ABSTRACT OF THE DISCLOSURE

Electrical connector for forming sealed connection comprises U-shaped channel member with insulation piercing projections extending upwardly from web of channel. Entire internal and external surface of connector is covered by film of rupturable material. Sealant is provided between film and web of connector adjacent to projections. Upon crimping connector onto insulating wire, film is ruptured and the sealant flows around, and seals, the interface between the wire and the connector.

This invention relates to open U- or channel-type connecting devices and particularly to the moisture-proofing and packaging of such connecting devices. Crimpable connecting devices are usually either of the open U-type or the closed barrel type. The open channel type of crimpable connector has a trough-like or U-shaped ferrule which is crimped onto a wire by bending its sidewalls towards each other and onto the wire positioned therebetween. The closed barrel type of crimpable connector, on the other hand, has a generally cylindrical ferrule portion into which the wire is inserted and which is compressed onto the wire at the time of crimping. Both types of crimpable connecting devices are widely used and each has its comparative advantages. The closed barrel type, for example, can be preinsulated with relative ease and can be designed in a way such that the crimped connection between the wire and the ferrule is fully sealed after crimping. The open U-type ferrule is usually less expensive than the closed barrel type and also has the advantage that the wire can be positioned between the ferrule sidewalls prior to crimping by a simple lateral movement of the wire. In other words, the wire must be inserted into the opening at the end of a closed barrel ferrule prior to crimping but the wire need only be positioned between the sidewalls of an open U-type ferrule and can be moved laterally into the ferrule. By reason of this advantage of ease of positioning the wire, open barrel-type ferrules are widely used where the terminals are being crimped onto the wire with an automatic lead-making machine. In at least one application, an open U-type ferrule is used because of the fact that the crimping tool functions to locate the wire in the ferrule by moving it laterally on its axis between the ferrule sidewalls. This type of crimping tool is disclosed and claimed in application Ser. No. 559,230, filed Jan. 7, 1966, by Richard Ellwood Reem et al., now U.S. Patent No. 3,528,872.

Therefore, open U-type ferrules offering the advantages of a moisture-proof and preinsulated connection have not been generally available because of the difficulty of providing an insulating covering which, after crimping, will completely surround or cover the crimped connection. An insulating film can be provided on the external surface of an open U-type connecting device but at the time of crimping, it usually happens that some exposed material edges will remain and complete insulation will not be obtained. The present invention is directed to the problem of providing an insulating film on an open U-type connector.

The present invention is also directed to the problem of packaging open U-type connecting devices in a manner such that they will be completely protected within an impervious envelope prior to crimping. An outstanding feature of an packaging arrangement in accordance with the invention is that this envelope is not prior to crimping but will be breached or penetrated selectively by the wire in a manner such that it will remain over substantially the entire surface of the connector and continue to perform its protective functions although it will not interfere with the electrical contact between the wire and the ferrule. It should be mentioned that it is frequently desirable to protect uncrimped electrical connecting devices from the degrading effects of corrosive atmospheres during the period after manufacture when they are stored or shipped to the ultimate user. Connecting devices are subject to surface oxidation or corrosion during this period and the presence of oxidizable in the connector can seriously degrade the finished crimped connection. The present invention thus provides a means for avoiding any such deleterious effects without interfering with the normal procedures followed in crimping electrical connectors.

It is thus an overall object of the present invention to provide improved methods and means for packaging open U-type electrical connecting devices and rendering such devices moisture-proof or moisture resistant when they are crimped onto wires so that the electrical interface between the wire and the connector will be protected against adverse atmospheric conditions.

This object and additional objects of the invention are achieved in one embodiment in which the open U-type electrical connector has an upstanding tongue or projection on its web portion capable of penetrating the wire and/or the insulation of the wire at the time of crimping. The connector is laminated between two sheets of impervious film with the film adhering to the surface of the connecting device. The film thus covers the entire inside surface of the connecting device as well as its external surface and the two sheets are bonded to each other to form a continuous seal. When the connector is crimped onto a wire, the wire is positioned between the sidewalls of the connector and the sidewalks are bent down against the wire to force the wire against the projection which punctures or ruptures the insulating film only in the immediate area of contact. The projection penetrates the film and establishes electrical contact with the wire although the film remains on the other surface portions of the connector. In accordance with this aspect of the invention, the wire is completely surrounded by the connector after crimping and the surface of the connector, both internal and external, is completely covered with insulating film excepting the portions of the projection which extend into the conductor and establish electrical contact therewith.

In accordance with a further aspect of the invention, a suitable flowable sealing material is contained between the insulating film and the surface of the web portion of the connector adjacent to the projection. When the connector is crimped onto the wire in this instance, the projection ruptures the film as explained above and the wire imposes a hydrostatic pressure on the sealing material contained by the film. The sealing material flows, under the influence of this pressure, through the breach in the film during crimping and surrounds the intersection of the wire and the projection thereby sealing the immediate contact area between the wire and the connector.

In the drawing:

FIGURE 1 is a longitudinal sectional view in perspective of an uncrimped connecting device in accordance with the invention;

FIGURE 2 is a view taken along the lines 2-2 of
FIGURE 1 and showing the location of the wires at the beginning of the crimping operation; FIGURE 3 is a view similar to FIGURE 2 but showing the positions of the parts during an intermediate stage of the crimping operation; FIGURE 4 is a transverse sectional view of a crimped connection in accordance with the invention; FIGURE 5 is a fragmentary longitudinal sectional view of a connecting device in accordance with the invention prior to crimping; and FIGURE 6 is a view similar to FIGURE 5 but showing the positions of the parts after crimping.

In the description which follows, the invention is disclosed in conjunction with a particular type of open U-connecting device which is used for making splice connections between wires extending axially towards each other. The general principles of this type of connector are more fully explained in U.S. Patent No. 3,320,354, issued to James Earl Marley et al., and one form of tool for crimping connectors of this type is described in U.S. Patent No. 3,328,872. This type of connecting device is particularly intended for use in the communications industry for splicing the numerous conductors of the telephone cable. It is sometimes desirable that such connections in telephone cables be completely water-proof because of the fact that a high degree of reliability and a long life expectancy are required. It is to be understood at the outset, however, that the principles of the invention can be applied to a wide variety of open-U-type connecting devices if improved packaging and/or a water-proof finished connection is desired.

Referring to FIGURES 1 and 2, this type of open U-ferrule 2 comprises a web 4 having sidewalks 6 extending from its longitudinal edges. Two pairs of struck-up tongues 8a, 8b, 10a, 10b are provided in the web, one pair being located adjacent to, and being associated with, each end of the connector. These tongues are equipped with a pair of sideways extending slots 12, the width of which is substantially equal to, but slightly less than, the diameter of the insulating core portion 13 of the wires which are to be connected. These wires are provided with an insulating sheath 15 which is not stripped from the wire ends at the time of crimping but is penetrated to make electrical contact with the wire cores as described below. The upper edges of the tongues slope downwardly towards the slots 12 and function to guide the wires into the slots when the crimping operation is carried out.

The sidewalks 6 are provided with spaced apart notches 18 on each side of the pair of upright tongues and the isolated sections of the sidewalks between these notches are inwardly formed as shown at 20 to form an integral stuffing tool in the sidewalks to force the wires into the slots. Additionally, ears 22 are struck up from the sidewalks and extend beside the inwardly formed sidewall sections 20 to further assist in the stuffing operation and force the wires downwardly into the grooves 12. These features of the disclosed embodiment are fully described in U.S. Patent No. 3,320,354, and need not be further discussed here.

A film 24 of a suitable polymeric material is bonded to the external surface of the connector and extends upwardly beyond the edges of the sidewalks shown at 26 and beyond the ends of the connector as shown at 25. A variety of suitable plastic materials are presently available which can be used for this insulating layer. Good results have been obtained, for example, with Surlyn A, an ionomer resin film available from E. I. Du Pont. This ionomer film can be bonded by the mere application of heat to the metal surface of the connector and two sheets of this film will seal to each other when heat is applied. The self-sealing characteristic of these ionomer films is advantageous in the practice of the invention since an additional film of the same material is bonded to the film 24 as described immediately below.

A variety of types of insulating films can be used in the practice of the invention. The film used should be hydrophobic, should be sufficiently tough to withstand the stresses imposed during crimping, and should be capable of being bonded to the metallic connector. Some materials other than ionomers which might be used are polyvinyl chloride, polystyrene, acrylonitrile butadiene styrene, acrylic, poly carbonate, vinylidene chloride, or vinylidene fluoride. Other above listing is not necessarily complete and still other materials might be used.

A second film 28 of ionomer resin is sealed to the side portions of the film 24 as shown at 27 and extends over the upper edges of the film 24 and downwardly between the sidewalks of the connector. The film 28 follows the contours of the internal surface of the connector and is bonded to the inwardly formed sections 20 at 29, to the central portion of the web at 31 (see FIGURE 5) and to the upper edges of the tongues as shown at 30 in FIGURE 2. An effective method of applying the film 28 to the connector is by well-known vacuum-forming techniques in which a sheet of the film is laid over the connector and drawn downwardly against its surface by the application of a partial vacuum to the underside of the film. The film, during application, heated to a temperature sufficient to cause it to bond to the metallic surface of the connector at 31 and to cause it to seal to the surface of the tongues. If the edges of the tongues, it might prove desirable to use a bonding agent to bond the film to the connector. A conventional polyester adhesive such as the type manufactured by E. I. Du Pont can be used if needed. As best shown in FIGURES 1 and 5, the film 28 will not follow the exact surface contours of the connector but will form fillets 33 extending from the upper edges of the tongues to the surface of the web. The film 28 will also bridge the space between the tongues 8a, 8b as shown at 34. These bridging and filleting effects are a result of the fact that the film is incapable of following extremely sharp bends in the contours of the connector.

After application of the films 24, 28 to the connector, it is completely sealed from the atmosphere so that it is protected against the degrading effects of adverse atmospheric conditions or other hostile environments. The connector thus has an unlimited shelf life and need not, after a prolonged period of storage, be reexamined or otherwise recalibrated before it is used.

A mass of suitably plastic sealing material 40 is deposited between each pair of tongues 8a, 8b, 10a, 10b before the upper film 28 is applied to the connector. A variety of materials can be used for this sealing which should be moisture resistant, relatively stable chemically, and should be nonflowable when subjected to pressure for reasons explained below.

In one preferred form of the invention, the sealing material takes the form of a small piece of a sponge-like polyurethane foam having open (i.e., intercommunicating) cells. The cells are extremely small and the foam has a density of about 1.43 pounds per cubic foot. The foam is impregnated with a suitable moisture-resistant material such as polyisobutylene which may be applied to the foam with a dropper. Other materials can be used as impregnants for the foam, for example, a polyvinyl ethyl ether or any suitable moisture-resistant liquid. Alternatively, a relatively firm but flowable plastic material can be used without the foam, for example, soft pitch (a coal tar product) or a combination of paraffin wax and the polymerization product of ethylene glycol with ethylene oxide (commercially available under the trade mark Carbowax).

In use, the wires are positioned between the two打死 the film 10, FIGURE 1 with each wire extending over a pair of aligned grooves 12 in one of the pairs of struck-up tongues. The disclosed type of connector is adapted to make a common electrical connection among as many as four wires as shown in FIGURE 2 although it is frequently used to splice two wires extending axially towards each other. Where a simple splice is made between two wires, each wire is located above the pair of the grooves in the struck-up tongues.
The sidewalls of the connector are bent inwardly towards each other in the manner described in detail in the Patent No. 3,320,354, and the wires are forced downwardly by the sidewall portions 20, 22 into the grooves 12 over which they were positioned.

Since the grooves have a width which is substantially equal to, or slightly less than, the diameter of the conducting cores 13 of the wires, the sides of the grooves penetrate the insulation 15 and establish electrical contact with the cores. During crimping, the wires are pressed against the portions 36 of the film 28 that bridge the grooves 12 and rupture these bridge portions of the film. The wires are also pressed against the bridging portions 34 of the film which extend between the tongues 8a, 8b, 10a, 10b thereby to impose a hydrostatic pressure on the flowable insulating material 40 contained between the tongues. The pressure imposed on the insulating material 40 causes it to flow through the openings, indicated at 38 in FIGURE 3 in the film and into surrounding relationship with the intersection of the wires and the struck-up tongues. The sealing material will also flow around the ends of the wires and seal these ends as indicated at 41 in FIGURE 6. In the finished cramped connection and after the wires have been forced downwardly into the grooves 12 as shown in FIGURE 6, the sealing material will entirely surround the lines of intersection of the wires and the tongues as shown in FIGURES 4 and 6 and will cover the ends of the wires. During crimping, then, the sealing envelope formed by the films 24, 28 is broken if the wires are forced down into the grooves but the breaks or openings are themselves immediately sealed so that the finished connection is water-tight.

It should be mentioned that the representations of the drawings illustrating the behavior of the film 27 during crimping are somewhat idealized in that the film may not necessarily follow the precise contours of the connector with the degree of reality illustrated in the drawings. The drawings, however, do illustrate the principles of the invention and are in general the manner in which the film is deformed by the crimping operation.

After crimping, the ends of the connector will be closed relatively tightly by the formed-over sidewalls and a seam indicated at 39 will extend along the axis of the connector on the upper side thereof. The closed ends and the tightness of the seam 39 will, to a large extent, exclude moisture and seal the crimped connections against the atmosphere. However, a sealed connection in accordance with the invention does not depend upon this end seal and this axial seal 39 since the entire internal surface of the connector remains covered by the film 28 excepting those areas 38 where the film was broken by the wires and these areas are sealed by the sealing material. It follows that if any moisture should enter the inside of the cramped connector through the ends or through the seam 39, the moisture-proof integrity of the connection would not be lost since the entire internal surface of the connector is also sealed from the atmosphere.

The sealing material 40 may be dispensed with under some circumstances, particularly where it is desired only to protect the connector against the atmosphere during storage and where a moisture-proof connection of the highest quality is not required. As noted above, a degree of sealing is obtained even if this sealing material 40 is not utilized.

The insulating film 24 on the external surface of the connector may, if desired, take the form of Mylar (polyethylene terephthalate) film in accordance with the teachings of U.S. Patent No. 3,320,354. Where this film is of Mylar, the ionomer film 28 may be bonded thereto by a suitable adhesive. All the film 24 can take the form of a Mylar-ionomer laminate with the ionomer film facing outwardly. The upper ionomer film 28 can then be vacuum formed on the Mylar-ionomer laminate as described above.

Other alternative methods of providing a continuous layer of insulation over both the internal and external surfaces of the connector might be used. As an alternative to using a film, the entire surface of the connector might be covered with a suitable plastic by fluid-bed coating methods or by spraying, electrostatic spraying, or similar processes. The herein disclosed principles of penetrating the internal insulating covering and causing an encapsulated seal material to flow through the openings formed during penetration would also be applicable to these alternative film or insulation coating methods.

It will be understood that the principles of the invention can be applied to many alternative types of open U-connectors and connecting devices. A simple open U-type connector of the type having insulating piercing lances, for example, as shown in U.S. Patent 2,680,235, can be used in the practice of the invention and the sealing material 40 employed to seal the intersection of the lances with the wire.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The foregoing description and accompanying drawings is offered by way of illustration only. The actual scope of the invention is to be determined by the following claims when viewed in their proper perspective against the prior art.

1. An electrical connecting device comprising, a wire-receiving ferrule of conductive material, said ferrule having a web and having sidewalks extending from the longitudinal edges thereof, a projection on the internal surface of said ferrule for penetrating a wire to make electrical contact therewith upon crimping said ferrule onto a wire, and insulating material covering the entire internal and external surface of said connecting device whereby said connecting device is completely encapsulated, the portion of said insulating material on said projection being rupturable in the zone of engagement of said projection with said wire during crimping to permit electrical contact of said wire by said projection.

2. An electrical connecting device comprising, a wire-receiving ferrule of conductive metal, said ferrule having a web and having sidewalks extending from the longitudinal edges thereof, a projection on the internal surface of said ferrule for penetrating a wire to make electrical contact therewith upon crimping said ferrule onto a wire, and a film of polymeric insulating material covering the entire internal and external surface of said connecting device including said projection, said film being rupturable along the penetrating edge portions of said projection when said connecting device is cramped onto said wire whereby said wire is penetrated and electrically contacted by said projection and the ferrule of the resulting cramped connection is entirely covered by said insulating film excepting the portion of said projection which extends into said wire, said film extending to the intersection of said wire and said projection.

3. A device as set forth in claim 2 including flowable sealing material between said film and surface portions of said web adjacent to said projection, said sealing material being flowable under hydrostatic pressure developed during crimping into surrounding and sealing relationship with the intersection of said wire and said projection.

4. A connector as set forth in claim 3 in which said projection means comprises an upwardly extending tongue extending from said web, a wire-receiving notch in said tongue, said film extending from edge portions of said tongue to said web and sloping with the outer face of said web, said sealing material being enveloped between said film and said web whereby a pressure is applied to said sealing material when said wire is forced thereagainst.

5. An electrical connecting device comprising an open U-type ferrule of conductive metal, said ferrule having
a web and upstanding sidewalls extending from opposite edges thereof, a conductor contacting projection on internal surface portions of said ferrule adapted to penetrate, and make electrical contact with a conductor positioned between said sidewalls upon crimping said ferrule onto a wire, a covering of insulating material over the entire surface of said ferrule including the internal surface portions thereof and said projection, said covering adhering to said surface with a tenacity such that upon crimping said ferrule onto a conductor with concomitant forcing of said conductor against said projection, said covering is removed from said projection at the points of engagement of said projection with said conductor, and the exposed metal of said projection makes electrical contact with said conductor, said covering extending to the intersection of said conductor and said projection to seal the electrical contact between said conductor and said ferrule.

No references cited.

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