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Luongo

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[54] **PARALLEL SPLICE AND METHOD OF MAKING SAME**

[75] Inventor: **Albert M. Luongo,** Edison, N.J.

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

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[52] **U.S. Cl.** ..... **29/628;** 29/517; 174/84 C; 174/94 R; 403/285

[51] **Int. Cl.²** **H01R 43/00**

[58] **Field of Search** ..... 29/628, 630 R, 630 A, 517, 29/518, 455; 403/210, 274, 285, 300; 174/84 C, 84 R, 75 R, 75 B, 94 R, 94 S; 24/115 A, 129 W, 129 C, 115 R

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Primary Examiner—C. W. Lanham
Assistant Examiner—James R. Duzan
Attorney, Agent, or Firm—David Teschner; Jesse Woldman

[57] **ABSTRACT**

A localized compression force is selectively applied between two juxtaposed chambers of an elastically deformable connector to peripherally cold flow the chamber wall material about one or more relatively noncompressible articles such as steel rods or the like disposed within the chambers to provide a reliable splice joint therebetween. For electrical applications, a splice joint may be similarly provided between a noncompressible ground rod and an electrical conductor which may be either noncompressible or readily compressible. In a further embodiment, the connector is subjected to a pair of selectively spaced localized compression forces to provide additional peripheral cold flow of one of the chamber walls. The localized compression forces are applied along axes selectively offset from the radial axis of the connector chambers to minimize spring-back of the connector and to establish a firm grip about the relatively nondeformable articles contained therewithin.

4 Claims, 7 Drawing Figures

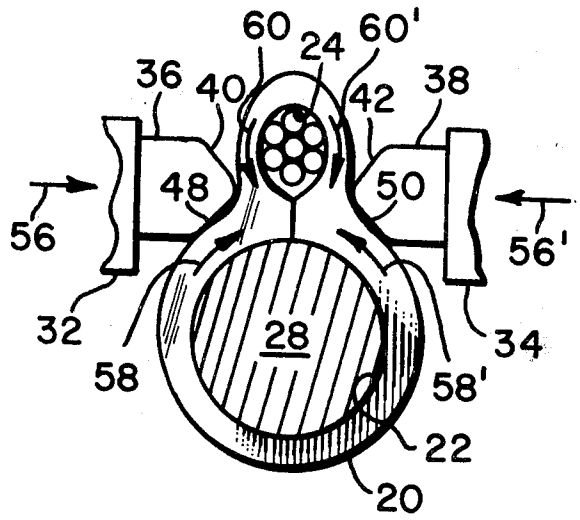
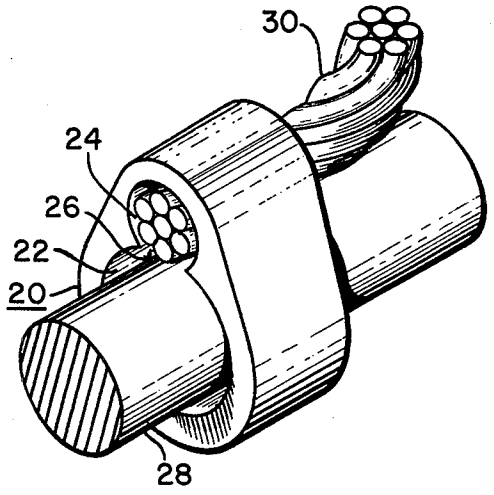


FIG. 1



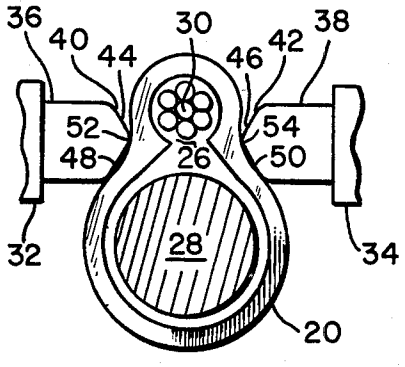


FIG. 2

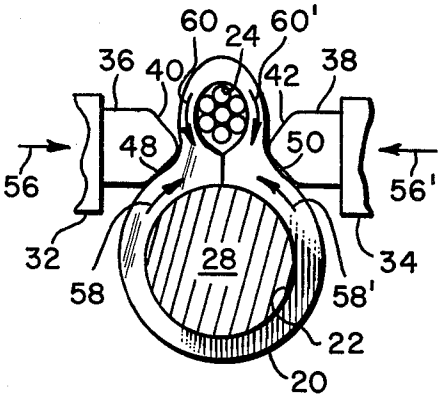


FIG. 3

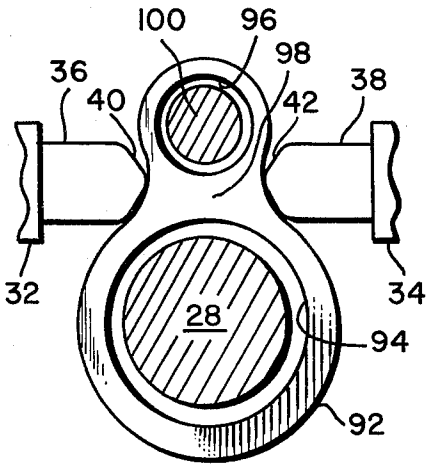


FIG. 4

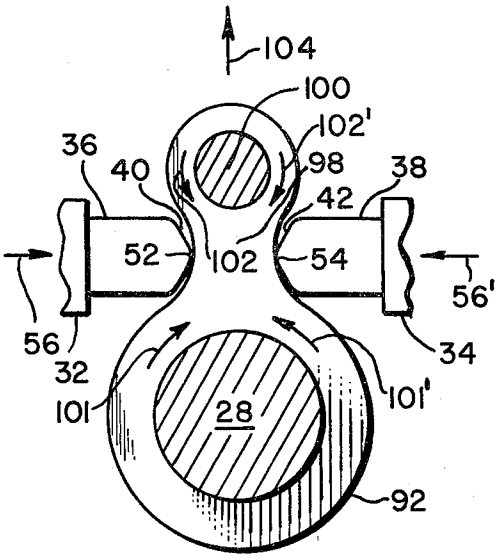


FIG. 5

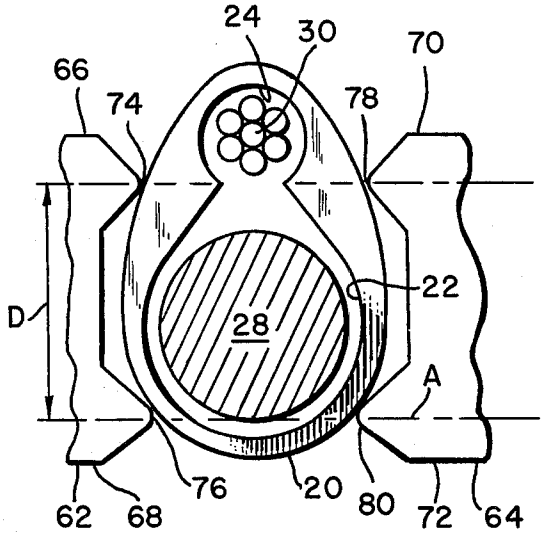


FIG. 6

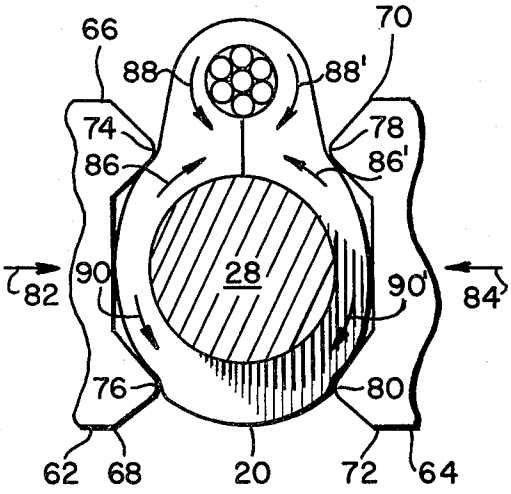


FIG. 7

PARALLEL SPLICE AND METHOD OF MAKING SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention is directed to the field of connecting devices and principally to an improved means and method for establishing a splice connection between two or more articles.

2. Description of the Prior Art

Various prior art cold flow methods have been devised to connect a sleeve or collar about relatively nondeformable rigid articles such as steel rods or the like to overcome the difficulties encountered when attempting to compress the collar or sleeve radially inwardly in the usual manner. The inherent resiliency of the collar or sleeve tends to cause spring-back of the connector material after removal of the compressive force, resulting in a loose joint between the article and the sleeve or collar. Examples of such prior art methods are disclosed in U.S. Pat. No. **2,102,325** issued Dec. **14, 1937** to J. Klystra; U.S. Pat. No. **2,476,731** issued July **19, 1949** to W. Hobbs, Jr; and U.S. Pat. No. **3,551,999** issued Jan. **5, 1971** to S. Guttman. Two of the aforementioned references pertain to a method of establishing a butt joint between two rigid articles, while the third reference utilizes a cold flow method to compress a collar about a loose bundle of stranded wires. In many electrical applications, however, it is desired to provide a parallel splice connection between either two relatively nondeformable members such as steel ground rods or the like, or a steel ground rod and a relatively deformable copper or aluminum conductor. These members are generally located at the workplace in such manner as to preclude the use of a butt splice, and are further generally sufficiently remote from a workshop as to limit the availability of the special tools and dies required to effect such prior art crimping methods.

SUMMARY OF THE INVENTION

The invention overcomes the difficulties and limitations noted above with respect to prior art devices by providing a unique method and means for establishing a parallel splice connection between two members either of which may be relatively nondeformable. The members are inserted within appropriately proportioned juxtaposed chambers in a deformable connector and the assembly subjected to a localized compression force applied generally intermediate the chambers and of sufficient magnitude as to cause at least a portion of the material forming the walls of the chambers to be both peripherally displaced towards the line of application of the compression force and contracted about the contained members. The die means for effecting such closure comprises in one embodiment, a pair of opposingly disposed, tapered members selectively contoured to provide suitably directed forces against the outer surface of the connector at the line of application. In a further embodiment, the die means is constructed so as to apply a localized compression force along two lines selectively spaced from one another and generally flanking a chamber opening, each force being applied generally tangential to the interior wall of the chamber. It is therefore an object of this invention to provide an improved method and means for effecting a parallel splice connection.

It is another object of this invention to provide an improved crimping method.

It is a further object of this invention to provide a method and means for establishing a reliable and secure parallel splice connection between two relatively nondeformable elongate articles.

It is yet another object of this invention to provide a method and means for peripherally displacing the wall material of a deformable orificed connector about one or more rigid, nondeformable elongate articles. It is still another object of this invention to provide a method and means for joining a steel grounding rod to an electrical conductor.

other objects and features will be pointed out in the following description and claims and illustrated in the accompanying drawings which disclose, by way of example, the principle of the invention and the best modes contemplated for carrying it out.

BRIEF DESCRIPTION OF THE DRAWINGS.

In the Drawings:

FIG. **1** is a fragmentary perspective view, partly in section of an assembly comprising a dual chambered connector in which are disposed elongate articles preparatory to establishing a parallel splice connection in accordance with the concepts of the invention.

FIG. **2** is a fragmentary front elevational view, partly in section, showing the assembly of FIG. **1** disposed between a die set in accordance with the concepts of the invention.

FIG. **3** is a fragmentary front elevational view, partly in section, showing a further step in the formation of a parallel splice in accordance with the concepts of the invention.

FIG. **4** is a fragmentary front elevational view, partly in section, of a further embodiment of a connector for establishing a parallel splice connection in accordance with the concepts of the invention.

FIG. **5** is a fragmentary front elevational view, partly in section, showing the assembly of FIG. **4** being subjected to a compression force in accordance with the concepts of the invention.

FIG. **6** is a fragmentary front elevational view, partly in section, of a further embodiment of die means for forming a parallel splice connection in accordance with the concepts of the invention.

FIG. **7** is a fragmentary front elevational view of the assembly of FIG. **6** showing a further step in the formation of a parallel splice in accordance with the concepts of the invention.

Similar elements are given similar reference characters in each of the respective drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to FIGS. **1, 2** and **3,** there is shown a connector **20** for practicing the method of the instant invention. The connector **20** is formed from a deformable material such as commonly employed for electrical connectors, which may include copper, brass, bronze, aluminum and other like highly conductive materials.

A first chamber **22** and a second chamber **24** extend generally longitudinally through the connector **20** in juxtaposed relationship and communicate with one another along a longitudinally extending slot **26.** For purposes of illustration, the first chamber **22** is shown as

having a larger opening than the second chamber **24**, although it should be understood that the chambers may be similarly dimensioned, if necessary or desirable, without departing from the spirit of the invention and within the concepts herein disclosed. To further illustrate the method of the invention, there is shown a solid, nondeformable rod-like member **28** inserted within the first chamber **22** and a stranded electrical conductor **30** inserted within the second chamber **24**. The relative proportions of the first and second chambers **22** and **24** are chosen so as to provide a relatively close fit about the respective elements **28** and **30**. The assembly is then selectively located between a pair of opposingly disposed die members **32** and **34**, respectively, each comprising a jaw member **36, 38** having a tapered end **40, 42** respectively, so that the tapered ends **40** and **42**, which lie along a common axis, engage the connector **20** generally intermediate the first and second chambers **22** and **24**, respectively, substantially as shown, and preferably flank the slot **26**. Each of the tapered ends **40** and **42** is defined by a first inclined surface **44, 46**, and a second inclined surface **48, 50**, communicating with one another at a preferably slightly rounded apex **52, 54**. The surfaces **48** and **50** are each angularly offset from the longitudinal axis of its respective die member **32, 34**, so as to lie preferably closely against the adjacent surface of the connector **20**. The die members **32** and **34** are then urged towards one another in the direction indicated by the arrows **56, 56'** in FIG. **3**. Accordingly, the generally tangential component of the forces applied by the die surfaces **48** and **50** against the adjacent surfaces of the connector **20** cause a peripheral displacement of the connector material surrounding each of the chambers **22** and **24** towards the line of application of the compressive die forces generally in the direction shown by the arrows **58, 58'** surrounding the first chamber **22**, and the arrows **60, 60'** surrounding the second chamber **24**. This displacement is due to the ability of the material comprising the connector **20** to cold flow under suitable pressure. The wall at least of the chamber **22** is thus caused to be moved into firm intimate contact with the outer surface of the rod **28**. Since substantially no compression of the major part of the chamber wall has taken place, the problem of spring-back of the chamber is thus effectively eliminated so that a secure permanent joint is formed between the wall of the chamber **22** and the rod **28**. The wall of the chamber **24** is similarly subjected to cold flow to cause peripheral displacement of at least a portion of the material forming such wall and a certain degree of contraction of the opening of the chamber **24**. However, the longitudinal component of the compressive forces applied by the die members **32** and **34** cause a closure of the slot **26** which tends to further contract the wall of the chamber **24** about the conductor **30** to effect a second secure joint thereat. Additional peripheral displacement of the chamber wall material may be accomplished in a similar manner by providing modified die members such as **62** and **64** shown in FIGS. **6** and **7**. Each of the die members **62** and **64** comprises a pair of jaw members **66, 68** and **70, 72**, respectively, each jaw member having a contour essentially duplicative of the jaw members **36** and **38** described above with respect to the embodiment illustrated in FIGS. **2** and **3**. The jaw members **66** and **68** each terminate at an apex **74, 76**, respectively, and the jaw members **70** and **72** each terminate at an apex **78, 80**, respectively. The die members **62** and **64** are essentially identically configured and the spacing D between each pair of apexes is chosen so that, upon placement of the connector **20** therebetween with the jaw members **66** and **70** located intermediate the first and second chambers **22** and **24** in the manner indicated above with respect to FIGS. **2** and **3**, the apexes of the jaw members **68** and **72** will contact the outer surface of the connector **20** along an axis A substantially tangent to the chamber **22**. As the die members **62** and **64** are urged together in the direction indicated by the arrows **82** and **84** in FIG. **7**, the wall material encompassing the chamber **22** in the general area of the apexes **74** and **78** of jaw members **66** and **70**, respectively, will be peripherally displaced in the direction indicated by the arrows **86, 86'**, while the wall material encompassing the chamber **24** in the same general area of the apexes **74** and **78** will be peripherally displaced in the direction indicated by the arrows **88** and **88'**. Additionally, the wall material encompassing the chamber **22** in the general area of the apexes **76** and **80** of the jaw members **62** and **64**, respectively, will be peripherally displaced in the direction indicated by the arrows **90** and **90'**. Accordingly, although the chamber **24** is subjected to substantially the same forces described above with respect to the embodiment illustrated in FIGS. **2** and **3**, the chamber **22** is subjected to additional forces applied by the jaw members **68** and **72** to further increase the engagement between the connector **20** and the rod **28** due to the additional cold flow of the connector material.

Referring now to FIGS. **4** and **5**, there is shown a connector **92** similar to connector **20** with respect to the physical characteristics thereof, but differing, however, in its construction in that the connector **92** is provided with two discrete longitudinally extending, juxtaposed chambers **94** and **96** separated from one another by a solid web portion **98**. This arrangement has been found advantageous where it is desired to provide a parallel splice connection between two relatively nondeformable rigid rods such as the rod **28** shown disposed within the chamber **94** and a furthr rod **100** shown disposed within the chamber **96**. The connector **92** is positioned between the jaw members **36** and **38** of the die members **32** and **34** in essentially the same position as the connector **20**, that is, with the tapered ends **40** and **42** of the jaw members **36** and **38**, respectively, located generally intermediate the two chambers. The die members **32** and **34** are then urged together with sufficient force in the direction indicated by the arrows **56** and **56'** as to cause the peripheral displacement of the material forming the walls of the chambers **94** and **96** in the direction indicated generally by the arrows **101, 101'** and **102, 102'** in FIG. **5**. The resulting cold flow of the connector material about each of the rods **28** and **100** thus established a firm gripping action between the interior surfaces of the chambers **94** and **96** and the respective exterior surfaces of the rods **28** and **100**. In this case, however, the web portion **98** is compressed under the influence of the longitudinally directed component of the forces generated by the die members **32** and **34**, and a partial extrusion takes place, whereby the web portion **98** elongates slightly generally in the direction indicated by the arrow **104** in FIG. **5**, causing a further peripheral displacement of the material of the wall surrounding the chamber **96** and a corresponding increase in the interfacial engagement between the rod

100 and the interior surface of the chamber 96. The contraction of the chambers 94 and 96 about the respective rods 28 and 100 is thus accomplished by cold flow of the surrounding material in essentially the same manner described above with respect to the embodiment illustrated in FIGS. 2 and 3. It should be further noted that the die members 62 and 64 shown in FIGS. 6 and 7 may be employed in conjunction with connector 92 to provide additional cold flow of the material forming the wall of the chamber 94 in essentially the same manner as described above with respect to connector 20. It should also be noted that although each of the jaw members 36, 38, 66, 68, 70, and 72 is contemplated as having a depth substantially equal to the width of the connector 20 or 92 so as to provide a continuous line of contact therewith, the jaw members may be selectively recessed or relieved in the area of the apex thereof at one or more discrete intervals along the length of the apex to selectively concentrate and direct the forces applied by the die members against the outer surfaces of the connectors 20 and 92.

I claim:

1. A method of making a parallel splice between a first and a second relatively incompressible rigid elongate article comprising the steps of: providing an elastically deformable connecting means having a first chamber and a second chamber arranged in juxtaposed parallel relationship; inserting said first article within said first chamber; inserting said second article within said second chamber; and subjecting said connecting means to a highly localized compression force directed along a common axis and restrictively confined solely to an area located intermediate said first chamber and said second chamber to cause at least a portion of the material forming the walls of said first chamber and said second chamber to be simultaneously peripherally displaced towards the axis of application of said localized compression force and contracted about said first article and said second article.

2. A method of making a parallel splice between a first relatively incompressible rigid elongate article and a second compressible elongate article comprising the steps of: providing an elastically deformable connecting means having a first chamber and a second chamber communicating with one another and arranged in juxtaposed parallel relationship; inserting said first article within said first chamber; inserting said second article within said second chamber; and subjecting said connecting means to a highly localized compression force directed along a common axis and restrictively confined solely to an area located intermediate said first chamber and said second chamber to cause at least a portion of the material forming the wall of said first chamber to be simultaneously peripherally displaced towards the axis of application of said localized compression force and contracted about said first article, and to cause the wall of said second chamber to be contracted about said second article.

3. A method of making a parallel splice between a first and a second relatively incompressible rigid elongate article comprising the steps of: providing an elastically deformable connecting means having a first chamber and a second chamber arranged in juxtaposed parallel relationship; inserting said first article within said first chamber; inserting said second article within said second chamber; and simultaneously subjecting said connecting means to a first highly localized compression force and a second highly localized compression force, said first localized compression force being directed along a common axis and restrictively confined solely to an area located intermediate said first chamber and said second chamber, and said second localized compression force being directed along a common axis and restrictively confined solely to an area located tangential to the interior wall of said first chamber remote from the axis of application of said first localized compression force and against the exterior surface of said first chamber, said first localized compression force being of such magnitude as to cause a portion of the material forming the walls of said first chamber and said second chamber to be simultaneously peripherally displaced towards the axis of application of said first localized compression force and contracted about said first article and said second article, said second localized compression force being of such magnitude as to cause a portion of the material forming the wall of said first chamber to be simultaneously peripherally displaced towards the axis of application of said second localized compression force and contracted about said first article.

4. A method of making a parallel splice between a first relatively incompressible rigid elongate article and a second compressible elongate article comprising the steps of: providing an elastically deformable connecting means having a first chamber and a second chamber communicating with one another and arranged in juxtaposed parallel relationship; inserting said first article within said first chamber; inserting said second article within said second chamber; and simultaneously subjecting said connecting means to a first highly localized compression force and a second highly localized compression force, said first localized compression force being directed along a common axis and restrictively confined solely to an area located intermediate said first chamber and said second chamber, said second localized compression force being directed along a common axis and restrictively confined solely to an area located tangential to the interior wall of said first chamber remote from the axis of application of said first localized compression force and against the exterior surface of said first chamber, said first localized compression force being of such magnitude as to cause a portion of the material forming the wall of said first chamber to be simultaneously peripherally displaced towards the axis of application of said first localized compression force and contracted about said first article, and to cause the wall of said second chamber to be contracted about said second article, said second localized compression force being of such magnitude as to cause a portion of the material forming the wall of said first chamber to be simultaneously peripherally displaced towards the axis of application of said second localized compression force and contracted about said first article.

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