United States Patent

[11] 3,594,702

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[54] **CONNECTOR**
15 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** ..... **339/95 R,** 339/276 T
[51] **Int. Cl.** **H01r 11/20**
[50] **Field of Search** 339/95, 97, 276

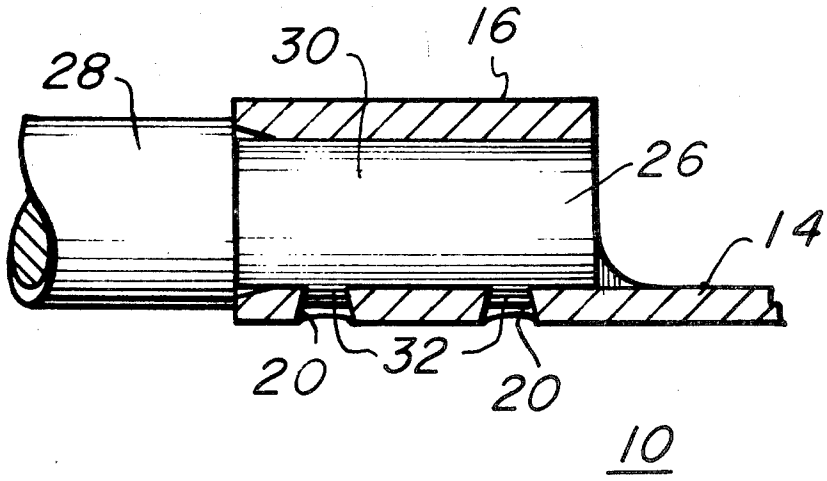
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ABSTRACT: A connector for coupling an electrical conductor to a terminal comprising a wire barrel arranged to be mechanically deformed about the portion of an electrical conductor from which the insulation has been removed to provide an electrical and mechanical connection therewith and a terminal-engaging means coupled to said wire barrel. A plurality of apertures extend through the wire barrel to permit the extrusion of adjacent portions of the metal of the conductor into such apertures to improve the mechanical and electrical coupling therewith. Further, the apertures will permit the breakdown of surface oxides to insure a good electrical connection with the conductor. An insulating jacket may be placed atop the wire barrel and deformed portions of the insulating jacket will also penetrate the apertures to securely, mechanically lock the jacket to the wire barrel.



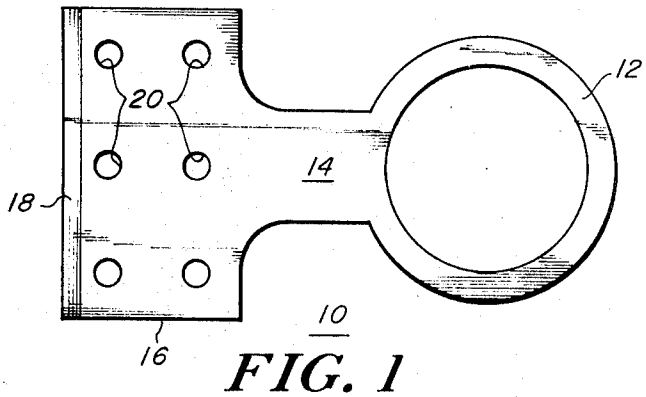


FIG. 1

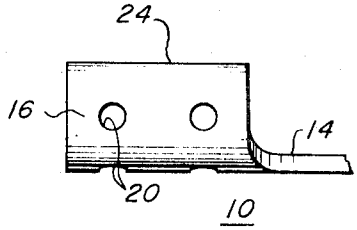


FIG. 2

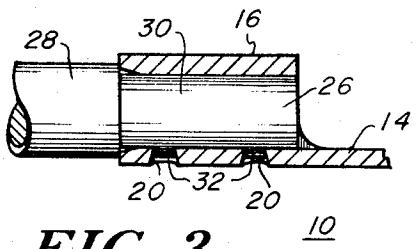


FIG. 3

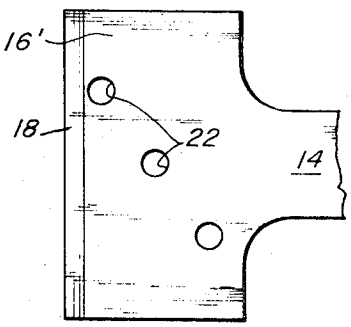


FIG. 4

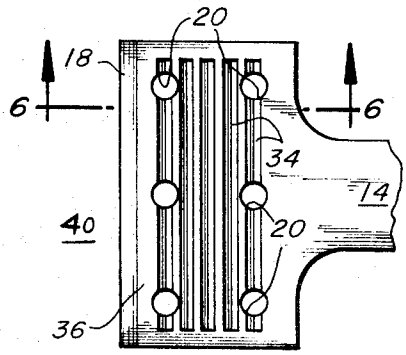


FIG. 5

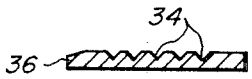


FIG. 6

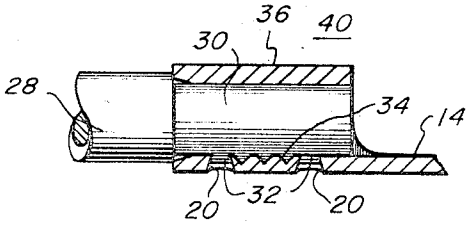


FIG. 7

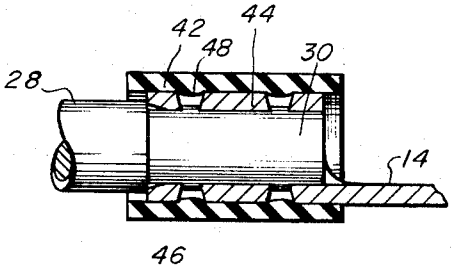


FIG. 8

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CONNECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention is applicable to the field of joining electrical conductors to electrical terminals. In order to employ the connector the insulation must be removed from a portion of the conductor to permit contact between the metallic wire barrel of the connector and the uninsulated portion of the conductor. Joinder of the connector and conductor is accomplished by externally applied mechanically deforming forces to make a good mechanical and electrical coupling between the conductor and connector. Further, the connector is to be used with electrical conductors fabricated from copper or aluminum. The connector is then coupled to an electrical terminal.

2. Description of the Prior Art

Current practice is to separate the conductors, based upon their material, that is copper conductors and aluminum conductors. With respect to the copper conductors the connectors used therewith are fabricated from copper or copper alloy materials. However, with the aluminum conductors an entirely different technique must be employed due to the presence of the aluminum oxide which readily forms when bare aluminum is exposed to air. In order to properly terminate, or place a connector upon an aluminum conductor, it is necessary that the oxide be removed just prior to application of the connector. Alternatively, the connector may be fabricated with an abrasive material placed in the wire barrel of the connector such that the crimping, or mechanical defamation of the connector about the conductor, will cause the abrasive material to remove the oxide coating in order to establish an appropriate connection, mechanical and electrical, between the connector and the conductor. Attempts made to use copper, or copper alloy connectors, upon aluminum conductors have generally resulted in failure of the electrical joint after a given period of time. The rates of thermal expansion of the copper, or copper alloy connector, is different than that of the aluminum conductor causing the aluminum conductor to heat up and expand faster than the copper, or copper alloy connector and after a number of cycles of heating and cool down produce a loose joint providing a bad mechanical and electrical coupling between the connector and the conductor.

SUMMARY OF THE INVENTION

The present invention seeks to overcome the difficulties noted above with respect to prior art connectors by providing a copper, or copper alloy, connector which can be suitably used with both copper and aluminum conductors. The connector is fabricated with a wire barrel portion which can be mechanically deformed about the conductor and a terminal-engaging portion which may be in the form of a ring tongue, fork, taper pin or the like. A plurality of holes are placed through the wire barrel communicating from the outer surface of the wire barrel to the longitudinal opening therethrough. The apertures may have parallel walls, or may be inclined such as to have varying diameters with the greatest diameter being on the outer surface of the wire barrel and the smaller diameter being adjacent the longitudinal opening of the wire barrel. The conductor having a portion of its insulation removed therefrom is then inserted within the longitudinal opening of the wire barrel and the entire wire barrel is mechanically deformed by a crimping tool or the like. As a result of the crimping action a portion of the conductor material itself is caused to extrude within the apertures thereby providing a good mechanical coupling between the wire barrel and the conductor. In addition, the extrusion of the conductor material causes the removal of any surface oxide on the conductor material thereby improving the electrical coupling between the wire barrel and the conductor. This action is particularly important with the use of aluminum conductors wherein it is necessary to remove the aluminum oxide almost immediately formed on exposed aluminum conductors in order to ensure a good electrical connection therewith. Further, the apertures provide the aluminum conductor breathing room wherein it may expand or contract readily as a result of heating without weakening the connection between the conductor and the connector. Further, the presence of the apertures reduces the amount of material to be deformed and thus reduces the mechanical forces required to produce the desired coupling. In addition, a number of serrations may be placed in the inner surface of the wire barrel to further increase the mechanical holding and the breakdown of the oxide coatings of any of the conductors to which the connector is joined. The use of a truncated conical-shaped aperture to permit extrusion of the material of the conductor into the connector also increases the holding power of the connector upon the conductor. Finally, an insulating jacket may be applied to the outer surface of the wire barrel and when crimped, or otherwise mechanically deformed, a portion of the insulating jacket will also extrude within the apertures thereby assuring a good mechanical locking between the insulating jacket and the wire barrel. It is therefore an object of this invention to provide an improved form of electrical connector which can be employed with conductors of both copper and aluminum.

It is yet another object of this invention to provide a simple mechanical connector which provides a reliable coupling between the connector and conductor which is of simple construction and does not require previous preparation of the conductor surfaces other than removal of the insulation therefrom.

It is still another object of this invention to provide an improved connector for joining electrical conductors to an electrical terminal which has at least one aperture extending through the wire barrel of the connector therein to provide a good mechanical and electrical connection therewith.

It is yet another object of this invention to provide an improved electrical connector having a combination of apertures extending through the wire barrel with serrations on the inner surface thereof to provide an improved coupling, both mechanical and electrical, with conductors placed within the wire barrel.

It is yet another object of this invention to provide an improved electrical connector having a plurality of apertures within its wire barrel for receipt therein of the extruded portion insulating jacket placed thereupon and providing good mechanical locking between the insulating jacket and the wire barrel.

Other objects and features of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principles of the invention, and the best modes which have been contemplated for carrying them out.

BRIEF DESCRIPTION OF THE DRAWING

In the drawings in which similar elements are given similar reference characters:

FIG. 1 is a top plan view of the connector constructed in accordance with the concepts of the invention, with the wire barrel portion thereof shown prior to its being rolled.

FIG. 2 is a side elevation of a portion of the connector of FIG. 1 showing the wire barrel in its completed condition.

FIG. 3 is a side elevation, partially in section, of the connector of FIG. 1 installed to a conductor.

FIG. 4 is a top plan view of the wire barrel portion of the connector of FIG. 1 modified according to a further embodiment of the invention.

FIG. 5 is a top plan view of a further modification of the wire barrel portion of the connector of FIG. 1.

FIG. 6 is a side elevation, partially in section, of a portion of the wire barrel of FIG. 5 taken along the line 6–6.

FIG. 7 is a side elevation of the connector of FIG. 5, partially in section, installed to a conductor.

FIG. 8 is a side elevation, partially in section, of a further modification of the connector of FIG. 1 and showing the installation of an insulating jacket about the wire barrel portion.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to FIG. 1 there is shown a connector 10 constructed in accordance with the concepts of the invention. Connector 10 has a terminal-engaging member 12, which in FIG. 1 is illustrated as a closed ring, and which can also take the shape of an open ring, a spade, a pin, a tapered pin or the like as is suitable to the particular terminal block or other terminal member to which the connector 10 is to be coupled. An intermediate member 14 couples the terminal-engaging member 12 to the wire barrel 16 shown in its flat state after stamping and prior to the wire barrel 16 being rolled to form a wire-receiving cavity therein. The rear edge of the wire barrel 16 is tapered as at 18 to make installation of the conductor into the rolled wire barrel 16 easier. Placed in the walls of the wire barrel 16 are a plurality of apertures 20 whose function will be described below. The apertures 20 may be placed in regular rows as is shown in FIG. 1 or may be placed along a diagonal extending across the wire barrel portion 16' as is shown in FIG. 4. The apertures 22 of FIG. 4 are shown to extend along a diagonal of the wire barrel portion 16'. However, it should be noted that any arrangement, or any number of apertures such as 20 or 22, may be made in accordance with desired use of the connector 10 or the type of material of the conductor.

As is shown in FIG. 2, wire barrel portion 16 will be rolled in order to form a seam 24. Seam 24 may be a butt seam, an overlap seam or may be omitted entirely as by forming the connector 10 from seamed, or seamless, tubing and forming the intermediate portion 14 and the terminal-engaging portion 12 by flattening portions of the tubular stock.

Turning now to FIG. 3, additional details of the apertures 20 may be appreciated. Apertures 20 are of varying diameters according to their depth, having their widest diameters at the surface of the wire barrel 16 and their narrowest diameter where the apertures 20 connect to the longitudinal opening 26 of the wire barrel 16 formed when the flat wire barrel portion 16 is rolled. The apertures 20 thus appear as frustoconical openings with their widest base at the outer surface of the wire barrel 16, and their smallest base at their joinder with the longitudinal opening 26. A conductor 28, having a portion 30, from which the insulation has been removed, is inserted within the longitudinal opening 26 of the connector 10 and the wire barrel 16 is crimped, or otherwise mechanically deformed about the uninsulated portion 30 of the conductor 28. As a result a portion of the bare metal of the exposed conductor portion 30 will be caused to extrude through the apertures 20 forming locking ares 32 within the apertures 20. The locking areas 32 will take on a general shape of the apertures 20 and prevent separation of the conductor portion 30 from the terminal 10.

Additionally, these locking areas 30 will also improve the electrical connection between the connector 10 and the conductor portion 30. With aluminum conductors, which have an insulating aluminum oxide formed about their surface, extrusion of the metal of the exposed portion of the conductor 30 into the apertures 20 will cause a breaking of the oxide and thus provide a good electrical connection which otherwise might not be achievable employing connectors of the prior art. Further, the apertures 20 provide breathing space for an aluminum conductor 28. It should be noted that the rate of thermal expansion of copper of which the connector 10 is fabricated, and aluminum from which the conductor 28 may be fabricated, differ such that the aluminum will expand more rapidly than will the copper. Apertures 20 provide space for the expansion of the aluminum which prevents the aluminum, during expansion, from opening the seam or otherwise injuring the jointure between the connector 10 and the conductor 28. It has been found in practice that should a conductor be warmed up as by the presence of an electrical signal therein and retained in its warmed-up condition on a steady state basis the expansion would stop at some fixed point and thus would not injure the coupling between the connector 10 and the conductor 28. However, most conductors 28 are subject to heat cycles during which time they are heated up by the presence of signals and allowed to cool off due to the absence of such signals because a particular circuit is not used or because the equipment has been turned off. It is the repeated heating up and cooling down of the conductor 28 which causes the loosening of the joint and the ultimate mechanical and electrical failure of the coupling between the connector 10 and the conductor 28. Also, the presence of apertures such as 20 permit the connector 10 to be mechanically deformed upon the conductor portion 30 more readily due to the smaller mass of material of the wire barrel 16.

To further improve the coupling between the connector 40 and the conductor portion 30 a series of serrations 34, as is shown in FIG. 5, may be placed across the wire barrel 36. The connector 40 will have a plurality of apertures 20 within its wire barrel 36 and will also have serrations 34 extending across the width of the wire barrel 36 in a direction transverse to the length of the connector 40. These serrations 34 will improve the coupling between the connector 40 and the conductor portion 30 and will further increase the ability of the connector 40 to break up the oxide of aluminum conductors and thus assure a better electrical connection. As is shown in FIG. 6, the serrations are formed by notching and scoring the wire barrel portion 36. In FIG. 7 the application of a connector 40 to a conductor portion 30 is shown. It should be noted that the locking areas 32 are formed within the apertures 20 as was described above with reference to FIG. 3 and in addition metal of the exposed portion 30 of the conductor 28 is caused to deform and fill portions of the serrations 34 as a result of the crimping of the connector 40 to the conductor portion 30.

In FIG. 8 there is shown the inclusion of an insulating jacket 42 about the wire barrel portion 44 of a connector 46. Wire barrel 44 will be fabricated from seamless, or seamed, tubing and will have apertures 20 placed about its entire circumference. As a result of the crimping of the connector 46 to the bare portion 30 of the conductor 28, portions of the insulating jacket 42 will be extruded into the apertures 20 to form locking portions 48 to hold the insulating jacket 42 to the wire barrel 44. Thus a good mechanical joint is created between the wire barrel 44 and the insulating jacket 42. The same arrangement is possible with a seamed wire barrel which is rolled from flat stock as is true of FIG. 1.

The embodiments of the invention in which I claim an exclusive property or privilege are defined as follows:

1. A connector for electrically and mechanically coupling an electrical conductor to a terminal comprising: a wire barrel having a longitudinal opening therethrough for receiving therein the end of an electrical conductor from which the insulation has been removed; terminal-engaging means; an intermediate member coupled to said terminal-engaging means and said wire barrel and three apertures in said wire barrel arranged along a diagonal of said wire barrel, said apertures being transverse to said longitudinal opening for receiving therein a portion of said stripped electrical conductor end when said connector is deformed about said conductor whereby a good mechanical and electrical coupling between said conductor and connector is created.

2. A connector, as defined in claim 1, wherein said apertures are of varying diameters along their depth.

3. A connector, as defined in claim 1, wherein said apertures are of varying diameters, along their depth, having the greatest diameter at the outer surface of said wire barrel and the smallest diameter where said apertures meet said longitudinal opening.

4. A connector, as defined in claim 1, further comprising an insulating jacket about said wire barrel, portions of said jacket adjacent said apertures extruding into said apertures when said connector is deformed to mechanically lock said jacket to said wire barrel.

5. A connector, as defined in claim 1, wherein the inner surface of said wire barrel is serrated.

6. A connector, as defined in claim 5, wherein said serrations extend in planes transverse to said longitudinal opening.

7. A connector for electrically and mechanically coupling an electrical conductor to a terminal comprising: a wire barrel having a longitudinal opening therethrough for receiving therein the end of an electrical conductor from which the insulation has been removed; terminal-engaging means; an intermediate member coupled to said terminal-engaging means and said wire barrel and six apertures in said wire barrel arranged in two columns about the circumference of said wire barrel, said apertures being transverse to said longitudinal opening for receiving therein a portion of said said stripped electrical conductor end when said connector is deformed about said conductor whereby a good mechanical and electrical coupling between said conductor and connector is created.

8. A connector, as defined in claim 7, wherein said apertures are of varying diameter along their depth.

9. A connector, as defined in claim 7, wherein said apertures are of varying diameters along their depth, having the greatest diameter at the outer surface of said wire barrel and the smallest diameter where said apertures meet said longitudinal opening.

10. A connector, as defined in claim 7, further comprising an insulating jacket about said wire barrel, portions of said jacket adjacent said apertures extruding into said apertures when said connector is deformed to mechanically lock said jacket to said wire barrel.

11. A connector as defined in claim 7, wherein the inner surface of said wire barrel is serrated.

12. A connector, as defined in claim 11, wherein said serrations extend in planes transverse to said longitudinal opening.

13. A connector for electrically and mechanically coupling an electrical conductor to a terminal comprising: a wire barrel having a longitudinal opening therethrough for receiving therein the end of an electrical conductor from which the insulation has been removed; terminal-engaging means; an intermediate member coupled to said terminal-engaging means and said wire barrel and at least one aperture in said wire barrel transverse to said longitudinal opening, said aperture is of varying diameters along its depth, said aperture receiving therein a portion of said stripped electrical conductor end when said connector is deformed about said conductor whereby a good mechanical and electrical coupling between said conductor and connector is created.

14. A connector for electrically and mechanically coupling an electrical conductor to a terminal comprising: a wire barrel having a longitudinal opening therethrough for receiving therein the end of an electrical conductor from which the insulation has been removed; terminal-engaging means; an intermediate member coupled to said terminal-engaging means and said wire barrel and at least one aperture in said wire barrel transverse to said longitudinal opening, said aperture is of varying diameters along its depth, having the greatest diameter at the outer surface of said wire barrel and the smallest diameter where said aperture meets said longitudinal opening said aperture receiving therein a portion of said stripped electrical conductor end when said connector is deformed about said conductor whereby a good mechanical and electrical coupling between said conductor and connector is created.

15. A connector for electrically and mechanically coupling an electrical conductor to a terminal comprising: a wire barrel having a longitudinal opening therethrough for receiving therein the end of an electrical conductor from which the insulation has been removed; terminal-engaging means; an intermediate member coupled to said terminal-engaging means and said wire barrel, at least one aperture in said wire barrel transverse to said longitudinal opening for receiving therein a portion of said stripped electrical conductor end when said connector is deformed about said conductor to create a good mechanical and electrical coupling between said conductor and connector; and an insulating jacket about said wire barrel, a portion of said jacket adjacent said aperture extruding into said aperture when said connector is deformed to mechanically lock said jacket to said wire barrel.