 22 in that the two rib members closest to ring tongue **8** are of the same height and the other rib members decrease in height. The tallest rib members are for penetrating through the insulating sheath and engaging the conductive portion of conductor means **7** while the other rib members penetrate into the insulating sheath for engagement therewith so as to provide a strain relief between the conductor means and connector means. FIGURE 21 shows a cross section through one of the rib members and in engagement with the conductive portion of the conductor means. FIGURE 21*a* illustrates a cross section of the connector means when the rib members do not extend to the ends of the sides of the metallic member.

FIGURE 23 illustrates an embodiment of the connector means of FIGURES 19 through 22 in that rib member **9** closest to ring tongue **8** is higher than any of the other rib members and constitutes a shearing rib member so that upon the crimping dies reaching the end of their crimping position, they are held in this position for a short period of time and a minimal force is applied to the conductor means being illustrated as **7'** over ring tongue **8** thereby severing the conductor means at this point from the portion of the conductor means crimped onto the connector means. This is accomplished by shearing rib member **9** almost shearing the conductor means through at this point thereby obviating having to cut or strip the conductor means in the area where the conductor means is to be terminated onto the connector means. This feature can also be applied to the connector means of FIGURES 1–18.

FIGURES 24 through 29 illustrate a further embodiment of the present invention which is directed to a coaxial connector means CCM and more particularly to coaxial connector means of the phonoplug variety. The coaxial connector means in this embodiment comprises a U-shaped barrel member **10** having spaced rib members **11** extending outwardly from the interior surface. As can be discerned, rib members **11** are of varying heights from the outermost rib member to the innermost rib member; the top of each rib member defines a sharp edge. A stop member **12** extends outwardly from the bottom surface of barrel member **10** and slots **13** are disposed in the forward portion of barrel member **10**. The thickness of barrel member **10** from stop member **12** to the outer end is about four times the thickness of the portion of the barrel member containing slots **13**, because the portion carrying the rib members is preferably thicker to allow proper crimping to be obtained while the thinner portion has to have spring characteristics. An insulator **14** is disposed in barrel member **10** between stop member **12** and an adjacent rib member; slot **15** is disposed in insulator **14**. Insulator **14** is made of yieldable plastic material and the inner part of slot **15** is substantially circular.

A center contact **16** is hollow and has one end defining a rounded configuration while the other end has lugs **17** extending outwardly therefrom. The lugged end of center contact **16** is disposed within slot **15** of insulator **14** as illustrated in FIGURES 24, 25, and 27. Thus, center contact **16** is placed within slot **15** of insulator **14** and the insulator is placed within barrel member **10** against stop member **12**. Insulator **14** is slightly larger than barrel member **10** so that the insulator fits snugly within the barrel member thereby maintaining the insulator and center contact **16** within the barrel member.

A coaxial cable means **18** is stripped so as to expose only a suitable length of center conductor **19** as illustrated in FIGURES 24 and 25. The coaxial cable means is placed within barrel member **10** and into engagement with insulator **14** and the lugged portion of center contact **16** so that center conductor **19** is disposed within the lugged portion thereof as illustrated in FIGURE 25. The coaxial connector means with the coaxial cable means in place

therein is then placed within suitable crimping dies (not shown). The crimping dies are operated to crimp the coaxial connector means onto the coaxial cable means thereby forming a crimped connection having a substantially O-configuration as illustrated in FIGURE 26.

During the crimping operation, barrel member **10** is compressed around the coaxial cable means and insulator **14** causing rib members **11** to penetrate outer insulation **22** with the highest rib members engaging outer conductor **20** and the shortest rib members penetrating just into the outer insulation so as to form a strain relief between the coaxial cable means and the coaxial connector means. Center conductor **19** and inner insulation **21** supplies sufficient backup support to allow the crimp to be performed. The action of crimping is transmitted through insulator **14** which crimps the lugged portion of center contact **16** onto center conductor **19** as illustrated in FIGURES 28 and 29. Thus, the embodiment of FIGURES 24 through 29 discloses a unique coaxial connector means that is crimpable onto coaxial cable means and stripping of the coaxial cable means to expose the center conductor is all the stripping operation that has to be performed.

While metallic member **3** and barrel member **10** have been disclosed as being U-shaped in configuration, it is obvious that they may take any suitable form and that crimping dies are to be used that will perform the desired crimping operation.

The present invention is useful in terminating conductor means that uses aluminum as the conductive portion. The present invention can be used in conjunction with conductor means whereby the conductive portion has been exposed via a stripping operation and, instead of ribs, these can be replaced by a thicker disposition of material in the crimping area of the connector means which would allow the crimping operation to be performed without rupturing or damaging the insulation material in the connector means and this is especially directed to the embodiments of FIGURES 2 and 19 on stripped conductor means. More than two conductor means can be terminated when using the connector means of FIGURE 2 and the free ends of the conductor means will evenly engage the conductor means. Extensions can be disposed on the free ends of the connector means of FIGURES 2 and 19 so as to extend outwardly from the sides where the rib members are located, because if more metal is provided in the central area of the metallic member, then this is the point of greatest pressure and at which the insulation material can support itself. Tapering of the metallic member to match the pressure gradient of the crimp allows the deformation of the metallic member through the insulation material without damaging the insulation material which has a lower yield than the metallic member.

As can be discerned, there has been disclosed a unique connector means for terminating insulating conductor means as well as a unique coaxial connector means for terminating coaxial cable means.

It will, therefore, be appreciated that the aforementioned and other desirable objects have been achieved; however, it should be emphasized that the particular embodiments of the invention which are shown and described herein, are intended as merely illustrative and not as restrictive of the invention.

What is claimed is:

1. An electrical connector comprising an open-barrel ferrule member having an interior surface extending generally throughout the ferrule member, a series of rib members extending outwardly from said interior surface of said ferrule member and extending transversely with respect to the longitudinal axis thereof, said rib members being disposed along an area of said ferrule member, said area being spaced inwardly from each end of said ferrule member extending along about one-half the length thereof, and insulation means on an exterior surface of said ferrule member and extending entirely thereover.

2. An electrical connector according to claim **1** wherein said rib members are equally spaced from one another.

3. An electrical connector according to claim **1** wherein said rib members have the same cross-sectional configuration.

4. An electrical connector according to claim **1** wherein some of said rib members have a cross-sectional configuration different from the other rib members.

5. An electrical connector according to claim **1** wherein said rib members have the same height.

6. An electrical connector according to claim **1** wherein said rib members have varying heights.

7. An electrical connector according to claim **1** wherein said insulation means is laminated.

8. In a connector means, a ferrule member having an interior surface extending generally throughout the ferrule member, rib members extending outwardly from said interior surface of said ferrule member transversely to a longitudinal axis thereof, said rib members being equally spaced from each other along substantially an equal area of a central part of said ferrule member, said area being spaced inwardly from ends of said ferrule member, and laminated insulation means on an exterior surface of said ferrule member.

9. An electrical connector crimpable onto insulated conductor means comprising an open barrel ferrule member having an interior surface extending generally throughout the ferrule member, rib means extending outwardly from said interior surface surface of said ferrule member and extending along about half the length thereof within a central portion thereof, said rib means extending transversely to a longitudinal axis of said ferrule member for penetrating insulation on said conductor means and electrically engaging the conductive portion thereof upon said ferrule member being crimped onto said conductor means, and insulation means on said ferrule member, said ferrule member being crimped through said insulation means onto said conductor means without impairing the insulation properties of said insulation means.

10. An electrical connector crimpable onto insulated conductor means comprising an open barrel ferrule member having an interior surface extending generally throughout the ferrule member, rib means extending outwardly from said interior surface of said ferrule member and extending along about half the length thereof within a central portion thereof, said rib means extending transversely to a longitudinal axis of said ferrule member, some of said rib means penetrating insulation on said conductor means and electrically engaging the conductive portion thereof while the other rib means penetrate the insulation without engaging the conductive portion to provide a strain relief between the connector and conductor means upon said ferrule member being crimped onto said conductor means, and insulation means on said ferrule member, said ferrule member being crimped through said insulation means onto said conductor means without impairing the insulation properties of said insulation means.

11. An electrical connector according to claim **10** wherein said ferrule member includes a shearing rib means positioned at an end of said ferrule member opposite from the end where the insulated conductor means extends outwardly from said ferrule member, said shearing rib means being of greater height than the other rib means so that upon crimping of said ferrule member onto said conductor means, said shearing rib means severs said conductor means.

12. A blank for making an electrical connector including as a ferrule-forming section a substantially rectangular piece of metal having an interior surface and a middle section and outer sections on each side of said middle section, said interior surface extending generally throughout said piece of metal, the combined length of said outer sections being of substantially the same length as said middle section, and a series of parallel ribs extending out from said interior surface along said middle section.

13. An electrical connector comprising a generally U-shaped ferrule member having an interior surface and a middle section and outer sections on each side of said middle section, said interior surface extending generally throughout said ferrule member, said middle section having a length substantially equal to a combined length of said outer sections, a series of parallel ribs extending outwardly from said interior surface along said middle section toward a longitudinal axis of said ferrule member, and insulation means in engagement with an exterior surface of said ferrule member and extending outwardly beyond the free ends of said ferrule member and the outer sections.

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