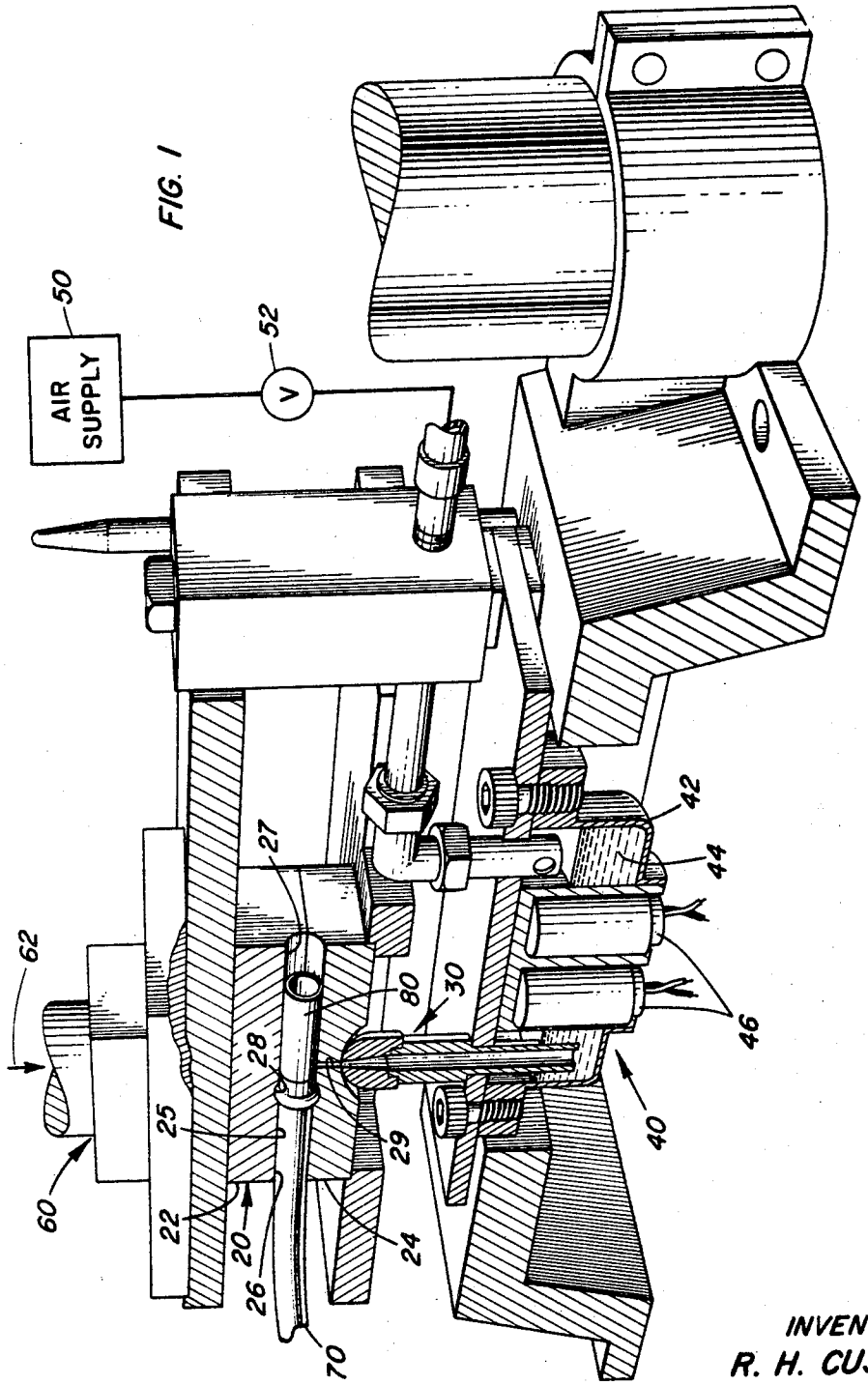
Sept. 24, 1968 R. H. CUSHMAN 3,402,758

METHOD FOR DIE CASTING ELECTRICAL CONNECTIONS

Filed June 8, 1966 3 Sheets-Sheet 1

FIG. 1



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ATTORNEY

METHOD FOR-DIE CASTING ELECTRICAL CONNECTIONS

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FIG. 2

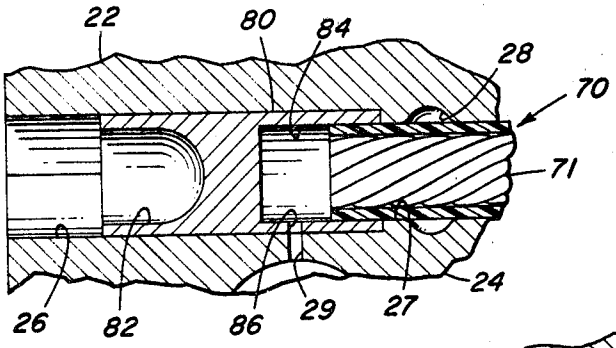


FIG. 4

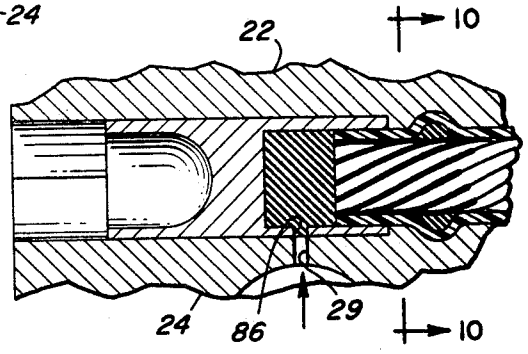


FIG. 5

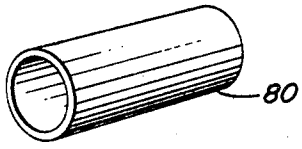


FIG. 6

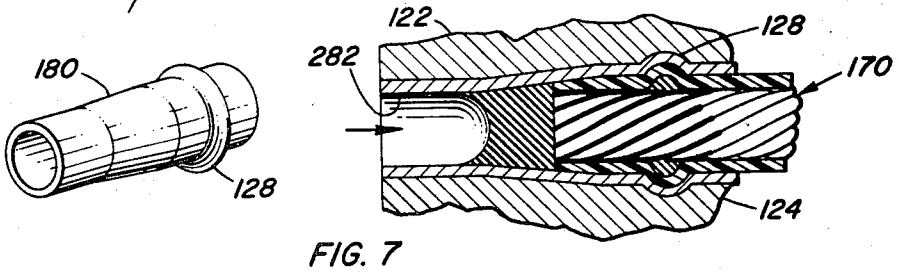


FIG. 7

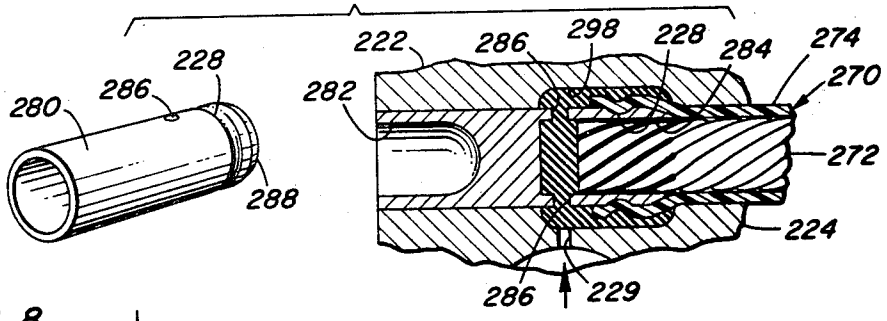
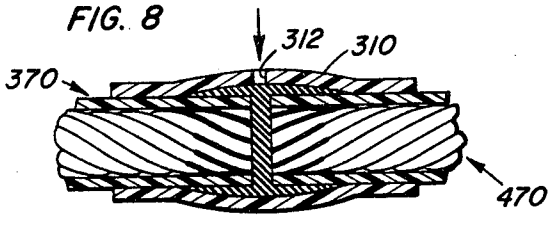


FIG. 8



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FIG. 3

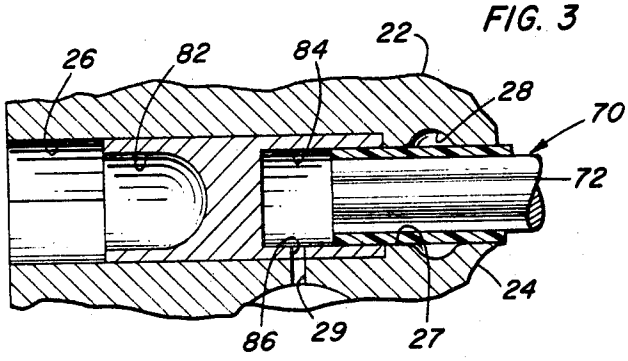


FIG. 9

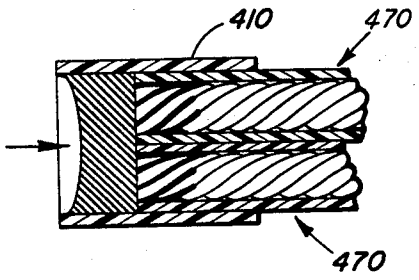


FIG. 10

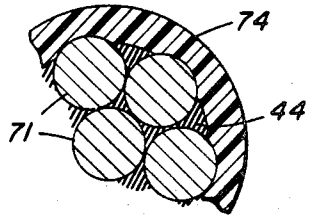


FIG. 13

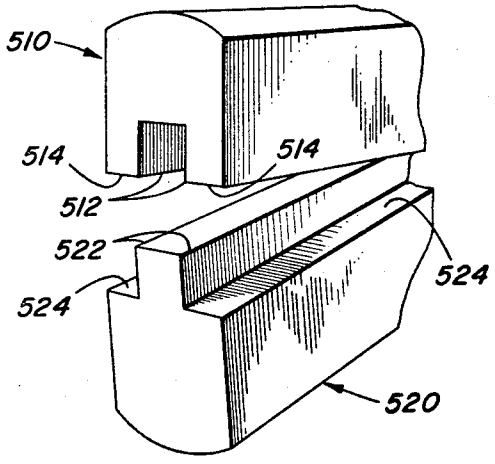


FIG. 11

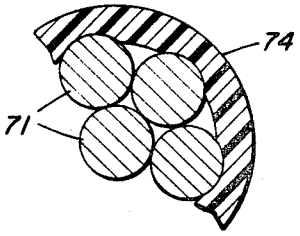
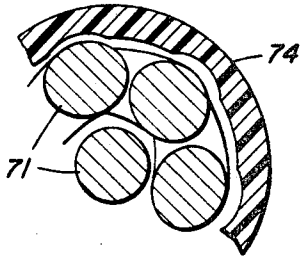


FIG. 12



United States Patent Office 3,402,758 Patented Sept. 24, 1968

3,402,758

METHOD FOR DIE-CASTING ELECTRICAL CONNECTIONS

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Filed June 8, 1966, Ser. No. 556,133
15 Claims. (Cl. 164—108)

This invention relates to a method of utilizing die-casting techniques to simultaneously, electrically and mechanically, interconnect insulated, stranded or solid unstripped conductors with each other, and with terminals.

Measurable and highly desirable economies in manufacturing time and effort can be accomplished if a new and improved method is provided whereby a terminal can be connected simultaneously, mechanically and electrically, to an insulated, stranded or solid, unstripped conductor.

Accordingly, it is an object of this invention to provide such a method.

A further object of the present invention is to provide a method for using a die-casting technique and a suitable electrically conductive adhesive medium to simultaneously, mechanically and electrically, connect a terminal to an insulated, stranded or solid, unstripped conductor.

A feature of the present invention is a method of simultaneously, mechanically and electrically, connecting an insulated, stranded or solid, unstripped conductor to a terminal, at least a portion of which terminal is hollow, by means of an electrically conductive, adhesive medium having both a fluid and a solid state, which method includes the steps of placing the terminal and one end of the conductor in telescoping relationship, forming a mold cavity about the so placed terminal and conductor, forcing the medium in its fluid state into the hollow portion of the terminal and against said one end of the conductor to cause a portion of the medium to penetrate a predetermined distance upwardly of the conductor into the space between the conductor and the insulation, and solidifying the medium.

Another feature of the present invention is a method of simultaneously, mechanically and electrically, connecting an insulated, stranded, unstripped conductor to a terminal, at least a portion of which terminal is hollow, which includes the steps of placing the terminal and the end of the conductor in telescoping relationship, forming a mold cavity about the so placed terminal and conductor, forcing molten solder into the hollow portion of the terminal and against the end of the conductor to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the conductor into the interstitial spaces between the conductor strands, and rapidly cooling the molten solder to prevent damaging of the insulation.

Additional measurable and highly desirable economies in manufacturing time and effort can be accomplished if a new and improved method is provided whereby insulated stranded or solid, unstripped conductors can be simultaneously interconnected mechanically and electrically.

Accordingly, it is another object of the present invention to provide such a method.

A still further object of the present invention is to provide a new and improved method for using a die-casting technique and solder to simultaneously, mechanically and electrically, interconnect insulated, stranded or solid, unstripped conductors, without damaging the insulation.

Another feature of the present invention is a method of simultaneously, mechanically and electrically interconnecting insulated, stranded or solid, unstripped conductors, which includes the steps of cutting the ends of the conductors and crushing the insulation adjacent the ends of the conductors to loosen the insulation from the underlying conductor, placing the cut and crushed ends of the conductors into an annular retaining ring, forming a mold cavity around the retaining ring, forcing molten solder into the retaining ring and against the ends of the conductors to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the conductors into the space between the insulation and the underlying conductor, and rapidly cooling the molten solder to prevent damaging of the insulation.

Yet another feature of the present invention is a method of simultaneously mechanically and electrically interconnecting insulated, stranded, unstripped conductors, which includes the steps of cutting the ends of the conductors and crushing the insulation adjacent the ends of the conductors to loosen the insulation from the underlying conductor strands, placing the cut and crushed ends of the conductors into an annular retaining ring, forming a mold cavity around the retaining ring, forcing molten solder into the retaining ring and against the ends of the conductors to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the conductors into the interstitial spaces between the insulation and the conductor strands and between the interstitial spaces between the conductor strands, and rapidly cooling the molten solder to prevent damaging of the insulation.

An even more complete understanding of the present invention may be obtained from the following detailed description when read in conjunction with the appended drawings, wherein:

FIG. 1 is a fragmentary, cross-section view, in perspective, of die-casting apparatus suitable for the practice of the method of the present invention;

FIG. 2 is a cross-sectional view of a terminal and a stranded conductor to be simultaneously, mechanically and electrically, interconnected, and includes a partial view, also in cross section, of a split mold;

FIG. 3 is a view similar to FIG. 2, but showing a terminal and a solid conductor to be simultaneously, mechanically and electrically, interconnected;

FIG. 4 is a view similar to FIG. 2, but showing the manner in which the terminal and stranded conductor are interconnected by pressure injected, molten solder;

FIG. 5 is a view, in perspective, of the terminal of FIGS. 2 and 3;

FIGS. 6 and 7 are respectively similar to FIGS. 5 and 4, but show terminals of different configuration and assist in explaining other embodiments of the method of the present invention;

FIGS. 8 and 9 are cross-sectional view of insulated, stranded, unstripped conductors which have been simultaneously interconnected mechanically and electrically;

FIG. 10 is a fragmentary view of a section taken substantially along the line 9—9, in the direction of the arrows, in FIG. 4;

FIG. 11 is a partial end view of an insulated, stranded, unstripped conductor before the surrounding insulation has been crushed;

FIG. 12 is a view, substantially the same as FIG. 11, but after the surrounding insulation has been crushed; and

FIG. 13 is a fragmentary view, in perspective, of implements suitable for simultaneously cutting and crushing insulated, stranded or solid, conductors.

Referring now to FIG. 1, there is shown die-casting apparatus suitable for the practice of the method of the present invention. Primarily, the die-casting apparatus includes a split mold **20**, a nozzle **30**, solder supply **40**, air supply **50**, and ram **60**.

In the usual manner, the split mold **20** is comprised of upper and lower mold segments **22** and **24**, which, when closed, provide a die cavity **25** substantially complementary in shape to the workpieces to be accommodated therein. The mold cavity **25** of the embodiment of FIG. 1, is comprised of an orifice **26** for permitting the insertion into the mold cavity of a portion of one end of an insulated, stranded or solid, unstripped conductor, such as indicated by the numerical designation **70**. The opposite end of the mold cavity is comprised of another orifice **27** for accommodating a terminal **80** to be simultaneously, electrically and mechanically, interconnected with the conductor. The mold cavity is also provided with an annular recess **28** (best seen in FIG. 2) whose purpose will be set forth in detail infra. The lower mold segment **24** is provided with a gate **29** through which molten solder, under pressure, may be forced into the die cavity.

The lower end of the nozzle **30** extends downwardly into the solder supply **40**, which supply includes a solder pot **42**, a supply of molten solder **44**, and a pair of centrally located electrical heaters **46** for maintaining the solder supply in a desired molten condition.

The solder supply, as shown, is in communication with the supply of pressurized air **50** through suitable connections and an intermediate pressure valve **52**.

The ram **60**, in response to any suitable force indicated by the arrow **62**, is reciprocable in the vertical plane, and is movable downwardly to close the mold segments **22** and **24**; ff desired, the downward movement of the ram may be utilized to initiate injection of the molten solder into the die cavity.

Upon the delivery of a pulse of air from the air supply **50** to the solder supply **40**, the air pulse will displace a suitable quantity of molten solder and force such quantity upwardly of the nozzle **30** into the die cavity **25**.

The conductor **70**, FIGS. 2 and 3, as is well known to those skilled in the art, is comprised typically of a plurality of twisted strands **71**, or a solid conductor **72**, respectively, each made of some suitably conductive material, around which solid conductor or strands is extruded, or otherwise formed, a coating of insulation **74**, comprised of some suitable insulation material, such as a suitable plastic. With regard to the stranded conductor, it will be understood that, although the conductor strands **71** are twisted together closely, interstitial spaces are present between the conductor strands; the significance of such interstitial spaces being set forth infra.

There are at least three primary considerations involved in securing the terminal **80** to the conductor **70**; one, the terminal and conductor must be interconnected mechanically, two, the terminal and conductor must be interconnected electrically, and three, such interconnections must not damage the insulation of the conductor such as by causing the insulation to shrink back away from the terminal. For the reasons stated hereinabove, great advantages accrue to the method of the present invention which provides simultaneous electrical and mechanical interconnection between such terminal and conductors, and which method does not cause damage to the conductor insulation shrink-back.

More specifically with regard to the problem of insulation shrink-back, the adhesive medium most generally used to provide such mechanical and electrical interconnection is solder, whose characteristics are well known to those skilled in the art, and whose adhesive qualities are related directly to its wetting action, and, whose wetting action is related directly to the temperature at which the solder is applied. It has been found that the die-casting technique of applying molten solder provides such desired wetting action. However, since, as aforesaid, the quality of the wetting action of the solder is related directly to the temperature of the solder, problems have arisen in the use of such die-casting technique, as when the molten solder is applied to the conductor and terminal at the elevated solder temperatures desired,

frequently such action causes unwanted damage to the conductor insulation, such as insulation shrink-back, which can cause unwanted, and even ruinous, exposure of the conductor or strands. The method of the present invention permits the application of the molten solder at the desired temperatures, yet also solves the shrink-back problem by providing for rapid cooling of the molten solder.

With further regard to the adhesive medium for providing electrical and mechanical interconnection, it will be understood by those skilled in the art that various other electrically conductive, adhesive mediums having both a fluid and a solid state, other than solder, may be utilized in the practice of the present invention. For example, a suitable electrically conductive epoxy, or a thermosetting or thermoplastic material, could be utilized.

Referring again to FIG. 1, it will be noted that the mold segments **22** and **24** are comparatively quite massive with respect to the conductor **70** and terminal **80**, and it will be understood, that the mold segments are quite massive with respect to the quantity of molten solder to be injected. Thus, such mold segments, which are at room temperature, provide a heat sink of sufficient magnitude to provide rapid cooling of the injected solder, and, thereby, prevent any thermal degradation of the insulation, such as shrink-back.

Referring now in general to FIGS. 1, 2, 3, 4 and 5, and initially to FIG. 2, the terminal **80** is provided at one end with a bore **82** for mating with another electrical connector, and is provided at the other end with a hollow portion, or cavity portion, **84**. The hollow or cavity portion is provided with an aperture or orifice **86** for admitting injected molten solder into the cavity portion. The orifice **86** is substantially aligned with the gate **29**; however, due to the pressure behind the injected molten solder, neither perfect, nor even very accurate alignment, is required.

The end of the insulated, stranded, unstripped conductor **70** of FIG. 2, is inserted partially into the hollow or cavity portion **84** of the terminal **80**; such insertion may be made manually or by suitable machinery. The terminal and conductor, having thus been placed in such telescoping relationship, are placed in the lower mold segment **24** and the upper mold segment **22** is closed on the lower mold segment; the orifice **26** of the mold cavity **25** closely accommodating the terminal **80**, the orifice **27** closely accommodating the conductor **70**, and the annular recess **28** surrounding the conductor near the end thereof.

In response to some suitable trigger mechanism, such as mentioned above, a pulse of pressurized air is delivered to the molten solder **44** and a quantity of molten solder is injected through the nozzle **30**, the gate **29**, and aperture **24**, into the hollow or cavity portion **84** of the terminal **80**. As will be understood from viewing FIGS. 2 and 4, the quantity of pressurized, molten solder injected will fill the hollow or cavity portion **84** of the terminal **80**, and being confined under pressure, the molten solder will be forced against the end of the conductor **70** to penetrate a predetermined distance upwardly of the conductor into the space between the insulation and the conductor strands and into the interstitial spaces between the conductor strands **72**. The manner in which the solder **44** penetrates into the interstitial spaces can be well seen in FIG. 10.

A portion of the pentrating molten solder, being under pressure, will force a portion of the insulation to bulge outwardly into the annular cavity recess **28**, and, a portion of such solder will bulge outwardly into the annular recess, as may be best seen in FIG. 4.

As described above, the mold **20** provides a heat sink which rapidly cools the injected molten solder to prevent thermal degradation of the insulation **74**, such as insulation such as insulation shrink-back.

The injected solder, when cooled, will adhere to the

walls of the terminal cavity **84** and the conductor strands **72** along their lengths a predetermined distance, and thus will simultaneously interconnect the terminal and conductor both mechanically and electrically. The portion of solder bulging outwardly into the annular recess, will provide an annular ring, or anchor, under the insulation, to further assist in interconnecting the terminal and conductor mechanically, and will make difficult the unwanted removal of the terminal from the conductor.

The mold **20** is opened by suitable upward movement of the mold segment **24**, and the interconnected terminal and conductor are removed.

The predetermined distance the molten solder is forced upwardly of the conductor, is readily determinable and controllable, viz., the pressure valve **52** is adjusted such that the solder is under pressure only sufficiently great to cause the solder to penerate a distance slightly past the annular recess **27**, as shown in FIG. 4.

Referring now to FIG. 3, it will be understood that the present method of simultaneously, electrically and mechanically, terminating the solid conductor **72**, of FIG. 3, with the terminal **80**, is substantially the same as set forth with regard to the stranded conductor **71**, of FIGS. 2 and 4, except that when the injected molten solder is forced against the end of the solid conductor, the injected molten solder penetrates a predetermined distance upwardly of the conductor into the space between the conductor and the surrounding insulation; the penetrating solder then forming the annular bulge of insulation as before.

Referring now to FIG. 6, the method of the present invention may be practiced with a hollow terminal **180** which is provided with a ferrule portion **128** which forms an annular recess around the interior of the terminal.

The insulated, stranded, unstripped conductor **170** is inserted partially into one end of the terminal **180** such that the annular recess, provided by the ferrule portion **128**, surrounds the conductor a predetermined distance from the end.

The mold segments **122** and **124** are complementary in shape to the external configuration of the terminal **180**, as shown in FIG. 6, and such mold segments, in substantially the same manner as described above with regard to mold segments **22** and **24**, form a mold cavity about the terminal.

In this embodiment of the invention, the molten solder is pressure injected into the end of the terminal to fill a portion of the hollow terminal and to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the space between the insulation and the conductor strands and upwardly of the interstitial spaces between the conductor strands, and to cause a portion of the insulation and penetrating solder to bulge outwardly into the annular recess provided by the ferrule portion **128** of the terminal. The molten solder is rapidly cooled by the heat sink provided by the mold segments **122** and **124**.

The solder residing within the hollow terminal and the penetrating solder residing within the interstitial spaces between the conductor strands, mechanically and electrically, interconnect the terminal and the conductor. Furthermore, the complementary cooperating mating action of the annular recess provided by the ferrule portion **128** of the terminal **180**, and the portion of the insulation and injected solder residing within such annular recess, firmly and securely mechanically interconnect the conductor and the terminal, and prevent the unwanted separation of the two workpieces.

Referring now to FIG. 7, another embodiment of the method of the present invention may be practiced with the terminal **280** which is provided with a ferrule portion **228** which portion provides an annular recess around the exterior of the terminal. The terminal is also provided on one end with a tapered or beveled portion **288**, and as may be best seen in the rightward portion of FIG. 7, the terminal on the same end is provided with a cavity portion **284**. The other end of the terminal **280** is provided with a bore **282** for interconnecting the terminal with other suitably mating terminals or electrical hardware.

The mold segments **222** and **224** are substantially complementary in shape to the exterior of the terminal **280** and conductor **270**, but also include cavity portions which define an annular mold cavity **298**.

The terminal **280** and insulated, stranded unstripped conductor **270** are placed in telescoping relationship, and in this embodiment, the end of the terminal providing the cavity portion **284** is forced a predetermined distance upwardly of the conductor, around the conductor strands, and between the conductor insulation **274** and the conductor strands **272**, with the annular recess formed in the terminal underlying the conductor insulation a predetermined distance from the end of the conductor; the tapered or beveled portion **288** facilitating such relative telescoping positionment of the terminal and conductor.

The terminal **280** and conductor **270** are placed in the lower mold segment **224** and, in the manner described above, the upper mold segment **224** is closed onto the lower mold segment to provide the annular mold cavity **228** around the portions of the conductor and terminal in the telescoping relationship, as shown in the rightward portion of FIG. 7.

The cavity portion of the terminal **280** is provided with a pair of substantially diametrically opposite apertures **286**, one of which is placed in substantial alignment with the gate **229** formed in the lower mold segment **224**.

Molten solder is forced through the gate **229** into the annular mold cavity **228** to cause a portion of the molten solder to fill the balance of the terminal cavity portion **284** not occupied by the conductor, to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the space between the insulation and the conductor strands and upwardly of the interstitial spaces between the conductor strands **272**, and to cause a portion of the molten solder in the annular mold cavity **298** to force a portion of the conductor insulation **274** to bulge inwardly into the annular terminal recess **228**. The molten solder is rapidly cooled by the heat sink provided by the mass of the mold segments **222** and **224** to prevent any damage of the conductor insulation, such as insulation shrink-back.

The solder occupying the interior of the terminal cavity portion **284**, and the solder occupying the interstitial spaces between the conductor strands **272**, mechanically and electrically interconnect the terminal and conductor. Additionally, the annular ring of solder, formed in the annular mold cavity **298**, and the portion of such solder and conductor insulation bulging inwardly into the annular terminal recess **228**, firmly and securely mechanically interconnect the conductor and the terminal, and prevent unwanted separation of the two workpieces.

Reviewing generally, in the invention embodiments of FIGS. 4, 6 and 7, the terminal and insulated, stranded, unstripped conductor are placed in telescoping relationship (either partially inside the other), molten solder is pressure injected to fill a portion of the terminal and to penetrate a predetermined distance upwardly of the space between the insulation and the conductor strands and upwardly of the interstitial spaces between the conductor strands thereby mechanically and electrically interconnecting the terminal and conductor, and an annular ring of solder and mating bulge of conductor insulation are formed to mechanically interlock the two workpieces. And most importantly, in each embodiment, the electrical and mechanical interconnections were performed simultaneously.

Referring now to FIGS. 8 and 9, the method of the present invention can be utilized to simultaneously, mechanically and electrically interconnect insulated, strand-

ed, unstripped conductors, such as conductors **370** and **470**.

Generally, as shown in FIG. 11, when the conductor insulation **74** is formed, typically by being extruded around the conductor strands **71**, the insulation surrounds the strands closely, as is desired for good insulation.

It has been found that improved electrical and mechanical interconnections between such conductors can be facilitated if the insulation adjacent the ends of the conductors is crushed to loosen the insulation from the underlying conductor strands, and thereby, provide increased interstitial spacing between the insulation and the underlying conductor strands.

The implements **510** and **520**, shown in FIG. 13, may be utilized to simultaneously cut the conductors and crush the conductor insulation adjacent the conductor ends. When the implements are closed on each other, either manually or by other suitable means, the edges **512** and **522** shear the conductor, or conductors, placed therebetween, and the surfaces **514** and **524** crush the conductor insulation adjacent the end of the conductor, or conductors.

The cut and crushed ends of the conductors, such as conductors **370** and **470** are then placed in a retaining ring such as retaining rings **310** and **410**, FIGS. 8 and 9, respectively; the retaining ring, depending upon conductor orientation, being shaped either as shown in FIG. 8 or FIG. 9.

In the embodiment of FIG. 8, the cut and crushed ends of the conductors **370** and **470** are placed in the retaining ring **310** in spaced end-to-end relationship, and in the embodiment of FIG. 9, the cut and crushed ends of the conductors are placed in the retaining ring **410** in side-by-side relationship.

In each embodiment, mating mold segments (not shown), such as the mold segments **22** and **24** of FIG. 1, form a complementary mold cavity around the retaining ring.

In FIG. 8, the pressure injected molten solder is forced into the ring through an aperture **312** formed substantially in the middle of the ring; and, in FIG. 9, the molten solder is forced into the end of the retaining ring opposite the end into which the cut and crushed conductors are placed.

In each embodiment, the molten solder is forced into the retaining ring and against the ends of the conductors to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the conductors into the interstitial spacing between the insulation and the conductor strands, and into the interstitial spaces between the conductor strands. The injected molten solder is rapidly cooled, to prevent damaging the insulation, by the heat sink provided by the presence of the comparatively massive mold segments.

In each embodiment, the penetrating solder electrically and mechanically interconnects the conductors and does so simultaneously in a single manufacturing operation. Further, it will be noted, such simultaneous interconnection was performed between insulated, stranded and unstripped conductors.

With regard to the embodiments of FIGS. 6, 7, 8 and 9, it will be understood that the conductor, or conductors, in each instance could be solid conductors, with the injected molten solder or other suitable electrically conductive adhesive medium, having both a fluid and solid state in each instance penetrating upwardly of the conductor into the space between the insulation and the solid conductor.

It will be further understood, that in the embodiments of FIGS. 8 and 9, in some applications, the retaining rings **310** and **410** can be dispensed with, and suitably shaped, complementary molds could be utilized to confine the injected molten solder instead. If required, insulating sleeves could be placed over the conductors, and solder joint, to provide electrical insulation.

It will be understood by those skilled in the art that many variations and modifications may be made in the method of the present invention without departing from the spirit and scope of the invention.

What is claimed is:

1. The method of simultaneously, mechanically and electrically connecting an insulated, stranded or solid, unstripped conductor to a terminal, at least a portion of which terminal is hollow, by means of an electrically conductive, adhesive medium having both a fluid and a solid state, which comprises the steps of:

placing the terminal and one end of the conductor in telescoping relationship,

forming a mold cavity about the so placed terminal and conductor, and

forcing the medium in its fluid state into the hollow portion of the terminal to fill such hollow portion and against said one end of the conductor to cause a portion of the medium to penetrate a predetermined distance upwardly of the conductor into the space between the insulation and the conductor, and

solidifying the medium.

2. The method of simultaneously, mechanically and electrically connecting an insulated, stranded, unstripped conductor to a terminal, at least a portion of which terminal is hollow, which comprises the steps of:

placing the terminal and one end of the conductor in telescoping relationship,

forming a mold cavity about the so placed terminal and conductor,

forcing molten solder into the hollow portion of the terminal to fill such hollow portion and against the end of the conductor to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the conductor into the interstitial space between the conductor strands, and

rapidly cooling the molten solder to prevent damaging of the insulation.

3. The method of simultaneously, mechanically and electrically connecting the end of an insulated, stranded or solid, unstripped conductor to a terminal having a cavity portion formed therein, which comprises the steps of:

inserting the end of the conductor partially into the cavity portion of the terminal,

forming a mold cavity around at least a portion of the terminal and a portion of the insulated conductor,

providing an annular recess around the insulated conductor near the end thereof,

forcing molten solder into the cavity portion of the terminal to fill such portion and against the end of the insulated conductor to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the insulated conductor into the space between the conductor and the insulation and to cause the insulation and a portion of the penetrating molten solder to bulge outwardly into the annular recess, and

rapidly cooling the molten solder to prevent damaging of the insulation.

4. The method of simultaneously, mechanically and electrically connecting the end of an insulated, stranded, unstripped conductor to a terminal having a cavity portion formed therein, which comprises the steps of:

inserting the end of the conductor partially into the cavity portion of the terminal,

forming a mold cavity around at least a portion of the terminal and a portion of the insulated conductor,

providing an annular recess around the insulated conductor near the end thereof,

forcing molten solder into the cavity portion of the terminal to fill such portion and against the end of the insulated conductor to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the insulated conductor into the interstitial spaces between conductor strands and between the conductor and the insulation and to cause the in-

sulation and a portion of the penetrating molten solder to bulge outwardly into the annular recess, and rapidly cooling the molten solder to prevent damaging of the insulation.

5. The method of simultaneously, mechanically and electrically connecting an insulated, stranded or solid, unstripped conductor to a hollow terminal having an annular recess formed therein, which comprises the steps of:

inserting the conductor partially into one end of the terminal such that the annular recess surrounds the conductor a predetermined distance from the end thereof,

forming a mold cavity about at least a portion of the terminal,

forcing molten solder into the other end of the terminal to fill a portion of the hollow terminal and to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the conductor between the conductor and the insulation and to cause a portion of the insulation and penetrating solder to bulge outwardly into the annular recess, and

rapidly cooling the molten solder to prevent damaging of the insulation.

6. The method of simultaneously, mechanically and electrically connecting an insulated, stranded, unstripped conductor to a hollow terminal having an annular recess formed therein, which comprises the steps of:

inserting the conductor partially into one end of the terminal such that the annular recess surrounds the conductor a predetermined distance from the end thereof,

forming a mold cavity about at least a portion of the terminal,

forcing molten solder into the other end of the terminal to fill a portion of the hollow terminal and to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the interstitial spaces between conductor strands and to cause a portion of the insulation and penetrating solder to bulge outwardly into the annular recess, and

rapidly cooling the molten solder to prevent damaging of the insulation.

7. The method of simultaneously, mechanically and electrically connecting an insulated, stranded or solid, unstripped conductor to a terminal having a cavity portion and an annular recess formed therein, which comprises the steps of:

forcing a portion of the cavity portion of the terminal a predetermined distance upwardly of the conductor between the conductor insulation and the conductor to place the terminal and the conductor in a telescoping relationship with the annular recess formed in the terminal underlying the insulation a predetermined distance from the end of the conductor;

forming a mold cavity around at least a portion of the terminal and the conductor;

providing an annular mold cavity around the portions of the conductor and terminal in the telescoping relationship;

forcing molten solder into the annular mold cavity to cause a portion of the molten solder to fill the balance of the terminal cavity portion not occupied by the conductor to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the conductor into the space between conductor and the insulation, and to cause a portion of the molten solder in the annular mold cavity to force a portion of the conductor insulation to bulge inwardly into the annular terminal recess; and

rapidly cooling the molten solder to prevent damaging of the insulation.

8. The method of simultaneously, mechanically and electrically connecting an insulated, stranded, unstripped conductor to a terminal having a cavity portion and an annular recess formed therein, which comprises the steps of:

forcing a portion of the cavity portion of the terminal a predetermined distance upwardly of the conductor around the conductor strands to place the terminal and the conductor in a telescoping relationship with the annular recess formed in the terminal underlying the insulation a predetermined distance from the end of the conductor;

forming a mold cavity around at least a portion of the terminal and the conductor;

providing an annular mold cavity around the portions of the conductor and terminal in the telescoping relationship;

forcing molten solder into the annular mold cavity to cause a portion of the molten solder to fill the balance of the terminal cavity portion not occupied by the conductor, to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the interstitial spaces between conductor strands, and to cause a portion of the molten solder in the annular mold cavity to force a portion of the conductor insulation to bulge inwardly into the annular terminal recess; and

rapidly cooling the molten solder to prevent damaging of the insulation.

9. The method of simultaneously, mechanically and electrically interconnecting insulated, stranded or solid, unstripped conductors together, which comprises the steps of:

cutting the ends of the conductors and crushing the insulation adjacent the ends of the conductors to loosen the insulation from the underlying conductor, and to provide interstitial spacing between the insulation and the underlying conductor;

placing the cut and crushed ends of the conductors into an annular retaining ring;

forming a mold cavity around the retaining ring;

forcing molten solder into the retaining ring and against the ends of the conductors to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the conductors into the space between the insulation and the conductor; and

rapidly cooling the molten solder to prevent damaging of the insulation.

10. The method according to claim 9 wherein the cut and crushed insulated conductors are placed into the retaining ring in spaced end-to-end relationship, and the molten solder is forced into the ring through an aperture formed substantially in the middle thereof.

11. The method according to claim 9 wherein the cut and crushed insulated conductors are placed into one end of the retaining ring in a side-by-side relationship, and the molten solder is forced into the other end of the retaining ring.

12. The method of simultaneously, mechanically and electrically interconnecting insulated, stranded, unstripped conductors together, which comprises the steps of:

cutting the ends of the conductors and crushing the insulation adjacent the ends of the conductors to loosen the insulation from the underlying conductor strands and to provide interstitial spacing between the insulation and the underlying conductor strands;

placing the cut and crushed ends of the conductors into an annular retaining ring;

forming a mold cavity around the retaining ring;

forcing molten solder into the retaining ring and against the ends of the conductors to cause a portion of the molten solder to penetrate a predetermined distance upwardly of the conductors into the interstitial spacing between the insulation and the conductor strands, and into the interstitial spaces between the conductor strands; and

rapidly cooling the molten solder to prevent damaging of the insulation.

13. The method according to claim 12 wherein the cut and crushed insulated conductors are placed into the

retaining ring in spaced end-to-end relationship, and the molten solder is forced into the ring through an aperture formed substantially in the middle thereof.

14. The method according to claim **12** wherein the cut and crushed insulated conductors are placed into one end of the retaining ring in a side-by-side relationship, and the molten solder is forced into the other end of the retaining ring.

15. A method of simultaneously, mechanically and electrically connecting an insulated, stranded or solid, unstripped conductor to another workpiece, at least a portion of which is hollow, by means of an electrically conductive, adhesive medium having both a fluid and a solid state, which comprises the steps of:

inserting the conductor partially into the hollow portion of the workpiece,

forming a mold cavity about the so-placed conductor and workpiece,

forcing the medium in its fluid state into the hollow portion of the workpiece to fill the remainder of such hollow portion not occupied by said conductor and

to penetrate between the conductor and its insulation, and

causing the medium to solidify.

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