PROCESS OF FORMING ELECTRICAL CONNECTORS

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ABSTRACT

Electrical connector or terminal lugs are provided by using bending, stretching and drawing techniques rather than cold flow methods. To fabricate the terminal lugs, a flat piece of aluminum or copper is first formed as a cup by drawing techniques. Then, the closed end of the cup is sheared free, flattened and wedged within the walls of the cup. Afterward, suitable holes are punched or drilled to accept wires, or cables, and fasteners. The resulting terminal lugs may be used in fastening wires or cable to bus bars.

6 Claims, 23 Drawing Figures
This invention relates to wire connectors and their fabrication and particularly to connectors in the form of terminal lugs made of copper or aluminum.

Terminal lugs are normally used to fasten essentially round (solid or stranded) wires to bus bars having flat surfaces. The optimum material for terminal lugs is pure copper when such factors as cost, ductility and conductivity are considered.

Small terminal lugs are normally made of copper and are normally cold forged. In this way, the high conductivity and ductility of copper are used advantageously and the superior strength of cold worked material is available. In the past, however, large sized terminal lugs have not been cold forged because of the great compressive forces that are required to cause cold flow of the large quantity of material involved. The cost of machinery and dies capable of withstanding the extreme pressures required have always made this method uneconomical. Because of this, large lugs are usually made by casting bronze material. The conductivity of bronze is much less than that of copper. The bronze lugs, therefore, have inferior electrical characteristics when compared to copper lugs.

It is an object of the present invention to provide for improvements in large terminal lugs. It is a further object to improve the fabrication of large terminal lugs and similar articles from flat strip stock of pure copper or aluminum. Certain aspects of the invention involve the use of bending, stretching and drawing techniques, rather than cold flow methods. These techniques require far less force than cold forging and therefore the tooling and machinery are more economical.

The foregoing objects and other ancillary thereto are preferably realized by drawing part of a flat strip of metal in successive stages into a cup while another portion is left flat. The flat portion forms the tang of the lug. The bottom of the uniform portion of the cup is then formed to a spherical curvature. At this same time, the edge of the opening at the other end of the cup, where the transition from cup to flat tang occurs, is formed as a seat which may be a circular ledge, a crimp ring, or a ledge made up of a number of lands. In this way, the diameter of the hole at the tang end of the cup is defined by the seat and is made smaller than the internal diameter of the cup. The spherically curved bottom portion is then sheared free and punched down into the hole by means of a punch against the seat where it is flattened and wedged within the walls of the cup. Holes are then punched, or drilled, vertically through the cup near the closed end to receive wires or cables. The open end of the cup is prepared, e.g., by cutting threads, so that a plug may be inserted to hold the wire or cable in place. A suitable hole may be drilled in the tang to produce a finished terminal lug of use in fastening wires and cables to bus bars.

All of the steps referred to in the preceding paragraph may be performed serially in a multistation progressive die. The part is carried from station to station by means of a scrap train. This method requires a minimum of direct labor cost.

The above mentioned and other features and objects of this invention and the manner of obtaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, in which:

FIG. 1 illustrates a flattened piece of copper or aluminum pre-shaped for use in the practice of the invention.

FIG. 2 is a perspective view showing a cup formed from the strip of metal of FIG. 1.

FIGS. 3 and 4 are perspective views showing the cup at further stages of formation and more clearly showing the tang as well.

FIGS. 5 and 6 are perspective views in which FIG. 5 shows the lug following removal of the closed end and FIG. 6 shows how holes are placed in the tang and through the main body of the lug.
may be performed with a suitable die and anvil as shown in detail elsewhere in this specification. FIG. 15 shows in cross section the effect of piercing the closed end 3' of the cup (as shown in FIG. 14A) to form a slug and flattening the slug as shown at 3", with a suitable flat punch P1, against the lands L and an anvil at A1.

FIG. 16 illustrates a different procedure for further shaping a cup such as that shown in FIG. 12. In this embodiment of the invention a cup 2 is placed in a pair of dies D1 and D2 and punches P2 and P3 are positioned. Pressure is then applied to the dies and punches to shape the cup as shown in cross section. By this procedure the cup 2 is shortened when the metal at 20 is extruded upward to form a ridgelike ring.

FIG. 17 illustrates a manufacturing step in which the vertical circular protrusion or ridge at 20 (FIG. 16) is depressed or 10 turned over by a punch P4 to form a seat for a slug in the form of a crimp ring at 21. The crimp ring 21 may be said to serve as a floor, a ledge or a seat for the slug 3" which is pierced at the same time by the punch P5. In FIG. 18, the punch P5 is shown to have pierced the curved closed end 3' forming the slug 3" and forcing it against an anvil A2 and against the crimp ring 21.

FIGS. 19 and 20 illustrate an additional way of forming a lug in accordance with the invention. In this instance, the cup 2 is pierced at its closed end 3' by a punch at P6 and pushed through the cup to abut against an anvil at A3 and against a ledge at L2 formed by action of the anvil A3 against the cup 2 and the die at D3.

We claim:

1. A method for forming a terminal lug comprising
   forming a cup by drawing a portion of a flat metallic piece in
   a series of steps,
   shaping the closed end of the cup by imparting a curvature
   to each face of the end,
   forming a ledge at the open end of the cup,
   shearing free the closed end of the cup to form a slug,
   punching the slug through the interior of the cup and into
   contact with the ledge, and
   flattening the slug into the open end of the cup to wedge it
   firmly within the walls of the cup and against the ledge.

2. A method for forming a terminal lug as claimed in claim
   1, in which
   the method for forming a ledge includes broaching a plurality
   of lands to serve as said ledge.

3. A method for forming a terminal lug as claimed in claim
   1, in which
   the step of shearing free the closed end of the cup to form a
   slug includes piercing the closed end with a die, and
   the step of punching the slug through the interior of the cup
   and into contact with the ledge includes flattening the
   slug against an anvil at the same time it is flattened against
   the ledge.

4. A method for forming a terminal lug as claimed in claim
   1, in which
   the method for forming a ledge at the open end of the cup
   includes forming a ridgelike ring by subjecting the cup to
   pressure along its central axis and punching the ridgelike
   ring to turn it over and form a crimp ring to serve as the
   ledge.

5. A method for forming a terminal lug as claimed in claim
   1, in which
   the method for flattening the slug to wedge it within the
   walls of the cup and against the ledge includes the application
   of force to the slug between an anvil on one side of the
   ledge and a punch on the other side of the ledge.

6. A method for forming a terminal lug as claimed in claim
   1, in which the method for forming a ledge comprises:
   placing the cup within the cradle of a die, and applying
   force on an anvil at the open end of the cup to form the
   ledge against the die.