# United States Patent [19]

**Jones et al.**

[11] **3,876,280**

[45] **Apr. 8, 1975**


[54] **ELECTRIC TERMINATOR COMPRISING ONE-PIECE BIMETALLIC CONNECTOR AND METHOD FOR MAKING SUCH CONNECTOR**


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[73] Assignee: **Coatings Inc.**, Milwaukee, Wis.



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[52] **U.S. Cl.** ..... **339/276 T**; 339/278 C

[51] **Int. Cl.** ..... **H01r 11/08**

[58] **Field of Search** ..... 339/60, 61, 275, 276, 278



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*Primary Examiner*—Joseph H. McGlynn

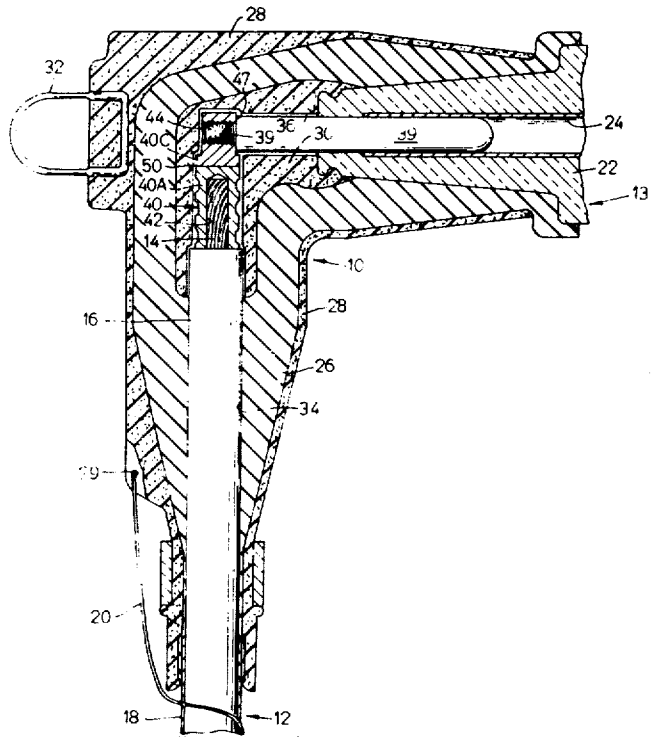
*Attorney, Agent, or Firm*—James E. Nilles



[57] **ABSTRACT**

An elbow-type loadbreak/deadbreak terminator or bushing for electrically connecting an insulated aluminum conductor wire to a copper terminal of an electrical device comprises an L-shaped insulated housing having intersecting passages, one of which accommodates a one-piece bimetallic (aluminum-copper) connector and the other of which accommodates a cylindrical copper probe threaded at its inner end. The connector comprises an aluminum portion and a copper portion welded together across their entire interface by an inertia welding process. An opening extends inwardly axially from the end of the aluminum portion of the connector for receiving the bare end of the aluminum wire which is crimped therein. A threaded opening extends inwardly transversely from a side of the copper portion of the connector for receiving the threaded inner end of the copper probe which screws thereinto. A method for making a one-piece bimetallic connector broadly comprises the steps of providing a cylindrical copper blank and a cylindrical aluminum blank, heat treating the aluminum blank, cleaning those faces of the blanks which are be welded, welding the two blanks together by an inertia welding process and machining the joined blanks into a connector of desired shape.


**19 Claims, 8 Drawing Figures**



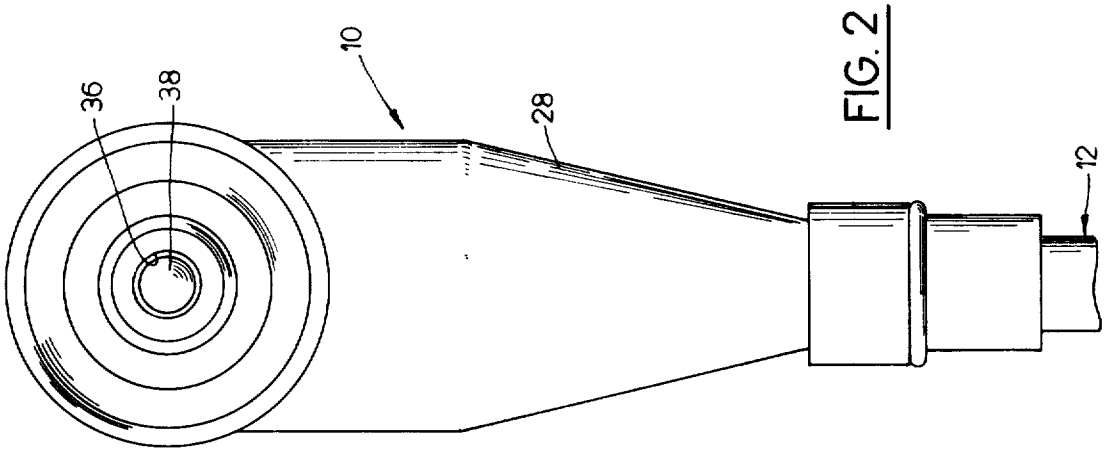

10
36
38
28
12

FIG. 2

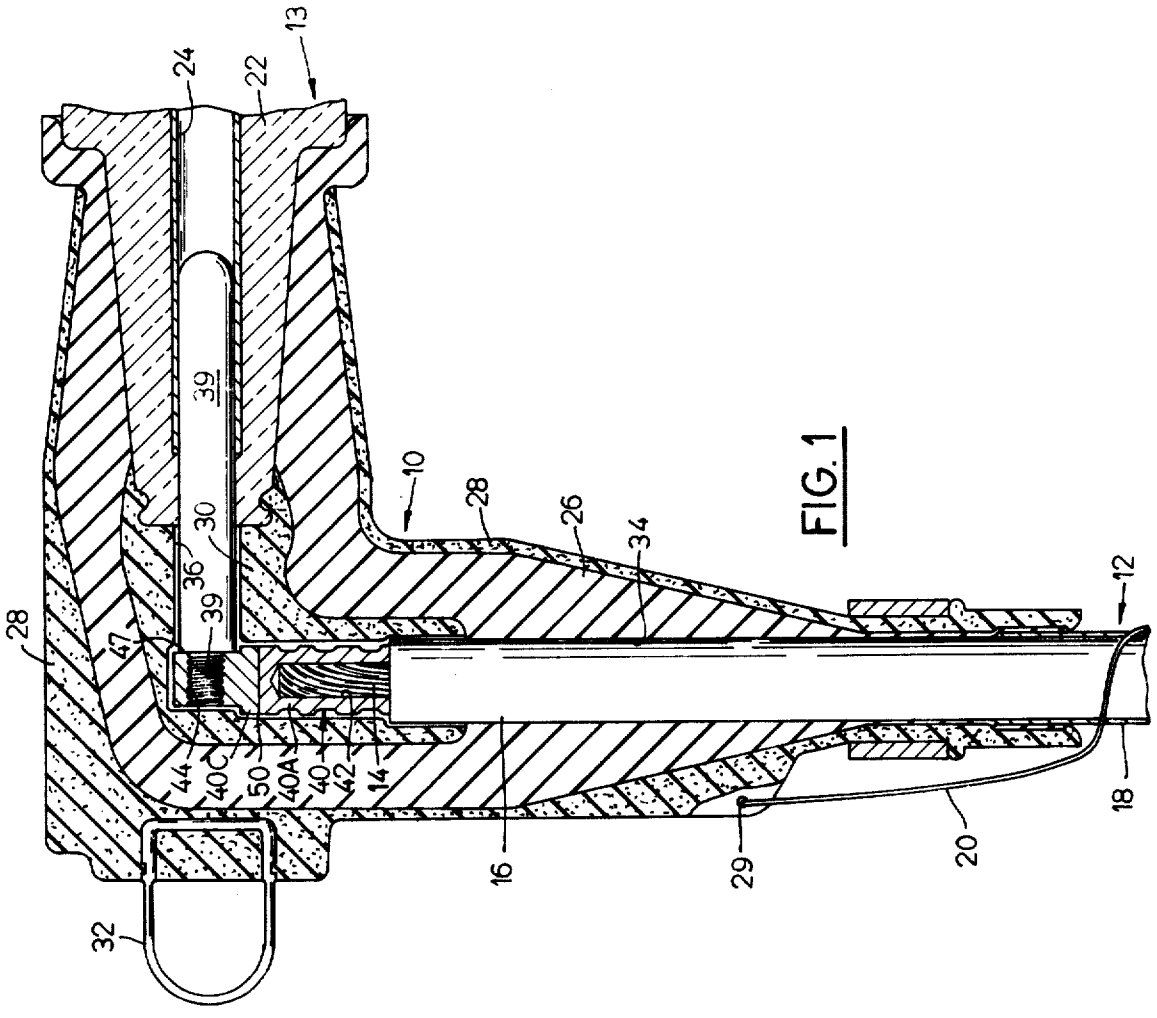

13
24
22
39
10
28
26
34
12
30
36
39
28
47
44
40C
50
40A
40
42
14
16
29
20
18
32

FIG. 1

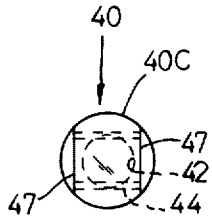



FIG. 5

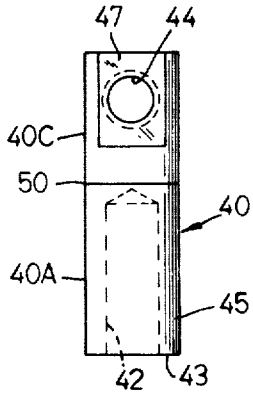



FIG. 3

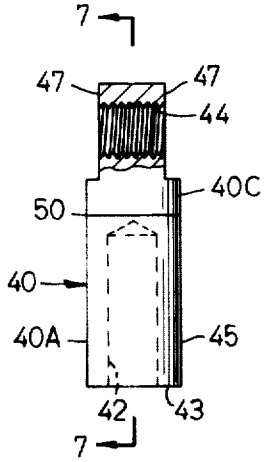



FIG. 4

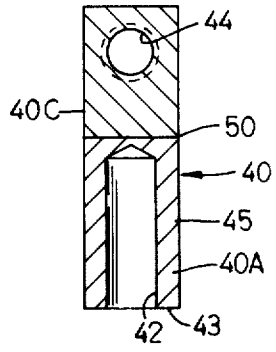



FIG. 7

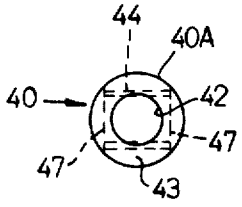
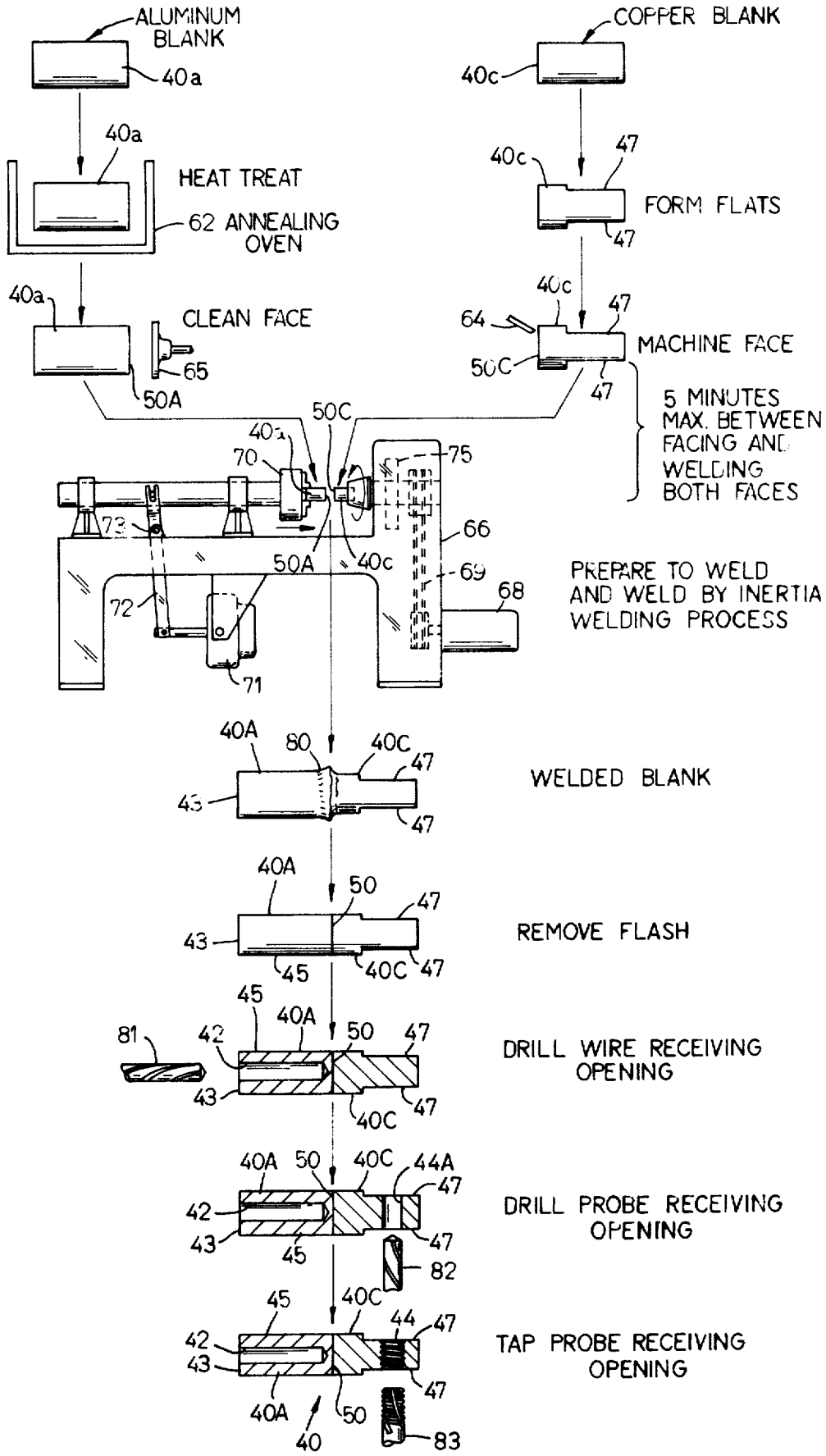



FIG. 6

FIG. 8


ALUMINUM BLANK
40a
HEAT TREAT
62 ANNEALING OVEN
CLEAN FACE
65
50A
COPPER BLANK
40c
47
FORM FLATS
64
MACHINE FACE
50C
5 MINUTES MAX. BETWEEN FACING AND WELDING BOTH FACES
70
75
73
66
69
68
72
71
PREPARE TO WELD AND WELD BY INERTIA WELDING PROCESS
40A
80
WELDED BLANK
43
50
REMOVE FLASH
45
81
42
DRILL WIRE RECEIVING OPENING
44A
DRILL PROBE RECEIVING OPENING
82
44
TAP PROBE RECEIVING OPENING
40
83

# ELECTRIC TERMINATOR COMPRISING ONE-PIECE BIMETALLIC CONNECTOR AND METHOD FOR MAKING SUCH CONNECTOR

## BACKGROUND OF THE INVENTION

1. Field of Use

This invention relates generally to electric terminators such as loadbreak or deadbreak terminators and in particular to electrical connectors used therein.

2. Description of the Prior Art

Terminators of the aforesaid character are used, for example, in underground electrical distribution systems to connect flexible insulated electrical conductor wires or cables to the terminals of electrical devices or apparatus, such as transformers, mounted in vaults located below ground level. Typically, such terminators are of the elbow-type (i.e., generally L-shaped) and comprises an L-shaped insulated housing having a passage in each leg, which passages intersect with each other within the housing. One passage accommodates an electrically conductive male probe which is threaded at its inner end and adapted at its outer end for plug-in connection with a female receptacle or terminal on the apparatus. The other passage in the terminator accommodates an electrically conductive cylindrical connector which is adapted, as by a hole extending axially into one end, to be crimped or otherwise connected to a bare end of the cable which extends into the latter passage. The probe, which is threaded at its inner end, screws into a threaded hole extending transversely through the connector near the other end thereof. In practice, the terminator is usually furnished for field installation with the probe and connector screwed together within the housing or in kit form for field assembly. During installation, the connector is securely attached, as by crimping, to the bare end of the cable. Then, the end of the cable with the connector attached is inserted into the appropriate passage in the housing and the threaded end of the probe disposed in the other passage is screwed into the threaded hole in the connector thereby readying the terminator for plug-in connection to the terminal on the apparatus.

If the conductor wire, apparatus terminal, probe and connector are all made of a similar metal, such as copper, electrical resistance and heating problems at the point where each such member connects to the other can be minimized. However, if any two adjoining members are of dissimilar metals (such as copper and aluminum), the difference in their coefficients of thermal expansion can result in resistance and heating problems at their connection point as the two members expand and contract unevenly in response to cyclical heating and cooling resulting from increasing or decreasing electric current flow therethrough or climatic variations. Such cycling, if prolonged or exaggerated or both, facilitates the formation of oxides and other high-resistance films at the contact points between the members, thereby increasing contact point resistance and heating until the problem becomes so aggravated that a burn-out, explosion or other electrical failure can occur. In addition, the poor creep, strength, or dimensional stability, of aluminum, when copper is threaded therein, results in a loose fitting, high resistance connection within a relatively short period of time.

In many instances the apparatus terminals are copper, whereas the cables to be connected thereto are aluminum. If the terminator employs an all-copper connector and a copper probe, failure sometimes occurs at the connection between the wire and the connector. Attempts to solve the problem by substitution of an all-aluminum connector for an all-copper connector in the terminator have proven unsatisfactory for several reasons. More specifically, although the aluminum connector is well-adapted to make a good electrical and mechanical connection to the aluminum cable, attempts to screw the threaded end of the copper probe into the threaded hole in the all-aluminum connector often result in cross-threading (especially in cases where the connector is cocked or off-center with respect to the probe) as the harder copper threads cut into or deform the softer aluminum threads. Such cross-threading can itself result in a very poor high-resistance connection because the probe is not in full threaded engagement with the connector and subsequent reattachment of the probe may be impossible because of damage to the connector. Furthermore, all-aluminum connectors are mechanically weak and can be bent or deformed as the terminator is connected and disconnected during use, rendering them unfit for subsequent detachment and reattachment of the cables.



## SUMMARY OF THE INVENTION

In accordance with the present invention there is provided an electrical terminator for connecting a wire to a terminal on an electrical device where, for example, the wire and terminal are made of dissimilar metals, such as aluminum and copper, respectively. The terminator comprises an insulating housing having a pair of transverse intersecting passages therein. A one-piece bimetallic electrically conductive connector is removably mounted in one of the passages and comprises two portions of dissimilar metals welded together across their entire interface, as by inertia welding. An electrically conductive probe, preferably threaded at its inner end, is disposed in the other passage and is connectable to the connector. Wire connection mmeans are provided on one portion of said connector which is made of the same metal as said wire. Probe connection means are provided on the other portion of said connector which is made of the same metal as the probe. The connection means comprise a wire receiving opening extending inwardly into the said one portion from an end of said connector to receive a wire and define crimpable wall means on the connector. The probe connection means comprise an opening, preferably threaded, extending laterally inwardly from a side of the said other portion of the connector. In a preferred embodiment, the said one portion of the connector is aluminum and the said other portion of the connector is copper.

A method for making the one-piece cylindrical connector in accordance with the invention broadly comprises the steps of providing a cylindrical copper blank and a cylindrical aluminum blank, annealing or heat treating the aluminum blank to a specified degree of hardness, cleaning the end faces of the blanks which are to be joined, inserting the blanks in an inertia welding or friction welding machine and performing the welding process to effect weld bonding of the aluminum and copper blanks entirely across their interface, and subsequently removing the flash from the finished weld and providing the specified holes. The foregoing method steps may be carried out discretely on or by means of separate machines or may be carried out on

automated machinery comprising appropriate tools for performing the various method steps. Furthermore, certain of the steps may be performed in sequences differing from the above described sequence.

Inertia welding is a solid state welding process which requires that temperature of the metals to be joined be in the forging range to permit plastic flow, and requires forging of the face or faces to obtain intimate contact and produce a weld across the entire interface of the materials being joined. Morer specifically, the inertia welding process, which is described in detail in U.S. Pat. No. 3,273,233, issued Sept. 20, 1966 to Oberle et al. for "Method of Bonding Metal Workpieces" is a method of bonding metal workpieces by using a flywheel to control the process and comprising storing in a rotating flywheel coupled with and driving a first workpiece all of the energy required to bond the workpieces; applying pressure to force a surface of said first workpiece into rotational rubbing contact with a surface of a second workpiece; continuing said rotational rubbing contact to heat said surfaces to a plastic condition and a bondable temperature at the pressure applied until said surfaces bond and the stored energy of the flywheel is expended; and predetermining the duration of such rotational rubbing contact between said surfaces by the amount of energy stored in the flywheel. Continued rotation after the beginning of bonding serves to refine the structure of the weld and to force out any entrapped voids, oxides and other defects from the weld. The inertia weld results in an interface wherein no intermetallic compounds are present to increase electrical resistance or physically weaken the mechanical bond between the joined metals. Other advantages of inertia welding are disclosed in a publication entitled "Caterpillar's Inertia Welding Process" by T. L. Oberle et al. and identified as bulletin ME-20890-1 of Caterpillar Tractor Co., Peoria, Ill.

The welding to provide a connector in accordance with the invention was performed on a Caterpillar Model No. 150 machine being sold and serviced by Production Technology Inc., a subsidiary of the Caterpillar Tractor Co. located in Peoria, Ill.

A bimetallic connector in accordance with the invention has superior electrical conductivity properties as compared to prior art connectors due to the fact that the inertia weld joins the dissimilar metals across their entire interface and eliminates voids and high resistance brittle intermetallic compounds. Furthermore, such a greatly improved transverse bending strength properties and can be bent up to and beyond 60° from its axis without failure of the weld. Furthermore, a bimetallic connector in accordance with the invention makes excellent electrical and mechanical contact with the metals of the probe and wire with which it is associated. The method disclosed herein for making a bimetallic connector enables low cost mass production of connectors having uniform electrical and mechanical properties. Connectors in accordance with the invention are mechanically and electrically superior to bimetallic connectors formed by crimping together dissimilar metals or by flash butt welding of dissimilar metals which results in the formation of intermetallic compounds along the interface which increase electrical resistance and produce a mechanically weak, easily broken connector. Other objects and advantages of the invention will hereinafter appear.

## DRAWINGS

FIG. **1** is a side view in cross section of a terminator employing a connector in accordance with the present invention;

FIG. **2** is an end elevation view taken of the terminator of FIG. **1**;

FIG. **3** is an enlarged front elevational view of the connector shown in FIG. **1**;

FIG. **4** is a side elevational view of the connector shown in FIG. **3**;

FIG. **5** is an end view of the top of the connector shown in FIG. **4**;

FIG. **6** is an end view of the bottom of the connector shown in FIG. **4**;

FIG. **7** is a cross sectional view taken on line **7—7** of FIG. **4**; and

FIG. **8** is a flow chart or schematic showing of one preferred series of method or process steps for making a connector in accordance with the invention.

## DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIGS. **1** and **2**, the numeral **10** designates an elbow-type terminator in accordance with the invention which is used to connect a flexible high voltage cable **12** to a receptacle **13** which, for example, may be mounted on a high voltage device or apparatus, such as an underground distribution transformer, circuit breaker or the like, or even on the end of another cable. Cable **12** comprises an aluminum conductor **14**, cable insulation **16**, an electrically conductive cable sheath **18**, and a concentric connector wire **20**. Receptacle **13** comprises an insulating cone **22** in which a hollow electrically conductive copper terminal member **24** is mounted.

Terminator **10** is representative of a variety of commercially available elbow-type terminators which may differ in size and in details as regards various features and options available. Terminator **10** comprises a generally L-shaped insulating body, member or housing **26** having a cable passage **34** extending inwardly of one leg and a probe passage **36** extending inwardly of the other leg. The passages **34** and **36**, which are of circular cross-section, are transverse (i.e., at right angles) to each other and intersect with each other within housing **26**. Housing **26** is provided electrically conductive shielding on its exterior, as at **28**, and on a portion of its interior, as at **30**. Such shielding may take the form of a neoprene compound molded or bonded to housing **26**. Terminator **10** is provided with a metal pulling ring or eye **32** secured to the shielding **28** on its exterior and with an attachment hole **29** for connector wire **20**.

Terminator **10** is provided with a one-piece electrically conductive bimetallic cylindrically shaped connector **40**, hereinafter described in detail, which is disposed in passage **34** and with a one-piece electrically conductive cylindrically shaped copper probe **38** having an externally threaded inner end portion **39** which is disposed in passage **36**. Probe **38** is engageable in and with terminal **24** of receptacle **13**. Connector **40** comprises an aluminum portion **40A** for permanent crimp connection to the bare end of aluminum conductor **14** and a copper portion **40C** for releasably threaded engagement with or connection to the inner end of probe **38**. The portions **40A** and **40C** of connector **40** are welded together across their entire interface **50**, as by

the process of inertia welding, and in accordance with a method hereinafter described.

Aluminum portion **40A** of connector **40** is provided with a cylindrical wire receiving opening **42** which extends axially inwardly of the connector from one end face **43** of the connector. After wire receiving opening **42** is formed, it is surrounded by an adjacent relatively thin cylindrical wall **45** of aluminum which is adapted to be crimped or swedged into tight engagement with the wire **14** inserted in opening **42.**

Copper portion **40C** of connector **40** is provided with a cylindrical internally threaded probe receiving opening **44** which extends laterally inwardly of the connector from a side of the connector. Preferably, copper portion **40C** is provided with two flat surfaces or flats **47** on opposite sides thereof adjacent or near the end thereof between which the opening **44** extends. The flats **47** are useful during the manufacture of connectors **40,** as hereinafter expalined, and also aid in aligning and directing the threaded portion **39** of probe **38** into threaded opening **44** during field assembly and installation. It is to be understood, however, that opening **44** need not extend entirely through connector **40.**

If terminator **10** is furnished for field installation with probe **38** and connector **40** secured together therein, then prior to installation it is necessary to unscrew probe **38** from connector **40** and to slide the connector out of passage **34.** A portion of the insulating **16** is stripped from an end of cable **12** to expose an end of conductor **14** and a portion of conductive cable sheath **18** is stripped from the cable to expose a portion of the insulation **16.** The exposed end of conductor **14** of the cable is inserted into opening **42** in connector **40** and the wall **45** of the latter is crimped in place on the wire by means of a suitable conventional crimping tool. The cable **12** with connector **40** attached is then inserted into passage **34** and manipulated so that one end of threaded opening **44** is aligned with passage **36** and probe **38** is inserted into passage **36** and rotated to screw its threaded portion **39** into threaded opening **44** in connector **40.** Subsequently, conductor **20** of cable **12** is attached to opening **29** on terminator **10** and the terminator is ready to be attached to or plugged into receptacle **13,** as shown in FIG. **1.**

The connector **40** shown in FIGS. **1** and **3** through **7** may, for example, be on the order of 2 inches long and 0.64 inch in outside diameter. Hole **42** therein may be on the order of 1 inch deep and 0.312 inch in diameter. Each flat **47** may extend inwardly from the end of connector **40** on the order of 0.63 inch and the distance between the two flats **47** may be on the order of 0.44 inch. Hole **44** may be centered inwardly from the connector end about 0.31 inch and may be about three-eighths of an inch in diameter prior to provision of internal screw threads therein. However, connectors of other sizes and having dimentions other than specified are within the scope of the invention.

FIG. **8** is a flow chart or diagram showing one preferred series of method or process steps in accordance with the invention for providing a connector **40** for terminator **10** in accordance with the invention. Certain of the method steps depicted and described may be carried out in a different order than specified, as hereinafter explained.

In carrying out the method in accordance with the invention to provide a connector such as **40** of the aforedescribed size and dimensions, it has been discovered that it is desirable to start with a cylindrical aluminum blank **40*a*** and a cylindrical copper blank **40*c***, such as shown in FIG. **8,** with the aluminum blank **40** being of slightly larger diameter than the copper, i.e., on the order of one-sixteenth of an inch in the size range specified above, to facilitate welding by providing a large enough mating surface and a proper amount of flash. All materials, dimensions, temperatures, pressures and other physical data and parameters hereinafter mentioned, are to be understood to apply to a connector **40** of the size hereinbefore described, unless otherwise noted, and may or may not apply to connectors of another size.

Copper blank **40*c*** is preferably fabricated either of OFHC (Oxygen Free High Conductivity) 99.99% pure copper or of ETP (Electrolytec Tough Pitch) 99.9% pure copper. However, copper of lower purity or conductivity or copper alloys could be employed. Copper blank **40*c*** may be purchased as cylindrical bar stock or formed (as by forging, impact extrusion, rough machining, casting or sintering from powdered metal) and cut to proper length.

Aluminum blank **40*a*** is fabricated either of 99.0% or higher purity aluminum, such as EC or No. 1,000 series aluminum, or of lower percentage aluminum, such as No. 5,000 or No. 6,000 series aluminum. These standards are known in the industry and may be found in the January 1972, Third Edition of The Aluminum Association Standards.

Aluminum blank **40*a*** is heat treated, as in an annealing oven **62,** to provide a specified degree of hardness so that all aluminum blanks in the same batch or production run are of a uniform degree of hardness. Typically, blank **40*a*** is annealed at 800°F. for 3 hours, followed by a controlled 50°F per hour drop in temperature over an additional 9 hour interval. This normally results in a hardness level of approximately 30–50 $R_B$.

One or more flats **47** are formed on blank **40*c*** by a suitable process such as forging or milling. The flats **47** may be formed at a suitable stage before or after the welding step, depending on requirements, but preferably not between the finishing and welding of surface **50C.**

In preparation for welding, the copper blank surface **50C** which is to be welded is machine cleaned or finished, as by a cutting or facing tool **64** of a lath, to square it and to remove dirt, oxides and other foreign materials. Surface **50C** of copper blank **40*c*** is finished to approximately 90 RMS. Finished surface **50C** must be kept absolutely clean after finishing and prior to welding and make to physical contact with other materials or surfaces, including human hands. The time interval between cleaning surface **50C** and welding should not exceed approximately 5 minutes so that undesirable films do not form or redeposit on finished surface **50C.**

In preparation for welding, the aluminum blank surface **50A** which is to be welded is subjected to a cleaning treatment or finishing, as by abrasive means such as a disc sander wheel **65,** to remove dirt, oxides and other foreign materials, but need not be machined as on a lathe. Like surface **50C,** surface **50A** must be kept absolutely clean after the cleaning treatment or finishing and prior to welding and, again, the time interval between cleaning and welding should not exceed approximately five minutes so as to avoid reformation and redeposit of undesirable films or coatings which would

inhibit the welding process or result in the possible formation of gas-formed voids or intermetallic compounds.

As FIG. **8** schematically shows, welding of the blanks **40***a* and **40***c* is typically carried out on an inertia welding machine **66** of a type and in accordance with a method described in U.S. Pat. No. 3,273,233 hereinbefore referred to. Generally considered, inertia welding machine **66** comprises a linearly movable rotatable chuck, spindle or fixture **67** driven by an electric motor **68** by means of a belt drive **69**. A flywheel **75** is attached to and drives chuck **67**, as hereinafter explained. Welding machine **66** further comprises a rotatable linearly movable chuck or fixture **70** movable by means of a drive means or element **71**, such as a pneumatic roto-chamber, through a lever arm **72** pivotally mounted at point **73** on machine **66** and connected between fixture **70** and drive element **71**.

In the embodiment shown, copper blank **40***c* is mounted in rotatable chuck **67** and aluminum blank **40***a* is mounted in linearly movable chuck **70**, with the surfaces **50C** and **50A** opposite each other. However, if preferred, either blank could be placed in either chuck to carry out the welding. In any event, the aluminum blank **40***a* must be placed in its chuck or fixture so that not more than approximately one-fourth inch projects from or out of the fixture. Furthermore, no rotational slippage of either blank in its fixture is permitted during any phase of the welding cycle.

Inertia welding machine **66** with the blanks **40***a* and **40***c* in place thereon operates as follows to carry out the inertia welding process whereby the blanks are welded together across the entire interface **50** between the surfaces **50A** and **50C**, respectively. In the inertia welding process, the flywheel **75** is used to control the process. Sufficient inertia energy from motor **68** is stored in rotating flywheel **75** which is coupled with and rotates blank **40***c* to bond the faces of **50A** and **50C** of the blanks **40***a* and **40***c*, respectively. This inertial energy is on the order of 2,460 foot pounds. The surface **50C** rotates at a speed of about 250 feet per minute. Pressure is applied by drive means **71** to move aluminum blank **40***a* and to force surface **50C** of copper blank **40***c* into rubbing contact with surface **50A** of aluminum blank **40***a*. An axial load pressure on the order of 22,800 psi is required. Rotational rubbing contact between the surfaces **50A** and **50C** is continued to heat the surfaces to plastic condition and a bondable temperature at the applied pressure until the surfaces bond and the stored energy of flywheel **75** is expended. The duration of such rotational rubbing contact between the surfaces **50A** and **50C** is predetermined by the amount of energy stored in flywheel **75**. The continued rotation after the beginning of bonding serves to refine the structure of the weld and to force out any entrapped voids, oxides and other defects from the weld. Thus, the inertial weld results in an interface **50** wherein no intermetallic compounds are present to increase the electrical resistance in or through the weld or physically weaken the mechanical bond between the joined pieces. In the course of welding material upset or loss, in the form of flash **80**, as shown in FIG. **8**, occurs only on aluminum blank **40***a* and amounts to approximately one-fourth inch of the length of the blank. As FIG. **8** further shows, the weld results in a one-piece integrally welded bimetallic connector **40** wherein full electrical and mechanical contact exists across and between the portions **40A** and **40C** at and near their interface **50**. An uninterrupted, electrically conductive path is obtained, as compared to prior art connectors wherein two dissimilar members are mechanically connected and have only partially contacting surfaces. A connector **40** in accordance with the invention, if subjected to tensile and bend tests, will exhibit a failure which will occur only in the weaker of the two materials and not in the weld region.

As FIG. **8** also shows, after welding the joined blanks are subject to treatment for removal of the aluminum flash and to provide a connector of finished diameter. These steps may be carried out together or sequentially as by machining on a lathe, forcing through a trim die, impact extrusion or other suitable processes. The flats **47** could also be provided before, during or after the flash removal and diameter finishing stages.

FIG. **8** shows that hole **42** in connector **40** is end-drilled by means of a drill **80**, that hole **44A** is cross-drilled by means of a drill **82**, and that threads in hole **44A** are formed by means of a tap **84**.

In accordance with other aspects of the invention and assuming proper conditions and machinery, the method steps of flash removal, sizing in a trim die and provision of wire receiving opening **42** could be carried out in a single operation, with drilling and tapping of hole **44** following thereafter.

The foregoing method steps can be carried out discretely on or by means of separate tools or machines in the various orders described or can be carried out on a turret type machine or other types of automated machinery comprising or associated with appropriate tools or devices for performing the various steps.

What is claimed is:

**1.** In an electrical terminator for connecting a wire to a terminal, said wire and terminal being made of dissimilar metals, a housing having a pair of transverse intersecting passages, a one-piece bimetallic electrically conductive connector in one of said passages and comprising two portions of dissimilar metals, each portion initially having a solid uninterrupted flat end surface and each end surface abutting the other along a common interface, said portions being joined together across their entire interface in a solid state bond, wire connection means on one portion of said connector, said one portion being made of the same metal as said wire, probe connection means on the other portion of said connector, and an electrically conductive probe in said other passage connected to said probe connection means of said connector, that portion of said probe connected to said connector being of the same metal as said terminal and as that portion of said connector to which it is connected.

**2.** A terminator according to claim **1** wherein said wire connection means comprises a wire receiving opening extending inwardly into said one portion from an end of said connector and wherein said probe connection means comprises an opening extending laterally inwardly from a side of the other portion of said connector.

**3.** A terminator according to claim **2** wherein the opening comprised in said probe connection means is threaded and wherein said portion of said probe connected thereto is threaded.

**4.** A terminator according to claim **3** wherein said one portion of said connector is aluminum and wherein the other portion of said connector is copper.

5. A terminator according to claim 4 wherein said portions are joined together in a solid state bond.

6. In an electrical terminator for connecting an aluminum wire to a copper terminal: a housing having a pair of transverse intersecting passages; a one-piece electrically conductive connector in one of said passages and comprising an aluminum portion and a copper portion, each portion initially having a solid uninterrupted flat end surface and each end surface abutting the other along a common interface, said portions being joined together across their entire interface in a solid state bond; wire connection means on said aluminum portion of said connector for attachment to said aluminum wire; probe connection means on said copper portion of said connector, and an electrically conductive copper probe in said other passage for connection to said probe connection means on said connector.

7. A terminator according to claim 6 wherein said wire connection means comprises a wire receiving opening extending inwardly into said one portion from an end of said connector and wherein said probe connection means comprises an opening extending laterally inwardly from a side of the other portion of said connector.

8. A terminator according to claim 7 wherein the opening comprised in said probe connection means is threaded and wherein said portion of said probe connected thereto is threaded.

9. A terminator according to claim 8 wherein said portions are joined together in a solid state bond.

10. In an elbow type electrical terminator for connecting an aluminum wire to a copper terminal: an insulating housing having a pair of transverse intersecting passages; a one-piece electrically conductive connector removably mounted in one of said passages and comprising an aluminum portion and a copper portion, each portion initially having a solid uninterrupted flat end surface and each end surface abutting the other along a commonn interface, said portions being joined together across their entire interface in a solid state bond; wire connecting means on said aluminum portion of said connector for attachment to said aluminum wire, said wire connection means comprising a wire receiving opening extending axially inwardly of said aluminum portion from an end of said connector and further comprising a crimpable wall portion adjacent said wire receiving opening; probe connection means on said copper portion of said connector, said probe connection means comprising a probe receiving opening extending laterally inwardly from a side of said copper portion of said connector; and an electrically conductive probe mounted in the other of said passages and having a copper portion for engagement with said probe receiving opening in said connector.

11. A terminator according to claim 10 wherein said crimpable wall portion adjacent said wire receiving opening completely surrounds said wire receiving opening.

12. A terminator according to claim 10 wherein said probe receiving opening is threaded and wherein said copper portion of said probe is threaded.

13. A terminator according to claim 12 wherein said connector is cylindrical.

14. A terminator according to claim 13 wherein said copper portion of said connector is provided with at least one flat surface on a side thereof and wherein said probe receiving opening extends inwardly from said flat surface.

15. A terminator according to claim 14 wherein said copper portion of said connector is provided with flat surfaces on two opposite sides thereof and wherein said probe receiving opening extends between both said flat surfaces.

16. In a connector for an electrical terminator: a one-piece body comprising two portions of electrically conductive dissimilar metals, each portion initially having a solid uninterrupted flat end surface and each end surface abutting the other along a common interface, said portions being joined together across said entire interface in a solid state bond, wire connection means comprising a wire receiving first opening extending axially inwardly of one of said portions from an end face of said body, and probe connection means comprising a second opening extending inwardly of a side of the other of said portions, said second opening being transverse to said first opening.

17. A connector according to claim 16 wherein said second opening is threaded.

18. A connector according to claim 17 wherein said first opening is surrounded by a crimpable wall portion.

19. A connector according to claim 18 wherein said one portion is aluminum and said other portion is copper.

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