United States Patent [19]

O'Loughlin

[11] **3,744,006**

[45] **July 3, 1973**

[54] **EXTRUSIBLE ELECTRICAL CONNECTOR AND CONNECTION METHOD**

[75] Inventor: **Francis A. O'Loughlin,** Scotch Plains, N.J.

[73] Assignee: **Thomas & Betts Corporation,** Elizabeth, N.J.

[22] Filed: **Feb. 9, 1971**

[21] Appl. No.: **113,833**

[52] **U.S. Cl.**..... **339/97 R,** 339/273 F, 339/276 R

[51] **Int. Cl.**..... **H01r 9/08**

[58] **Field of Search**..... 339/95, 97–99, 339/276, 273; 174/84 C, 94

[56] **References Cited**

UNITED STATES PATENTS

2,963,775	12/1960	Chadwick	174/84 C
1,001,054	8/1911	Lawrence	339/273 R
3,345,452	10/1967	Logan et al.	339/276 R

FOREIGN PATENTS OR APPLICATIONS

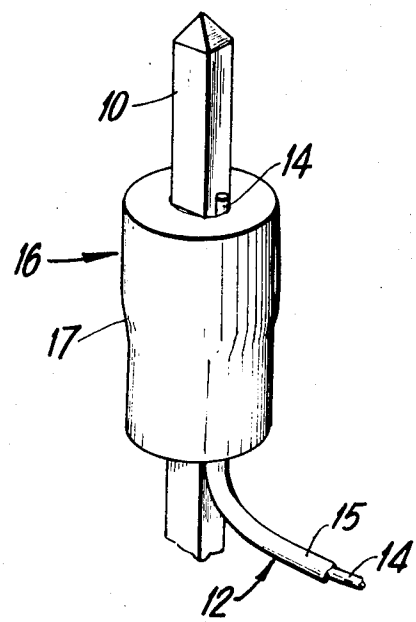
908,815	10/1962	Great Britain	339/273 F

Primary Examiner—Joseph H. McGlynn
Attorney—Thomas M. Marshall

[57] **ABSTRACT**

An extrusible electrical connector comprised of a sleeve having axially spaced portions of different diameters and constructed of a ductile material. The connector is best adapted to making connections to a terminal post, wherein a bare terminal end of an insulated conductor is inserted together with the post into the aperture of the sleeve, after which the ductile connector is compressed tightly about the post and the conductor by extruding the larger diameter portion of the connector through a die.

9 Claims, 11 Drawing Figures



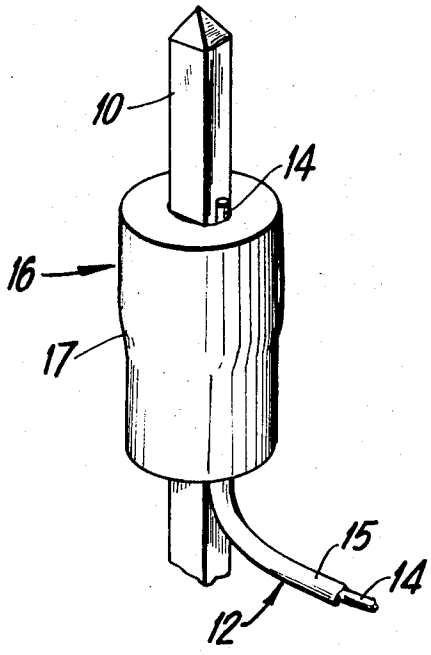


FIG. 1

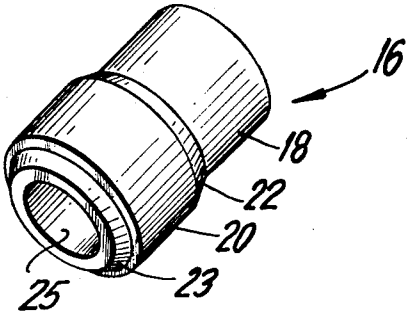


FIG. 2

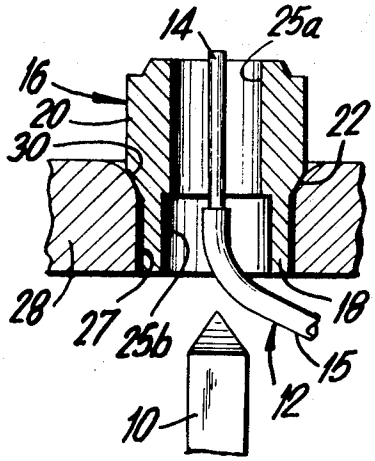


FIG. 3A

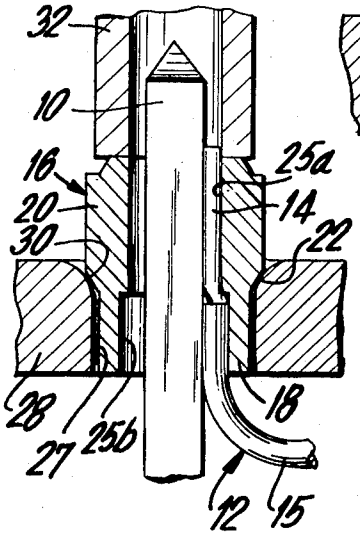


FIG. 3B

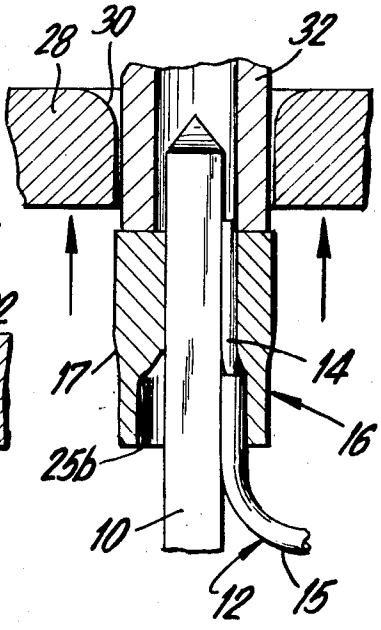


FIG. 3C

INVENTOR.
FRANCIS A. O'LOUGHLIN
BY
Thomas M. Marshall
ATTORNEY

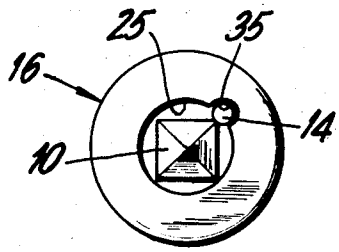


FIG. 4

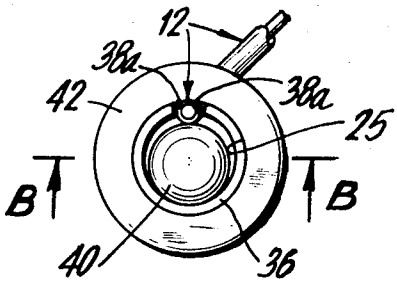


FIG. 5A

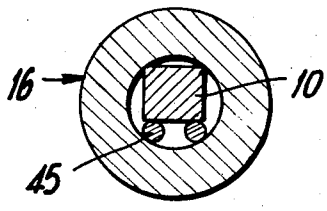


FIG. 6A

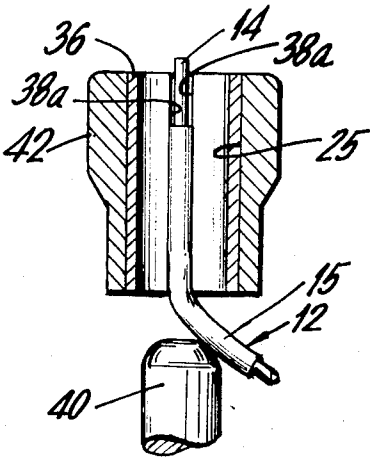


FIG. 5B

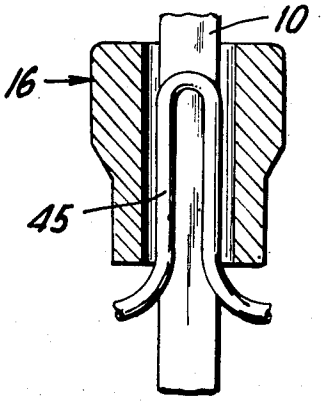


FIG. 6B

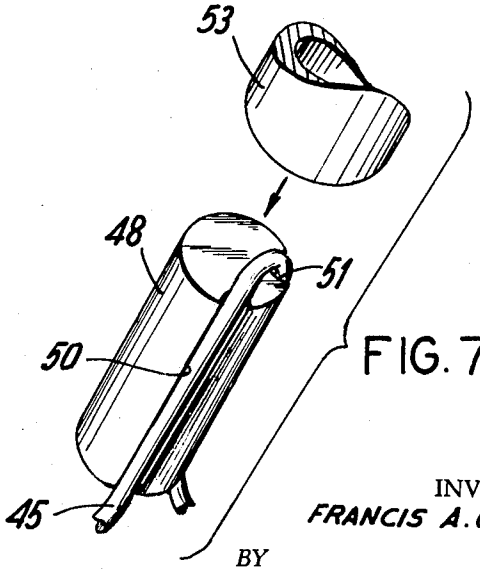


FIG. 7

INVENTOR.
FRANCIS A. O'LOUGHLIN

BY

Thomas M. Marshall
ATTORNEY

EXTRUSIBLE ELECTRICAL CONNECTOR AND CONNECTION METHOD

BACKGROUND OF THE INVENTION

This invention relates to electrical connectors and, more specifically, to a ductile electrical connector which may be used to form tight, reliable connections to an electrical connector by extrusion.

This invention represents an improved type of ductile connector for providing a mechanical and electrical interconnection between a conductor and, for example, a small terminal post of the type found in computers and other complex electrical and miniaturized electronic equipment. It is suited to making gas tight connections and provides mechanical strain relief for the wires of small insulated conductors by gripping a portion of the insulation.

It is presently common practice to secure conductors to terminal posts and the like either by wrapping the wire of the conductor in several close helical turns about the terminal post, by soldering the connector to the post or by affixing the bared wire to the post by a small resilient clip formed previous to or during connection. In the case of stranded conductor wires, soldering is usually used because the fragile strands of small guage wires (e.g., A.W.G. No. 30) are often ruptured if the connection operation is performed by automated equipment.

Although soldering certainly provides a secure electrical connection to the post, soldering has two distinct disadvantages. First, soldering requires soldering apparatus and adequate terminal post and conductor preparation, such as chemical cleaning or pretinning in order to assure a good soldered joint. Moreover, soldering can be used only where the components immediately surrounding the connection can withstand the effects of the heat required to make the solder joint and soldering is generally considered somewhat more expensive than other methods of connection. Finally, soldering does not permit removal of the wire, as does a wrapped connection, without again applying heat to the terminal post or breaking the wire.

Another disadvantage to all types of presently used connections is that the wire, if deflected or bent, may become weak and break due to its low fatigue resistance. Breakage usually occurs, in this case, immediately adjacent the point where the wire is held rigidly at the terminal post. Breakage also occurs in wrapped joints. If, for example, even momentary tension is applied to the conductor during automated wrapping, the wires may fracture. With connections made with miniature clips holding the wire to the post, a gas-tight connection is not readily achieved and, too, such clips do not work satisfactorily with parts of rounded, as opposed to square, geometries. They are, therefore, limited in application.

One of the objects of this invention is to provide a terminal connection between elongated elements, such as terminal posts and wires, which forms a tight electrical and mechanical connection and which, at the same time, provides strain relief for the wire conductor by gripping the conductor insulation.

Another object of the invention is to provide a connector for attaching electrical conductors to terminal posts and the like which may be easily applied in a single operation and which may be removed or moved on the terminal post without destroying the post or the conductor.

Yet another object of the invention is the provision of novel connector and method of connection using extrusion techniques.

SUMMARY OF THE INVENTION

In accordance with the invention, the foregoing and other objects are met by extruding a ductile connector through a die to radially compress the connector about the conductor and elements to be joined. Preferably, the connector comprises a unitary sleeve having an aperture for receiving the conductor and the element to which the conductor is to be attached, and constructed to have axially spaced portions of different outside dimensions. In general, the sleeve is constituted of a material having a ductility sufficient to enable it to be extruded axially through a die to compress the sleeve radially inwardly and thereby encase the conductor and element.

In preferred embodiments, the connector is cylindrical in shape and contains a tapered shoulder portion intermediate the small and large diameter portions of the sleeve. The aperture of the sleeve may be fitted with special inserts to pierce conductor insulation upon compression, if desired, and the aperture may take on specialized geometries to receive different-shaped terminal posts and a variety of conductors.

BRIEF DESCRIPTION OF DRAWINGS

For a better understanding of the invention, reference should be made to the following detailed description and to the drawings, in which:

FIG. 1 is a perspective view showing a connection between a conductor and a terminal post using an extrusible connector of the invention;

FIG. 2 is a perspective view of a connector in accordance with the invention;

FIGS. 3A–3C are cross-sectional schematic representations showing the manner in which the connector of FIG. 2 is used to connect a conductor to a terminal post to arrive at the connection of FIG. 1;

FIG. 4 is a plan view of a modified form of the connector;

FIG. 5A is a plan view of a different form of connector having a special insulation piercing insert;

FIG. 5B is a cross-sectional view of the device shown in FIG. 5A, taken along the lines B—B in the FIG. 5A;

FIG. 6A is a plan view of another connection according to the invention;

FIG. 6B is a cross-sectional view in elevation of the emobdiment of FIG. 6A; and

FIG. 7 is a perspective view of a mandrel suitable for forming a conductor loop in the embodiment of FIGS. 6A and 6B.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a connection in accordance with the invention, made with an extrusible connector which has been compressed into tight engagement with a terminal post **10** and conductor **12**. The conductor **12**, consisting of the wire conductor **14** and outer insulation **15**, is aligned generally axially of the terminal post to have a portion of the insulation **15** encased by the radially compressed connector **16**. It can be observed, as illustrated, that the connector **16** may not be of uni-

form outside transverse dimension throughout its length, having a slight bulge at **17**, intermediate the length of the connector. An explanation of this bulge **17** will be made shortly.

The connector in accordance with the invention is designed so that it may be placed over two elements to be connected, such as the terminal post **10** and conductor **12**, in normal fashion. Instead of being crimped or compressed by radial pressure applied directly about the elements, however, the connector is extruded, that is, passed through a die having an aperture of smaller transverse dimension than the connector element, compressing at least a portion of the connector radially inwardly and, simultaneously, perhaps slightly elongating the connector. Fundamentally, the connector is formed by radially compressing the connector by means of axial motion of a tool.

FIG. **2** shows a preferred form of connector according to the invention. The connector **16** comprises a sleeve having one portion **18** or relatively small transverse dimension and a second portion **20** of relatively large outside transverse dimension. In the case of the cylindrical connector shown the connector can be considered comprised of a small cylinder **18** and a large cylinder **20.** Preferably, the two cylinders **18, 20** are joined by a tapered shoulder **22,** and the larger end of the terminal connector has a chamfered edge **23** which serves to preclude the formation of flash during extrusion.

Extending the length of the connector is an aperture **25** for receiving the one or more conductors **12** and a terminal post **10.** This aperture may be of constant transverse dimension throughout its length or, as is clearly illustrated in FIG. **3A–3C**, the aperture may have a small diameter portion **25***a* for accepting the post and the bared conductor and section of larger diameter **25***b* for accomodating both the post and the conductor with the insulation on it.

FIGS. **3A–3C** illustrate the manner of using the connector to attach a conductor to the terminal post **10.** For purposes of explanation, it may be assumed that the connection is made by machines of the type now used for wrapping solid conductor insulated wire about terminal posts. These machines, which have advanced to a highly developed state, can be controlled by computers to wrap conductors about individual terminal posts and connection points in the terminal boards of computers and other electronic equipment. These machines generally include a movable carriage mechanism for positioning the wrapping head vertically over the terminal post to which a conductor is to be connected. The machine accepts a pre-stripped conductor, locates the wire over the post and wraps a predetermined number of turns about the post. These machines, however, are not generally employed to wrap stranded conductors, for the reasons already mentioned.

Because the present invention implements extrusion concepts which can make use of the vertical motion capability of the machine just described, such machine can be harnessed to the application of extrusible connectors of the present invention.

Thus, since the connector is extrusible, the vertical motion of the operable part of the head, in this case the extruding die, can be employed to apply axial force to the connector sufficient to make the extruded connection. The extrusion die walls afford the radial constriction so that radial movement of parts of the connector head is not required. This can be accomplished far easier and better than if a conventional terminal connector were used, since conventional connectors must be crimped and often there is not sufficient space between adjacent terminal posts to receive any type of crimping mechanism. With the connector according to the present invention, only space sufficient for receiving a small extrusion die plate is necessary. These attributes are brought into close focus by the following description of the method of making an extruded connection.

Referring to FIGS. **3A** through **3C**, the connector is shown in a position within the extrusion opening **27** of a die plate **28** used to affix the connector to one or more conductive elements. In practice, the die plate **28** may be constructed small enough to fit between adjacent terminal posts of a circuit board assembly and may constitute the vertically moveable part of the mechanism of an automatic terminal post connection machine of the type described above. The die plate **28** supports the connector, with the tapered shoulder **22** resting against a bevelled or rounded annular bearing surface **30** immediately surrounding the die opening **27.**

Prior to connection, the prestripped (bared) wire is inserted into the connector such that the bared end of the wire **14** is located within the the small diameter portion **25***a* of the The wire is positioned such that at least a portion of the insulation **15** is received within the larger diameter portion **25***b* of the aperture.

In the next step of the operation, the die plate and connector, together with the conductor, is brought over the terminal post **10** to the position shown generally in FIG. **3B.** In this position, the post and bared wire **14** are received in the small diameter portion **25***a* of the aperture, whereas the insulation and post are received within the larger diameter portion **25***b.* (It should be here mentioned that the connector also may have a single aperture of uniform diameter throughout its length in which case the insulation of the conductor may extend at least partially into the aperture).

With the parts in that position (FIG. **3B**), a ram or stop sleeve **32,** as the case may be, is brought into contact against the large end of the connector and the die plate **30** and ram **32** are relatively moved toward one another in the axial direction. In general, the ram is held stationary while the die plate is moved axially upwardly. The rounded annular edge **30** of the die opening **27** then bears against the tapered shoulder **22** of the connector, tending to compress the connector **16** radially inwardly to encase the terminal post and bared portion of the conductor. A slight elongation of the connector **16** also may be expected to occur, since the material compressed radially inwardly about the post and conductor is usually of slightly greater volume in its compressed state than the free space immediately surrounding the terminal post **10** initially.

The relative movement between the die plate **28** and the ram **32** continues until the entire connector has passed completely through the die opening **27.** At this point, the parts occupy the positions shown in FIG. **3C.** The connector **16** grips the insulated portion of the conductor with enough pressure to securely hold the conductor in place, whereas the bared portion of the conductor is held tightly against the post by the ductile connector, completely encasing the post and conductor to form a substantially gas tight connection. Because of the material removed from chamfered edge **23** of the

connection, there is an absence of any excess material that otherwise tends to be urged upwardly as a thin rim of flash. As a last step, the die plate **30** and stop **32** are removed, as when the automatic connection machine head is vertically retracted. The finished connection shown in FIG. **1** is the result.

It should be remarked that the extrusion connection of the invention, depending on the finish of the terminal post and connector material, can be slided along the post by applying sufficient axial pressure. This is a significant advantage where several connections are made on one terminal post and a lower connection must be replaced. In such case, the upper connections can be forced to lower positions so that the former connection (to be replaced) can then be made over the top of the post in the manner just described.

A number of materials may be used to construct the connector **16,** any of which should have a sufficient degree of ductility to completely encase the post and conductor without rupturing the connector during or following extrusion. Among such materials is sintered powdered metal of the type disclosed in Logan et al. U.S. Pat. No. 3,345,452; copper, hot tin finish; and 40 percent glass-filled "NORYL" or other suitable plastic.

FIG. **4** shows an alternate embodiment in which the connector sleeve contains a small groove **35** of a circular cross-section opening to the interior aperture **25** and extending longitudinally of the sleeve. This groove **35** may be dimensioned to receive the bared portion of the conductor or, in certain cases, may be dimensioned to receive an insulated conductor in a manner such that the corner of the terminal post **10** pierces the insulation as the connector sleeve is compressed radially inwardly.

FIGS. **5**A and **5**B illustrate yet a further alternate embodiment in which the aperture **25** of the sleeve is of uniform diameter and the interior of the sleeve is fitted with a circumferentially deformable insert **36,** which may be constructed of a phosphor bronze or brass, one-half hard. The cylindrical insert is not fully closed, so that it forms an open channel for receiving a conductor **12,** while leaving sufficient space for a round terminal post **40.** As the outer sleeve **42** is compressed radially inwardly during extrusion, the sleeve **36** deforms circumferentially to move the ends **38***a* of the insert into contact with the conductor **12** to pierce the conductor insulation. In this connection, the extrusible sleeve and insert combination is similar to the assembly disclosed in my co-pending application, Ser. No. 76,940, filed Sept. 30, 1970 for "Double Sleeved Connector for Connecting Insulation to Round Post", that application describing a sleeve that is deformed by direct radial pressure.

FIGS. **6**A and **6**B illustrate yet another application of the invention providing a connection for a continuous uninsulated conductor **45.** The connector sleeve **16** is identical to that described in connection with FIGS. **1**–**3**B and has an identical manner of use. In this case, however, the connection employs an unbroken conductor loop **45** that allows a single connection to be used for tap connections to a given terminal post **10.** Instead of a single conductor end pressed into contact with the post, the dual runs of the loop **45** are inserted into the connector sleeve **16.**

One manner of implementing such a connection is depicted in FIG. **7.** There the conductor **45** is formed in a tight loop over a specially constructed mandrel **48** having a pair of closely spaced channels **50, 51** opening to the exterior of the mandrel for receiving the runs of the loop **46.** A sleeve **53,** or actual connector, is brought down over the mandrel **48,** with the conductor **45** placed transversely over the mandrel top. As the sleeve is moved (in the direction of the arrow) over the mandrel, the conductor is bent downwardly with the runs received within the channels **50, 51.** It should be understood that the mandrel might, in fact, constitute a terminal post and, further, that the mandrel might be part of an automated connection machine.

From the foregoing, it should be apparent that the invention provides an improved connector and connection, together with a method of connecting conductors to elongated elements such as terminal posts and the like. Its advantages include simplicity and the capability of use with modified, existing wire wrapping machines and in other spaces where crimping or squeezing tools cannot be applied. It is capable of forming a relatively gas tight electrical connection to terminal posts of all shapes, easily, simply and without soldering. Further, the connector is capable of providing strain relief for frail standard wire conductors and, of course, can be designed to apply varying pressures to the terminal post and conductor during extrusion.

Although the invention has been described with reference to specific embodiments, it should be understood that many variations and modifications will occur to those skilled in the art. For example, other geometric shapes may be used for the connector to adapt connectors for special extrusions. Thus, a connector can be smoothly tapered from one end to the other rather than including instinct separate small and large and transverse dimensional portions. For the purposes of the claims herein, these structures should be considered generally equivalent, although the preferred embodiment is the one described herein. Insofar as the method is concerned, the connector might include a shaped cylinder, with the die of cemetry, such as a tapered die opening, designed to achieve radial compression. As another modification, the internal aperture of the connector may vary according to specific needs and uses and a variety of materials may also be used to construct the connector. All modifications variations of this nature, accordingly, are intended to be included within the scope and spirit of the appended claims.

What is claimed is:

1. An electrical connection formed by extrusion, comprising: a terminal post having a first end and at least two generally planar, longitudinally extending surfaces; a lead wire disposed in generally parallel juxtaposition with at least one of said terminal post surfaces; and an extrudably deformable unitary sleeve having an aperture extending therethrough, said aperture being proportioned to fit loosely about said lead wire and said terminal post prior to the formation of said connection, said sleeve further comprising at least two axially separated portions each having a different transverse exterior dimension, said sleeve being constituted of a material having sufficient ductility to be extrudably compressed in secured fashion about said terminal post and said lead wire upon extrusion of the larger portion of the sleeve through a die, said sleeve being disposed over said terminal post and said lead wire and extrudably compressed thereabout in the area of said sleeve generally adjacent the sleeve portion having the larger dimension by extrusion through a die to effect a sub-

stantially uniform mechanical and electrical bond between said lead wire and said terminal post.

2. An electrical connection as defined in claim 1 wherein said sleeve further includes a portion intermediate two of said sleeve portions providing a tapered shoulder therebetween.

3. An electrical connection as defined in claim 1, wherein said aperture in the sleeve portion having the smaller dimension is of larger transverse dimension than said aperture in the sleeve portion having the larger dimension.

4. An electrical connection as defined in claim 1, in which the end of the sleeve portion having the larger dimension is tapered radially inwardly to lessen the formation of flash during extrusion thereof.

5. An electrical connection as defined in claim 1, wherein said sleeve includes a longitudinal channel communicating with said aperture for receiving said lead wire, at least partially, for contact by said tubular element.

6. An electrical connection as defined in claim 1, in which said lead wire forms a continuous loop extending parallel to the post.

7. An electrical connection as defined in claim 1 wherein said sleeve is selectively positioned about said terminal post a given length remote from said terminal post first end to provide a terminal post extension for engagement with a further member.

8. An electrical connection as defined in claim 1 wherein said lead wire is at least partially insulated and said connection further comprises means interior of said sleeve and movable with the interior surface thereof to pierce the insulation of said lead wire.

9. An electrical connection as defined in claim 8, wherein said interior means comprises a tubular element generally coaxial with said aperture and providing spaced longitudinal edges adjacent the surface defining said aperture for receiving the insulation of said lead wire, said tubular element being deformed circumferentially wherein said edges are moved together thereby causing them to pierce the insulation as said sleeve is extruded.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,744,006 Dated July 3, 1973

Inventor(s) Francis A. O'Loughlin

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 27, after "the" insert --aperture.--

Column 6, line 23, "standard" should be --stranded--

Column 6, line 33, "instinct" should be --distinct--

Signed and sealed this 8th day of January 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.