July 5, 1966 W. C. J. ESSER 3,259,874

INSULATION PIERCING ELECTRICAL CONNECTORS

Filed Jan. 6, 1964

FIG.2.

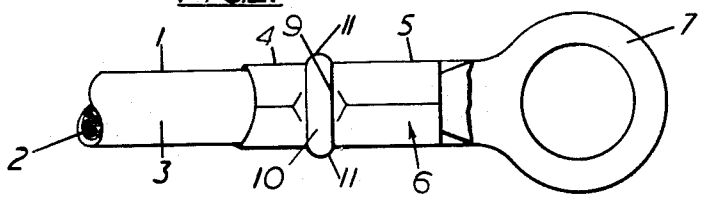


FIG.1.

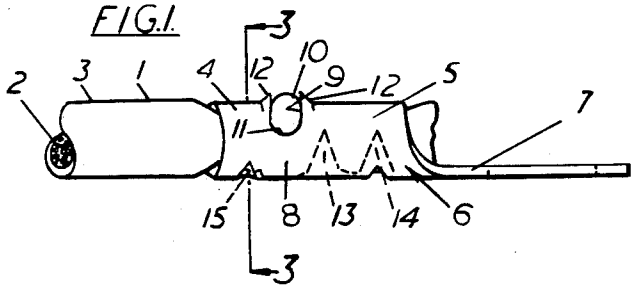


FIG.3.

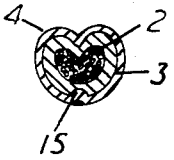


FIG.5.

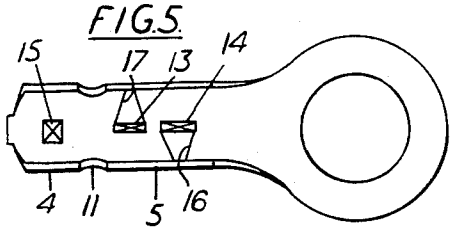


FIG.6.

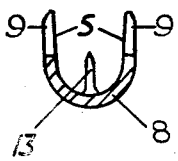
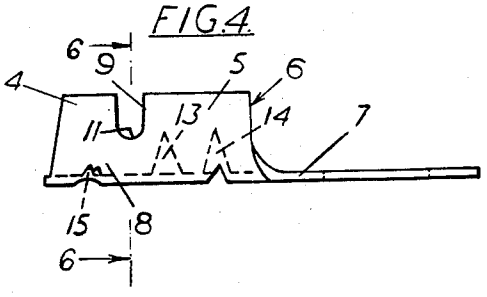


FIG.4.



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INSULATION PIERCING ELECTRICAL CONNECTORS

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3 Claims. (Cl. 339—97)

This invention relates to insulation piercing electrical connectors suitable for crimping to an insulated conductor to effect electrically conducting contact between the connector and the conductor by lance means which pierce the insulation to penetrate the core of the conductor.

Hitherto electrical connections of this type have been subject to mechanical weakness to pull-out forces. When the conductor has been subject to a force tending to pull it out of the connector, mechanical breakage of the conductor has occurred in the region of the puncture formed in the insulation by the lances. As a result, the pull-out strengths of this type of connection have been too low for many applications and more expensive connectors which have been more difficult to apply, have had to be used.

It is an object of the invention to provide an improved connector of the insulation piercing type with which higher pull-out strengths may be attained.

An insulation piercing electrical connector according to the invention comprises a terminal ferrule portion having insulation piercing lance means for effecting electrical connection with a conductor core when the ferrule portion is crimped to an insulated conductor and a support ferrule portion presenting a slot or aperture between the terminal ferrule and support ferrule portions, the support ferrule portion having an inwardly directed protuberance of smaller height than the lance means for engaging the conductor insulation when the support ferrule portion is crimped to the conductor.

The invention also includes a connector secured to an insulated conductor by crimping of the terminal ferrule and support ferrule portions about the conductor with the lance means penetrating the insulation to engage the conductor core and the protuberance engaging the insulation without penetrating to the core.

The invention further includes the method of securing the connector to the insulated conductor by crimping the terminal ferrule portion about the conductor to effect penetration of the lance means into the conductor core and crimping of the support ferrule portion about the conductor to engage the protuberance with the insulation without penetrating to the core, the crimping effecting extrusion of the insulation through the slot or aperture between the ferrule portions.

Suitably the protuberance is adapted to puncture the outer surface of the insulation and it has been found that substantial increases in pull-out strength are achieved if the protuberance has the form of a square-based pyramid, the apex of the pyramid being open to form lance points at each side of the pyramid.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there is shown and described illustrative embodiments of the invention; it is to be understood, however, that this embodiment is not intended to be exhaustive nor limiting of the invention but is given for purposes of illustration in the invention and principles thereof and the manner of applying it in practical use so that they may modify

it in various forms, each as may be best suited to the conditions of a particular use.

The invention will now be described, by way of example, with reference to the accompanying partly diagrammatic drawings, in which:

FIGURE 1 is a side view of an insulation piercing electrical connector secured to the end of an insulated conductor;

FIGURE 2 is a plan view of FIGURE 1;

FIGURE 3 is a cross-section taken at the line 3—3 of FIGURE 1, viewed in the direction of the arrows;

FIGURE 4 is a side view similar to FIGURE 1 but of the electrical connector before application to the conductor;

FIGURE 5 is a plan view of FIGURE 3; and

FIGURE 6 is a cross-section taken on the line 6—6 of FIGURE 4 viewed in the direction of the arrows.

The connection of FIGURES 1 to 3 comprises an insulated conductor **1** having a stranded core **2** and a surrounding sheath **3** of insulation. The end of the conductor **1** extends axially through ferrule portions **4** and **5** of a connector **6** having a ring tongue **7** projecting beyond the conductor end. Ring tongue **7** may, of course, have any other suitable configuration. The ferrule portions **4** and **5** are substantially cylindrical and are arranged end-to-end to define a substantially cylindrical body embracing the end of the conductor **1**. The ferrule portions **4** and **5** are formed from a single piece of metal and are secured together by a U-section bridge part **8** at a lower part of the connector, seen in FIGURE 1, and above the bridge part **8** is a slot **9** between the ferrule portions **4** and **5** into which the insulation **3** is bulged by extrusion as at **10**. The slot extends through substantially half of the conductor cross-section periphery and has radiused ends **11** and bell-mouthed sides **12** to avoid cutting the extruded insulation bulge **10**.

The ferrule portion **5** is a terminal portion disposed adjacent the end of the conductor **1** and, as seen in FIGURE 1, at its lower side is formed with axially spaced radially inwardly directed insulation piercing lances **13** and **14** which are described below in greater detail in connection with FIGURES 4 to 6. The lances **13** and **14** are of triangular form and extend through more than half of the conductor diameter to penetrate the insulation **3** and engage in electrically conducting contact with strands of the core **2** of the conductor.

The ferrule portion **4** is a support portion disposed on a side of the terminal portion **5** remote from the conductor end. At a lower side, as seen in FIGURE 1, the support ferrule portion **4** is formed with an inwardly directed protuberance **15** of height much less than that of the lances **13** and **14** and less than the thickness of the insulation **3**. The protuberance **15** is described below in greater detail in connection with FIGURES 4 and 5 and is of generally pyramid form having points which puncture the outer surface of the insulation **3** without penetrating it.

The ferrule portions **4** and **5** are crimped to the conductor to define crimped cross-sections of substantially the same form as shown in FIGURE 3 for the support ferrule portion **4**. The ferrule portions **4** and **5** are crimped from U-section ferrule-forming portions as described below, the limbs of the U being inturned and indented, longitudinally of the ferrule portions, to compress the insulated conductor into the two-lobed cross-section shown in FIGURE 3. As is shown in FIGURE 3, the protuberance **15** does not penetrate the insulation **3**.

The ferrule portions **4** and **5** are crimped over substantially their entire lengths but the adjacent ends of the ferrule portions **4** and **5** are suitably free from the crimp dies so that the bell mouths **12** are formed dur-

ing the crimping and are not pressed down onto the conductor insulation 3. During the crimping, the insulation is compressed and extruded longitudinally, insulation being extruded longitudinally outwards from the adjacent ends 12 of the ferrule portions being constrained to bulge into the slot 9 between the bell mouths 12, as at 10.

The connector described is formed into a rolled-up blank having the form shown in FIGURES 4 to 6, in which like reference numerals refer to similar parts. The blank is formed with the ring tongue 7 and the sides of the ferrule portions 4 and 5 are rolled-up to define U-section ferrule-forming portions 4 and 5, as seen in FIGURE 6 for the portion 5. Upper parts of the sides of the U-section ferrule portions 4 and 5 are spaced apart on each side of the section by slots 9. At the base of the U-section, the ferrule-forming portions are joined by the bridge part 8, the terminal ferrule-forming portion 5 is formed with lances 13 and 14 which are pushed up from substantially triangular apertures 16 and 17 which extend from a middle of the base on respective opposite sides, and the support ferrule-forming portion 4 is formed with the protuberance 15 midway between ends of portion 4. The ends of the ferrule-forming portion 4 remote from the portion 5 are inclined from the base slightly towards the portion 5.

The protuberance 15 is of pyramid form having a square base with a pair of sides of the square extending parallel to the longitudinal axis of the connector. The protuberance is suitably formed by a pyramid-tipped punch when the connector is in flat blank form, the punch being pushed into the blank to push up the metal and define the pyramid protuberance. Preferably the punch does not pierce the thickness of the blank but penetrates sufficiently to break the metal along edges of the pyramid around the apex to define four points around a cross-shaped aperture. After punching, the connector is rolled up into the form of FIGURES 4 to 6 which serves partially to close the cross-shaped aperture and move the four points around the aperture closer together.

In comparative tests between connectors of the form shown in the drawings and connectors not having the protuberance 15 of the particular form described, it was found that the latter connectors, when subject to a dynamic pull-out force at a rate of 100 mm./minute pull-out strength ranged between 5 and 6.5 kg., whereas the former connectors having the protuberance 15 of the particular form described showed a strength of between 7.7 and 9.54 kg.

It will, therefore, be appreciated that the aforementioned and other desirable objects have been achieved; however, it should be emphasized that the particular embodiments of the invention, which are shown and described herein, are intended as merely illustrative and not as restrictive of the invention.

I claim:

1. An electrical connection between an insulated conductor and an insulation piercing electrical connector which comprises a terminal ferrule portion crimped about the conductor and having insulation piercing lance means extending substantially in a plane including the axis of the ferrule portion and penetrating the conductor insulation and effecting connection with the conductor core, a support ferrule portion integral with the terminal ferrule portion, the ferrule portions having a slot therebetween, and an inwardly directed protuberance on said support ferrule portion having substantially smaller height than the lance means engaging the conductor insulation without penetrating to the core of the conductor, said protuberance being of square-based pyramid form defining four points about a cruciform aperture, the support ferrule portion being crimped about the conductor and the conductor insulation being extruded longitudinally to bulge outwardly through the slot.

2. An electrical connection between an insulated conductor and an insulation piercing electrical connector which comprises a terminal ferrule portion crimped about the conductor and having insulation piercing lance means extending substantially in a plane including the axis of the ferrule portion and penetrating the conductor insulation and effecting connection with the conductor core, a support ferrule portion integral with the terminal ferrule portion, the ferrule portions having a slot therebetween, an inwardly directed protuberance on said support ferrule portion having substantially smaller height than the lance means engaging the conductor insulation without penetrating to the core of the conductor, said protuberance being of square-based pyramid form defining four points about a cruciform aperture, the ferrule portions being crimped over regions which terminate short of the slot to form bell-mouthed sections at the sides of said slot, said bell-mouthed sections constraining a bulge of insulation extruded through the slot.

3. An electrical connector for an insulated conductor including a terminal ferrule portion having insulation piercing lance means extending substantially in a plane including the axis of the ferrule portion for effecting electrical connection with the conductor core, a support ferrule portion integral with the terminal ferrule portion, the ferrule portions having a slot therebetween, an inwardly directed protuberance on said support ferrule portion having substantially smaller height than the lance means for engaging the conductor insulation, the protuberance being of square-based pyramid form open at its apex to define four points about a cruciform aperture, the pyramid having a pair of base edges substantially parallel with the longitudinal axis of the connector.

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