April 16, 1957 W. L. SCHUMACHER 2,789,277

ELECTRICAL CONNECTION AND METHOD

Filed Feb. 3, 1953

FIG. 1.

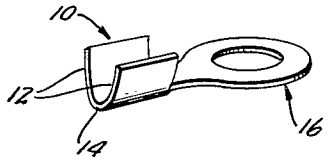


FIG. 2.

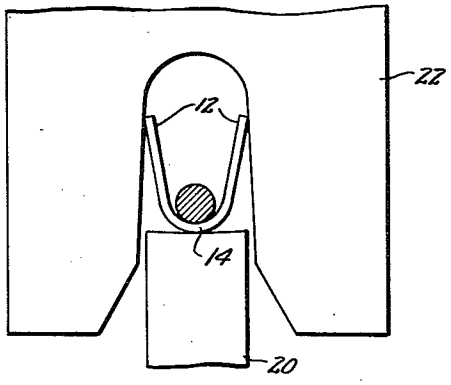


FIG. 3.

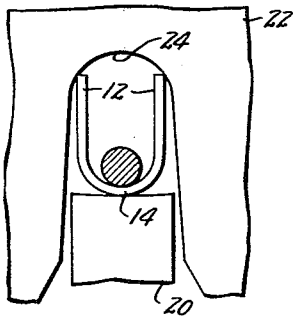


FIG. 4.

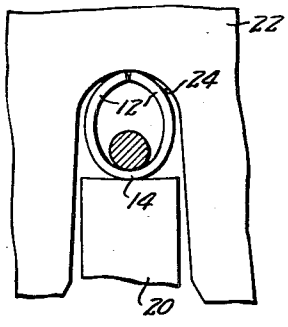


FIG. 5.

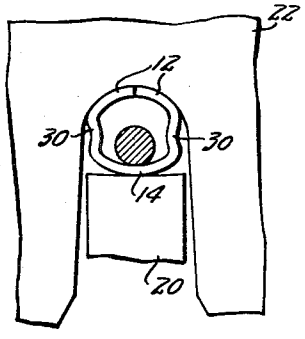


FIG. 6.

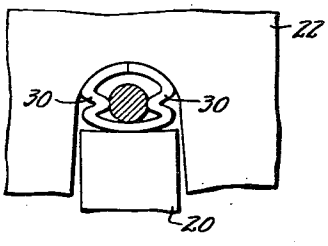


FIG. 7.

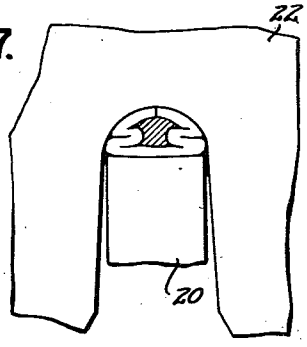


FIG. 8.

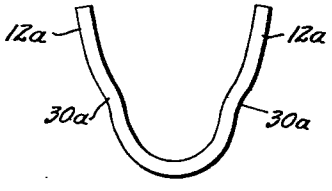
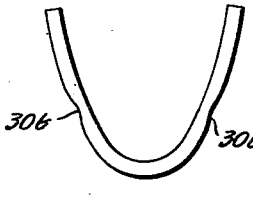


FIG. 9.



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United States Patent Office 2,789,277 Patented Apr. 16, 1957

2,789,277

ELECTRICAL CONNECTION AND METHOD

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Application February 3, 1953, Serial No. 334,839

5 Claims. (Cl. 339—276)

This invention relates to a method of making electrical connections and to electrical connections such as are produced by this method. More particularly, the invention relates to connections of the type in which a ferrule is formed and cold forged onto a conductor such as an ordinary electrical wire.

The art of making electrical connections without soldering or otherwise fusing the connection or a bonding metal has become highly developed, and one type of connection which has proven most satisfactory for stranded wires is that described and claimed in the patents of Macy No. 2,600,012, dated June 10, 1952, and No. 2,557,126, dated June 19, 1951. Although such connections have been used satisfactorily with solid wire as well as stranded wire, the solid single strand wire presents problems which are not as satisfactorily met by such connections as are those of a stranded wire.

It is accordingly an object of the present invention to provide an improved connection which is particularly adapted for use on solid single strand wire, although it may also be used effectively and with satisfaction on other types of conductors.

Another object of the present invention is to provide a method of crimping wherein forces applied oppositely along a single axis are efficiently converted to the forging of the connection together with the wire, and especially to forging on an axis transverse to the axis along which the forces are originally applied.

In the accompanying drawings:

Figure 1 is an isometric view of a connector such as may be used in my invention, having a ring tongue terminal portion and a channel or U-shaped connector portion;

Figure 2 is a view in elevation of a pair of crimping dies with the terminal shown therein in end view and a single strand solid wire shown in section positioned therein ready for crimping;

Figure 3 is a view corresponding to Figure 2, but after initial movement of the dies in the crimping direction;

Figures 4, 5, 6 and 7 are fragmentary views showing progressive stages in the closing together of the dies, these figures otherwise corresponding to Figures 1 and 2;

Figure 8 is a view in transverse section through a connector which may be similar to that of Figure 1, but is modified as shown, to be better adapted to the present invention; and

Figure 9 is a view similar to Figure 8 of another modified connector.

Referring first to Figure 1, the terminal there shown at **10** is provided with a connector portion having sides **12** upstanding from a bottom or lap portion **14**. In the case illustrated, the connector is provided with an extending integral tongue portion, in this case a ring tongue **16**, any portion of which is adapted to make connection with another electrical element which is to be connected to a wire received in the trough **12, 14**.

According to my invention, the trough portion of the connector is placed with its bottom on an anvil member **20** and its sides **14** extending into the die recess of a female die **22** and a wire or other connector is inserted between the sides **12** over the lap **14**.

The die members **20** and **22** are then moved together by any suitable means, e. g., a toggle press, hydraulic press, pneumatic press, or a pliers type hand tool. As these dies come together, the sides **12** are first pushed to the end of the female die onto the cylindrical surface **24** which in this case is arcuate in cross section. As the closing reaches the stage shown in Figure 3, the sides **12** have been bent in to an almost parallel relation and their ends are stressed toward one another by the camming action. As the closing is continued, the bending stresses produce an approximate conformance to the shape of the female die, excepting that the upper portion of each side **12** tends to bend as a cantilever instead of following perfectly the curvature of the die. Continued closing drives the sides **12** in close conformity with the shape of the recess between the dies **20** and **22**, and then, after that space has been filled and the edges **28** of the sides **12** have been pressed together, the sides **12** yield to further pressure by buckling, as indicated at **30**. Continued closing drives the buckled portions down into a tight fold, which tends to squeeze the wire away from each fold and to the exact center of the connection. Eventually the inner edges of each fold are pushed down beside the wire and further collapsing of the fold drives these edges into the wire by a toggle action, as indicated in Figure 6. The final closing from Figure 6 to Figure 7 results in a forging of the metal into a dense, solid cross section, filling all the gaps left by the inward folding and deforming the solid wire so that it is keyed into the connection and any oxide film is broken and a highly conductive forged connection results.

With thicker metal in the side portions **12**, the buckle stage tends to be more effectively resisted until if too thick sides are used, the metal will be merely compressed without buckling, in which case the wire will tend to keep its original cross-sectional form and most of the force of compression exerted on the dies would be taken up in thickening of the side walls by circumferential compression.

In Figure 8 I have shown such a connector with thicker walls wherein an initial inward bend **30***a* is preformed in each side **12***a*. Thus, when the connector is compressed between the dies, the force cannot be exerted axially along the side, but acts as a toggle from the beginning, since the side is already broken inward to produce a leverage about the bend.

In Figure 9 I have shown another expedient which facilitates the initiation of toggle action when a thick wall ferrule is required. In this case the thickness of the stock is reduced along the fold lines **30***b* in the stamping operation by which the connector is formed. When this connector is compressed between the dies, it will buckle at the areas of reduced thickness and thus behave in the same manner as illustrated in Figures 2–7 inclusive.

In the design of the crimping tool, it is important that the width of the die recess should be such, relative to the connector trough, that the inward fold engages the sides of the wire before the fold is entirely flattened, as this gives the toggle action which results in the forging together of wire and connector by lateral compression, as well as compression along the axis of applied forces. The crimping dies should close together to an extent such that the cross-sectional area is somewhat smaller than the sum of the total solid cross-sectional area of the trough portion of the connector and the wire. Advantageously, the cross-sectional area of the space between the dies should be about sixty to eighty percent of the total solid cross-sectional area of the wire and connector before crimping, depending upon the type of wire and

connector being used. The best relation is that in which the wire first breaks under a direct pull without pulling out of the connection.

I claim:

1. An electrical connection which comprises a central conductor a ferrule having an unsecured seam surrounding said conductor having a bottom lap portion on which the conductor is centrally positioned, opposed lateral folds extending from the extremities of the bottom portion substantially radially inwardly relative to the conductor providing bight portions pressing against and firmly gripping diametrically opposite sides of said conductor, and cover portions extending toward one another from the outer edges of said folds with their edges pressing together into substantially sealed relation, covering said conductor and pressing it downwardly against said lap portion.

2. An electrical connection as defined in claim 1 in which the whole is compressed to a substantially dense solid cross section.

3. An electrical connection as defined in claim 1 in which the conductor is a single strand solid wire.

4. An electrical connection comprising a central conductor, a ferrule surrounding said conductor and having a bottom lap portion on which the conductor is centrally positioned, opposed lateral folds extending inwardly from the extremities of the bottom portion and pressing against and indented into diametrically opposite sides of said conductor, and cover portions extending toward one another from the outer edges of said folds with their edges pressing together into substantially sealed relation, covering said conductor and pressing it downwardly against said lap portion.

5. An electrical connection comprising a central conductor, a ferrule surrounding said conductor and having a substantially flat bottom lap portion on which the conductor is centrally positioned, opposed lateral folds extending inwardly from the extremities of the bottom portion and pressing against and indented into diametrically opposite sides of said conductor, and cover portions extending toward one another from the outer edges of said folds with their edges pressing together into substantially sealed relation, covering said conductor and pressing it downwardly against said lap portion.

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