United States Patent

[11] 3,622,939

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[21] Appl. No. **15,178**
[22] Filed **Feb. 27, 1970**
[45] Patented **Nov. 23, 1971**
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[54] **COAXIAL CABLE CONNECTION SYSTEM**
4 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** ..... **339/89 C,** 339/177 E
[51] **Int. Cl.** **H01r 13/54,** H01r 17/04
[50] **Field of Search** ..... 339/60 C, 89 C, 90 C, 91 P, 94 C, 126 J, 103 B, 177 R, 177 E, 95 R, 268, 273, 276 T; 174/75 C, 88 C, 89

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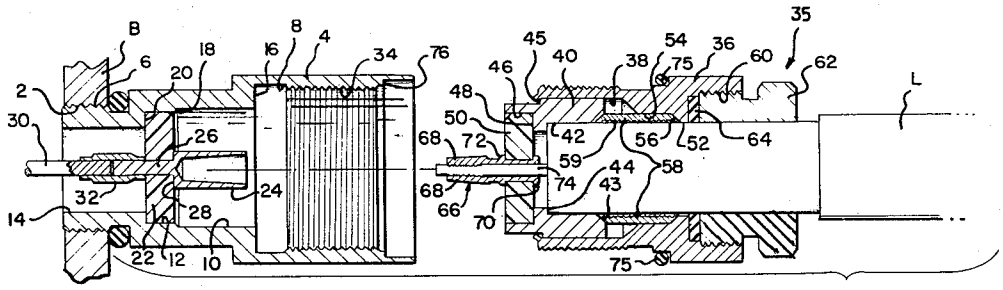
ABSTRACT: For connecting a coaxial cable to a tap box housing a high-frequency circuit, a first connector element comprising an outer conductor is secured to the box and is provided with a center contact which is secured at one end to the circuit, the other end being a socket with a conical bore. A second connector element is secured to the face end of the first element and includes an outer cylindrical member secured to the outer conductor of the cable and having centrally located spring fingers through which the inner conductor of the cable extends, the spring fingers being forced to grip the center conductor where the spring fingers enter the conical bore when the two connector elements are assembled.



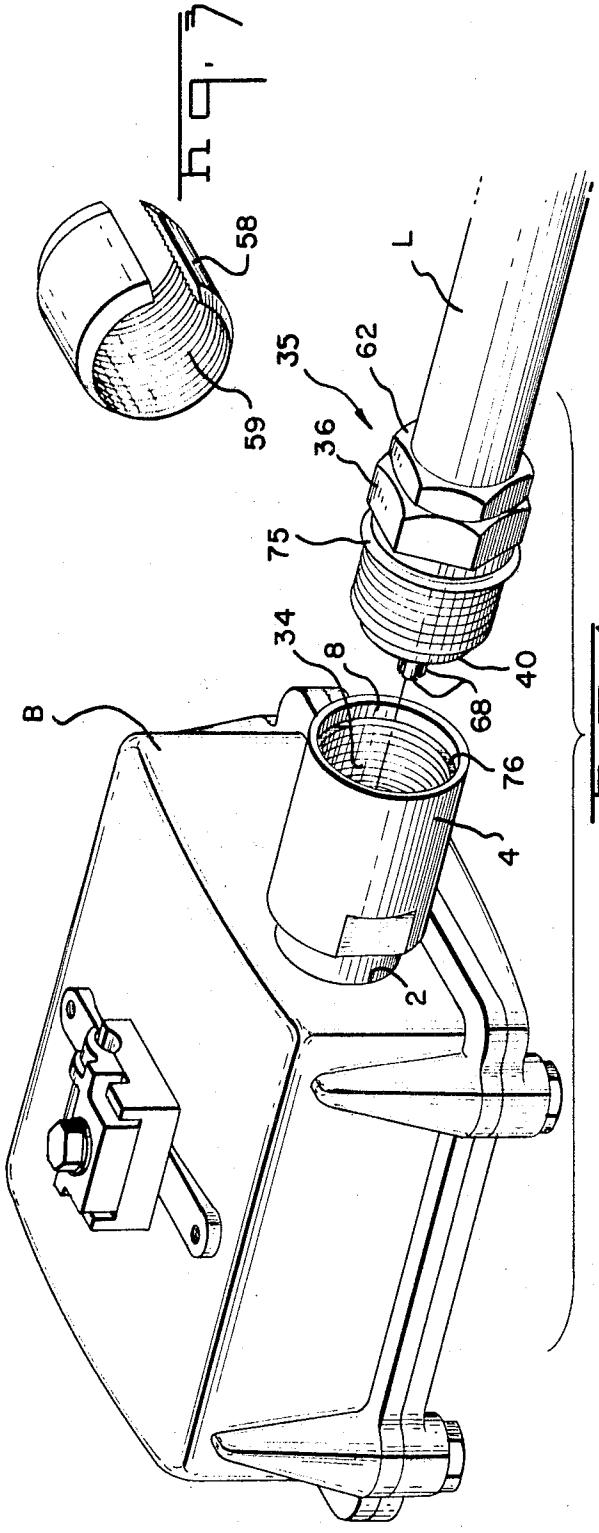

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Fig. 1

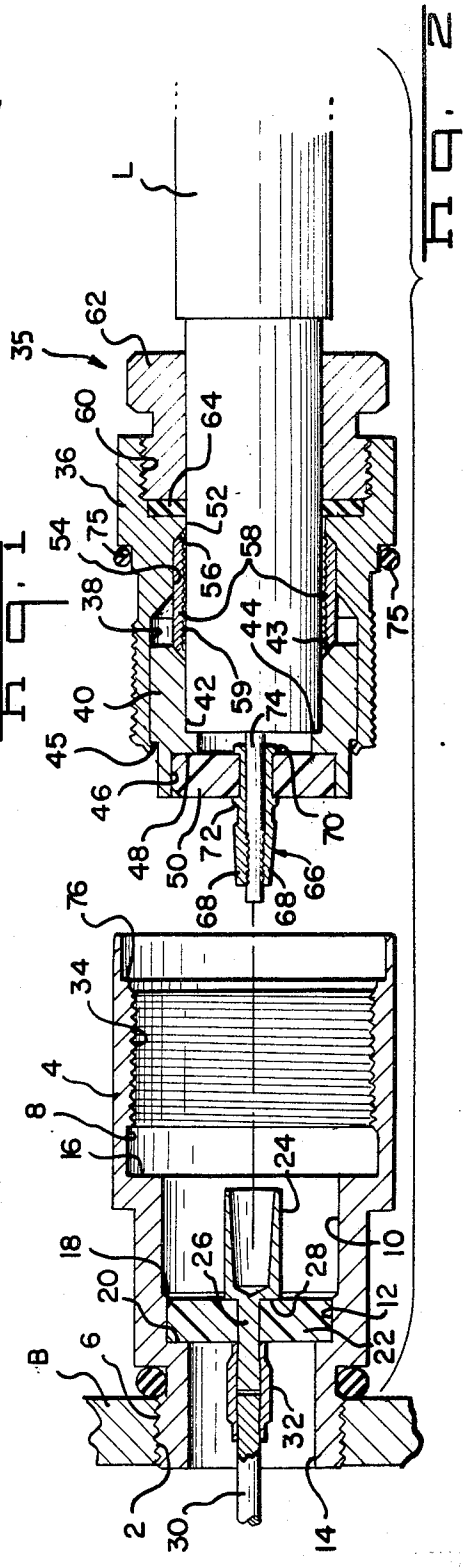
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Fig. 2

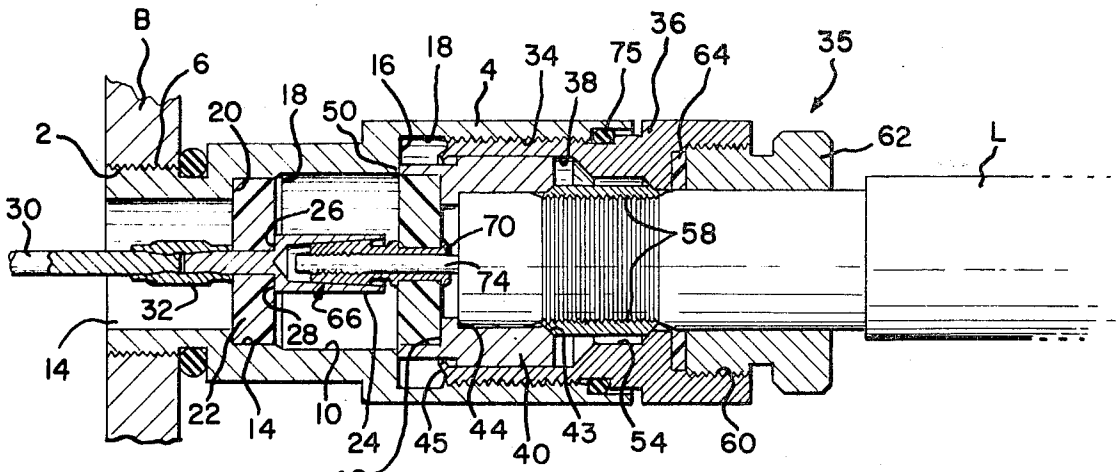
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Fig. 4

COAXIAL CABLE CONNECTION SYSTEM

The invention relates to improvements in coaxial cable connection system.

High-frequency signal-distribution systems which transmit audio and video signals over coaxial transmission lines are in wide use today. One example is known as community antenna television (CATV). Enclosure containing amplification circuitry are located at various points in the cable system to maintain the signal level. To distribute the signals to various subscribers, tap boxes are spaced along the cable from which individual lines lead to each subscriber. Since the boxes, in many instances, are exposed to weather conditions, the coaxial connector devices to be tapped into the boxes must be weatherproof. They must be so constructed that no positive axial forces be transmitted through the center contact of the connector part extending into the box and connected to the circuit or component therein which may be part of a relatively fragile printed circuit board. On the other hand they must resist axial forces in the opposite direction which will cause disconnects from the circuitry. Such axial forces are caused by differential thermal expansion and contraction of the coaxial cable center conductor and shield or physical forces due to wind, snow load, etc.

The coaxial connection system disclosed herein has been developed to overcome the many problems and to simplify the application of coaxial connectors in cabled radio frequency systems. Their use is not limited to this application, but may be adapted anywhere that some or all of the advantages of this structure are applicable. Basically, the coaxial connection is made between the coaxial cable and an adapter which adapts any coaxial cable to mate into either a universal receptacle which interfaces with system components, or into either side of a universal splice. The above-mentioned universal receptacle with which the connector mates, allows the supplier of system components, such as amplifiers, splitters, etc., to standardize on one connector receptacle, simplifying both electrical and mechanical matching problems.

The universal receptacle as hereinbelow described is essentially a coaxial plug member provided by a hollow conductive shell which is threaded at its forward end for insertion into a threaded socket in a tap box housing a circuit such as, for example, a directional coupler which is utilized in CATV systems to direct signals on the transmission line to a subscriber. The center contact of the receptacle, which is secured in insulated relation thereto, is provided by a rearwardly facing socket for receiving the center contact of a coaxial line and a contact member extending forwardly of the shell member for connection with the input or output of the circuit or component within the box. The coupling member which adapts the coaxial cable for electrical and mechanical connection to the housing is secured at its rearward end portion to the cable outer conductor and is provided with a concentric collet comprising spring fingers through which the inner conductor of the cable extends. As the coupling member is being secured at its forward end to the rear end of the receptacle, as by a threaded connection, the collet and center conductor of the cable therewithin are moved into the socket of the receptacle, which has a conical recess, and operates to force the spring fingers of the collet against the center conductor.

It is therefore an object of the invention to provide a coaxial line connector which is waterproof.

A further object of the invention is to provide a connector for a coaxial line which resists pull out of the conductors in use.

Another object of this invention is to provide a connector for coaxial lines which is especially adapted for connection to a circuit components housed in a tap box and which will transmit a minumum of axial forces caused by temperature changes.

It is a still further object of the invention to provide a coaxial cable connector which is comprised of a universal receptacle and an attachable cable adapter in which the receptacle may be utilized with cables of different sizes.

With the above objects in view, together with other and further objects thereof, the following description with particular reference to the drawings should provide a full understanding of the invention.

FIG. **1** is a perspective view of the tap box on which the receptacle, as part of the connector assembly, is mounted;

FIG. **2** is a view in cross section of the receptacle and cable adapter assembly with the cable secured therein;

FIG. **3** is a perspective view of the spring clamp within the cable adapter; and

FIG. **4** is a longitudinal cross-sectional view of the receptacle and cable adapter in assembled relation.

With reference to FIG. **1**, there is shown a tap box B, which usually houses a component circuit of a CATV system such as a directional coupler or an amplifier. The tap box B may be suspended from a messenger cable for connection to the coaxial cable L, although it may be underground or on a wall of a building. In any case, the tap box is provided with at least a pair of threaded openings, only one of which, such as **2**, is shown, through which the input and output conductors respectively extend. The universal receptacle **4** is provided at its forward end with threads **6** for interengaging with the threads in opening **2** of the box. The receptacle **4** comprises a hollow cylindrical member open at both ends and provided with four concentric bores **8**, **10**, **12** and **14** which respectively decrease in diameter from the rear end into which the cable carrying coupling member enters. Each of the three larger bores provides an annular wall **16**, **18** and **20** at their respective junctions with the smaller bores. Extending across the bore **12** and against the wall **20** is a centrally apertured dielectric bead **22** having high resistance to bending. The thickness of the bead is substantially the axial extent of the bore **12** so that the edge portion of the wall **18** may be spun over against the forward edge of the bead to secure it within the receptacle and against the shoulder **20**.

A center contact supported by the bead **22** is provided by a cylindrical socket member **24** extending axially from the rear face of the bead centrally of the bore **10** and an integrally formed stem portion **26** of smaller diameter than the socket portion extending forwardly through the aperture in the bead. A wall **28** of the center contact, provided at the junction of stem portion **26** and socket member **24** abuts the rear face of bead **22**, while a sleeve **32** of a larger outer diameter than the stem portion is crimped to the projecting portion thereof and abuts the opposite side of the bead. The center contact is thus captivated by the bead and can withstand large forces tending to move it axially either rearwardly or forwardly. The other end of sleeve **32** is crimped to a conductive axial extension **30** of the stem portion which projects forwardly of the shell member **4** for connection with a terminal within the tap box when the receptacle is mounted thereon. The socket member is provided at its rear end with a central tapered recess which diverges outwardly.

The inner wall of the large bore **8** of the shell member **4** is threaded as at **34** to threadably receive therein a cable adapter comprising coupling nut assembly **35** which is externally threaded to cooperate with the thread **34**. The coupling nut assembly comprises a hollow cylindrical shell member **36** having a bore **38** of a predetermined diameter opening at its forward end. Slidably and rotatably mounted within the bore **38** is an inner ferrule assembly comprising a ferrule **40** having a rearwardly open bore **42** of a predetermined diameter to closely encompass the semirigid outer conductor of a coaxial cable such as line L. Intermediate the ends of the ferrule **40** the diameter of the bore is abruptly reduced leaving a rearwardly facing wall **44** against which the end of the outer conductor of the line L abuts. The extreme forward end of the ferrule is provided with an opening **46** of somewhat larger diameter than bore **42** and which extends inwardly for a predetermined distance to present a forwardly facing circumferential wall **48**. A centrally apertured dielectric bead **50** extends across the opening **46** and against the wall **48**. The bead **50** has a thickness substantially equal to the depth of the opening **46**

and is held therein by the material of the forward edge of the ferrule which is spun over and about the forward edge portion of the bead. The forward end portion of the ferrule is provided with a reduced outer diameter, to leave a forwardly facing circumferential shoulder **45** which abuts the inturned edge portion of the forward end of the shell member **36** to prevent outward movement of the ferrule.

Rearwardly of the bore **38** in the coupling nut assembly, the shell member **36** is provided with a central opening **52** of a diameter substantially the same as bore **42** and the outer diameter of the outer conductor of the line L.

Intermediate the opening **52** and bore **38** in shell member **36** is an opening **54** of a diameter which is slightly larger than the the diameter of opening **52**. A tapered inner wall **56** leads from smaller opening **52** into larger opening **54**. Normally seated against the wall of opening **54** and extending into bore **38** is a spring clamp **58** in the form of a C which is of an axial length to extend between the tapered wall **56** and the rear end wall of the ferrule **40** within bore **38**. The radial thickness of the clamp **58** is substantially the difference between the radii of openings **52** and **54**, so that it does not obstruct entry of line L when normally seated against the wall of opening **54**. The inner surface of the clamp is provided with circumferential grooves **59**, the lands between the grooves being rounded to form in effect blunted serrations. The near end of the shell **36** is provided with a bore **60** which is internally threaded to cooperate with an externally threaded gland nut **62**. Between the enlarged bore **60** and smaller opening **52** is formed a rearwardly facing bottom wall, so that by placing a washer of sealant material **64**, such as unvulcanized soft butyl rubber, against the bottom of the bore **60** and tightening of the gland nut, the sealant will be forced against the bottom wall and be distributed evenly about the cable at its entrance into opening **52**.

Supported within the central aperture of the bead **50** is a collet **66**. The collet comprises a hollow tubular member longitudinally slotted at its forward end to form a plurality of spring fingers **68**. The opposite unslotted end at the rear of the collet extends through the central opening in the bead and the preformed shoulder **70** of the collet locks it in place to prevent forward axial movement thereof. Forwardly of its rear end, the collet is provided with a thickened peripheral bead or shoulder **72** having a rearward face abutting the forward face of the bead, whereby the collet is captivated and pullout is prevented. The inner surfaces of the spring fingers **68** are provided with serrations in planes normal to the axis of the collet for gripping a wire **74** located within the fingers.

In use, the receptacle **4** is first threaded into an opening in the tap box B with the conductive member **30** effecting electrical contact with a terminal of a circuit housed in the box. The cable to be clamped to the cable adapter is prepared by first removing a length of outer insulation from an end of the cable to bare a short length of outer conductor. An end portion of the outer conductor and inner dielectric is then removed to expose a length of inner conductor **74**. The gland nut **62** is then slipped over the outer conductor and the cable end inserted into the coupling nut assembly **35** including the ferrule **40** until the end of the outer conductor abuts the end of the wall **44** of the ferrule. At the same time, the inner conductor **74** extends through the interior of collet **66** including the spring fingers **68**. The forward end of the coupling nut assembly **35**, with the cable end disposed therein, is then threaded into the rear opening **8** of the receptacle **4**. The shell member **36** of the coupling nut assembly is rotatable relative to the ferrule **40**, as explained heretofore, and as the shell member advances within the receptacle **4** by continued rotation thereof, the tapered wall **56** forces the clamp member **58** against the rear edge of ferrule **40**. Since the edge of the opening **42** in the latter is chamfered as at **43**, such chamfered edge at one end of the clamp and the tapered wall **56** at the other end of the clamp provide camming surfaces which cause the clamp to be compressed radially inward against the outer conductor of the cable therein as the shell moves inwardly. Simultaneously, during such forward movement of shell **36**, the spring fingers **68** within the substantially conical opening in socket member **24** will be forced against the conductor **74** by the wall of the opening to grip the conductor and provide a secure mechanical and electrical connection, thereto. Both the receptacle **4** and shell member **36** are provided on their outer surfaces with flat portions for engagement by a wrench for easy assembly or disassembly of the parts.

A shallow circumferential groove is provided in the periphery of the shell member **36** just rearwardly of its threaded portion for the reception of an O-ring **75**. The rear entrance to the bore in receptacle **4** is somewhat enlarged in diameter to leave a rearwardly facing circumference shoulder **76**. When the shell member **36** is fully threaded into receptacle **4**, the O-ring is compressed by the shoulder **76** to provide a seal. A further O-ring for sealing purposes at the entrance to the tap box is provided at the forward end of the receptacle **4**. Typically, a split clamp such as shown will provide cable holding strength of 300–500 lbs. depending on cable size. The blunt serrations on the clamp prevent fractures due to notch effects caused by sharp lands between the grooves.

The collet **66** may be provided with spring fingers **68** of different thicknesses, so as to be capable of use with center conductors of different sizes. Positive captivity of the collet **66** by the rigid dielectric bead and high clamping force due to the action of the spring fingers within the socket tends to eliminate the common center-conductor pullout failures due to the differential thermal expansion and contraction. Preliminary tests indicate that resistance to pullout is typically in the neighborhood of 250 lbs. for No. 7AWG copper wire. Furthermore, the connectors of the system described above are reusable and the fact that the cable adapter can be disconnected from the receptacle with which the socket member is associated, allows easy replacement of component circuits, such as amplifiers, in the system.

Having thus described the invention as exemplified by a preferred embodiment, obvious changes and modifications by persons skilled in the art are deemed to fall within the spirit and scope of the disclosure and claims.

1. A coaxial line terminal adapter element for detachable connection of a receptacle, comprising:

a hollow conductor body member having a cylindrical bore therethrough, means in said bore for conductively securing the body member to the end portion of an outer conductor of a coaxial line, insulating means mounted within the bore, a collet having an unobstructed opening therethrough for receiving the inner conductor of the line supported by said insulating means centrally of the bore, the collet being longitudinally slotted to provide a socket having a plurality of fingers between which the central conductor of the coaxial line slidably extends when the outer conductor of the coaxial line is disposed in the body member, a ferrule member supporting the insulating means and slidably mounted within the cylindrical bore, means within the bore providing radially inwardly extending circumferential ledge means, the means for securing the body member to the outer conductor of the cable comprising a resilient split sleeve coaxial with the bore and disposed between the ledge means and an inner end wall provided on the ferrule member, said ledge means and said inner end wall being provided with camming means to cause radial compression of the sleeve in response to relative axial movement of the ferrule and ledge means toward each other, said receptacle being provided with engaging means for detachably engaging the body member, said receptacle having bearing means for bearing against and moving the ferrule member axially against the split sleeve,

said receptacle provided with a bore therethrough, and insulating means provided within the receptacle bore for supporting a conductive socket member concentrically therewithin, said socket member including an opening to receive the spring fingers therein.

2. A coaxial line terminal adapter element for detachable connection of a receptacle, comprising:

a hollow conductor body member having a cylindrical bore therethrough, means in said bore for conductively securing the body member to the end portion of an outer conductor of a coaxial line, insulating means mounted within the bore, a collet having an unobstructed opening therethrough for receiving the inner conductor of the line supported by said insulating means centrally of the bore, the collet being longitudinally slotted to provide a socket having a plurality of fingers between which the central conductor of the coaxial line slidably extends when the outer conductor of the coaxial line is disposed in the body member, a ferrule member supporting the insulating means and slidably mounted within the cylindrical bore, means within the bore providing radially inwardly extending circumferential ledge means, the means for securing the body member to the outer conductor of the cable comprising a resilient split sleeve coaxial with the bore and disposed between the ledge means and an inner end wall provided on the ferrule member, said ledge means and said inner end wall being provided with camming means to cause radial compression of the sleeve in response to relative axial movement of the ferrule and ledge means toward each other, said receptacle being provided with engaging means for detachably engaging the body member, said receptacle having bearing means for bearing against and moving the ferrule member axially against the split sleeve, a socket member supported in the receptacle and provided with an opening which is substantially conical and divergent toward one end of said socket.

3. A coaxial line terminal adapter element for detachable connection of a receptacle, comprising:

a hollow conductor body member having a cylindrical bore therethrough, means in said bore for conductively securing the body member to the end portion of an outer conductor of a coaxial line, insulating means mounted within the bore, a collet having an unobstructed opening therethrough for receiving the inner conductor of the line supported by said insulating means centrally of the bore, the collet being longitudinally slotted to provide a socket having a plurality of fingers between which the central conductor of the coaxial line slidably extends when the outer conductor of the coaxial line is disposed in the body member, a ferrule member supporting the insulating means and slidably mounted within the cylindrical bore, means within the bore providing radially inwardly extending circumferential ledge means, the means for securing the body member to the outer conductor of the cable comprising a resilient split sleeve coaxial with the bore and disposed between the ledge means and an inner end wall provided on the ferrule member, said ledge means and said inner end wall being provided with camming means to cause radial compression of the sleeve in response to relative axial movement of the ferrule and ledge means toward each other, said receptacle being provided with engaging means for detachably engaging the body member, said receptacle having bearing means for bearing against and moving the ferrule member axially against the split sleeve, the insulating means supporting the socket comprises a centrally apertured bead extending across the bore, and the socket having a portion thereof extending through the apertured bead with the socket extending from the apertured bead and provided with radially extending projecting means respectively abutting opposed surfaces of the bead for captivating the socket against axial movement.

4. The structure as recited in claim 1, wherein one end of said receptacle is provided with means for detachably connecting the receptacle to a housing for a circuit board.

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