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ELECTRICAL CONNECTION FOR SHEATHED CONDUCTORS

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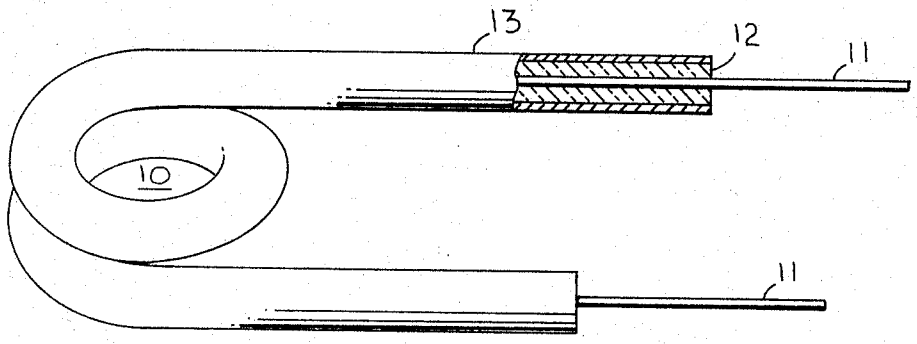

Fig. 1

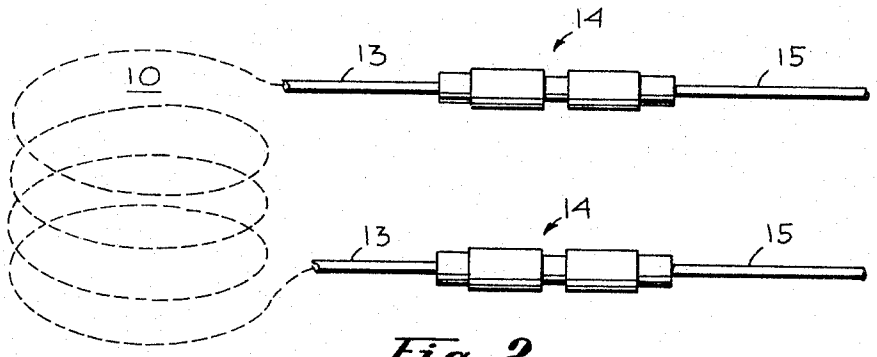

Fig. 2

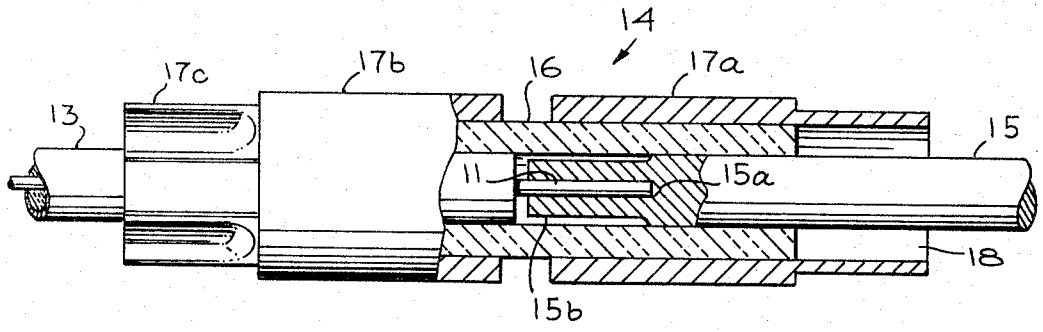

Fig. 3

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ELECTRICAL CONNECTION FOR SHEATHED CONDUCTORS

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The present invention relates in general to solderless connectors of the type used for joining the ends of electrical conductors to provide an electrically conductive joint therebetween, and more particularly relates to a novel sleeve-type of connector which is adapted to receive the ends of a pair of insulated conductors and to be crimped to provide a joint that is substantially water tight and that has good electrical conductivity.

While the present invention has wider application, it is particularly adaptable for use with an electric heating device of the sheathed type comprising a resistor and a sheath enclosing the resistor, the latter being electrically insulated from the sheath by suitable electrical-insulating, heat-conducting means. The invention provides means for sealing the ends of heating devices and also provides means for electrically connecting the heating device to a source of electrical current, the electrical connection between the terminal of the resistor and the conductor wire being adequately protected against shorting and against action of deleterious matter which may be in close relation to the device.

More particularly, in the usual sheathed-type of heater element, a thin resistive wire is covered with a thin layer of appropriate insulation and the combination protected with a metal tubing or sheath. However, the ends of the heater wire protrude from the sheath and connection is made to them for the purpose of sending current through the wire. One of the troubles with this kind of arrangement is the fact that the ends of the heater wire are subject to bending due to vibration or the weight of attachments to them, with the result that the wire eventually breaks. In missile usage, for example, the wire ends experience a great deal of vibration.

A number of attempts have been made in the past to prevent this from happening but the results this far have not been satisfactory. For one thing, these prior art devices turned out to be incompatible with operation in a vacuum and at elevated temperatures. Accordingly, they proved to be unreliable. For another thing, because of the materials and the techniques used in the manufacture of these earlier devices, they turned out to be rather expensive.

Accordingly, it is an object of the present invention to provide an electrical connector that would function successively in vacuums when operated therein at elevated temperatures.

It is another object of the present invention to provide a simple and effective connector that is operative to produce a joint of good electrical conductivity under a wide variety of environmental conditions.

It is a further object of the present invention to provide a sturdy, reliable and relatively inexpensive electrical connector.

These objects are achieved by means of the electrical connector encompassed by the present invention. More particularly, a connector according to the present invention is a sleeve-type connector in which an end of the heater wire is joined, as by crimping, to another wire of larger diameter. More specifically, the larger wire has a hole bored in it for a short distance along its axis and the end of the resistor wire is fitted into it. The two are then crimped together to form a good mechanical and electrical bond. Following this, the tube-wire joint is then

enclosed in an insulated sleeve which, in turn, is mounted between a pair of metal sleeves. However, the manner in which this is done provides the desired protection of the joint against mechanical and electrical breakdown, even under quite adverse conditions. An added advantage lies in the fact that the cost of such electrical connectors is less than comparable prior art devices.

The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawing in which an embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawing is for the purpose of illustration and description only and is not intended as a definition of the limits of the invention.

FIGURE 1 is a view, partly in cross-section, of a heater element, the heater element representing one kind of device with which an electrical connector according to the present invention may be used;

FIGURE 2 is a view of the same heater element but with electrical connectors according to the present invention respectively mounted on its ends; and

FIGURE 3 is a cross-sectional view of the electrical connector and illustrates the manner in which wires of two different diameters may be joined and the joint protected.

Considering now the features of the invention in detail, reference is made to the drawing wherein like or similar parts or elements are similarly designated throughout the several figures. In FIG. 1, the heater element, generally designated **10**, is in the form of a coil and includes a relatively thin resistive wire **11** surrounding which is a layer **12** of suitable dielectric material, the dielectric layer itself being covered over with a metal tubing or sheath **13**. Stated differently, wire **11**, layer **12** and sheath **13** are concentrically arranged, with the wire and sheath respectively being the inside and outside elements and the insulation being located therebetween. Moreover, as will be noted from the figure, insulation **12** and sheath **13** have been stripped from the ends of wire **11** so that the ends are exposed for a short distance for the purpose of allowing connections to be made to them. It should also be noted that although the heater in FIG. 1 is in the shape of a coil, other configurations may at times also be involved. In other words, the shape of the heater element is not important insofar as the invention is concerned.

Referring now to FIG. 2, a pair of electrical connectors, generally designated **14**, are shown mounted on the ends of heater **10**, the primary purpose of the connectors being to firmly interconnect the ends of wire **11** with external wires or leads **15**. It will be noticed from FIG. 2 that, in accordance with the preferred arrangement of the connectors, the diameter of wires **15** are the same or substantially the same as the diameter of sheath **13**.

For a detailed consideration of electrical connector **14**, attention is directed to FIG. 3 wherein an enlarged view of an electrical connector, partly in cross-section, is presented. As shown therein, external wire or lead **15** has a hole **15***a* bored in it, the hole starting at the end of the wire and extending along its axis for a short distance. The exposed or stripped end of wire **11** is inserted in hole **15***a* and, after this is done, the end portion of wire **15** that surrounds the hole is crimped, as at **15***b*, thereby forming a firm mechanical and electrical bond with wire **11**.

Mounted over and, therefore, surrounding this juncture of wires **11** and **15** is an insulative or dielectric sleeve or

tube **16** which may, as an example, be made of aluminum oxide (Al_2O_3). Member **16** is rigid and, therefore, not only protects the wires electrically but also provides some measure of mechanical support to prevent the wires from bending. In this regard, it should be noticed that sleeve **16** fits over the wires snugly, with the result that the wires are held firmly in position. Furthermore, as previously mentioned and as can now more clearly be seen from FIG. 3, the diameter of wire **15** is equal to the outer diameter of sheath **13** covering wire **11**.

Insulative sleeve **16** is itself mounted within a pair of metal sleeves **17***a* and **17***b* which may, for example, be made of Kovar metal. Sleeves **17***a* and **17***b* fit quite tightly over sleeve **16**. This, plus the fact that sleeves **17***a* and **17***b* are extra thick where they cover insulative sleeve **16**, provides an air tight arrangement with the needed mechanical and electrical protection, even under such adverse operating conditions as are found in a vacuum and at elevated temperatures. Lastly, as a final bond or seal, sleeves **17***a* and **17***b* are crimped at their ends, as at **17***c*, the crimping being made possible by the fact that insulative sleeve **16** does not extend fully through metal sleeves **17***a* and **17***b*. As a result, a space **18** exists between sleeves **17***a* and **17***b* and wires **13** and **15** which permits this crimping to take place. However, the technique of brazing may be used as a substitute for such crimping.

Although a particular arrangement of the invention has been illustrated above by way of example, it is not intended that the invention be limited thereto. Accordingly, the invention should be considered to include any and all modifications, alterations or equivalent arrangements falling within the scope of the annexed claims.

Having thus described the invention, what is claimed is:

1. An electrical connector combination comprising: a tubular-shaped electrical element having a first wire extending from one end thereof, the diameter of said element being greater than the diameter of the wire extending therefrom; a second wire whose diameter is equal to the diameter of said electrical element and which has a hole in it along its axis in which said first wire is mounted to form a mechanical and electrical junction therebetween; a tubular-shaped insulative sleeve mounted on said electrical element and said second wire to insulatingly cover said junction therebetween; and a pair of tubular-shaped metal sleeves snugly mounted on said insulative sleeve and extending beyond the ends thereof, said insulative sleeves being spaced apart at their inner ends to provide insulation therebetween and respectively bonded to said element and said second wire at their outer ends.

2. An electrical connector combination comprising: an electrical conductor having a first wire, a layer of insulative material surrounding said first wire, and a metal sheath surrounding said insulative layer; a second wire whose diameter is equal to the diameter of said metal sheath and which has a hole in it along its axis in which said first wire is mounted; an insulative sleeve mounted and extending over said metal sheath and second wire, the diameter of said sleeve being equal both to the diameter of said second wire and the diameter of said metal sheath to provide a snug fit therebetween; a pair of metal sleeves mounted on said insulative sleeve and respectively extending beyond the ends thereof; and means for respectively bonding the ends of said metal sleeves to said electrical conductor and said second wire.

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