

[54] **APPARATUS FOR MAKING ELECTRICAL CONNECTOR**

[75] Inventors: **Ralph G. D'Ascoli; Leon L. Alleva,**
both of Westchester, N.Y.

[73] Assignee: **The Anaconda Company, New**
York, N.Y.

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abandoned, which is a division of Ser. No. 710,944,
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[51] Int. Cl. **B29c 27/22**

[58] Field of Search **425/110, 112;**
174/84, 87; 29/628, 627; 339/97, 275 R, 275

T

[56]

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Primary Examiner—Robert L. Spicer, Jr.

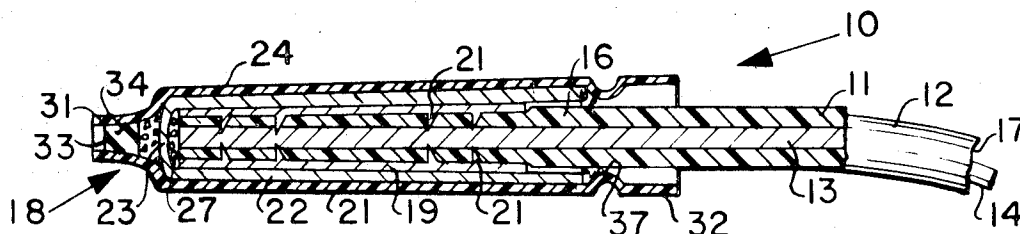
Attorney—Victor F. Volk

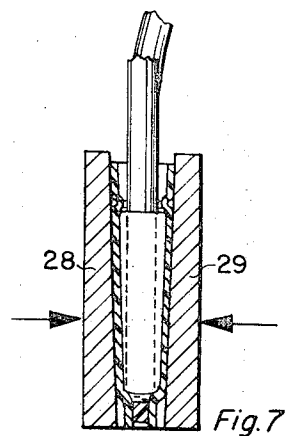
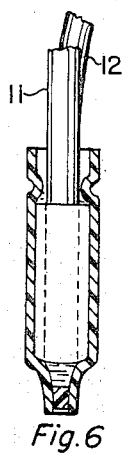
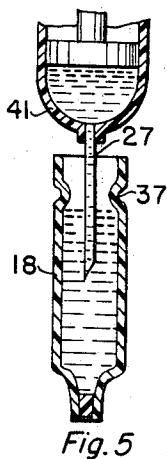
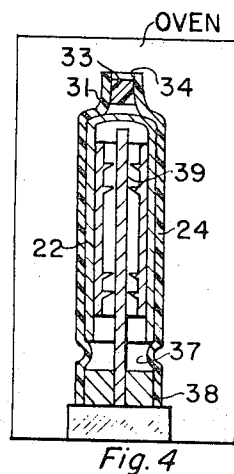
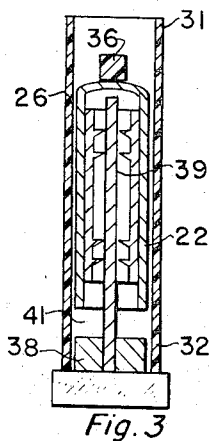
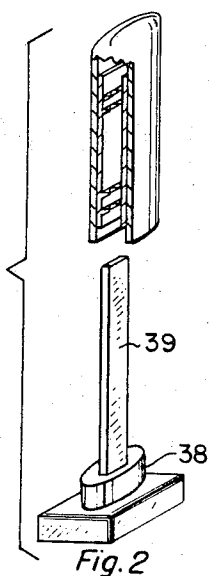
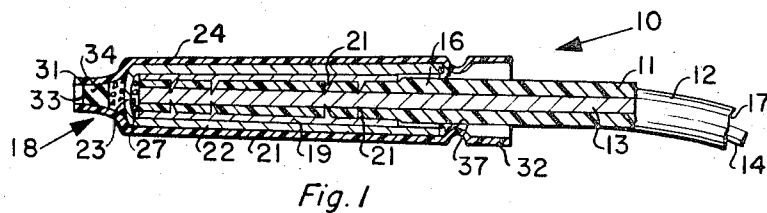
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ABSTRACT

Moisture-tight connectors are made from cut lengths of heat-shrinkable plastic tubing by shrinking one end of the tubing around a plastic pellet that softens and bonds to it thus forming a seal. An inward constriction is formed in the other end of the tubing by shrinking it over a block that is spaced away from an internal metal sleeve. The constriction is needed to retain a dielectric paste with which the connector is filled.

1 Claim, 7 Drawing Figures





APPARATUS FOR MAKING ELECTRICAL CONNECTOR

RELATED U.S. APPLICATIONS

This is a division of application Ser. No. 24,952 filed Mar. 6, 1970 now abandoned, a division of application Ser. No. 710,944 filed Mar. 6, 1968, now U.S. Pat. No. 3,539,708.

BACKGROUND OF THE INVENTION

This invention relates to electrical connectors and particularly to connectors suitable for rapidly joining two or more plastic-insulated telephone wires in a moisture-tight, insulated splice.

An understanding of the state of the art prior to our present invention can best be obtained by reference to Graff et al. U.S. Pat. No. 3,064,072 and Smith U.S. Pat. No. 3,265,807. These patents describe a type of connector which has acquired a widespread commercial usage for splicing telephone conductors without the need of first stripping off the insulation. They comprise a thin-walled, hard-metal shell with inwardly facing prongs and are capable of piercing the conductor insulation and the outer surface of the conductors themselves. This hard-metal shell is surrounded by relatively thick-walled deformable metal sleeve inserted in an insulating plastic jacket. The ends of conductors which are to be connected are inserted, together, into the hard-metal shell. The whole connector is then compressed by the action of a tool against the outside of the jacket. The compression is severe enough to deform the deformable sleeve which, in turn, presses together the surfaces of the pronged shell, driving the prongs into the conductors. When the pressure of the tool is released the thick-walled deformed sleeve retains its new shape and prevents the hard-metal prongs from springing back out-of-contact with the conductors.

These known types of "B-connectors" have found their greatest use for paper insulated telephone conductors. Their application to plastic-insulated conductors has been handicapped by the fact that there has been no known reliable method of making them moisture-tight.

To properly understand this problem it should be understood that cost considerations require that the plastic jackets of the connectors should be made by chopping up continuous lengths of tubing. This means that the individual jackets are open at both ends. One end must remain open for inserting the conductors to be spliced, and any sealing of the other end must be such that large numbers of connectors can be sealed automatically and economically, at the same time retaining a high degree of reliability for the moisture-tightness of the seals. The open end of the connector is sealed by means of a pasty composition with which the connector is filled as described in D'Ascoli U.S. Pat. No. 2,906,810. This patented connector, however, has not proven commercially successful because of the cost of the plug used to prevent compound from pressing out of the open end, and in any event was not intended for the piercing insert type of "B-connector." In the practical use of "B-connector" type splices the overriding consideration concerns the time spent by the men who make the splices in the field. To save their time the connectors are supplied to them factory-filled with water-repellant composition, such as the composition described in D'Ascoli and Alleva U.S. Pat. No. 3,536,626.

The ends of the conductors to be spliced are inserted into the open end of the connector, pushing aside the compound, and entering into the pronged shell. The connector is then compressed, piercing the insulation, and extruding compound back along the conductors. The connectors cannot, practically, be entirely filled with compound, for in that case, the excess compound from many hundreds of splices that might be made at one time would create an untidy condition and slow up the splicing operation. Only enough compound should be originally included in the connector to fill it after it has been compressed. There is a tendency, however, for the compound to "channel" when it is extruded backward during the compression of the splice and not to fill all the vacant space at the end of the connector. This has even resulted in having the compound squirt in a narrow stream entirely out of the connector, leaving channels free for the ingress of moisture.

In the commercial manufacture of "B-connector" the tubular insulating jacket is formed of a heat-shrinkable substance such as polyethylene or polyvinyl chloride that is shrunk down over the metal sleeve by heating in an oven or similar means. The resulting open-ended connector has been quite satisfactory where moisture-tightness was not required. When, however, as in the present case it is desired to make the connectors moisture-tight by filling them with an appropriate composition it becomes necessary to seal one end of the jacket to prevent loss of the composition when the connector is compressed. No economically acceptable means for sealing one end of B-connectors has been discovered prior to our present invention.

SUMMARY

We have invented improvements in connections of the type containing a dielectric compound and comprising a pressure deformable sleeve surrounding a plurality of conductors within a tubular plastic jacket that is shrunk down, such as by the application of heat, tightly around the sleeve. In this type of connector the jacket extends beyond the sleeve to provide unsupported first and second tubular extensions of the jacket at the ends, and the conductors are inserted into the first of these extensions. Our improvements comprise a radial constriction in the first extension deflecting the free flow of compound from the jacket when the sleeve is deformed and a pellet of sealant within the second extension. The pellet fits easily into the second extension of the jacket in its preshrunk condition and fills the area in the shrunken condition. The pellet softens into the shape of the extension at the heat-shrinking temperature and bonds to the jacket at that temperature thereby forming a moisture-tight seal of the extension.

We have invented an apparatus for forming a connector of the type described above comprising a base, a stretcher block mounted on the base and a pin projecting upwardly centrally from the base. The stretcher block has a horizontal section approximating the section through the deformable sleeve of the connector and the pin fits within the sleeve and supports it spaced vertically from the block so as to provide a gap between the block and the sleeve for the formation of a radial constriction when the jacket shrinks down tightly on the sleeve and on the block.

We have also invented a method for making our connectors, comprising the steps of providing a block and pin assembly, with the pins substantially smaller in hori-

zontal section than the block and projecting upwardly from it. We mount the sleeve on the pin in such a manner that the sleeve is spaced vertically from the block, and position a length of heat shrinkable plastic tubing over the sleeve so that the tubing extends substantially above and below the sleeve, the lower extension covering a substantial portion of the block which has approximately the same horizontal section as the sleeve. We then deposit a heat-deformable plastic pellet into the upward extension of the tubing, which we heat sufficiently to shrink tightly around the pellet and the sleeve and to form a constriction between the sleeve and the block. Finally we inject a pasty dielectric compound into the connector.

An electrical splice made in accordance with our invention will typically comprise a plurality of insulated conductors, contact means piercing the insulation of the conductors and connecting them electrically, and a deformable sleeve that surrounds the conductors and the contact means. The sleeve is compressed so as to maintain the electrical continuity between the conductors and the contact means, and a tubular jacket is shrunk-fit tightly around the sleeve. The jacket has first and second tubular extensions beyond the sleeve with the conductors entering through the first extension. The second extension is sealed with a plastic plug such as a plug of ethylene ethyl-acrylate copolymer that bonds to the jacket, such as a polyethylene jacket. A pasty dielectric compound fills the connector, preferably one that will wet the conductor insulation, such as polyethylene insulation, and also the jacket material. To help retain the compound the first extension of the jacket has a radial constriction with an open area greater than the combined sectional areas of the insulated conductors but less than the transverse sections of the sleeve.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows, in section, a splice made to our invention.

FIG. 2 shows an apparatus of our invention.

FIGS. 3 and 4 show, in section, successive steps in the method of our invention employing the apparatus of FIG. 2.

FIGS. 5, 6, 7 show respectively the steps of filling our connector, inserting the conductors and deforming the sleeve.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring to FIG. 1 a splice, indicated generally by the numeral 10 shows a pair of conductors 11, 12 comprising wires 13, 14 covered by walls of polyethylene insulation 16, 17 connected electrically and protected from moisture and from outside electrical contact by means of a connector indicated, generally, by the numeral 18. Although the insulation on the conductors 11, 12 is solid polyethylene which is most commonly used for plastic telephone conductor insulation it will be understood that our invention is in no wise limited to this particular plastic. Foam or expanded plastic insulation such as foam polyethylene and polypropylene and other plastics such as vinyls and ethylene copolymers, and, indeed, many others will have applications for our connector and method. The conductors 11, 12 have been inserted into a hard bronze shell 19 with inwardly facing prongs 21 that have pierced the walls of insulation 16, 17 and made electrical contact with the

conductors 13, 14 thereby connecting these conductors, electrically, to each other. A deformable brass sleeve 22 surrounds the bronze shell 19. The sleeve 22 is closed at one end 23. The features so far described are all known, as is a jacket 24 shrunk down on the sleeve 22. Shrinkable tubing of polyethylene and of polyvinyl chloride is commercially available, cut into lengths 26 (FIG. 3) for covering the sleeve 22. It will be understood moreover that the use of such cut lengths of tubing is so much more economical than molded or pressed, closed-end jackets that their use may be considered competitively obligatory. The connector structure so far described, however, has been commercially used mainly for paper-insulated conductors and other cases where there has been no need or possibility of securing a moisture-tight, insulated splice. To render the splice moisture-tight we have filled the connector 18 with a compound 27 that not only has high dielectric strength but will wet the surface of the metals and of the polyethylene insulation 16, 17 and polyethylene jacket 24. The compound 27 must also, of course, be water repellant and a suitable compound is disclosed in D'Ascoli U.S. Pat. Nos. 2,914,501 and 3,536,626. In order to be able to insert soft copper conductors of small size such as size 24 Awg into a connector that contains compound the compound cannot be too stiff and we have now found it desirable to use the lower molecular weights of the range of polyethylene disclosed in the above patent to reduce the stiffness of the compound which although it is paired or injected into the connector hot is cold at the time it is used to make a connection and the conductors are inserted. The connectors so far described, with the exclusion of the compound filling, is known as a B-connector and a splice is made with such a connector by compressing it between anvils 28, 29 of a tool. This compression not only drives the prongs 21 through the insulation of the sleeve 22 which retains its deformed shape indefinitely. The compression, however, would tend to extrude or squirt the compound 27 from the connector if the ends were left open. These ends comprise an extension 31 of the tube 26 remote from the conductors and an extension 32 through which the conductors enter. We have discovered that the extension 31 can be permanently sealed at very low cost by means of a plug 33 of plastic material that will bond to the jacket when the latter is shrunk down around it, and preferably itself deform somewhat at the shrinkage temperature to assure the exact shape of a channel 34 that is left in the extension 31 after it shrinks. In commercial practice the shrinking of the tube 31 may be done as a batch process by placing a large plurality of the tube-covered sleeves in an oven, or it may be continuous with the individual connectors passing through an oven on a conveyor. In either method of shrinking, the plug 33 can be introduced into the extension 31 as a pellet 36 (FIG. 3) of a suitable plastic and requires no extra operation to seal the jacket 34, since the shrinking process also effects the sealing, as shall be seen. Any material that will bond to the jacket stock can be employed for the pellet 36 provided that it has the required dielectric and moisture resistant properties and is not adversely affected by the temperature of shrinking. We have found, however, that the copolymer of ethylene and acrylic acid containing about 8 percent of the acid and having a melt index, using ASTM Method D1238, of 5, is partic-

ularly suitable for forming the pellet 36. Suitable commercial products are known as Dow Zetaphin 70, available from The Dow Chemical Company and Union Carbide 6169 available from Union Carbide Corporation.

The pellet 36 forming the plug 33 adequately seals the extension 31 of the jacket 24 but it has been found that when the connector is compressed by the jaws 28,29 the compound 27 will still squirt out of the extension 32 in such a manner as to leave channels for the admission of moisture. Unexpectedly, however, we have discovered that, if a radial constriction or depression 37 is formed in the extension 32, extrusion or squirting of the compound will be deflected or hindered sufficiently to prevent channelling, as we have proven by immersion tests, to be described. The opening within the constriction 37 must be large enough to permit the easy insertion of the conductors 11,12 and we have found that if this constriction is about the size, or just a little smaller, than the inside opening of the sleeve 22, it will provide the required degree of deflection of the compound 27.

We have found, further, that the formation of the constriction 37 can be formed in a surprisingly efficient manner by means of a block 38 (FIG. 2-4) surmounted by a pin 39 of a proper height. The pin 39 fits into the sleeve 22, actually into the shell 19, and supports the sleeve-shell assembly at the end 23 of the sleeve so as to leave a gap 41 between the end of the sleeve 22 and the top of the block 38. This block has about the same horizontal area as a section through the sleeve 22. The tube 26 is placed over the sleeve 22 supported on the pin 39 so as to extend across the gap 41 over the block 38. The pellet 36 is dropped into the top of the sleeve and the tube is heated for about 2 minutes at 300°F. after which it assumes the shape of the jacket 24 (FIG. 4) closely gripping the sleeve 22 and shrunk above the block 38 to form the constriction 37. A consideration of typical dimensions of the connector 18 will aid in understanding, but other dimensions will, of course, still come within the scope of our invention. For use to connect 2 polyethylene-insulated 24 Awg telephone wires a connector about 1½ inch long will comprise a sleeve 22 about 13/16 inch with an outside section of 0.205 × 0.140 inch. For shrinking this connector the gap 41 is about 1/16 inch. In FIGS. 5-7 we have shown the succeeding steps of introducing the compound 27 by means of a syringe 41, inserting the conductors 11,12 to be connected, and comprising the connector over the conductors. Many millions of telephone conductor splices must be made each year so that it will be readily understood that much effort has been expended to achieve a practical moisture-tight splice, yet up to the

present invention this effort has not been successful. In order to test the connections described herein tests were conducted over an extended period.

EXAMPLE 1

Ten splices were aged for two days at 100° C and submerged in water for two hours. All splices showed infinite insulation resistance between the conductors and the water on a 600 volt megger.

EXAMPLE 2

Ten splices were aged for seven days at 80° C and submerged in water for two hours. All splices showed infinite insulation resistance between the conductors and the water on a 600 volt megger.

EXAMPLE 3

Ten splices were aged for thirty days at 70° C and submerged in water for two hours. All splices showed infinite insulation resistance between the conductors and the water on a 600 volt megger.

The splices of Examples 1, 2, and 3 were all prepared in accordance with FIG. 1 using the apparatus of FIG. 2 as described hereinabove for the preferred embodiment of our invention, and were filled with a composition of mineral oil, polyethylene, petroleum resin and dioctyl sebacate described in U.S. Pat. No. 3,536,626, above mentioned.

We have invented a new and useful connector and apparatus and method for making the same, of which the foregoing description has been exemplary rather than definitive and for which we desire an award of Letters Patent appended claims.

We claim:

1. An apparatus for forming a connector of the type comprising a pressure deformable metal sleeve within a shrinkable plastic jacket, said jacket extending beyond said sleeve to provide unsupported first and second tubular extensions of said jacket at both ends thereof, comprising:

- A. a base,
- B. a stretcher block, mounted on said base, having a horizontal area approximating the horizontal section through said sleeve,
- C. a pin projecting upwardly centrally from said block,
 - a. said pin fitting within said sleeve and supporting said sleeve spaced vertically from said block, thereby providing a gap between said block and said sleeve for the formation of a radial constriction upon the shrinking of a plastic jacket over said sleeve and said block.

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