Nov. 3, 1970 C. W. LANHAM, JR 3,538,487

COAXIAL CABLE CONNECTION MEANS

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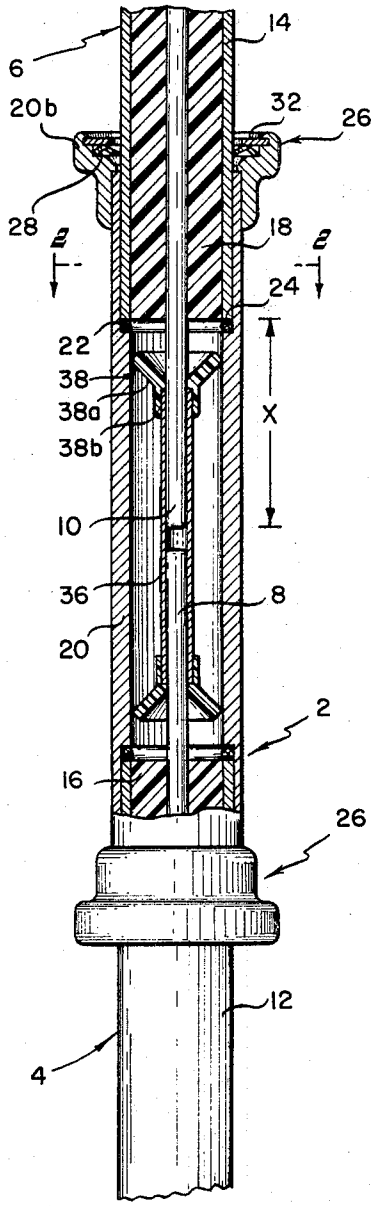


fig. 1

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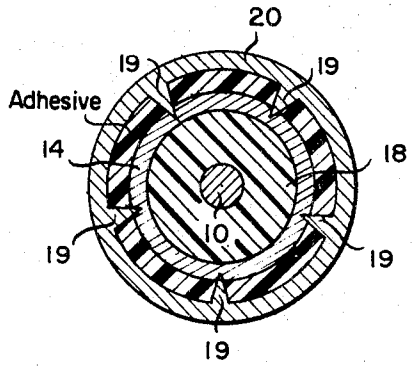


Fig. 2

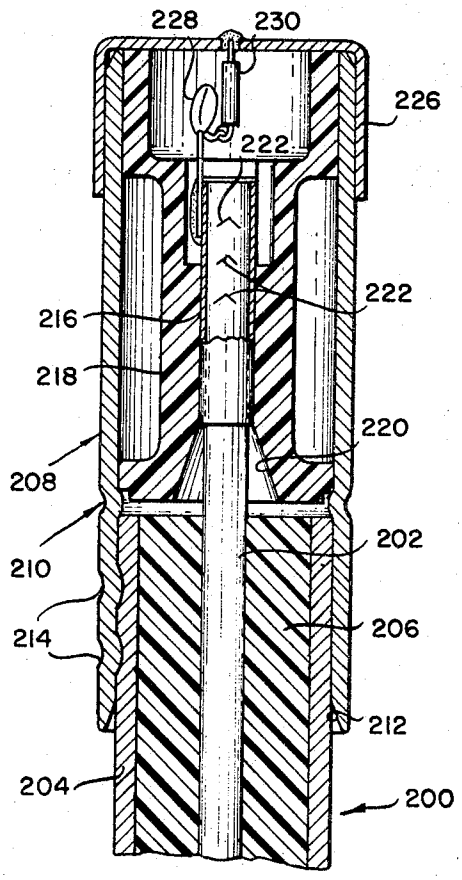


Fig. 3

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COAXIAL CABLE CONNECTION MEANS

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U.S. Cl. 339—95 13 Claims

ABSTRACT OF THE DISCLOSURE

Connector means adapted for connection with at least one coaxial cable having an inner conductor that extends a given distance beyond a spacer insulation layer and an outer conductor, characterized by the provision of a conductive tubular body having at one end a bore for receiving a cable end, non-conductive adhesive means curable to permanently bond said cable end to said body, retaining means for preventing withdrawal of the cable end from the body during the curing of the adhesive, and means electrically connecting said body with said outer conductor. In one embodiment the connector means comprises a splice for electrically connecting the ends of a pair of cables, and according to another embodiment, the connector means comprises a terminator for connecting a load impedance between the free ends of the conductors.

This invention relates to an improved connector construction for coaxial cables.

In the patented prior art, various types of devices have been proposed for splicing together in electrical and mechanical engagement a pair of electrical coaxial cables. For example, in the conventional flare type of connection, the spacer insulation between the concentrically arranged conductors is reamed out, ferrule means are arranged to extend at each end in the reamed out portions of the cables, and an outer body member is threadably connected with the ferrule means to axially tighten the assemblage and to effect both mechanical support and electrical connection of the cable. While the flare type of connection affords relatively high mechanical strength, the components are rather expensive, and the assembly of the parts is time consuming and requires special tools.

The use of grip ring means for retaining the components of an electrical connector against axial withdrawal is also known in the art, as evidenced by the Canadian Pat. No. 711,356, and the U.S. patents to Matthysse No. 3,019,283, Ustin No. 2,870,239 and Fuller et al. No. 3,288,914. Furthermore, the use of electrically conductive adhesive means has been proposed for both mechanically and structurally connecting together a pair of conductive electrical components.

The present invention was developed to provide improved coaxial cable connector means that provide extremely great structural strength, that are water and pressure tight, and that allow for the expansion and contraction of the coaxial cable.

The primary object of the present invention is to provide improved connector means for coaxial cables wherein great structural strength is obtained through the use of an extremely strong non-conductive adhesive for bonding together the structural parts.

A more specific object of the invention is to provide connector means including a conductive body containing a bore for receiving one end of a coaxial cable, non-conductive adhesive means curable to permanently bond the cable to the body, retaining means preventing withdrawal of the cable from the body during the curing of the adhesive, and means electrically connecting said body with the outer conductor of the cable. Preferably the non-

conductive adhesive is of the type affording a fluid- and pressure-tight seal and having a high shearing stress (for example, an anaerobic adhesive similar to the product Loctite Tube Sealant, manufactured by Loctite Corporation of Newington, Conn.). In accordance with a first embodiment of the invention, the connector means comprises a splice for connecting the ends of a pair of coaxial cables arranged colinearly end-to-end. In accordance with a second embodiment, the connector means comprises a terminator for connecting a dummy load impedance between the ends of the inner and outer conductors at one end of a coaxial cable.

A further object of the invention is to provide connector means including a retaining ring mounted in the conductive tubular body for engaging the outer conductor to prevent withdrawal of the cable from the body. In addition or in the alternative, the retaining means may be mounted in the body for electrical and mechanical engagement with the inner conductor of the cable.

A further object of the invention is to provide connector means that are quickly assembled without the provision of any special tools. To this end, the body member is provided with means defining at least one internal stop shoulder against which the cable outer conductor abuts in electrically conductive engagement. To increase the conductivity at this juncture, conductive means such as wire mesh or copper spring fingers are arranged between the conductor end on the cable and the internal shoulder on the body.

Other objects and advantages of the invention will become apparent from a study of the following specification, when viewed in the light of the accompanying drawings, in which:

FIG. 1 is a partly sectioned view of the coaxial cable splice embodiment of the invention;

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1; and

FIG. 3 is a detailed sectional view of a terminator embodiment of the invention.

Referring first to FIGS. 1 and 2, the cable splice means **2** is adapted to mechanically and electrically connect a pair of coaxial cables **4** and **6** having inner conductors **8** and **10** and outer tubular conductors **12** and **14** separated by annular insulation layers **16** and **18**, respectively. As shown in the drawing, the end portions of the outer conductors and the insulation of the colinearly arranged cables are removed so that the remaining bare ends of the central conductors protrude axially beyond the insulation and the outer conductor a given distance *x*. As is conventional in the art, the inner conductors are formed of copper, and the outer conductors are unitary imperforate sheaths formed from a relatively soft conductive metal, such as aluminum.

For mechanically connecting the cable ends and for electrically connecting the outer conductors **12** and **14**, the cable splice means includes a tubular conductive body **20** counterbored at each end to define a stop shoulder **22**, the diameter of the counter-bore being generally equal to the outer diameter of the outer conductors of the cable. Thus the counter bore is adapted to receive the cable end as shown, the extremity of the outer conductor terminating immediately adjacent the shoulder **22**. Preferably, in order to improve the electrical connection between the outer conductor and the tubular body **20**, there is compressed between the shoulder **22** and the adjacent extremity of the outer conductor an annular layer **24** of electrically conductive woven wire mesh. In the alternative, conductive spring finger means may be substituted for the conductive mesh. At each end, the tubular body **2** is provided with retaining ring means **26** that engage the outer conductors **12** and **14** to resist withdrawal of the cables from the tubular body **2**. More

particularly, each retaining ring means comprises a grip ring **28** mounted in a recess contained in an enlarged flange portion **20***b* of the tubular body **20**, said retaining ring having an effective inner diameter that is less than the outer diameter of the outer cable conductors, the inner circumference of said ring comprising a plurality of resilient, radially inwardly directed fingers having such configurations (as is known in the art) to engage the soft outer conductors to prevent withdrawal of the cables from the tubular body. Suitably designed washers **32** serve to retain the rings **28** in the flange recesses. As will be described below, preferably the enlarged flange portions **20***b* comprise separate portions secured to the central part of the tubular body by an adhesive having an exceptionally high shear strength, for example, an anaerobic adhesive (such as the aforementioned Loctite product).

The inner conductors of the cable are mechanically and electrically connected by a conductive tubular sleeve **36** that is tightly fitted concentrically upon the inner conductors **8** and **10**. On each end of the sleeve **36** is mounted an annular spacer member **38** formed of insulating material and including a tubular hub portion **38***b* in engagement with the sleeve, and an outwardly divergent conical portion **38***a* in engagement with the inner surface of the tubular member.

In accordance with the present invention, the counterbore wall of the tubular member **20** is permanently bonded to the outer surface of the outer conductor of the cable by a non-conductive adhesive having an extremely high shear strength (on the order of 2000 p.s.i., for example). Similarly, the sleeve **36** is permanently bonded to the inner conductors by a similar high shear strength adhesive. Finally, the flange portion **20***b* carrying the retaining ring means **26** is permanently bonded (generally at the factory) by the adhesive to the tubular body **20**. Preferably the adhesive is an anaerobic adhesive having a shear strength on the order of 2000 to 5000 p.s.i. (similar, for example, to the tube sealant grade of the product Loctite sold by Loctite Corporation of Newington, Conn.).

In order to provide electrical connection between each outer conductor and the tubular sleeve, conductive means are provided that penetrate the non-conductive adhesive. As shown in FIG. 2, these conductive means comprise pointed longitudinal ribs **19** that are carried by and extend radially inwardly from the bore wall. In the alternative, other adhesive penetration means—such as knurled surfaces, dimples, projections or the like—may be provided for electrically connecting the connector body with the outer conductor.

OPERATION

To effect the strong watertight electrically conductive cable splice illustrated in the drawing, the outer conductor and insulation layers are first stripped from the ends of the coaxial cable to expose given lengths *x* of the bare inner conductors, whereupon the ends of the inner and outer conductors are roughened and cleaned by suitable abrasive means. These roughened surfaces are then coated with the adhesive in the liquid state, whereupon the sleeve **36** is fitted upon the bore inner conductor of one cable, and the end of that cable is inserted within one end of the tubular member **20** until the extremity of the outer conductor engages stop **22** to compress the wire wesh layer **24**. Similarly, the other cable is inserted into the other end of the tubular member **20** with the inner conductor being received within the conductive sleeve **36**, and the outer conductor being received in the corresponding counterbore.

Electrical connection between the outer conductors and the tubular body is effected by the ribs **19**, and connection between the sleeve **36** and the inner conductors is effected by roughened surfaces or projections on the sleeve. Owing to the retaining action of the grip ring

means, together with the support of the sleeve **36** by the spacer means **38**, the adhesively joined surfaces are immobilized during the curing of the adhesive (which normally requires a period of from a matter of minutes up to several hours, depending on conditions of ambient temperature, and humidity). Thus the grip ring means affords a temporary support strength of about 140 pounds until the adhesive is completely cured, whereby the technician may assemble the connector and leave it during the final curing of the anaerobic adhesive.

The cable splice of the subject invention is water-tight and pressure tight and retains the inner and outer conductors against the expansion and contraction of the coaxial cable. The splice means requires only a minimum number of relatively inexpensive parts, and permits rapid connection of the cable ends with a minimum number of tools.

It is apparent that various modifications and improvements may be made in the disclosed invention. As indicated above, to improve the electrical conductivity between certain of the bonded surfaces (for example, the contiguous surfaces between the outer conductor and the counterbore walls of the tubular body, and the contiguous surfaces of the inner conductors and the sleeve **36**), the surfaces of one part may be grooved or scored to define sharp edges that penetrate the adhesive layer for electrical connection with the companion surfaces of the other part.

Referring now to the terminator embodiment of FIG. 3 the coaxial cable **200** includes an inner conductor **202** that extends axially beyond the outer conductor **204** and the spacer insulation **206**, said cable being received in a corresponding bore contained in one end in the conductive tubular body **208**. The extent of axial insertion of the cable into the body is limited by the annular stop shoulder **210** that is in electrical engagement with the outer conductor **204**. At its free extremity the bore contains a tapered surface **212** that guides the outer conductor **204** somewhat during insertion of the cable in the tubular body. As in the previous embodiment, a layer of curable anaerobic adhesive is provided on the outer surface of the outer conductor to permanently bond the cable to the body. In order to effect the forementioned electrical connection, the wall of the tubular body **208** is provided with dimples **214** that extend inwardly to penetrate the adhesive layer and thereby electrically engage the outer conductor.

The free extremity of the inner conductor **202** is received in a conductive sleeve **216** that is rigidly supported in the tubular body by the insulated support housing **218**. To facilitate insertion of the center conductor in the sleeve, the bore of the housing **218** includes a tapered orifice **220**. The sleeve **216** is secured in the plastic housing **218** by a layer of a suitable adhesive (such as an anaerobic adhesive) and is provided with partially punched out retaining points **222** that impale the center conductor to prevent withdrawal of the cable from the tubular body **208**. In the event that a curable layer of anaerobic adhesive is arranged between the inner conductor **202** and the sleeve **216**, the adhesive is penetrated by the points **222** to provide the aforementioned electrical connection.

The other end of the tubular body **208** is closed by the conductive end cap **226** that is in electrical contact with, and is fitted onto, the body **208**. The end cap maintains the plastic housing in engagement with the annular stop shoulder **210**.

Suitable dummy load impedance components (such as a capacitor **228** and a resistor **230**) are soldered between the cap **226** and the sleeve **216**, thereby defining a terminal load between the inner and outer conductors.

In operation, in order to terminate a given coaxial conductor with the dummy impedance load, the outer conductor and the projecting length of inner conductor are roughened and are coated with the anaerobic adhesive in the uncured state, whereupon the cable end is inserted

in the tubular body. Owing to the impalement of the inner conductor by the points **222**, and the gripping action on the outer conductor by the bore wall of the tubular body and the dimples **214**, the cable end is retained against withdrawal from the tubular body during the final curing of the adhesive.

Other changes and modifications may be made in the apparatus described without deviating from the invention set forth in the following claims.

What is claimed is:

1. Quick-fastening connector means adapted for connection with one end of a coaxial cable having an inner conductor that extends a given distance beyond successive concentrically arranged insulation and outer conductor layers, respectively, comprising

a tubular conductive body having at one end a bore for receiving said cable end, the diameter of said bore being generally equal to the outer diameter of said outer conductor, said body including also within said bore integral stop means adapted to cooperate with the end extremity of said outer conductor to limit the extent of axial insertion of said cable end in said bore;

a layer of curable adhesive operable, when cured, to permanently bond said outer conductor to said body;

means including said stop means for electrically connecting said outer conductor with said body when said cable end is in the fully inserted position defined by said stop means; and

retaining means preventing withdrawal of said cable from said fully inserted position relative to said body during the curing of said adhesive.

2. Apparatus as defined in claim **1**, wherein said adhesive layer is non-conductive and is arranged generally concentrically between the wall of said bore and the outer surface of said outer conductor;

and further wherein said electrical connecting means comprises first conductive means extending radially between said outer conductor and said bore wall to penetrate said adhesive layer, and second conductive means arranged between said integral means and the extremity of said outer conductor.

3. Apparatus as defined in claim **1**, wherein said adhesive means has a shear strength of at least 2000 pounds per square inch.

4. Apparatus as defined in claim **3**, wherein said adhesive means comprises an anaerobic adhesive.

5. Apparatus as defined in claim **1**, wherein said retaining means comprises a retaining ring mounted in said bore, said retaining ring having a plurality of radially inwardly directed spring fingers adapted to engage said outer conductor to prevent withdrawal of said cable from said body.

6. Apparatus as defined in claim **1**, wherein said retaining means comprises means mounted in said tubular body for engagement with said inner conductor to prevent withdrawal of said cable from said body.

7. Apparatus as defined in claim **6**, wherein said retaining means comprises a conductive sleeve;

and insulating means supporting said sleeve in said tubular body to receive said inner conductor when said cable end is inserted in said bore, said sleeve including projection means adapted to impale said inner conductor to prevent withdrawal of said cable end from said body.

8. Apparatus as defined in claim **7**, wherein said connector means includes an impedance load electrically connected between said sleeve and said tubular body, whereby said connector means serves as a cable terminator.

9. Apparatus as defined in claim **1**, wherein said tubular body contains in its other end another bore for receiving a second coaxial cable end the inner connector of which extends axially beyond the outer conductor and the space insulation layer; and further including

stop means limiting the extent of axial insertion of said cable ends in said tubular body;

an additional layer of curable non-conductive adhesive operable, when cured, to permanently bond said outer conductor to said body;

further retaining means for preventing withdrawal of said second cable end from said body during the curing of said adhesive; and

means electrically connecting said tubular body with the outer conductor of said second cable, whereby said connector means comprises a splice for electrically connecting the outer conductors of said cables.

10. Apparatus as defined in claim **9**, and further including a conductive sleeve mounted coaxially upon and electrically connecting the inner conductors of said cables.

11. Apparatus as defined in claim **10**, and further including a third adhesive layer curable to permanently bond said sleeve to said inner conductors.

12. Connector means as defined in claim **11**, and further including annular spacer means supporting said sleeve within said tubular body, said spacer means comprising at least one annular spacer member formed of insulating material and arranged concentrically upon said sleeve.

13. Connector means as defined in claim **12**, and further wherein said spacer means includes a pair of said spacer members arranged at opposite ends of said sleeve, respectively, each of said spacer members including a hub portion fitted upon the end portion of said sleeve, and an outwardly diverging conical portion the extremity of which engages the inner wall surface of said body.

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