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3,192,308 ELECTRICAL CONNECTOR FOR BRAIDED COAXIAL CABLE

Arden D. Van Horssen and Ottomar H. Vetter, Minneapolis, Minn., assignors to Nu-Line Industries, Inc., Minneapolis, Minn., a corporation of Minnesota
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This invention relates generally to electric connectors, and pertains more particularly to a connector to be attached to one end of a braided coaxial cable.

To protect against abrasions and radio interference, flexible shielded cables of the above alluded to type have become widely adopted. Typically, such cables comprise a solid or stranded conductor coaxially contained within a braided sheath or outer conductor. A layer of dielectric material, such as polyethylene, is interposed between the two conductors for insulating purposes. An outer covering, such as vinyl is placed over the braid for waterproofing reasons.

While the securement of the centrally disposed conductor to a connector presents no real problem, the attachment of the woven or braided conductor has posed a number of problems with respect to the time required to make the attachment, the establishing of good electrical continuity, resistance to mechanical strain, and the assurance that a reliable seal results so that the connection is impervious to moisture and gas transfer, especially when used in certain adverse and deleterious environments.

Accordingly, one object of the invention is to provide a connector to which a braided cable can be attached with but a minimum amount of time and effort, yet which can be readily detached should circumstances so dictate.

Another object of the invention is to provide a connector in which both the central and braided conductors have good electrical contact with the appropriate parts of the connector itself.

A further object is to effect a positive anchoring of the braided conductor to the connector whereby the connector can be subjected to considerable mechanical strain and vibration without becoming detached.

A still further object of the invention is to provide a connector that will be both moisture proof, as well as gas proof, thereby encouraging its use under damp and explosive atmospheric conditions.

Yet another object is to provide a connector of the foregoing character that lends itself readily to miniaturization.

Still another object of the invention is to provide a connector that will not damage the braided conductor of a coaxial cable.

These and other objects and advantages of our invention will more fully appear from the following description, made in connection with the accompanying drawing, wherein like reference characters refer to the same or similar parts throughout the several views and in which:

FIGURE 1 is a longitudinal sectional view through the center of a male connector part utilizing the teachings of our invention, although the invention will find equal usefulness in conjunction with a female part;

FIGURE 2 is a sectional view taken in the direction of line 2-2 of FIGURE 1, and

FIGURE 3 is an end view taken in the direction of line 3-3 of FIGURE 1.

Although shielded cables are commonly used, it will be helpful in understanding the benefits to be derived from our invention to describe a typical cable. Such a cable has been denoted generally by the reference numeral 10 in FIGURE 1 and it will be observed that this cable includes an inner conductor 12, which may be either solid or stranded, a layer of dielectric material 14 surrounding

the conductor 12, a braided or woven conductor 16 encircling the dielectric or insulating layer 14, and a waterproof layer 18 covering the braided conductor 16. The insulating layer 14 is usually of polyethylene or Teflon, whereas the outer layer or jacket is usually of vinyl, although other covering materials such as rubber may be employed. The braided conductor 16 will usually be of copper, although other metals are sometimes used.

The connector exemplifying our invention has been designated generally by the reference numeral 20. Actually, the connector 20 is only part of the complete connector unit, only the plug half having been illustrated. It will be appreciated, though, that whereas the male portion of the plug has been illustrated, the invention will find equal utility in connecting coaxial cables to the receptacle or female half of the connector unit.

Describing the connector 20 in detail, it will be seen that the connector includes a metal tubular housing or body 22 having a generally cylindrical bore 24. Although the bore 24 can be considered as generally cylindrical, as the description progresses it will be understood that the bore 24 is not of the same diameter throughout. Since the connector 20 is to be mated with another connector, some means for mechanically coupling the connector 20 to the other connector part is to be provided. A number of positive locking arrangements have been previously devised, but these are relatively complicated and difficult to illustrate. Accordingly, solely for the purpose of presenting a simplified type of coupling means, a plurality of angularly spaced spring fingers 26 have been depicted, these spring fingers having been shown integral with the tubular body 22. The free ends of these fingers 26 are configured so as to slide over a generally cylindrical sleeve on the other part of the connector unit and engage an annular groove provided for their reception. However, it will be understood that various types of coupling arrangements can be used and the invention is not really concerned with any particular coupling means.

It has already been stated that the bore 24 of the tubular body 22 is not truly cylindrical. At this time, reference will be made to an intermediate shoulder 28. The shoulder 28 prevents dislodgment of a dielectric liner 30, of appropriate plastic material, by reason of a flange 32 integral with the liner 30 which bears against the shoulder 28. The liner 30 has a recess or counterbore 34 at the left. The liner 30 also is formed with a recess or counterbore 36 at the right. Still further, the liner 30 has an intermediate bore portion 38 of reduced cross section. A rubber gasket 39 is placed between the tubular body 22 and the liner 30.

The connector 20 further includes an electrical contact in the form of a tapered prong 40 having a flange 42 at the right and an intermediate cylindrical portion 44 provided with a recess 46. Having one end thereof engaging the flange 42 is an insulating liner 48 of dielectric material, the other end thereof bearing against a resilient O ring seal 50. The seal 50 extends into a central opening formed in a metal washer 52. The metal washer 52 is constrained against longitudinal movement in the direction of the prong 40 by means of a shoulder 54 formed in the bore 24 of the tubular body 22.

A frusto-conical member 56 has a flange 58 integral therewith, the diameter of the flange being such that the flange can be received within the confines of the tubular body 22. The member 56 is also provided with a tapered nipple or sleeve 60 having a cylindrical bore 62 of a diameter corresponding substantially to the outer diameter of the dielectric or insulating layer 14. The nipple or sleeve 60 is formed with a plurality of annular ribs 64 of progressively increasing diameter in the direction of the flange 58. The annular ribs provide intervening

grooves and, of course, present an undulated or corrugated appearance when viewed in cross section.

Playing a very important role in the present invention is a layer or matrix 66 of relatively soft metal, such as tin plate, which is applied to the nipple or sleeve 60. Two extremely desirable results are obtained from the matrix 66: (1) the braided conductor 16 is firmly anchored or gripped so that for all intents and purposes there is no likelihood that it will pull out or become inadvertently detached, and (2) the electrical conductivity between the braided conductor 16 and the sleeve or nipple 60 is enhanced by reason of the embedding of the strands into the soft metal. With respect to the improved retention feature mentioned above, it will be apparent that each strand comprising the braided conductor 16 is securely gripped even though the individual wires or strands may vary somewhat in size. Consequently, the instant invention makes it such that close manufacturing tolerances need not be adhered to in fabricating the cable 10.

It will be discerned that the annular rib 64 have an arcuate or rounded appearance when viewed in cross section and thus with the superimposed matrix 66 provide a generally smooth surface that bears against the interior of the braided conductor 16. It will also be noted that the reduced diameter end of the nipple or sleeve 60 is such as to readily fit between the insulating or dielectric layer 14 and the braided conductor 16, the taper imparted to the nipple or sleeve 60 producing a wedging action that will be better understood hereinafter. While the precise degree of taper imparted to the outer surface of the nipple or sleeve 60 is susceptible to variation, a taper of five degrees has been found quite satisfactory in contributing to the clamping action yet to be explained.

At this time, attention is directed to a compression sleeve 63 having a tapered bore portion 70, the taper thereof corresponding generally to the taper imparted to the ribbed outer surface of the nipple or sleeve 60. The compression sleeve 63 is formed with a flat or blunt end 72 which is intended to engage the flange 58 of the frusto-conical member 56. Whereas the left end of the sleeves 63 in FIGURE 1 is flat, the opposite end constitutes a sharp knife edge 74 having a circular appearance when viewed from the right. Thus, in forming the edge 74, the sleeves 63 has a tapered bore portion and also a tapered outer surface in order to form the relatively sharp edge 74.

In order to provide an effective moisture and gas-proof sealing action in the vicinity of the sleeve 63, a rubber gasket 76 is employed. The sloping walls terminating in said sharp edge 74 forces the gasket material both inwardly and outwardly in achieving the desired sealing action in this region.

The means for forcing the compression sleeve 63 to the left in FIGURE 1, as well as effecting severance of the gasket 76, includes a washer 78 circumscribing the outer jacket or covering 18 of the cable 10. The end of the tubular body 22 is formed with internal threads 80 at its right end for the accommodation of threaded bushing 82, the bushing 82 acting in concert with the washer 78 in effecting the aforementioned forcing action.

Having presented the foregoing information, the manner of attaching the cable 10 to the connector 20 should be readily understood. The cable 10 is initially prepared by baring the conductor 12 to such an extent that it projects beyond the insulating layer 14. With the conductor 12 bared to the requisite extent, it can be inserted into the recess 46 in the contact member having the prong 40 thereon. Conventional soldering techniques can be employed in effecting a good electrical engagement of the conductor 12 in the recess 46.

Before inserting the exposed end of the conductor 12 into the recess 46, another step must be performed in preparing the cable 10 for attachment to the connector 20. This step involves the cutting back of both the braided conductor 16 and the outer covering or jacket 18

to the extent shown in FIGURE 1. This leaves a sufficient amount of the dielectric layer 14 exposed so that it can be inserted into the liner 48 when the exposed end of the conductor 12 is inserted into the recess 46.

Inasmuch as the reduced diameter end of the nipple or sleeve 60 of the frusto-conical member 56 is of a size to enter between the layer 14 and the braided conductor 16, it will be observed that the insertion of the cable 10 into the confines of the connector 20 will be instrumental in wedging the braided conductor 16 and also the covering 18 into the condition shown just to the right of the flange 58 on the member 56. The rounded or arcuate rib 16 present a smooth enough surface so that no damage results with respect to the engagement of the braided conductor 16 with the plated surface or layer labeled 66. It is contemplated, as previously stated, that the plating 66 be relatively soft and this contributes to a good electrical contact between the braided conductor 16 and the nipple or sleeve 60.

It is after the cable 10 has been inserted into the conductor 20 that the compression sleeve 63 is placed within the tubular body 22. Stated somewhat differently, the compression sleeve 63 circumscribes the outer covering 18. After placing the sleeve 63 in its encircling relationship with the cable 10, the gasket 76 can be inserted into the tubular body 22, followed by the placing of the washer 78 into the interior of the body to whatever extent is then permitted. Engagement of the threaded bushing 82 with the threads 80 will permit the bushing 82 to be advanced against the washer 78, thereby forcing the washer 78 against the gasket 76. Continued advancement will not only sever the gasket 76 but will force the compression sleeve 63 in the direction of the flange 58. As the compression sleeve 63 moves to the left, it compresses the layer 18 by reason of the tapered bore portion 70. The compression of the layer or covering 18, of course, clamps the braided conductor 16 against the tapered nipple or sleeve 60 on the member 56. This action results in the individual wires or strands comprising the braided conductor 16 being forced into the soft metal constituting the matrix 66 with a concomitant high degree of retention—actually in most instances higher than the breaking strength of the braided conductor 16 itself. In accomplishing this clamping action, no damage whatsoever is made to the braided conductor 16.

Should the cable 10 not have the outer layer or jacket 18 thereon, it is contemplated that a separate sleeve of similar material be employed. The compressive action and resulting gripping of the braided conductor 16 will be the same in both instances.

If for any reason the cable 10 must later be detached from the connector 20, such can readily be accomplished by backing off the threaded bushing 82. This will permit removal of the washer 78 so that access may be had to the gasket 76 and the compression sleeve 63. After appropriate heating of the prong 40 to unsolder the joint effected between the conductor 12 and the walls of the recess 56, the cable can be pulled from the connector very easily.

From the foregoing description of the connector 20, in addition to the positive retention, it should be readily understood that good electrical continuity is afforded between the braided conductor 16 and the tubular body 22. Hence, when the connector 20 is coupled to a mating connector, an excellent electrical path will exist between the braided conductor 16 of the connector 20 and the conductor of the cable similarly attached to the mating connector that is to form the over-all connector unit.

By reason of the seals 50, 76, it will be apparent that no moisture or gases can flow through the confines of the connector 20, inasmuch as the elements 50 and 76, especially the latter, provide a highly effective barrier against any such transfer. Therefore, our connector 20 can be utilized in various adverse environments.

It will, of course, be understood that various changes

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may be made in the form, details, arrangements and proportions of the parts without departing from the scope of our invention as set forth in the appended claims.

What is claimed:

1. An electrical connector for attachment to a shielded cable having an inner conductor, a braided outer conductor, and an intermediate layer of dielectric material, the connector comprising:
 - (a) a hollow body member receiving an end portion of said cable;
 - (b) a frusto-conical sleeve member disposed within said hollow body member and a bore encircling said dielectric material and a tapered outer surface forming a reduced diameter end disposed between said dielectric layer and said braided conductors;
 - (c) a metallic matrix which is soft relative to the material of said outer conductor disposed on a substantial portion of the tapered outer surface of said sleeve member;
 - (d) a compression sleeve member disposed between said hollow body member and said frusto-conical sleeve member encircling the received end of said cable, said compression sleeve member having a tapered bore complementing the general taper of the outer surface of said frusto-conical sleeve member and generally coextensive therewith, and
 - (e) means forcing said compression sleeve member axially within said body forcing a portion of said braided conductor into said matrix.
2. An electrical connector in accordance with claim 1 in which:
 - (a) the outer surface of said frusto-conical member is grooved forming a smooth irregular surface.

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3. An electrical connector in accordance with claim 1 in which:
 - (a) the outer surface of said frusto-conical member is provided with a plurality of spaced annular ribs, each having an arcuate cross-section.
4. An electrical connector in accordance with claim 3 in which:
 - (a) said dielectric is a plastic material.
5. An electrical connector in accordance with claim 3 in which:
 - (a) said shielded cable is provided with an outer covering overlying said braided conductor, said compression sleeve member bearing against said outer covering.
6. An electrical connector in accordance with claim 1 in which:
 - (a) said metallic matrix is of tin.

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JOHN F. BURNS, *Primary Examiner*.

JOHN P. WILDMAN, E. JAMES SAX, *Examiners*.