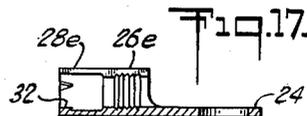
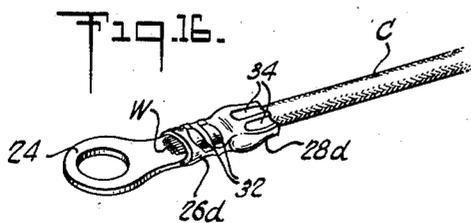
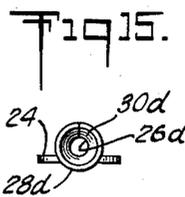
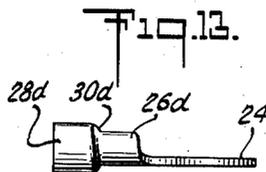
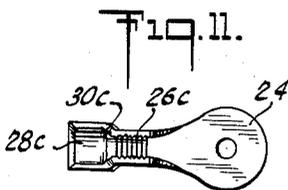
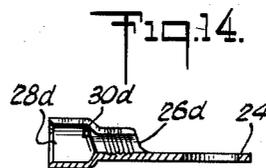
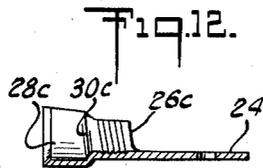
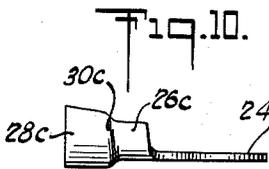
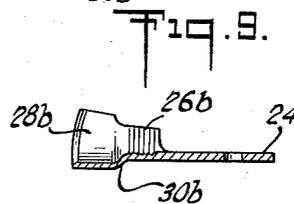
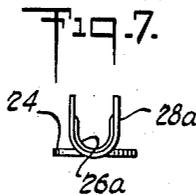
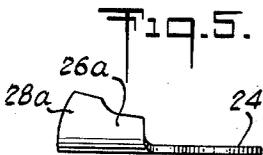
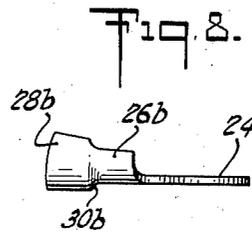
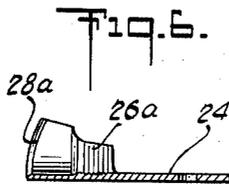
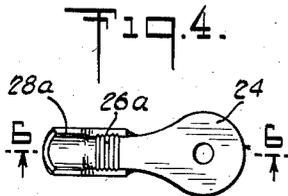
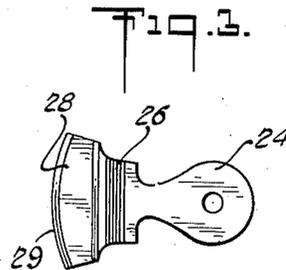
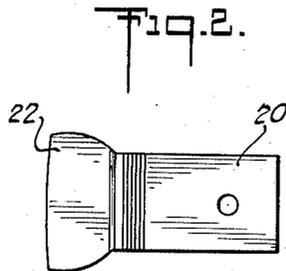
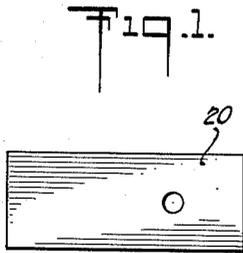


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V. E. CARLSON  
ELECTRICAL CONNECTOR HAVING COAXIAL  
BARRELS OF DIFFERENT DIAMETERS  
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INVENTOR  
VERNON E. CARLSON.  
BY  
Blair, Curtis & Hayward  
ATTORNEYS

# UNITED STATES PATENT OFFICE

2,596,528

## ELECTRICAL CONNECTOR HAVING COAXIAL BARRELS OF DIFFERENT DIAMETERS

Vernon E. Carlson, Camp Hill, Pa., assignor to Aircraft-Marine Products Inc., Harrisburg, Pa.

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3 Claims. (Cl. 173-269)

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This invention relates to electrical connectors. More particularly it pertains to a connector and a method of manufacturing a connector having two substantially coaxially arranged barrels forming a composite ferrule for receiving and embracing both the stripped end of the wire of an electrical conductor and the end of the insulation sheath covering the conductor. The present application is a continuation of my application Serial No. 603,532, filed July 6, 1945, now abandoned, which itself is a continuation in part of my applications Serial No. 455,034, filed August 17, 1942, Patent Number 2,385,792, issued October 2, 1945, and Serial No. 530,336, filed April 10, 1944.

Crimp type or solderless connectors are well-known. Among the kinds in common use is one whereby the stripped end of a wire is permanently fastened within the ferrule of the connector and the end of the insulation sheath covering the wire is supported by a sleeve, or ears, or some other insulation receiving portion of the connector. One such connector is disclosed and claimed in the application of Stephen N. Buchanan, Serial No. 421,408, Patent Number 2,379,567, issued July 3, 1945; another is disclosed and claimed in the application of James O. Johnson, Serial No. 530,313, Patent Number 2,452,932, issued November 2, 1948. Each of these connectors has supplied a long felt want and has enjoyed commercial success and each has its own advantages. The seamless sleeve of the Buchanan connector which was telescoped over the wire-receiving ferrule substantially strengthened the ferrule against opening during crimping and at the same time provided an excellent supporting collar for the end of the insulation sheath. The connector was subject to improvement to the extent that it was a relatively expensive item to produce. Various unsuccessful attempts have been made to provide a connector having the same functional advantages which could be manufactured more inexpensively. The Johnson connector has enjoyed considerable commercial success and has been widely used. Its insulation support does not give the same degree of protection against moisture as the insulation support of the Buchanan connector. On the other hand it is integral with the wire-gripping ferrule of the connector and hence eliminates the need of Buchanan's separate seamless sleeve and of various assembly operations. The art has long recognized that a connector made in one piece wholly by a series of mechanically performed operations which would support the insulation sheath, repel moisture, and make a proper, permanent crimp on the wire would have advantages over some of the

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best connectors of the prior art. By the present invention such a connector has been produced and at the same time with an important saving of the high quality sheet stock from which electrical connectors are fabricated.

It is an object of the present invention to provide a connector and a method of the character described having to a notable extent the characteristics and advantages hereinbefore set forth. Another object is the provision of a one-piece electrical connector suitable for crimping onto the wire and for receiving and supporting the end of the insulation sheath of an electrical conductor. Still another object resides in making a connector having a smooth, funnel-like ferrule opening for directing the end of a wire into the connector ferrule. A further object is to provide a method of manufacture whereby electrical connectors of the sought-after type mentioned may be economically produced. Other objects will be in part pointed out as the description proceeds and will in part become apparent therefrom.

According to the present invention an electrical connector is made from a strip of metal, preferably pure electrical copper, the strip entering one end of the process and the finished article leaving at the other end. A rectangular transverse portion of the strip may be considered as the blank and it may be severed at this stage or advantageously at a later stage in the formation of the terminal, or even after the terminal is completely formed and applied to the wire after the manner described and claimed in the copending application of William S. Watts, Serial No. 514,214, filed December 14, 1943, now abandoned. A portion of the blank is spread by a swaging operation to a greater width than the width of the original blank. The blank is trimmed to give a ferrule-forming portion which is thereafter gradually shaped by a series of steps into two integral coaxial barrels. One barrel is formed from the swaged portion and is of somewhat greater diameter than the other barrel. The circumference of the unswaged barrel is approximately equal to the full width of the strip portion from which the connector was formed. In the preferred embodiment the circumference of the swaged barrel is greater than the original width of the strip material, and due to the lengthwise extrusion of metal in the swaged portion the length of the swaged barrel is increased. Hence the use of a relatively small blank is made possible and a saving in material accomplished. At the same time an insulation supporting ferrule portion is formed having a

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thinner side wall than the side wall of the wire-receiving ferrule portion so that the larger ferrule can be more easily compressed and compacted onto the insulation than would otherwise be the case. Thus the ferrule can easily be attached by manually applied pressure from a hand tool such as is disclosed in my Patent No. 2,359,083, without taking too much pressure from the crimping of the wire contacting barrel.

In this specification and the accompanying drawings I have shown and described a preferred embodiment of my invention and suggested various modifications thereof; but it is to be understood that these are not intended to be exhaustive nor limiting of the invention but, on the contrary, are given for purposes of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in various forms, each as may be best suited to the conditions of a particular use.

In the drawings:

Figure 1 is a plan view on an enlarged scale of a blank for an electrical connector;

Figure 2 is a view similar to that of Figure 1 showing the blank after it has been swaged across one end;

Figure 3 is a view similar to that of Figure 2 but showing the blank after it has been trimmed;

Figures 4, 5, 6 and 7 are views of the connector blank showing the blank after it has been through a first forming step;

Figures 8 and 9 are views of the connector blank after it has gone through a second forming step;

Figures 10, 11 and 12 are views of the connector blank after it has gone through a third forming step;

Figures 13, 14 and 15 are views of the finished connector;

Figure 16 is a perspective view showing the connector crimped onto the end of an electrical conductor; and,

Figure 17 is an elevation in longitudinal section through a modified connector embodying the invention.

In Figure 1 a blank is generally indicated at 20. It is to be understood that the blank may not be discrete, as shown, but may be one of a series of similar blanks integral with one another and forming an indefinitely long strip. Blank 20 is preferably made from pure electrical sheet copper and in the present embodiment is of a thickness of about .032 in. Figure 2 shows blank 20 with a swaged strip 22 running across its left hand end. In the illustrated form the swaged strip has a thickness on the order of .020 in. In Figure 3 the blank is shown after having been trimmed to include a terminal contact portion 24, a wire ferrule portion 26 and an insulation ferrule portion 28.

It will be observed that the blank is provided with a curved edge 29 forming the end of the swaged strip. Curved edge 29 has a radius of curvature on the order of three to five times the inside diameter of the ferrule which is to be formed therefrom. During the subsequent forming operations which produce the ferrule, the metal is worked and stretched until this curved edge entirely disappears from the finished product. By properly designing the shape of the blank, for example, as shown in Figure 3, an even seam is produced running along the finished rolled ferrule. This seam may subsequently be sealed by brazing for example as disclosed and

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claimed in my application Serial No. 530,336. The brazing operation may be performed by an apparatus such as disclosed and claimed in the copending application of John R. Vickery, Serial No. 546,835, patent Number 2,549,868, issued April 24, 1951.

Figures 4, 5, 6 and 7 show the blank with its transversely extending ears bent to a configuration having a U-shaped cross-section best shown in Figure 7. In Figures 8 and 9 the central base portion of the U indicated at 30b has been offset somewhat so that the bottom edge of the blank no longer gives the straight line profile appearing in Figures 5 and 6. And in Figures 10, 11 and 12 a further offsetting has been effected as illustrated by 30c so that the entire insulation ferrule portion 28c has been offset and expanded with respect to the wire ferrule portion 26c. A comparison between Figures 6 and 12 reveals the extent to which curved edge 29 (see Figure 3) has already disappeared during the forming operations.

In Figures 13, 14 and 15 the finished connector is shown with curved edge 29 now lying in a substantially plane circle (see Figure 14) and with the insulation ferrule portion 28d and wire ferrule portion 26d coaxially arranged and separated throughout by the offset 30d. As is apparent in Figure 14, ferrule portion 28d and offset 30d form a smooth funnel-like guide for directing the strands of a wire into ferrule portion 26d.

At each of the stages shown in Figure 4-12 inclusive the forming may be done between male and female stamping dies of corresponding form as will be readily understood by those skilled in the art of stamping. The final step of Figures 13-15 is effected by a concave closing die acting against a stepped cylindrical core, or even without a core using only the stiffness of the metal to support it in the closing die.

In Figure 16 the connector is shown telescoped over the end of a conductor C with the wire W fitted within wire ferrule portion 26d and with insulation ferrule portion 28d embracing the end of the insulation on the conductor. Wire crimps 32 and insulation crimps 34 secure the connector in place. The thickness of the side wall of ferrule portion 26d is materially less than that of ferrule 26c when the forming operations are complete—on the order of two thirds of the original thickness. This reduction in thickness makes crimping easier. The work hardening which the drawing and forming operations impose upon the metal preferably is removed from the ferrule portions by subsequent selective annealing whereby the terminal portion 24 is left hard so as to resist bending forces. The forming operations have advantage in that they further compact and smooth the rolled surface of the sheet copper from which the blank is made. Thus the infinity of minute surface scratches which inevitably attend a machined surface and which invite rapid attack by moisture are avoided.

Figure 17 portrays a connector in which the ferrule portions 26e and 28e have the same outside diameters throughout. The internal diameter of ferrule portion 28e is greater than that of portion 26e by the extent to which portion 28e is thinned by the swaging. Such a connector is useful with conductors having particularly thin insulation sheaths. Additionally, the interior of ferrule 28e is provided with a few raised barbs 32 molded during the swaging operation, which aid in effecting a tight grip upon the end of the in-

sulation sheath. Some of the advantages which result from such barbs are brought out in the copending application of Vernon E. Carlson and Thomas C. Freedom, Serial No. 459,624, filed September 25, 1942, Patent Number 2,405,111, issued August 6, 1946.

From the foregoing it will be seen that an electrical connector made in accordance with the present invention is well adapted to attain the ends and objects hereinbefore set forth and to be economically manufactured since both the article and the method of making it are suited to common production methods and are susceptible to a wide latitude of variations as may be desirable in adapting the invention to different applications.

I claim:

1. In the art of manufacturing electrical connectors, that improvement which includes the steps of preparing an elongated blank of sheet material, substantially uniformly swaging a strip across one end of the blank to a thickness of about two-thirds the thickness of the unswaged blank, trimming the blank to define a terminal contact portion and a ferrule forming portion, the swaged strip being located across the end of the ferrule forming portion, trimming the transverse end edge of the swaged strip along an arc of radius about three to five times the diameter of the ferrule to be formed therefrom, the center of the arc lying in the long axis of the blank, bending the ferrule forming portion along the longitudinal axis of the blank to a trough-like configuration of U-shaped cross-section, offsetting the swaged strip from the rest of the ferrule forming portion first only at the central base portion of the U and thereafter up both sides of the U to give a U-shaped cross-section through the swaged strip which is similar to but larger than the original U-shaped cross section, and finally closing and longitudinally deforming the U-shaped ferrule forming portion to give two cylindrically shaped, integral barrel-like portions coaxially arranged but the one formed from the swaged portion being of greater diameter than the other and having its receiving edge lying in a plane normal to its long axis.

2. The method of manufacturing a ferrule having coaxial portions of differing internal diameter that comprises cutting an elongated sheet

metal blank having a width at one edge substantially equal to the internal circumference of one portion of the ferrule to be produced and having a width at the other edge substantially less than the internal circumference of the portion of the ferrule to be produced therefrom, swaging said other edge of said blank to reduce its thickness and to increase the width of material at that edge of the blank, trimming said other edge of said blank along an arc of radius of three to five times the internal diameter of the ferrule portion to be produced therefrom, the center of said arc lying on the long axis of the blank, trimming the unswaged portion of the blank to leave a flat terminal contact portion, deforming the swaged portion of the blank into a portion of a ferrule while deforming the unswaged portion of the blank, except for the terminal contact portion, into a coaxial ferrule portion of lesser internal diameter and while forming a shoulder between the ferrule portions resulting in the adjustment of the trimmed edge of the swaged portion of the blank into a plane normal to the ferrule axis.

3. An electrical connector of the deformed sheet type comprising a connector portion and an open ended ferrule portion integral therewith, said ferrule portion including two integral coaxial barrels of different internal diameters, said ferrule having a longitudinal seam with abutting edges, one barrel being adapted to fit around the stripped end of an electrical conductor and the other barrel being adapted to fit over the end of the insulation sheath on the conductor, the thickness of the wall of said barrel of larger diameter being less than the thickness of the wall of said barrel of small diameter in proportion to the differences in diameter.

VERNON E. CARLSON.

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