Dec. 20, 1966 W. E. GROPP ETAL 3,293,355

ELECTRICAL CONNECTOR

Filed Feb. 6, 1964 2 Sheets-Sheet 1

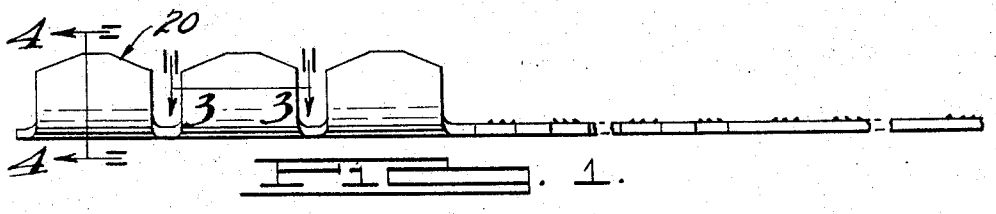


Fig. 1.

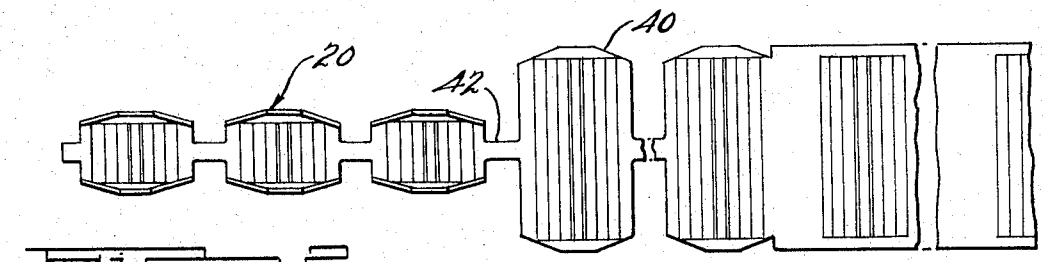


Fig. 2.

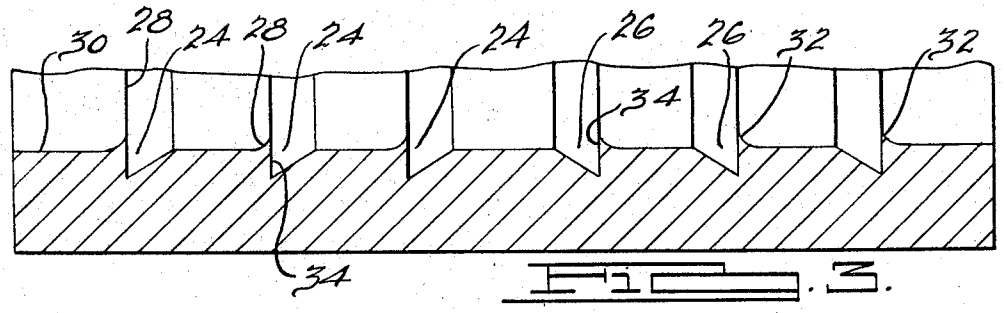
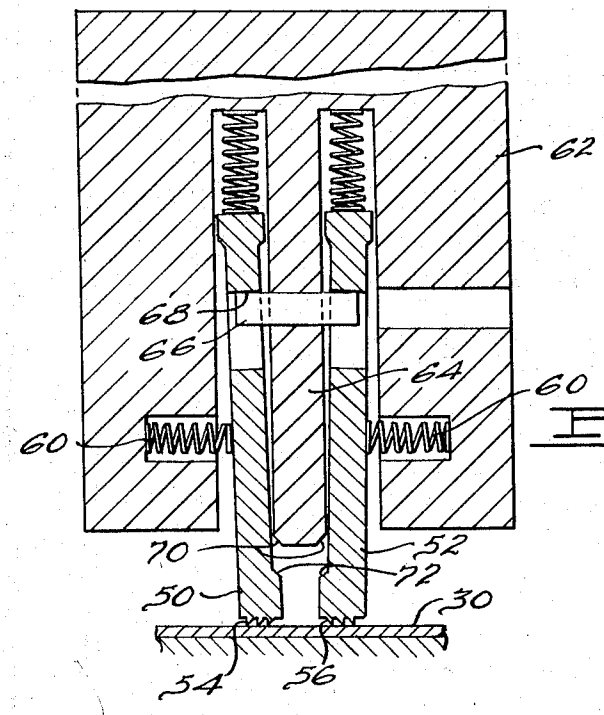


Fig. 3.



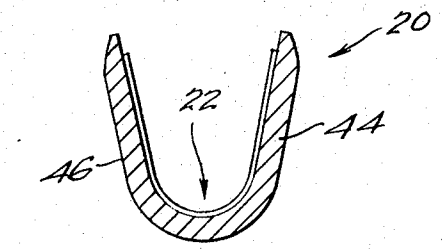


Fig. 4.

Fig. 5.

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ELECTRICAL CONNECTOR

Filed Feb. 6, 1964 2 Sheets-Sheet 2

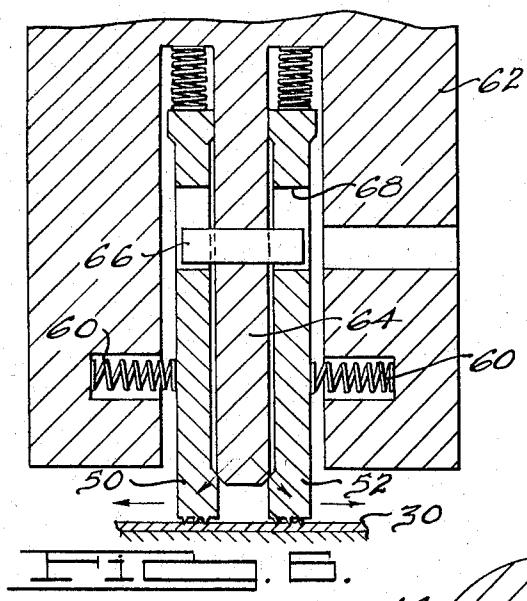


FIG. 6.

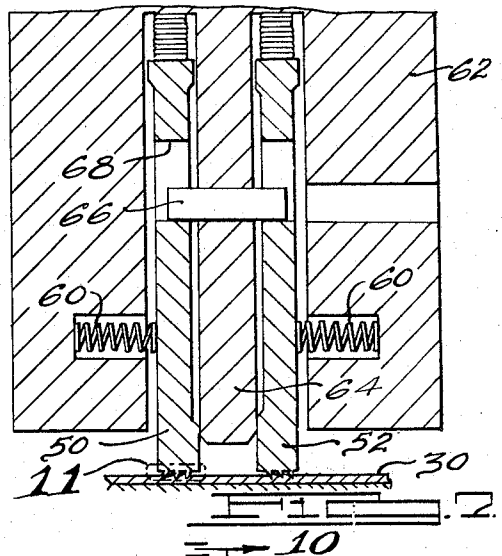


FIG. 7.

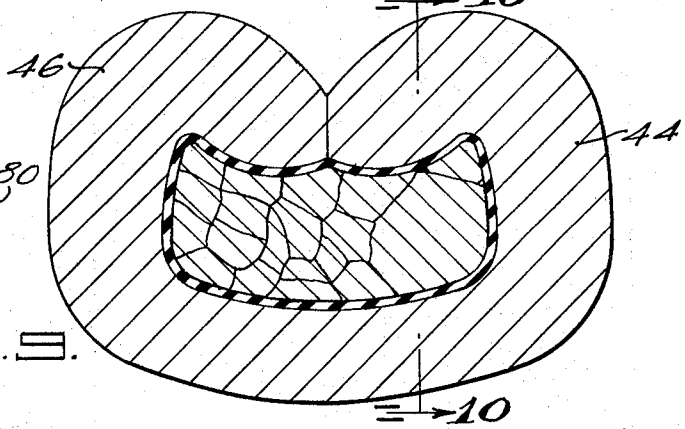


FIG. 9.

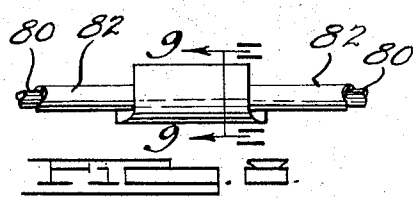
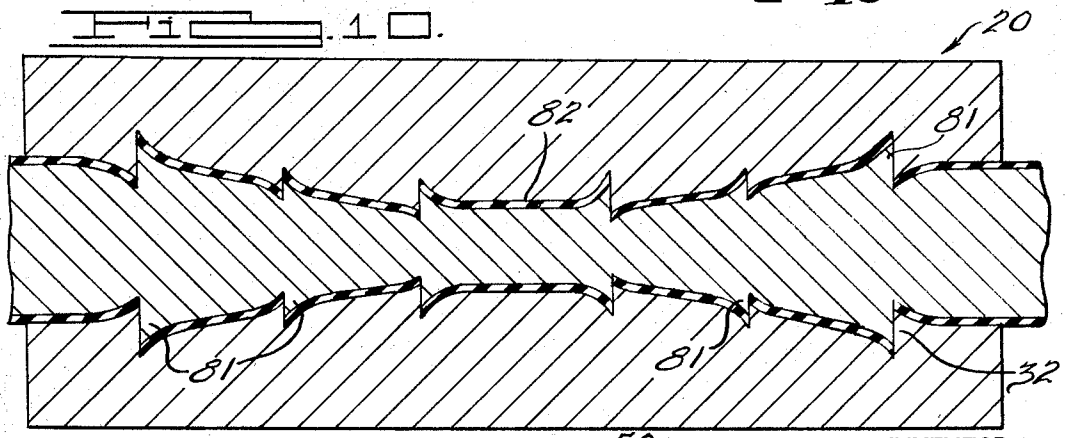


FIG. 8.

FIG. 10.



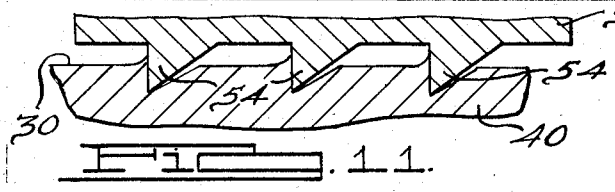


FIG. 11.

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ELECTRICAL CONNECTOR

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Filed Feb. 6, 1964, Ser. No. 343,042
2 Claims. (Cl. 174—84)

This invention relates to electrical splice connections and to a method of and apparatus for making terminals for making such connections. The terminal or connector of our invention is particularly adapted for splicing one or more varnish-insulated solid magnet wires to one or more stranded leads. Splicing connectors known to the art are exemplified by U.S. Letters Patent, Nos. 1,646,660, 1,836,497, and 2,800,638.

A principal object of the present invention is to provide a new and improved connector for making splice connections and particularly one which is more satisfactory in operation and less expensive to produce.

Another object of the invention is to provide a new and improved splice connection.

Other and further objects of the invention will be apparent from the following description and claims and may be understood by reference to the accompanying drawings, of which there are two sheets, which by way of illustration show a preferred embodiment of the invention and what we now consider to be the best mode of applying the principles thereof. Other embodiments of the invention may be used without departing from the scope of the present invention as set forth in the appended claims.

In the drawings:

FIG. 1 is a side elevational view of a strip of connectors illustrating certain steps in the method of making a strip of connectors;

FIG. 2 is a plan view of the strip shown in FIG. 1;

FIG. 3 is an enlarged fragmentary sectional view of a connector taken along the line 3—3 of FIG. 1;

FIG. 4 is an enlarged cross sectional view of a connector taken along the line 4—4 of FIG. 1;

FIG. 5 is a somewhat schematic elevational view of tooling useful in forming ribs on the connector blank;

FIGS. 6 and 7 are views similar to FIG. 5, illustrating how the tooling operates to form the ribs on the surface of the connector blank;

FIG. 8 is a side elevational view of a splice connection between two electrical conductors made with the splice connector of this invention crimped on such conductors;

FIG. 9 is an enlarged cross sectional view of the crimped connector taken along the line 9—9 of FIG. 8;

FIG. 10 is an enlarged fragmentary sectional view taken along the line 10—10 of FIG. 9; and

FIG. 11 is a fragmentary view illustrating the manner in which the ribs of the connector are embedded in the conductor metal during the crimping of the connector around the conductor.

As shown in FIGS. 1, 2, 3 and 4, a splice connector embodying our invention comprises a U-shaped metal ferrule **20** forming a channel **22**, the surface of which is relieved by two series of like grooves **24** and **26** disposed transversely of the channel with the groove **24** of one series oriented oppositely relative to the groove **26** of the other series, and with the grooves **24** of one series spaced longitudinally of the channel from the grooves **26** of the other series. Each of the grooves **24** and **26** is asymmetrical in cross section. One side of each of the grooves **24** forms a sharp-edged transverse rib or tooth **28** which projects above the inner surface **30** of the channel. Similarly, one side of each of the grooves **26** forms a sharp-edged transverse rib or tooth **32** which projects above the inner surface of the channel and the opposite sides of the grooves **26**. The ribs **28** of one series are inclined toward

the ribs **32** of the other series, and the spacing between adjacent grooves in each series is substantially greater than the width of each groove. Preferably the ribs or teeth **28** and **32** are formed with each having one surface **34** perpendicular to the longitudinal axis of the channel **22**.

We have found it advantageous to make the connectors from strip stock which is subjected to a series of operations to form a plurality of blanks **40** serially connected by connecting strips **42**, and which blanks are subjected to metal forming operations as hereinafter described to form the grooves **24** and **26** and the ribs **28** and **32**, and then formed into U-shaped cross section to form a series of open ferrules **20**. Preferably the sides **44** and **46** of the ferrules taper in height as shown in FIGS. 1 and 2 so as to increase in height in the direction of the inclination of the ribs **28** and **32**. Thus the sides **44** and **46** are higher at the longitudinal center of the channel than at the ends.

In forming the grooves and ribs, the oppositely oriented sets of teeth of the punches **50** and **52** are forced against the surface and into the metal of the blank as illustrated in FIGS. 5, 6 and 7, with the cutting edges of the teeth **54** of one set facing away from the cutting edges of the teeth **56** of the other set while the punches **50** and **52** are moved laterally apart so that the teeth **54** and **56** move in their cutting direction to form the grooves **24** and **26** and to displace metal from the blank above the surface **30** thereof to form the two series of oppositely disposed ribs projecting above such surface **30**.

In practice the blank is moved across a suitable supporting surface and a tool carrying the punches **50** and **52** is moved toward the surface **30** of the blank so as to bring the teeth **54** and **56** into contact therewith, the punches **50** and **52** being spring biased to their extended position and also biased by the springs **60** toward each other.

The tool holder **62** includes a tongue **64** which carries a cross pin **66** that projects into slots **68** in the punches **50** and **52**. As the tool holder **62** and the punches **50** and **52** descend, the teeth **54** and **56** first contact the work and then continued movement of the tool holder **62** brings the wedge or cam surfaces **70** on the tongue **64** into engagement with the cam or wedge surfaces **72** on the punches **50** and **52**, thereby first forcing the teeth **54** and **56** into the metal of the blank and then forcing the sets of teeth **54** and **56** apart while forcing the same further into the blank metal. The teeth **54** and **56** are thus simultaneously driven into the blank metal at an angle (that can be from 10° to 80°) to simultaneously produce the grooves **24** and **26** and the ribs **28** and **32**. The number of ribs and the spacing between the adjacent ribs of each set are not critical, and while we prefer that the edges of the ribs be sharp, they may be provided with a relatively small land area if desired.

The electrical conductors to be spliced are positioned in the channel **22** in overlapping relation and the open ferrule is then crimped around the wires under metal-deforming pressure so as to integrate the same into a unitary mass as shown in FIG. 9 whereby extrusions **81** of the conductor metal fill the cavities provided by the grooves **24** and **26** and the ribs **28** and **32** are embedded in the conductor metal. Where the conductors **80** are varnished or otherwise insulated as indicated at **82**, the teeth or ribs **28** will pierce the insulation so that the conductor metal may be brought into intimate metal-to-metal engagement with the metal of the connector as illustrated in FIG. 10. When the sides **44** and **46** of the connectors have tapered upper edges as shown in FIGS. 1 and 2, a higher crimping force will be created in the center of the connector than at the ends, causing extrusion or metal flow of the conductor metal. Since the connector material is harder than the conductor material, the latter will flow more readily, providing a good metal-to-metal contact along the surface **34** of each rib. The crimping operation may be

carried out with crimping dies of the type generally illustrated in Berg Patent No. 3,020,520.

We have obtained excellent results using three-quarter hard brass strip stock for the connectors of .018 inch nominal thickness.

While we have illustrated and described a preferred embodiment of our invention, it is understood that this is capable of modification, and we therefore do not wish to be limited to the precise details set forth but desire to avail ourselves of such changes and alterations as fall within the purview of the following claims.

We claim:

1. An electrical connector adapted for crimping around one or more conductors, said connector comprising a ferrule forming channel having two series of flat topped inclined ribs formed on the inside of the channel and extending transversely of the channel with the ribs of one series inclined toward the ribs of the other series and with one series spaced longitudinally of the channel so as to be disposed at one end of the other series, a flat topped central rib separating said series of ribs, the tops of all of said ribs defining the inner surface of said channel, the sides of adjacent ribs intersecting at an acute angle to form V-shaped grooves between such ribs with the grooves adjacent one series of ribs inclined toward the ribs of the other series, the one side of each rib in each series facing the other series being oriented perpendicular to said surface and extending upwardly past said surface to form a sharp cutting edge above the top of such rib, the other side of each rib in each series and both sides of said central rib being oriented obliquely to said surface so as to make an obtuse angle therewith, the width of said ribs being substantially greater than the width of said grooves.

2. A connector according to claim 1 wherein said channel comprises a U-shaped sheet metal blank, the sides of which taper so as to increase in height in the direction of the inclination of said ribs whereby upon crimping of said connector said sides are brought into abutment and create a higher crimping force adjacent said central rib than to either side thereof to cause extrusion of the conductors away from said central rib and past said series of ribs so as to establish a positive electrical connection between said connector and the conductors.

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