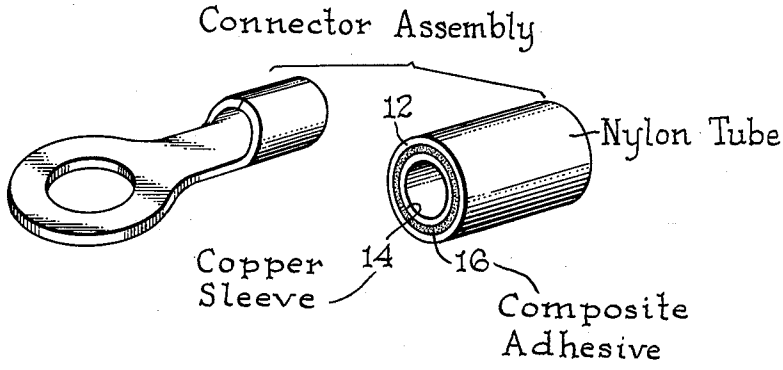
Aug. 16, 1955 H. O. WOOLLEY, JR 2,715,716

NYLON INSULATED ELECTRICAL CONNECTOR AND METHOD OF MAKING THE SAME

Filed Aug. 11, 1952

Fig. 1.



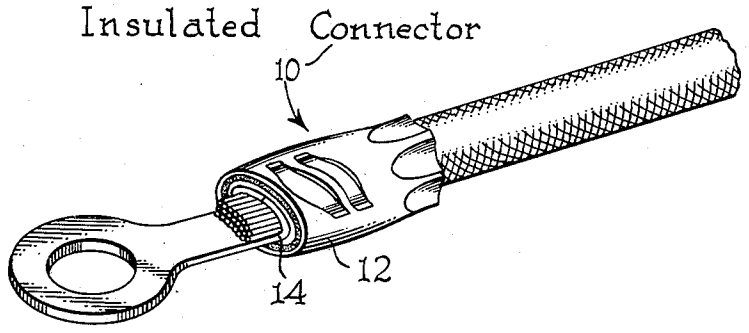


Fig. 2.

INVENTOR
HAROLD O. WOOLLEY, JR.

BY Curtis Morris & Safford
ATTORNEYS

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NYLON INSULATED ELECTRICAL CONNECTOR AND METHOD OF MAKING THE SAME

Harold O. Woolley, Jr., Lemoyne, Pa., assignor to Aircraft-Marine Products Inc., Harrisburg, Pa.

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4 Claims. (Cl. 339—276)

This invention relates to insulated electrical connectors of the type that are adapted to be crimped to one or more electrical conductors, and to a novel method of attaching the insulation to such connectors. More particularly the invention relates to a method of cementing a nylon insulating sleeve on a metal tube forming part of an electrical connector to provide an insulated connector having improved crimping properties.

In the manufacture of electrical connectors of the type adapted to be connected to the end of a conductor or to interconnect two conductors, it is often advantageous or desirable to insulate all or a portion of the connector e. g. the ferrule of the connector, which is attached to the conductor end. The connector is often attached to the conductor end by a crimping operation which not only assures a tight connection, but also one characterized by low resistance of excellent stability by reason of intimate pressure contact between the metal of the connector and that of the conductor. In carrying out the crimping operation there is severe deformation and plastic flow of the connector and its insulation as well as of the conductor to which the connector is attached.

It had been suggested prior to the present invention to cover the ferrule of such a connector with a sleeve of insulating plastic prior to the crimping operation by which the connector and conductor are compressed together, as disclosed in Patent No. 2,410,321 of W. S. Watts. It had also been proposed to cover a tubular connector entirely with a sleeve of insulating plastic as disclosed in Patent No. 2,478,082 of W. F. Broske and in application Serial No. 242,850, filed on August 21, 1951, by Ritter. However, because of the extremely high and localized pressures under the crimping dies, there is a tendency for portions of the insulating material to be pierced or objectionably reduced in thickness by the jaws of the crimping tool when the crimps are made.

To overcome this tendency of the plastic insulating sleeve to be extruded under the jaws of the crimping dies during the crimping operation, it has been proposed that the insulating sleeve be cemented to the conductive metal ferrule or tube that receives the conductor to be crimped. By firmly bonding the insulating sleeve to the underlying metal, axial and circumferential displacement of the plastic insulation during the crimping operation can be substantially reduced. However, the bonding of plastic to metal presents certain special problems. For example, nylon has been found to be a particularly satisfactory material for use in the insulation of connectors of the type referred to above, but considerable difficulty has been encountered in securing a satisfactory bond between a nylon insulating sleeve and the conductive metal ferrule or tube used in connectors of this type.

It is accordingly an object of the present invention to provide an improved nylon-insulated connector of the type described above. It is another object of the invention to provide an improved method of cementing a nylon sleeve to the metal ferrule or tube of an electrical connector to form an insulated connector that can be

crimped to a conductor without excessive extrusion of the nylon insulation from under the jaws of the crimping tool. Other objects of the invention will be in part obvious and in part pointed out hereafter.

In the accompanying drawing, Figure 1 is an expanded view of the parts of the assembly that go to make up a connector according to the present invention. Figure 2 is an isometric view of connection made by crimping onto a wire a connector assembly embodying the parts shown in Figure 1.

In accordance with a preferred embodiment of the present invention, an insulated connector **10** is made by bonding a tubular piece of nylon **12** to a conductive metal sleeve **14** by means of a composite adhesive **16** which is made up of an inner layer of adhesive especially selected for its ability to adhere to metal and an outer layer of adhesive especially selected for its ability to adhere to the inner surface of the nylon tube. Adhesive layer **16** is represented in the accompanying drawing with an exaggerated thickness relative to that of the copper sleeve **14** and more especially relative to the outer sleeve **12**. It should be understood that the drawing is intended to represent the concentric relation of these parts, but is not intended as a scale drawing, particularly with regard to thickness of these parts. I have found that by properly selecting the adhesives used in the composite cementing layer it is possible to bond the nylon insulation to the metal ferrule or tube of the connector in such manner as to increase appreciably the resistance of the material to puncture or near puncture at the crimped areas, and to reduce significantly the tendency of the nylon to be displaced axially and circumferentially during the crimping operation.

In order to point out more fully the nature of the present invention there is described below a specific example of the method of the invention. It is, of course, to be understood that this is not intended to be either exhaustive or at the ultimate limit of the invention but on the contrary it is chosen for the purposes of illustrating the invention in order that others skilled in the art may so fully understand the invention, its principles and the application thereof that they may embody it and adapt it to numerous forms each as may be best suited to requirements of a particular use.

The conductor-receiving copper sleeve **14** of a connector such as that described above was treated with an adhesive solution to form a first layer of adhesive on the external surface thereof. The adhesive used was a known composition comprising a copolymer of vinyl chloride and vinyl acetate mixed with a thermosetting phenolformaldehyde resin in a suitable solvent. The resins were present in the solution to the extent of about 1 part by weight of the vinyl resin to 4 parts by weight of the phenolic resin. The copper sleeve as thus treated was then cured for 30 minutes at 325° F.

Upon completion of the curing treatment, a second layer of adhesive so selected as to have a good bonding action for nylon was applied over the first layer of adhesive. The second adhesive used was a partially condensed resorcinol-formaldehyde resin dissolved in aqueous ethanol. Promptly after application of this second adhesive layer, a piece of nylon tubing **12** of the proper length and of such diameter as to fit snugly over the copper sleeve was positioned on the sleeve and the resulting assembly was subjected to a second cure at a temperature of 180° F. for about 15 minutes.

Connectors having nylon sleeves cemented thereon in accordance with the method just described were tested in various ways and showed substantial advantages over nylon-insulated connectors wherein the nylon was not cemented to the copper sleeve. Thus, after crimping, the force required to produce slipping of the nylon insulation

with respect to the copper sleeve of the connector was approximately four times as great in the case of the cemented sleeves as in the case of uncemented sleeves. Also the dielectric strength of the cemented-sleeve connectors at the point of crimping was appreciably greater than that of the connectors with uncemented sleeves, thus indicating that less of the insulating plastic was displaced from under the jaws of the crimping tool during crimping of the connector.

In other tests the cemented sleeve connectors were immersed in various liquids to test the resistance of the cementing layer to these liquids. Among the liquids used for immersion tests of the cemented-sleeve connectors were salt water, isopropyl alcohol, ethylene glycol, tricresyl phosphate, gasoline, lubricating oil and carbon tetrachloride. The cementing layer prepared in the manner described above exhibited good resistance to all of these liquids.

From the foregoing description it should be apparent that the present invention provides a method of insulating an electrical connector and a connector having a nylon insulating sleeve cemented thereto that are capable of satisfying the several objects set forth at the beginning of the present specification. By using a composite cementing layer including an adhesive particularly adapted to bond with the metal and a second adhesive particularly adapted to bond with the nylon, effective bonding of the nylon to the metal is obtained. Hence, even though relatively large crimping forces are applied to the connector to produce the desired compressive forging of the connector to the conductor therein, the bond between the nylon insulation and metal sleeve prevents substantial axial displacement of the nylon at the point of crimping and hence prevents excessive diminution in the thickness of the insulation at this point. Moreover, the nature of the substances used in forming the cementing layer is such that they have good resistance to substantially any of the liquids that are likely to be present in the environment in which the connectors are ultimately used.

What I claim as new is:

1. An insulated electrical connector of the type which is adapted to be applied to a wire by severe deformation and plastic flow of the wire and of the connector including its insulation, said connector comprising a soft conductive metal tube adapted to receive said wire for crimping thereto, a nylon insulating tube fitted over said metal tube and an intermediate composite cementing layer bonding the outer surface of the metal tube to the inner surface of the nylon tube, said composite cementing layer comprising an inner layer composed essentially of a mixture of vinyl chloride-vinyl acetate copolymer and a phenolic resin bonded to said metal tube, and an outer layer composed essentially of a resorcinol-formaldehyde resin bonded to said nylon tube, said two adhesive layers being bonded to one another.

2. The method of insulating an electrical connector that includes a soft metal sleeve adapted to receive a conductor and be connected thereto by crimping, which comprises applying to the outer surface of said sleeve a solution of a mixture of a phenolic resin and a copolymer of vinyl chloride and vinyl acetate, heating the sleeve at an elevated temperature to evaporate said solvent and deposit a first adhesive layer on said metal tube, thereafter applying to said first adhesive layer a solvent solution of a resorcinol-formaldehyde resin, then positioning a closely fitting tube of nylon over the copper tube and heating the resulting assembly at an elevated temperature to complete bonding of the nylon tube to the metal sleeve.

3. A method according to claim 2 and wherein the solution initially applied to the metal tube contains about 1 part by weight of the vinyl copolymer to 4 parts by weight of the phenolic resin.

4. A method according to claim 2 and wherein the initial heating to an elevated temperature is carried on for about 30 minutes at a temperature of about 325° F. and the second heating at an elevated temperature is continued for about 15 minutes at a temperature of about 180° F.

References Cited in the file of this patent

UNITED STATES PATENTS

2,514,196 Bradley ---------- July 4, 1950

FOREIGN PATENTS

613,013 Great Britain ---------- Nov. 22, 1948