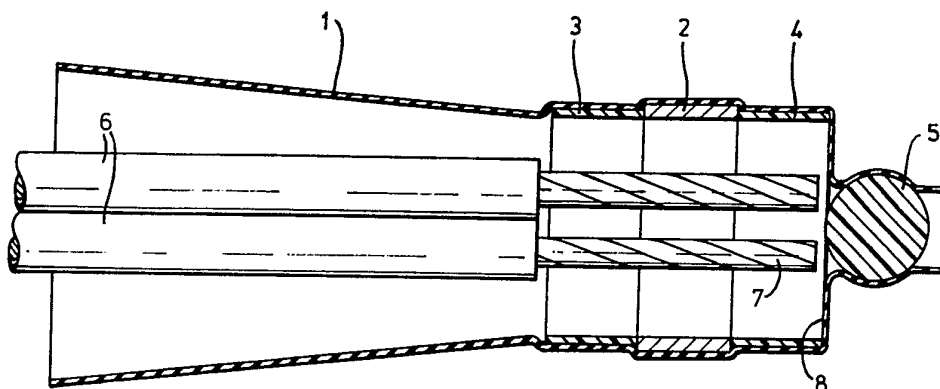




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁵ H01R 4/72, H02G 15/18</p>	<p>A1</p>	<p>(11) International Publication Number: WO 92/00617 (43) International Publication Date: 9 January 1992 (09.01.92)</p>
<p>(21) International Application Number: PCT/GB91/01015 (22) International Filing Date: 24 June 1991 (24.06.91) (30) Priority data: 9014117.7 25 June 1990 (25.06.90) GB (71) Applicant (for MG only): RAYCHEM LIMITED [GB/GB]; Rolls House, 7 Rolls Buildings, Fetter Lane, London EC4A 1NH (GB). (71) Applicant (for all designated States except MG US): RAY- CHEM S.A. [FR/FR]; 2, boulevard du Moulin-à-Vent, F-95800 Cergy-Saint-Christophe (FR). (72) Inventors; and (75) Inventors/Applicants (for US only): DELALLE, Jacques [FR/FR]; 36, rue du Général-Galliène, F-78510 Triel- sur-Seine (FR). LAMONE, Alain [FR/FR]; 11, rue d'Epluches, F-95480 Pierrelaye (FR).</p>		<p>(74) Agents: DLUGOSZ, A., C. et al.; Raychem Limited, Fara- day Road, Dorcan, Swindon, Wiltshire SN3 5HH (GB). (81) Designated States: AT (European patent), BE (European patent), CA, CH (European patent), DE (European pa- tent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (Euro- pean patent), IT (European patent), JP, KR, LU (Euro- pean patent), MG, NL (European patent), SE (Euro- pean patent), US. Published <i>With international search report.</i></p>

(54) Title: ELECTRICAL CONNECTOR



(57) Abstract

A device for forming a solder joint between two or more elongate electrical conductors comprises a dimensionally heat-recoverable sleeve (1) which contains a quantity of solder (2), and at least one dimensionally recoverable hollow insert (3, 4) that is located in the region of the solder, the dimensionally recoverable insert having a lower recovery temperature than that of the sleeve so that, when the device is heated, the insert will begin to recover before the sleeve begins to recover. The recoverable insert will force back any bent strands of an inserted conductor in order to prevent them piercing the heat-shrinkable sleeve during recovery.

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Electrical Connector

This invention relates to dimensionally recoverable articles, and especially to such articles that are used for forming electrical connections.

Dimensionally recoverable articles, especially heat-shrinkable articles, are now widely used in many areas where insulation, sealing and encapsulation are required. Usually these articles recover, on heating, towards an original shape from which they have previously been deformed, but the term "heat-recoverable", as used herein, also includes an article which, on heating, adopts a new configuration, even if it has not been previously deformed.

In their most common form, such articles comprise a heat-shrinkable sleeve made from a polymeric material exhibiting the property of elastic or plastic memory as described, for example, in US Patents 2,027,962; 3,086,242 and 3,957,372. As is made clear in, for example US Patent 2,027,962, the original dimensionally heat-stable form may be a transient form in a continuous process in which, for example, an extruded tube is expanded, whilst hot, to a dimensionally heat-unstable form but, in other applications, a performed

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dimensionally heat stable article is deformed to a dimensionally heat unstable form in a separate stage.

In other articles, as described, for example, in British Patent 1,440,524, and elastomeric member such as an outer tubular member is held in a stretched state by a second member, such as an inner tubular member, which, upon heating, weakens and thus allows the elastomeric member to recover.

Dimensionally heat-recoverable sleeves that contain a quantity of solder have been employed for a number of years for forming permanent, insulated solder joints between electrical conductors. Such devices may, for example be employed to form a splice between a pair of insulated wires by stripping the ends of the wires, positioning them in a heat-recoverable solder connector and heating the connector to cause the solder to flow and to cause recovery of sleeve about the wires. However, in certain circumstances, for example where the devices are employed to form an electrical connection between stranded conductors, it is possible for one or more strands of a conductor to pierce the wall of the recoverable sleeve as it recovers, thereby affecting the insulation and the moisture sealing properties of the joint.

According to one aspect the invention provides a device for forming a solder joint between two or more elongate electrical conductors, which comprises a dimensionally heat-recoverable sleeve which contains a quantity of solder, and at least one dimensionally recoverable hollow insert that is located in the region of the solder, the dimensionally recoverable insert having a lower recovery temperature than that of the sleeve so that, when the device is heated, the insert will begin to recover before the sleeve begins to recover.

The invention has the advantage that the insert is able to force back any bent strands of an inserted conductor in order to prevent them piercing the heat-shrinkable sleeve during recovery thereof. The insert

preferably has a wall thickness that is greater than the wall thickness of the heat-recoverable sleeve, for example from 2 to 4 times that of the heat-recoverable sleeve, in order to prevent itself being pierced by any of the strands of the conductor. Thus, when the sleeve is recovered about the electrical conductors, the insert can be observed to recover and maintain the conductors in place, including forcing into their correct position any bent strands of the conductor, before and during the recovery of the sleeve.

Preferably the or each recoverable insert is located adjacent to the solder. It is possible for a single insert to be employed, in which case it may be located entirely on one side of the solder or it may be located about the solder insert so that it extends on both sides of the solder. Preferably, however, the or each insert is located entirely on one side of the solder so that the insert or inserts can recover before the solder has melted. In the preferred case, a recoverable insert is located on each side of the solder.

The insert preferably has a recovery temperature that is at least 10°C and more preferably at least 20°C below the recovery temperature of the sleeve, but usually not more than 60°C and preferably not more than 40°C below that of the sleeve.

Any material to which the property of dimensional recoverability may be imparted can, at least in the broadest aspect of the invention, be used to form the heat-recoverable sleeve. For example, the sleeve may be formed from a polyolefin, eg. a low, medium or high density polyethylene, an ethylene copolymer, eg. ethylene vinyl acetate, a polyamide, eg. nylon 6 or nylon 11 or 12, or a halogen-containing polymer, especially a Fluoropolymer, eg. polyvinylidene fluoride, ethylene-tetrafluoroethylene copolymer or polytetrafluoroethylene. For most applications the preferred polymer for forming the recoverable sleeve will be polyvinylidene fluoride.

Many of these materials may be used for the recoverable insert in the device. The particular choice of material for forming the insert will depend on the material employed for the heat-recoverable sleeve. Thus, for example where the recoverable sleeve is formed from high density polyethylene, the insert may be formed from low density polyethylene. Polyamides are preferred for the recoverable insert, especially where the recoverable sleeve is formed from polyvinylidene fluoride. Thus, according to another aspect, the invention provides a device for forming a solder joint between two or more elongate electrical conductors, which comprises a dimensionally heat-recoverable sleeve that contains a quantity of solder, and at least one dimensionally recoverable hollow insert that is located in the region of the solder, the dimensionally recoverable insert being formed from a polyamide. In this case the insert preferably also has a recovery temperature that is below that of the sleeve as is the case with the other aspect of the invention although it could be possible in certain instances for the recovery temperature of the insert to be the same as, or even higher than, that of the sleeve.

A solder connection between a plurality of electrical wires may be formed in a simple manner according to the invention by

- (i) stripping a length of insulation from each of the wires to expose a length of the conductor;
- (ii) positioning a device according to the invention on the wires; and
- (iii) heating the device to recover the sleeve and to melt the solder.

Preferably the wires are stripped to have a length of conductor that is substantially the same as the combined axial extent of the insert(s) and solder so that the insert or the inserts together, and solder are substantially co-extensive with the bare conductors. In addition, it is

preferred for the recoverable insert as well as the recoverable sleeve to include no fillers that would render them opaque. If the recoverable insert and the sleeve are transparent it is possible to inspect the wires both before and after formation of the solder joint, and to inspect the quality of the joint.

If desired the recoverable sleeve may be coated with a fusible sealant over part or the whole of its length, or one or more sealant inserts, eg. rings may be provided in the sleeve in order to seal the sleeve against water ingress. The fusible sealant may, for example be formed from polyolefins, eg. low or medium density polyethylene, or from ethylene copolymers such as ethylene vinyl acetate copolymer.

As mentioned above, the device includes a quantity of solder, ie. a quantity of soft solder as distinct from brazing material, for forming a permanent solder connection. The solder may, for example, simply be in the form of an Sn₆₃Pb₃₇ eutectic composition which will melt as the device is heated and the sleeve recovers, or more than one solder composition having differing melting points may be employed, as described in International Application No. WO88/09068. In this form of device, melting of the higher melting point component, eg. Sn_{96.5}Ag_{3.5} eutectic will provide a visual indication that the device has been heated sufficiently to melt the lower melting point composition and to form a satisfactory solder joint. If desired the lower melting point solder may be a non-eutectic composition and, for example as described in International Application No. PCT/GB90/00234, the higher and lower melting point solder compositions may together form a eutectic composition. For example, a non-eutectic Sn₆₀Pb₄₀ lower melting point component may be employed with a higher melting point component formed from pure tin in relative amounts that an Sn₆₃Pb₃₇ eutectic is formed. The disclosures of these two patent applications are incorporated herein by reference. An advantage of employing a two component solder, and especially a tin, Sn₆₀Pb₄₀ combination is that it reduces the possibility of "wicking" that is to say, travel of the solder

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along the conductors and away from the joint area due to capillary action by the stranded conductors, which can be caused by prolonged heating of the device.

One device in accordance with the present invention will now be described with reference to the accompanying drawing which is a sectional elevation along the axis of the device.

Referring to the accompanying drawing, a device for forming a solder connection between a pair of insulated stranded electrical wires 6, comprises a dimensionally heat-recoverable sleeve 1 that has been formed from radiation crosslinked polyvinylidene fluoride and may be provided with a thin hot-melt adhesive coating (not shown) for sealing the device against moisture ingress. The sleeve 1 contains a ring 2 formed from a fluxed $\text{Sn}_{63}\text{Pb}_{37}$ eutectic solder composition and two rings 3 and 4 adjacent to the solder ring which are formed from transparent nylon 12 which has been crosslinked and expanded to render it recoverable.

The device is closed by means of a spherical plug 5 of sealing material, eg. irradiated or non-irradiated polyethylene, for example as described in British Patent Application No. 9002093.4.

In order to form a stub splice, the insulation is stripped from the ends of the wires 6 in order to expose a length of stranded copper conductor 7, and the wires are inserted in the sleeve until they abut the spherical insert 5 or an internal shoulder 8 in the sleeve. The sleeve is then heated, for example by means of a hot-air gun or infrared lamp, whereupon the nylon 12 inserts begin to recover when they reach their recovery temperature, this recovery maintaining the conductors in place and pushing back any strands of the conductors 7 that may have been bent. Then the sleeve 1 recovers about the wires and the solder ring 2 melts to form an encapsulated solder connection between the wires.

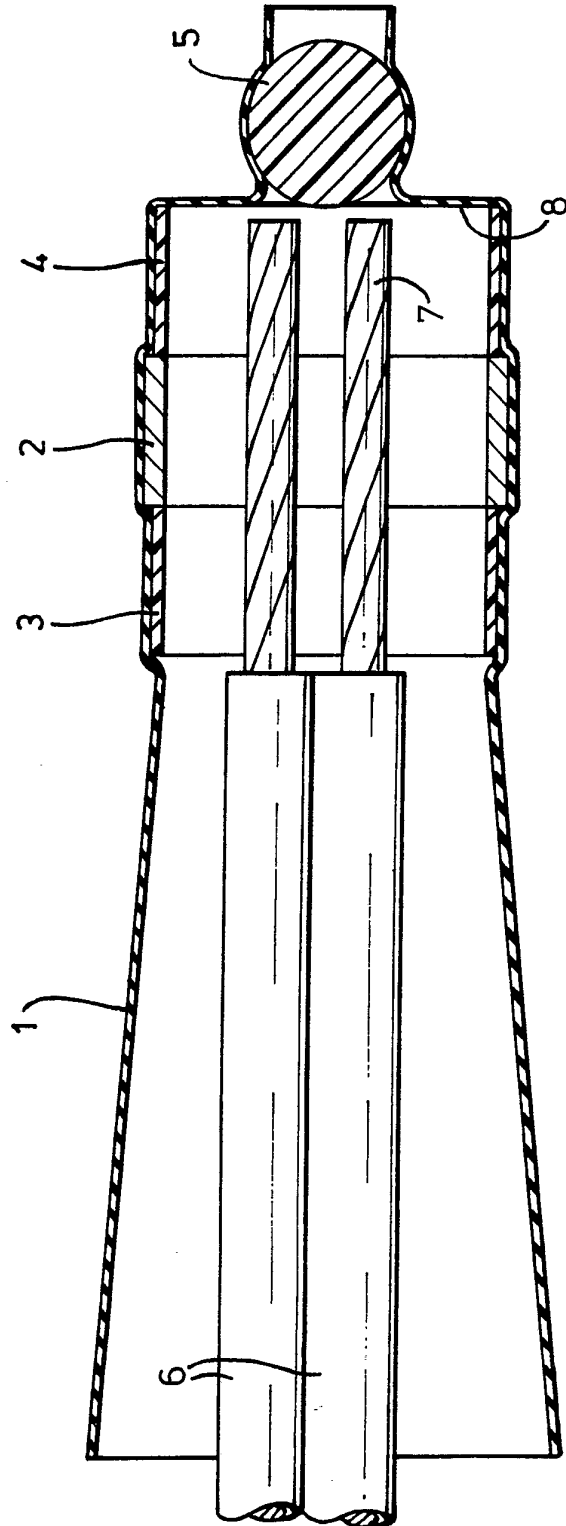
Claims:

1. A device for forming a solder joint between two or more elongate electrical conductors, which comprises a dimensionally heat-recoverable sleeve which contains a quantity of solder, and at least one dimensionally recoverable hollow insert that is located in the region of the solder, the dimensionally recoverable insert having a lower recovery temperature than that of the sleeve so that, when the device is heated, the insert will begin to recover before the sleeve begins to recover.
2. A device as claimed in claim 1, wherein the or each recoverable insert is located adjacent to the solder.
3. A device as claimed in claim 1 or claim 2, wherein the recoverable insert extends on both sides of the solder, a recoverable insert is located on each side of the solder.
4. A device as claimed in any one of claims 1 to 3, wherein the recoverable insert has a recovery temperature that is in the range of 10 to 60°C below the recovery temperature of the heat-recoverable sleeve.
5. A device as claimed in any one of claims 1 to 4, wherein the recoverable insert comprises a polyamide.
6. A method of forming a solder connection between a plurality of insulated electrical wires, which comprises:
 - (i) stripping a length of insulation from each of the wires to expose a length of the conductor;
 - (ii) positioning a device as claimed in any one of claims 1 to 5 on the wires; and

(iii) heating the device to recover the sleeve and to melt the solder.

7. A method as claimed in claim 6, wherein the recoverable insert(s) extend(s) along the sleeve for a length that is substantially equal to the length of the exposed conductors.

8. A device for forming a solder joint between two or more elongate electrical conductors, which comprises a dimensionally heat-recoverable sleeve that contains a quantity of solder, and at least one dimensionally recoverable hollow insert that is located in the region of the solder, the dimensionally recoverable insert being formed from a polyamide.



INTERNATIONAL SEARCH REPORT

PCT/GB 91/01015

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 H01R4/72 ; H02G15/18		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.Cl. 5	H01R ; H02G	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	EP,A,0159945 (RAYCHEM PONTOISE S.A.) 30 October 1985 see abstract; figure 1 ---	1, 2, 6, 8
A	EP,A,0270283 (RAYCHEM) 08 June 1988 see column 6, lines 27 - 42 see column 4, lines 19 - 28; figure 1 ---	1-3, 5-7, 8
A	EP,A,0203811 (RAYCHEM) 03 December 1986 see page 6, line 29 - page 8, line 16; figure 2 ---	1-3, 6, 8
<p>¹⁰ Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
17 SEPTEMBER 1991	25 SEPTEMBER 1991	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	KOHLER J.W. Janet W. Kohler	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

GB 9101015
SA 48815

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
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