Aug. 14, 1956 Q. BERG 2,759,161

ELECTRICAL CONNECTOR AND METHOD

Filed Jan. 13, 1953

Fig. 1.

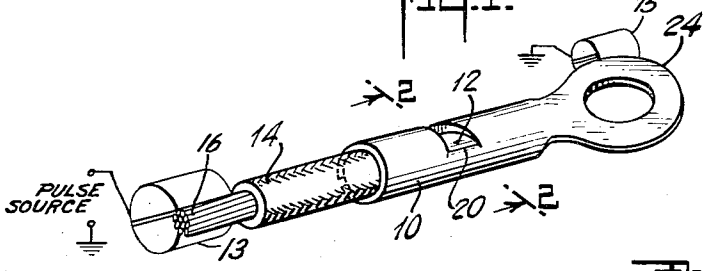


Fig. 2.

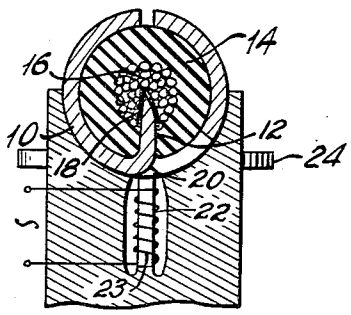


Fig. 3.

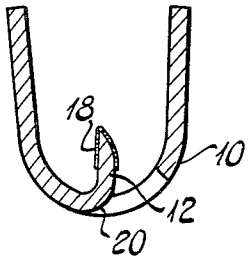


Fig. 4.

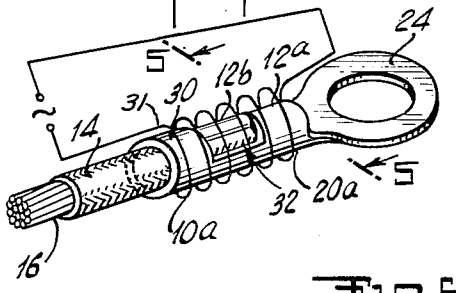


Fig. 5.

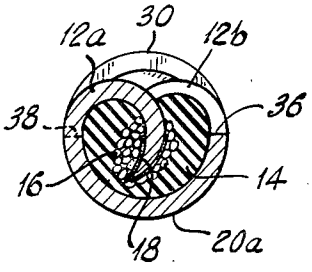
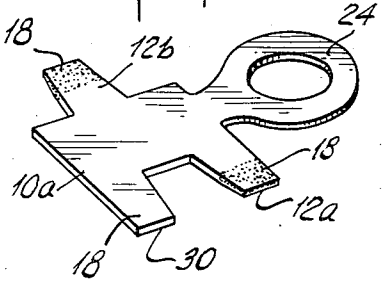


Fig. 6.



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2,759,161

ELECTRICAL CONNECTOR AND METHOD

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Application January 13, 1953, Serial No. 330,974

3 Claims. (Cl. 339—97)

This invention relates to electrical connectors, and more particularly to electrical connectors provided with one or more insulation-piercing members whereby they may be attached to the unstripped ends of insulated electrical conductors and brought into electrically conductive relation thereto by means of such insulation-piercing members.

In the past solderless connectors of the insulation-piercing type have had only a limited field of use because it has not been feasible to attain a stable low resistance connection for the heavier current loads, and soldering of the connection obviously was not feasible because of the presence of the insulation.

An object of the present invention is to provide an insulation-piercing connector and a process of making and applying it which will make available the advantages of a soldered connection without the necessity of stripping insulation from insulated wire. Another object is to provide an insulation-piercing connector constructed so that it can be applied merely with pressure and heat without handling any separate solder or soldering tool; and the resultant connection will be securely soldered between the insulation-piercing part of the connector and the electrical conductor.

In the drawings:

Figure 1 is a perspective view of a completed connection embodying my invention;

Figure 2 is a sectional view taken on line 2—2 of Figure 1;

Figure 3 is a view in transverse section of the blank with partially preformed ferrule from which the connection of Figures 1 and 2 is formed;

Figure 4 is a perspective view of another form of completed terminal embodying the invention applied to an insulated conductor;

Figure 5 is a sectional view through the completely crimped connector and conductor taken on line 5—5 of Figure 4;

Figure 6 is a perspective view of the blank from which the connection of Figures 4 and 5 is made, with partially preformed ferrule-forming portion.

As shown in Figures 1 and 2 the connector consists of a ferrule portion **10** made of malleable sheet metal, advantageously pure electrical copper or brass. This sheet metal is formed to a cylindrical shape embracing and tightly compressing the wire within it. The connector in this instance is shown as consisting only of a ferrule, but it will be understood that any desired tongue or connector ferrule or other part may be attached or made integral therewith. A portion **12** had been punched and turned in with one side still attached as shown; this portion is formed to a sharp edged or pointed conductor-engaging prong which, as shown, is pushed through the insulation **14** on the wire and into contact with the central conductor **16** of the wire. This structure is more particularly described and claimed in my copending application Serial No. 142,511 filed February 4, 1950.

The insulation piercing member **12** is provided on its sides, for a substantial distance back from and adjacent its point, with a coating of solder **18**, i. e., a low melting point electrically conductive solid which readily wets and adheres strongly to both the metal prong **12** and the conductor **16**. This may be one of the lower melting point solders commonly used in this art for making electrical connections; but advantageously is one which has its melting point lowered and its wetting power enhanced by indium included in the alloy, as available from the Indium Corporation of America.

In use the insulated conductor is inserted laterally into the open side of the connector as shown in Figure 3 and against the prong **12**. The connector is then closed onto the wire and compressed in crimping dies, e. g. according to practice already well known in this art excepting that in this instance the portion of the die which engages the base **20** of the prong **12** is strongly heated by means such as block **22** which in turn is heated by inductance coil **23** as indicated in Figure 2 at the instant when the prong **12** is piercing into the central conductor **16**, whereby heat is conducted along the prong to the solder coating **18**, which is thereby fused in contact with the wire **16**. The fused solder wets the wire and flows along it, thus forming a secure bond, and extruded areas of electrical conduction which are sealed against corrosion.

Instead of providing a heating element in the die, the crimped connection may be heated after crimping by an external heater, or by high frequency internal heating such as inductance coil **31** shown in Figure 4 or a strong overload current may be passed through the completed connection such as is indicated in Figure 1, with overload current passing from clamp **13** to clamp **15**, in the die or after it is removed therefrom, thus causing heating at the points of contact with the wire and thereby to fuse the solder and bond the connector to the wire. With this internal heating, whether by induction or resistance heating of the contact surfaces, higher melting solder alloys or even pure tin may be used because the heat is localized on the solder and is less likely to do serious damage to the insulation; the heating in such case should be continued just long enough to fuse the solder and heat above its fusion point the surfaces which are to be bonded.

Figures 4, 5 and 6 show the application of the invention to another insulation piercing connector of the type covered by the patent to Macy No. 2,557,126.

The connector blank, as shown, comprises a connecting tongue portion **24** and a ferrule portion **10***a* from one side of which extend ears **12***a* and **12***b* slightly tapering and long enough to be curled on a radius shorter than that of the wire to curl in through the insulation for engaging the central conductor. They are wide enough and thick enough to give the rigidity required to push them through the insulation while supported by the die as shown in Figures 13 and 14 of said patent; and to give the contact area and conductive cross-section required for low resistance conduction of the rated current. An ear **30** is designed to wrap around the wire and hold it fully in the embrace of the connector. The ears **30** and **12***a* are separated sufficiently to receive the opposite ear **12***b* between them when the blank is applied to an insulated conductor. This slightly tapering ear **12***b* extends from the other side of the blank opposite the space **32** and leaving ferrule edges **36** and **38** opposite the ears **12***a* and **30**.

Although the connecting tongue portion **24** of the blank is shown as a typical ring tongue for use with a binding post or screw, it will be understood that this portion of the terminal may be given any desired form or omitted entirely.

This terminal is applied to the wire in a manner, and by use of special crimping dies, such as are shown and described in the Macy patent hereinabove identified. The ferrule part of the connector is crimped upon an unstripped part of an insulated conductor, the ear **30** is crimped about the insulation **14** to securely grip the insulation throughout its circumference, while the ears **12***a* and **12***b* are curled by the crimping die to shorter radius and driven endwise into and through the insulation so as to make contact with the stranded conductor core of the wire **16**, as shown in Figures 4 and 5. It is at this point that the present invention is brought into play.

As will be seen from an inspection of Figures 1 to 4 and 6, the insulation-piercing tips of the ears **12***a* and **12***b* are each provided with an excess coating **18** of a solder suitable for soldering together said tips and the conductor **16** and in amount sufficient to flow into and along the capillary spaces where the ears touch the wire **16**. Such a solder, for example, for use with connectors made of copper or alloys thereof which are to be soldered to conductors **16**, also made of copper or alloys thereof, is advantageously one of those which is fusible below the softening and decomposition temperatures of the insulation on the connector or on the wire, e. g. below about 150° C. Such a solder may consist of 37.5% lead, 37.5% tin and 25% indium or other low melting alloy with suitable additions of indium to improve its melting power and bond strength. Such low temperature fusible alloys, e. g., Wood's metal, Lipowitz' metal and modifications of such metals may also be used without indium, even though they would not give sufficient bond strength for ordinary soldered connections. Because the solder is within a pressure crimped connection such strength is not required. In some cases (e. g. with asbestos or fiber glass insulation) much higher temperatures can be tolerated and ordinary solders and even "hard solder" brazing alloys can be used. This solder may be applied to the insulation-piercing ears **12***a* and **12***b* in any convenient manner, as, for example, by dipping these ears into a bath of molten solder, by spraying the solder on the tips of the ears, by electro-plating them with the solder or by any other suitable metal coating method known to the art.

The connector, provided with the solder coated insulation-piercing ears **12***a*, **12***b*, having been crimped upon the insulated conductor, as shown in Figures 4 and 5, with the ears **12***a* and **12***b* penetrating the stranded wire **16**, it is necessary to effect a fusion of the solder to produce a soldered joint between the ends of the ears **12***a* and **12***b* and the conductor **16**. Such fusion may be effected in various ways, as, for example, by heating the bases **20***a* of the ears **12***a* and **12***b* while the ferrule is under pressure in the crimping dies, to a temperature above the fusion temperature of the solder so that the heat conducted through the ears during the final stage of the crimping effects a sufficient fusion of the solder to insure a soldered joint, or, a quick heating, effecting fusion of the solder by causing a current to flow through this connection as the contact is made between the ears

12*a* and **12***b* and the conductor **16** during crimping—or after crimping is completed—as, for example, by connecting the ferrule and wire respectively to opposite plates of a charged condenser, so that it discharges a heavy but brief current through the points of contact of the ears **12***a* and **12***b* with the conductor **16**. This latter method is claimed in an application of William S. Watts, attorney's docket 121617.

From the foregoing description it will be seen that, not only is the mechanical strength of the connection between the connector and the insulated conductor increased, but, by reason of the soldered connection between the ears **12***a* and **12***b* and the conductor **16**, higher electrical conductivity and corrosion resistance is achieved.

I claim:

1. An electrical connector for effecting an electrical and mechanical connection with an insulated conductor having a stranded metallic core comprising a ferrule adapted to be crimped about an insulated portion of the conductor, insulation-piercing prong means disposed on said ferrule so as to be driven through the conductor insulation and between the core strands upon crimping said ferrule, said prong means being coated with solder for electrically and mechanically bonding said means to the core strands upon application of heat thereto after crimping of the connector.

2. The method of forming an electrical connection between a stranded insulated conductor and a connector having a ferrule with insulation piercing prong means thereon, including the steps of coating the prong means with a solder-type bonding material, crimping the ferrule about the insulated conductor and driving the prong means through the insulation and into the conductor core between the strands thereof, and heating at least the bonding material for causing the solder to flow and upon cooling to unite mechanically and electrically the strands and prong means.

3. In an electrical connection, a stranded electrical conductor having an insulation sheath thereon, an electrical connector including a ferrule embracing said conductor, insulation piercing means integrally extending from said ferrule through said sheath and into the conductor strands, and a solder-type bonding material mechanically and electrically uniting said strands and said piercing means.

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