

PATENT SPECIFICATION

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(53) ELECTRICAL CRIMPING FERRULE

(71) We, AMP INCORPORATED, a corporation organised and existing under the laws of the State of New Jersey, United States of America, of Eisenhower Boulevard, Harrisburg, Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to an electrical crimping ferrule.

According to the invention an electrical crimping ferrule has, in its internal surface, a series of grooves defining serrations extending transversely of the longitudinal axis of the ferrule, each groove having a floor and a first and second side wall, the first side walls facing in one axial direction of the ferrule and the second side walls facing oppositely to the first side walls and being all at the same constant angle with respect to the longitudinal axis of the ferrule, as seen in axial section through the ferrule, the depths to which successive grooves or groups of grooves extend into the ferrule material decreasing progressively in the one axial direction and the first side walls diverging from the second side walls, in the onward direction of the grooves, to an extent which progressively increases in the one axial direction.

The invention also concerns an electrical crimping ferrule, as defined above, when crimped to an electrical wire.

For a better understanding of the invention reference will now be made by way of example to the accompanying drawings in which;

Figure 1 is a perspective view of an electrical crimping ferrule.

Figure 2 is a perspective view, partly in section, showing the ferrule of Figure 1 when crimped to wires; and

Figure 3 is an axial sectional view taken on the lines III-III of Figure 2.

Figure 1 shows a crimping ferrule 10 prior to the insertion of wires to be spliced therein. The ferrule 10 is substantially U-shaped as seen in cross-section, comprising side walls 13 and 14 upstanding from opposite sides of a base portion 16 to define a cavity 11 for receiving the wires, the shape of the blank from which the ferrule was made being substantially rectangular.

The ferrule 1 is connected by a metal slug 18 to a further and similar ferrule (not shown) of a strip of the ferrules 10 formed by a series thereof joined together in end-to-end strip form.

A series of grooves 20 to 28 formed in the internal surface of the ferrule 10, to define serrations therebetween extend continuously along the walls 13 and 14 across the base portion 16 in a direction at right angles to the longitudinal axis of the ferrule 10. Each groove comprises two opposite sidewalls extending from a floor, the floors of all the grooves being parallel to one another.

Figure 2 shows the ferrule 10 after it has been crimped by means of tooling (not shown) to a pair of varnish insulated wires 30 and 31 previously placed in the cavity 11 so as to extend axially thereof. During the crimping operation, the slug 18 was severed, to separate the ferrule from the strip, by conventional shearing tools (not shown) including a shear blade which, during the crimping operation, blocked the left hand (as seen in Figure 1) open end of the ferrule according to normal practice. As a result of the crimping operation, the walls 13 and 14 are curled over (as shown in Figure 2) substantially to surround the wires 30 and 31, respectively. Also during the crimping operation, the insulation of the wires 30 and 31 was torn away from the electrically conductive cores of the

wires by the action of the serrations, although scraps (not shown) of the insulation may remain, in places, between the wire cores and the inner surface of the ferrule.

5 As shown in Figure 3, the shapes of the grooves 20 to 28 varies from groove to groove in the axial direction of the ferrule, the grooves progressively decreasing in depth, i.e. penetrating to a less extent into the ferrule material, from the left hand (as seen in Figure 3) towards the right hand (as seen in Figure 3) end of the ferrule 10. Thus the floor 40 of the groove 20 lies at a deeper level than the floor 41 of the next adjacent groove 21, which, in turn, is at a deeper level than the floor 42 of the next adjacent groove 22, and so on. The floor 45 of the last groove, 28, in the right hand axial direction, is, as shown, at the shallowest level of all the grooves 20 to 28. However, the crests 60 to 67 of the serrations defined by the grooves are all at the same level i.e. they are all at the same distance from the longitudinal axis of the ferrule.

As a practical matter, the shallowness of the grooves may be varied in respect of groups of the grooves. For example, the grooves 20 to 22 may all be of the same depth, the grooves 23 to 25 being shallower, but also all being all of the same depth, and the grooves 26 to 28 being the shallowest, but these also being all of the same depth.

35 As indicated in Figure 3, there occurs during crimping of the ferrule 10, a compressive force at the groove 20 which, as illustrated by the arrow 48 is directed at right angles to the longitudinal axis of the ferrule, such force tending to drive the wire into this groove. Since, however, as mentioned above, the left hand of the ferrule is blocked by the shear blade, the compressive force produced by the crimping tooling has an increasingly lateral component from left to right along the ferrule. This will be apparent from a comparison of the arrow 48, and the arrow 50 which indicates the compressive force at the right hand end of the ferrule. Since the floor depth of the grooves decreases rightwardly (as seen in Figure 3), the material of the wire 30 is forced down into the grooves to a decreasing extent rightwardly of the ferrule. This decreasing depth of the grooves produces optimum face-to-face contact between the wire and the ferrule and thus optimum electrical connection therebetween.

60 As shown in Figure 3, the serrations, which have flat crests 60 to 67, and the grooves are of generally trapezoidal shape, with crests 60 to 67 all equidistant from the longitudinal axis of the ferrule, the right hand (as seen in Figure 3) side wall

of each groove making approximately the same angle with respect to the floor of the groove and the longitudinal axis of the ferrule. These right hand side walls, which are referenced 70 to 78, are all angled by 70 approximately 10° with respect to the vertical (as seen in Figure 3) or by a 100° with respect to the floors of the grooves. This angle may, however, be between 8° and 15° with respect to the vertical or between 98° to 105° with respect to the longitudinal axis of the ferrule.

The left-hand walls 80 to 88 of the grooves are, however, progressively increasingly angled with respect to the vertical (as seen in Figure 3) or to the floors of the grooves, from left to right along the ferrule, these angles increasing from approximately 10° with respect to the vertical (100° with respect to the groove floor) in the case of the groove 20 to approximately 30° with respect to the vertical (120° with respect to the groove floor) in the case of the groove 28. Thus, the side walls 80 to 88 diverge from the side walls 70 to 78, in the outward direction of the grooves, to a progressively greater extent in the rightward axial direction of the ferrule. These angles may have a tolerance, for example, of plus or minus 5° , but must in any event increase rightwardly (as seen in Figure 3).

By virtue of the increasing angular positions of the walls 80 to 88, it becomes progressively easier, from left to right, for the material of the wire to be forced into the grooves and to flow into complete face-to-face contact with the walls and floors thereof. Also, since the angles of the walls 80 to 88 progressively increase towards the right, the maximum width (as seen in Figure 3) of the serrations is also increased progressively from left to right so that the strength of the serrations increases progressively from left to right, such strength also being increased by virtue of the diminishing depth of the grooves in the rightward direction, so that the serrations can withstand greater transverse forces progressively from the blocked end of the ferrule toward its open end i.e. the right hand end (as seen in Figure 3).

The grooves 20 to 28 may be formed by dragging a plurality of sharp pointed tools across the face of a sheet metal blank (not shown) from which the ferrule 10 is formed. The use of these tools normally results in the formation of barbs or ridges such as ridges 90 and 91 shown in Figure 3, on either side of the crest 60 of the serration defined by the grooves 20 and 21. Although the by-product of the formation of the grooves, these barbs or ridges are desirable, in that they assist in cutting through the insulation of the wire and also

serve to establish point or line contact with the wire core material.

As will be apparent from Figure 3, as a result of the decreasing floor depth of the grooves and the progressively increasing angle of the walls 80 to 88, the amount of wire material that flows into the grooves is maximised. The particular groove depth and wall angles chosen will depend upon the wire gauge and wire material.

Grooves as described above, may be usefully applied to a ferrule other than the simple wire splicing ferrule shown, in which an end of the crimping ferrule is not blocked during the crimping operation since commonly used crimping tooling tends to produce an uneven or tapered crimping force which in turn produces increasing lateral forces towards one end of the ferrule. In this case however since the ferrule is not blocked at one end, the deeper grooves may be shallower than as described above.

The fact that the groove depth decreases towards one end of the crimping ferrule, enables smaller gauge wires to be used than would otherwise be the case, because even if the wire is severed by the larger serrations, it will not be severed by the smaller serrations, so that a good connection between the wire and the ferrule will still be obtained.

WHAT WE CLAIM IS:—

1. An electrical crimping ferrule in the internal surface of which are a series of grooves defining serrations extending transversely of the longitudinal axis of the ferrule, each groove having a floor and a first and second side wall, the first side walls facing in one axial direction of the ferrule and the second side walls facing oppositely to the first side walls and being all at the same constant angle with respect to the longitudinal axis of the ferrule, as seen in axial section through the ferrule, the depths to which successive grooves or groups of grooves extend into the ferrule material decreasing progressively in the one

axial direction and the first side walls diverging from the second side walls, in the outward direction of the grooves, to an extent which progressively increases in the one axial direction.

2. A ferrule according to Claim 1, in which the floors of the grooves are parallel to one another, the first side walls being angled by between substantially 100° and 120° with respect to the floors of their grooves and the second side walls being angled by approximately 100° with respect to the floors of their grooves.

3. A ferrule according to Claim 1 or 2, in which the maximum thickness, in the longitudinal direction of the ferrule, of successive serrations increases progressively in the one axial direction of the ferrule.

4. A ferrule according to Claim 1, 2 or 3, in which the grooves were formed by dragging a plurality of sharp pointed tools across the face of a blank from which the ferrule was formed, to produce projections upstanding from the crests of the serrations.

5. An electrical crimping ferrule according to any one of the preceding claims when crimped to an electrical wire, in which the wire material extends into and fills each groove.

6. A ferrule according to Claim 1, in which the serrations are of substantially trapezoidal shape as seen in axial section through the ferrule and have crests which are equidistant from the longitudinal axis of the ferrule.

7. An electrical crimping ferrule substantially as hereinbefore described with reference to the accompanying drawings.

8. An electrical crimping ferrule when crimped to an electrical wire, substantially as hereinbefore described with reference to Figures 2 and 3 of the accompanying drawings.

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axial direction and the first side walls diverging from the second side walls, in the outward direction of the grooves, to an extent which progressively increases in the one axial direction.

2. A ferrule according to Claim 1, in which the floors of the grooves are parallel to one another, the first side walls being angled by between substantially 100° and 120° with respect to the floors of their grooves and the second side walls being angled by approximately 100° with respect to the floors of their grooves.

3. A ferrule according to Claim 1 or 2, in which the maximum thickness, in the longitudinal direction of the ferrule, of successive serrations increases progressively in the one axial direction of the ferrule.

4. A ferrule according to Claim 1, 2 or 3, in which the grooves were formed by dragging a plurality of sharp pointed tools across the face of a blank from which the ferrule was formed, to produce projections upstanding from the crests of the serrations.

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