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(19)

(54) CRIMP CONNECTOR AND CONNECTION METHOD

(71) We, RAYCHEM CORPORATION, a Corporation organized under the laws of the State of California, United States of America, of 300, Constitution Drive, Menlo Park, California 94025, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The present invention relates to connectors and, in particular, relates to an improved crimp connector comprising a heat-shrinkable insulating sleeve and a crimp barrel.

In one previous proposal, insulated crimp connectors have comprised two separate pieces, a ductile metal barrel and a heat-shrinkable insulating sleeve having a bore running therethrough capable of receiving the metal barrel. A connection between two electrical wires may be formed by first sliding the sleeve onto one of the wires. The ends of the two wires are stripped and inserted into opposite ends of the metal barrel and the barrel is then compressibly deformed into crimping engagement with the wires by the application of crimping pressures. The sleeve is then slid down the wire and over the barrel and is shrunk down onto the barrel and adjacent portions of the wires extending therefrom to protect the connection from the environment.

In the above arrangement, where the barrel and the sleeve are separate, one may in some cases become lost during storage. Further, while forming the connection, the sleeve may inadvertently not be put onto one of the wires before crimping the wires into the barrel. In the latter case, it is necessary to cut the wires from the barrel and begin again with a new barrel. Another problem associated with the use of separate crimp barrels and insulating sleeves relates to the final longitudinal positioning of the sleeve over the crimp connection. Thus care must be taken by the person making the connection to position the sleeve correctly (not necessarily centred) relative to the barrel and to avoid longtudinal shifting of a heat-shrinkable sleeve during heating to effect shrinking thereof.

In another previous proposal, a crimp connector comprises an insulating sleeve having a metal barrel permanently positioned therein. One previously proposed method of manufacturing this type of crimp connector involves inserting the barrel into a heat-shrinkable sleeve and then partially shrinking the sleeve into contact with the barrel in order permanently to retain the barrel therein. Another previously proposed method of manufacturing this type of crimp connector involves forcing a barrel into the bore of a sleeve having a slightly smaller internal diameter than the external diameter of the barrel. A connection between two electrical wires can then be formed by stripping the ends of the wires and inserting them into opposite ends of the metal barrel. The barrel is then compressibly deformed into crimping engagement with the wires by the application of crimping pressures to the sleeve overlying the barrel.

When using the last-mentioned connector, the crimping pressures are transmitted directly through the sleeve to the barrel thereby deforming the barrel and permanently retaining the conductors therein. Unfortunately, in response to the crimping pressure, the portion of the wall of the sleeve in the crimped areas is permanently damaged to the extent that the residual wall thickness is reduced. In some cases, the damage to the wall may cause the tube to split during subsequent heat shrinkage and sealing operations, thereby exposing the underlying electrically conductive crimp barrel. In other cases, the wall thickness

may be reduced to a point where it is insufficient to provide the necessary physical and dielectric strength.

One prior proposal for solving the problem of damage to the wall caused by crimping involves the reduction of the strength of the crimping forces. Although the reduced crimping forces do not cause damage to the wall of the sleeve, the resultant crimp is, in many cases, unacceptable because of the lower quality of the crimp and crimp connection. Another prior proposal for solving the problem involves shaping the crimping dies so that they distribute the crimping forces evenly throughout the wall of the sleeve. Unfortunately, again, the resultant crimp was, in many cases, unacceptable.

A further prior proposal for solving the problem of damage to the wall is disclosed in U.S. Patent Specification No. 3,143,595 (Martin) and involves forming the metal barrel in a substantially hour-glass configuration. The hour-glass configuration permits a cold plastic flow or spread of the sleeve in response to the crimping forces thereby aiding in the prevention of damage to the wall of the sleeve. However, the crimp operation still results in some damage to the wall of the sleeve.

The present invention provides a crimp connector which comprises a crimp barrel comprising a ductile metal and a heat-shrinkable insulating sleeve for receiving the crimp barrel, the sleeve being of a shape and size to enable retention of the barrel therein and to permit removal of the barrel and reinsertion of the barrel therein. The invention thus makes it possible to provide a one-piece crimp connector which enables the formation of a quality crimp in the barrel without causing damage to the sleeve. The invention also provides a method of making a connection between first and second substrates which comprises inserting an end of the first substrate into one end of a connector in accordance with the invention so that the end of the substrate is received within the barrel, removing the barrel from the sleeve and, in either order, inserting an end of the second substrate into the barrel and crimping the barrel onto the end of the first substrate, the barrel being crimped onto the end of the second substrate, after insertion of the latter therein, either at substantially the same time as or before or after it is crimped onto the end of the first substrate, the sleeve then being repositioned around the barrel and the assembly being heated to cause the sleeve to shrink. Advantageously the sleeve is such as to maintain the barrel therein after crimping and during heating to effect recovery of the sleeve.

The sleeve in the connector of the invention advantageously has a substantially cylindrical bore of substantially circular cross-section, and the barrel is also preferably substantially cylindrical in shape and is advantageously closed (preferably circular) in cross-section, although the barrel may, of course, if desired be open in cross-section and/or other than circular in cross-section, or may have any other suitable shape. The internal dimensions of at least part of the sleeve are preferably substantially equal to the outer dimensions of the barrel. Instead of being circular in cross-section, the sleeve may have a substantially oval cross-section and, whatever the cross-section of the sleeve, the sleeve may have at least one internal neck therein, the neck being capable of preventing the removal of the barrel from one end of the sleeve. An internal neck may also act to limit relative longitudinal movement of the barrel and sleeve when the barrel is reinserted into the sleeve, thereby enabling the barrel to be positioned at a desired location within the sleeve and to be maintained in the desired loaction during heating of a heat-shrinkable sleeve (see below).

At least one end of the sleeve in the connector of the invention may be flared to facilitate the insertion of the barrel into the sleeve, and at least one end of the sleeve may be provided with a sealing ring of, for example, a fusible material. The sleeve used in the connector of the invention is heat-shrinkable. Materials that may be used for heat-shrinkable sleeves are disclosed in, for example, U.S. Patent Specification No. 3,086,242, the disclosure of which is incorporated herein by reference. After forming the connection and reinserting the barrel into the sleeve, the sleeve may be shrunk down around the barrel and wires to protect the connection from the environment.

In one embodiment of the invention, a crimp connector comprises a substantially cylindrically-shaped insulating sleeve provided with a bore having a crimp barrel removably retained therein. The sleeve is of a shape and size to enable frictional and/or mechanical retention of the barrel within the sleeve. To form the connection the barrel is removed from the sleeve, preferably by insertion into the sleeve of a stripped electrical wire. Upon removal from the sleeve, the barrel may be crimped onto the wire. The other wire may then be stripped and inserted into the other end of the barrel and crimped into place. Alternatively, the barrel may be crimped onto the two wires substantially simultaneously. The barrel is then reinserted into the sleeve.

The present invention thus makes it possible to provide an insulated electrical crimp connector comprising a crimp barrel disposed in a heat-shrinkable insulating sleeve.

The sleeve is of a shape and size to enable retention of the crimp barrel therein but the barrel may be removed from the sleeve to permit crimping of the barrel onto electrical conductors. In one preferred embodiment the invention provides a crimp connector for making an electrical junction comprising a crimp barrel comprising a ductile metal, and a heat-shrinkable insulating sleeve having a bore of oval-shaped cross-section formed therein to frictionally retain said barrel disposed therein, said sleeve being such as to enable removal of said barrel and reinsertion of said barrel therein, while in a further preferred embodiment the invention provides a crimp connector comprising a crimp barrel comprising a ductile metal, and a heat-shrinkable insulating sleeve having detents formed therein to mechanically retain said barrel disposed therein, said sleeve being such as to enable removal of said barrel and reinsertion of said barrel therein.

A number of embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal section of a crimp connector in accordance with the invention with the barrel positioned in the sleeve;

Figure 2 is an exploded perspective view of the crimp connector of Figure 1 with an electrically conductive wire inserted therein;

Figure 3 is a perspective view of a second crimp connector in accordance with the invention;

Figure 4 is a longitudinal section through a third crimp connector in accordance with the invention; and

Figure 5 is a longitudinal section through an insulating sleeve suitable for use in accordance with the invention, having meltable inserts disposed therein.

Referring now to the drawings, the present invention contemplates the formation of an insulated electrical crimp connection by means of a connector comprising an insulating sleeve having a crimp barrel removably retained therein. A connector constructed in accordance with the invention is shown in Figures 1 and 2, where the crimp connector 10 comprises a crimping barrel 12 and a heat-shrinkable insulating sleeve 14. The crimp barrel 12 is preferably cylindrically shaped and consists of a ductile metal which is a good conductor and is capable of being deformed with a crimping device. Suitable metals are, for example, copper, aluminium and brass. The barrel is also preferably provided with a centrally located conductor stop 16 (see Figure 2) formed by lancing one side of the wall of the barrel and forcing a portion of the wall into the interior of the barrel.

The insulating sleeve is preferably substantially cylindrically shaped and has a bore formed therein which runs the length of the sleeve. The sleeve is shaped and sized to enable frictional retention of the barrel within the bore of the sleeve. Frictional retention usually requires that some part of the outer insulating sleeve must always be in contact with some part of the crimp barrel being held in position and requires that reasonably close tolerances be held during the fabrication process so that the retention forces are within appropriate limits. The sleeve is further shaped and sized to enable removal of the barrel from the sleeve for crimping without damaging the sleeve and subsequent reinsertion of the barrel into the sleeve.

The sleeve 14 shown in Figures 1 and 2 is substantially cylindrically shaped and comprises a circumferentially disposed channel 18 and flared portion 20. The channel 18 forms a corresponding neck 22 protruding into the interior of sleeve 14. The neck 22 has a diameter less than the outer diameter of barrel 12 and functions to centre the barrel midway along the length of the sleeve. The inner diameter of the central portion 24 of the sleeve is approximately equal to the outer diameter of the barrel 12 thereby enabling frictional retention of the barrel within the sleeve.

To form a connection an insulated electrical wire 26 is stripped to expose the conductor 28. The wire 26 is then inserted into the end of the sleeve 14 adjacent to the neck 22 and into the barrel 12 until the conductor 28 abuts stop 16; the sleeve 14 and the neck 22 form a wire guide which facilitates the insertion of the conductor 28 into the crimp barrel 12, this being particularly useful when the conductor 28 comprises a plurality of separate strands. The barrel is then urged from the sleeve 14 (see Figure 2) by pushing on the wire 26. After the barrel 12 has been removed from the sleeve it is crimped by any suitable manner permanently to retain wire 26 therein. A wire 27 is then stripped, inserted into the other end of barrel 12 and crimped permanently to retain it therein. The barrel 12 is then reintroduced into the sleeve 14 by holding the sleeve stationary and pulling on the wire 26. A flared portion 20 of the sleeve 14 has a larger diameter than the barrel 12 to facilitate the insertion of the barrel into the sleeve by enabling alignment of the barrel with the bore of the central portion 24 of the sleeve. Neck 22 acts to position the barrel 12 correctly in the sleeve 14.

In Figure 3, there is shown an alternative embodiment of the connector of the invention having a heat-shrinkable sleeve 29 formed with a bore having a cross-sectional shape other than round. The sleeve shown has a bore of oval cross-section for at least a

portion of its length, the major diameter 30 of the bore being larger than the external diameter of the barrel (not visible in Figure 3) and the minor diameter 32 of the bore being smaller than the external diameter of the barrel. The barrel may be inserted or removed from the sleeve by applying pressure along the major diameter of the sleeve thereby deforming the bore of the sleeve so that it is approximately round in cross-section. In its deformed state, the diameter of the bore is larger than the diameter of the barrel. The barrel may then be easily inserted or removed from the sleeve. When the pressure is released, the bore of the sleeve will regain its original shape and frictionally retain the barrel therein along its minor axis. The ends 34 of the sleeve are preferably slightly flared outwardly to facilitate insertion of the barrel and the wires into the sleeve.

Figure 4 shows an alternative embodiment of the invention having a heat-shrinkable insulating sleeve 36 shaped and sized to enable mechanical retention of a crimp barrel 37 therein. In order mechanically to retain the crimp barrel within the sleeve, the barrel is forced past a detent which is formed in the wall of the sleeve. As the barrel passes the detent, it falls into a cavity whose inside diameter is larger than the diameter of the barrel. A detent of this type can be easily fabricated and remains functional over a wide fabrication tolerance band. The sleeve 36 is substantially cylindrically shaped and is provided with two spaced-apart detents formed as circumferentially disposed channels 38 and 40 in the wall of the sleeve. The channels form corresponding necks 42 and 44 respectively which protrude into the interior of the sleeve 36. The necks 42 and 44 have internal diameters which are less than the outer diameter of the metal barrel. However, at least one of the necks has a diameter which is only slightly less than the outer diameter of the metal barrel thereby enabling removal of the barrel from the sleeve past that neck through elastic deformation of the plastics insulation material. The barrel may be readily removed for crimping by inserting a wire into the barrel and pushing the barrel past such an appropriately sized neck. After crimping the barrel onto the wires, it may be reinserted into the sleeve by holding the sleeve stationary and pulling on the wire. In an alternative embodiment, the neck may be formed in circumferentially disposed sections rather than as a continuous ring.

Referring to Figure 5, there is shown an insulating sleeve 46 for use in a connector according to the present invention, the sleeve being of a shape and size to enable frictional retention of a barrel therein and having its ends 48 flared outwardly to facilitate insertion of the barrel and wires (not shown in Figure 5) into the sleeve. The sleeve is heat-shrinkable and is advantageously further provided with circumferentially disposed sealing rings 50. The rings 50 comprise a material which will flow on the application of heat and environmentally seal the ends of the sleeve. Suitable materials for sealing rings are disclosed in, for example, U.S. Patent Specification No. 3,243,211, the disclosure of which is incorporated herein by reference.

The present invention may also be used for other electrical connections whose body must be all or partially covered with insulation after application, for example ring terminals and spade terminals. Thus, for example, the crimpable shank (crimp barrel) of a ring or spade terminal may be provided in accordance with the invention with a heat-shrinkable insulating sleeve which is of a shape and size to enable retention of the crimpable shank therein and to permit removal of the shank for crimping and reinsertion of the shank therein.

WHAT WE CLAIM IS:-

1. A crimp connector which comprises a crimp barrel comprising a ductile metal and a heat-shrinkable insulating sleeve for receiving the crimp barrel, the sleeve being of a shape and size to enable retention of the barrel therein and to permit removal of the barrel and reinsertion of the barrel therein.

2. A connector as claimed in claim 1, wherein the sleeve is of a shape and size to enable frictional retention of the barrel therein.

3. A connector as claimed in claim 1 or claim 2, wherein the sleeve is of a shape and size to enable mechanical retention of the barrel therein.

4. A connector as claimed in any one of claims 1 to 3, wherein the sleeve has a substantially cylindrical bore of substantially circular cross-section.

5. A connector as claimed in any one of claims 1 to 4, wherein the internal dimensions of at least part of the sleeve are substantially equal to the outer dimensions of the barrel.

6. A connector as claimed in any one of claims 1 to 3, wherein the sleeve has a bore of substantially oval cross-section.

7. A connector as claimed in any one of claims 1 to 6, wherein the sleeve has an internal neck therein which is capable of preventing the removal of the barrel from one end of the sleeve and of positioning the barrel at a selected location within the sleeve.

8. A connector as claimed in claim 7, wherein at least one end of the sleeve is flared.

9. A connector as claimed in any one of

claims 1 to 6, wherein the sleeve comprises first and second internal necks, the first neck having dimensions only slightly smaller than the outer dimensions of the barrel to enable insertion of the barrel into the sleeve, and removal of the barrel from the sleeve, by elastic deformation of the said neck.

10. A connector as claimed in any one of claims 1 to 9, wherein the ends of the sleeve are flared outwardly.

11. A connector as claimed in any one of claims 1 to 10, wherein a sealing ring is disposed at at least one end of the sleeve.

12. A connector as claimed in any one of claims 1 to 11, wherein the barrel is substantially cylindrical and has a substantially circular cross-section.

13. A connector as claimed in any one of claims 1 to 12, wherein the barrel comprises a substantially centrally located conductor stop.

14. A connector as claimed in any one of claims 1 to 13, wherein the barrel forms part of a ring terminal or spade terminal.

15. A crimp connector for connecting electrical conductors comprising a crimp barrel comprising a ductile metal, and a heat-shrinkable insulating sleeve having a bore formed therein, said bore being of a shape and size to enable retention of said barrel disposed therein and to permit removal of said barrel and reinsertion of said barrel therein.

16. A crimp connector for making an electrical junction comprising a crimp barrel comprising a ductile metal, and a heat-shrinkable insulating sleeve having a bore of oval-shaped cross-section formed therein to frictionally retain said barrel disposed therein, said sleeve being such as to enable removal of said barrel and reinsertion of said barrel therein.

17. A crimp connector comprising a crimp barrel comprising a ductile metal, and a heat-shrinkable insulating sleeve having detents formed therein to mechanically retain said barrel disposed therein, said sleeve being such as enable removal of said barrel and reinsertion of said barrel therein.

18. A connector constructed substantially as described herein with reference to, and as illustrated by, Figures 1 and 2, or Figure 3, or Figure 4 of the accompanying drawings.

19. A connector as claimed in claim 1, wherein the sleeve is substantially as described herein with reference to, and as illustrated by, Figure 5 of the accompanying drawings.

20. A method of making a connection between first and second substrates which comprises inserting an end of the first substrate into one end of a connector as claimed in any one of claims 1 to 19 so that the end of the substrate is received within the barrel, removing the barrel from the sleeve and, in either order, inserting an end of the second substrate into the barrel and crimping the barrel onto the end of the first substrate, the barrel being crimped onto the end of the second substrate, after insertion of the latter therein, either at substantially the same time as or before or after it is crimped onto the end of the first substrate, the sleeve then being repositioned around the barrel and the assembly being heated to cause the sleeve to shrink.

21. A method as claimed in claim 20, wherein both the barrel and sleeve are retained on the first substrate when the barrel is removed from the sleeve.

22. A method as claimed in claim 20 or claim 21, wherein the barrel is removed from the sleeve by pushing on the first substrate to urge the barrel from the sleeve.

23. A method as claimed in any one of claims 21 to 23, wherein the barrel is crimped onto the end of the first substrate before the end of the second substrate is inserted into the barrel.

24. A method as claimed in any one of claims 20 to 23, wherein the substrates are electrical wires.

25. A method of making an electrical connection between two conductors carried out substantially as described herein with reference to, and as illustrated by, Figures 1 and 2 or Figure 3, or Figure 4 of the accompanying drawings.

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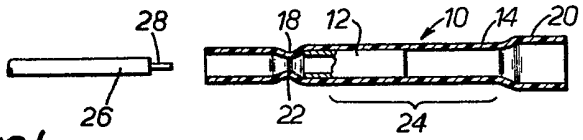

FIG.1.

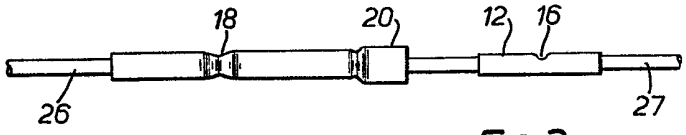

FIG.2.

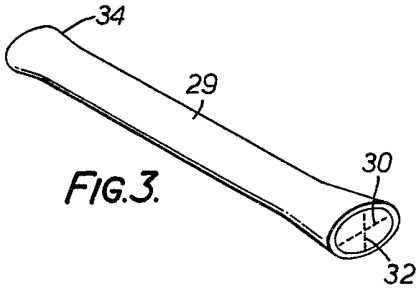

FIG.3.

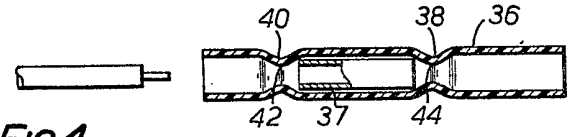

FIG.4.

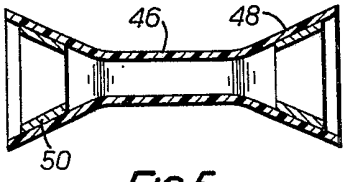

FIG.5.