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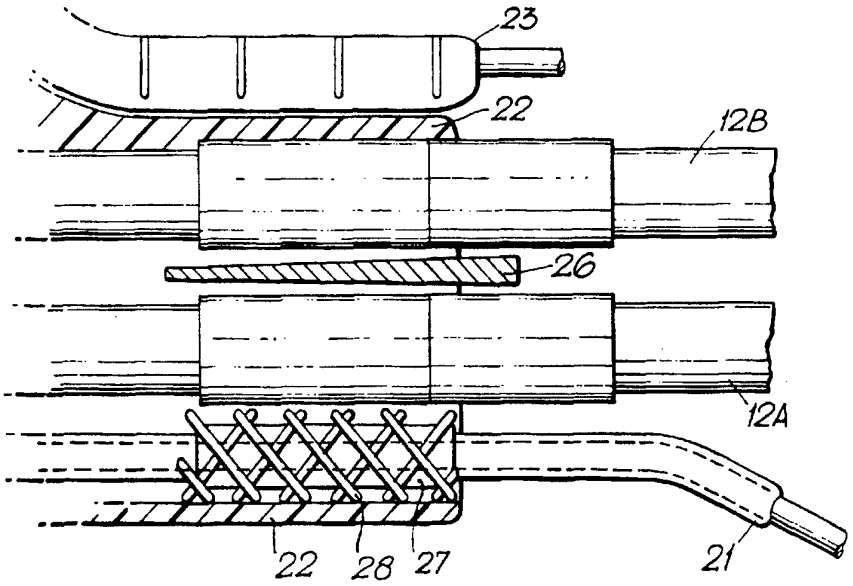

(57) Abstract

A method of forming a seal between a heat shrinkable sleeve and an elongate substrate wherein at least a portion of the elongate substrate is provided with a sealing material and a discontinuous spacer adjacent thereto, and heat is applied to the sleeve to cause shrinkage of the sleeve and flow of the sealing material into interstitial spaces in the discontinuous spacer and to form the desired seal.

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SEALING GROUND WIRES USING HEAT SHRINKABLE SLEEVES

This invention relates to a method of making a seal with a heat-recoverable sleeve, particularly around an elongate article such as a cable, wire or pipe. The invention can overcome a problem of insufficient adhesive flow during installation of the sleeve, and thereby around the formation of leak paths.

Heat-recoverable articles, especially-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 U.S. Patents 2,027,962: 3,086,242 and 3,597,372. As is made clear in, for example, U.S. 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 preformed dimensionally heat stable article is deformed to a dimensionally heat unstable form in a separate stage.

Heat-shrinkable sleeves find many applications, especially in the connection and the termination of wires, cables and pipes. However, there are other applications where it is desirable to provide a connecting, insulating or protective heat-recoverable member for elongate objects such as cables and pipes where the ends are not accessible or, if they are accessible, where it is undesirable to disconnect or otherwise displace them. For such applications so-called "wrap-around" sleeves have been developed. Basically these are heat-recoverable sheets which can be wrapped round the

substrate to form a generally tubular shape and which, in general are provided with fastening means for holding them in the wrapped up configuration during recovery.

Heat-recoverable sleeves have been successfully employed in many fields of application. However, problems may arise when two or more substrates such as supply lines, for example cables or pipes, have to be sealed at one position. This problem, which is known as "branch-off", may occur, for example, at the outlet of a heat-recoverable part. Amongst areas in which this problem is typically encountered there may especially be mentioned the outlets of the splice cases described and claimed in British Patent 1,431,167.

One solution which has frequently been employed is to use mastic tape to seal the gap between the supply lines so that, on recovery, a proper encapsulation is formed at the end of the heat-recoverable part. However, the use of such tape requires skill on the part of the installer and the method is not applicable to large parts. In addition, the mastic may degrade the overall performance of products which are provided with an inner lining or coating of a hot-melt adhesive.

The present standard solution is described in GB 1604981. There a method of forming a branch-off seal between a heat-shrinkable sleeve (preferably one internally coated with a hot-melt adhesive) and at least two cables or other substrates is described, which comprises the steps of

(a) positioning the substrates within the heat-shrinkable sleeve;
(b) forming at least two heat-shrinkable terminal conduits by positioning a clip having at least two elongate legs over the outer surface of the heat-shrinkable sleeve at an open end thereof, wherein at least two of said legs are

positioned externally of the sleeve, and the substrates are within the terminal conduits and

(c) while the clip remains on the outer surface of the heat-shrinkable sleeve applying heat so as to effect shrinkable of the sleeve (and preferably melt flow of the adhesive and to form the desired seal.

However, under unfavourable conditions problems can arise when such a method is used with a small diameter wire eg a ground wire, adjacent a larger diameter cable. This is because of possible excessive or insufficient adhesive flow.

Accordingly there is provided a method of forming a seal between a heat-shrinkable sleeve and an elongate substrate wherein at least a portion of the elongate substrate is surrounded by or otherwise provided with a sealing material, preferably a layer of hot-melt or other adhesive adjacent, and preferably enclosed within, a discontinuous spacer, and heat is applied to the sleeve to cause shrinking of the sleeve and flow of the sealing material into interstitial spaces in the discontinuous spacer and to form the desired seal.

The discontinuous spacer provides room for sufficient but not excessive sealing material flow. Surprisingly, the provision of voids around the substrate results in a reduction in the likelihood of leak paths after installation. The spacer may also act to reinforce the sealing material and/or other components of the overall structure.

Preferably the discontinuous spacer comprises a polymer material fabric or net, preferably a polyolefin such as polyethylene. It may however comprise a plurality of rings or other structures spaced along the sealing material and/or elongate substrate. It may be heat-shrinkable, preferably shrinking during installation of the sleeve and flow of the sealing material. The material is preferably

cross-linked such that it can soften and adapt its shape as necessary during installation without melting.

Also according to the invention there is provided an elongate substrate having an electrically insulating outer sheath at least a portion of which is surrounded by a sealing material adjacent, and preferably enclosed within, a discontinuous support.

Further provided is a kit for making a seal between an elongate substrate and a heat-shrinkable sleeve and which comprises a sleeve of sealing material for sliding onto the substrate, and a discontinuous support member for placing around the sealing material sleeve.

The invention will be described by way of example and with reference to the accompanying drawings in which:

Figure 1 is an isometric projection of a cable splice closure sealed by a method according to the present invention.

Figure 2 is a cross-section through a branch-off seal taken on the line II-II of Figure 1; and

Figure 3 is a longitudinal section illustrating the end portion of a cable and sleeve assembly taken on the line III-III of figure 2.

With reference to figures 1-3 there is illustrated a cable 12 which may be a telecommunications cable, such as a multicore copper cable, a coaxial cable or a fibre optics cable, the individual conductors of which are joined to individual conductors of another cable in a splice closure 13. Alternatively, a single cable may be looped with the head of the loop held in the closure 13 and two cable portions 12A and 12B passing in and out of the closure. The closure 13 is shown as a butt splice closure known as a FOSC 100B (TM) closure sold by Raychem Limited but other types of closure could be used such as in-line closures and branch closures.

The closure 13 comprises a butt end plate 14 and a dome-shaped housing 15 secured to the end plate 14 by any suitable means such as a circular clamp, or as illustrated a heat-shrinkable sleeve 16. The heat shrinkable sleeve 16 may be electrically heated via power input 17, or it may be heated with a torch etc.

The cable 12 passes into and out of the housing through an oval port 18 in the butt end plate 14, and the take off conductors to subscribers (not shown for simplicity) leave the housing 15 through hollow spigots 19 in the butt end plate 14.

In some applications it is a requirement that the splice be electrically earthed through at least one ground wire 21 which may also be colour coded to identify various cables in the splice.

The two cable portions 12A, 12B and ground wire 21 are sealed to the oval port 18 by a heat shrinkable sleeve 22 having a power input 23 for heating the sleeve 22.

The two cable portions 12A and 12B are sealed within the heat shrinkable sleeve 22 by a clip 24 having two legs 25 external of the sleeve, and third central leg 26 having hot-melt adhesive thereon within the sleeve. As heat is generated within the heat-shrinkable sleeve 22 the adhesive on the clip and any adhesive coating on the sleeve melt and flow to fill any gaps left by shrinking the sleeve. All this is disclosed in detail in GB 1604981.

A potential problem associated with sealing cables 12A, 12B and ground wire(s) 21 within one sleeve 22 can be that low adhesive melt temperatures are required. This can result in excessive adhesive flow as it is squeezed out of the shrinking sleeve, thereby causing leaks. Further the disparity in sizes between the ground wire and the cable 12 can cause gaps, since close conformance of the

sleeve with a wire or cable of very small radius can be difficult to achieve.

This problem is solved by a portion of ground wire 21 within the sleeve 22 having a tubular sleeve of sealing material 25 thereon surrounded by a discontinuous spacer 26 which can act during heat-installation as a restrainer or support for the flowing sealing material. The sealant is preferably a hot-melt adhesive based on polyamide or EVA materials, and the spacer 26 is preferably a polymeric material net, preferably a cross-linked polyethylene net 26. The adhesive material tubing and polyethylene net are placed over the insulating sleeve of the ground wire 21. When the sleeve 22 is heat shrunk around the ground wire 21 the net 26 both allows the adhesive to flow whilst always ensuring that some adhesive is retained around the ground wire.

This makes it feasible to use low melt temperature adhesives.

Tests have been carried out to compare the integrity of splice closure in which the ground wire is sealed to the sleeve according to the present invention, with splice closures in which the ground wire is merely covered in an adhesive layer prior to heat shrinking of the sleeve.

1. All test samples installed at 0°C using 1 power cycle and blanket during installation. FOSC 100B domes and bases were used for installations. All samples soaked at 0°C for 3 hours prior to installation.

2. Samples were subject to internal pressure surges at 40 KPa and environmentally cycled from -40°C to 60°C/3 times a day, with an internal pressure of 20 KPa.

3. All installations were done in the oval ports of FOSC 100B closures using 2 x 0.5: (12.5mm) cables (capped) and with a

single ground wire installed as per the installation instructions.

4. The escape of air bubbles on immersion in water was taken as an indicate of failure.

RESULTS

DESCRIPTION	NUMBER OF SAMPLES INSTALLED	NUMBER OF SAMPLES FAILED IN CYCLING
INSTALLATIONS WITHOUT THE ADHESIVE SUPPORT	18	10
INSTALLATIONS WITH THE CROSS LINKED PE NET TUBE	6	NONE

CLAIMS

1. A method of forming a seal between a heat shrinkable sleeve and an elongate substrate wherein at least a portion of the elongate substrate is provided with a sealing material and a discontinuous spacer adjacent thereto, and heat is applied to the sleeve to cause shrinkage of the sleeve and flow of the sealing material into interstitial spaces in the discontinuous spacer and to form the desired seal.

2. A method as claimed in claim 1 wherein the sealing material is provided in the form of a sleeve of adhesive which is placed over the elongate substrate.

3. A method as claimed in claim 1 or claim 2 wherein the discontinuous spacer is provided in the form of a polymeric fabric or net which is placed over the sealing material.

4. A method as claimed in claim 3 where the polymeric fabric or net comprises a net of cross-linked polyethylene.

5. A method of forming a branch-off seal between a heat-shrinkable sleeve and at least two elongate substrates wherein at least one of the substrates is sealed within the heat-shrinkable sleeve by a method as claimed in any one of claims 1 to 4.

6. A method of forming a branch-off seal as claimed in claim 5 wherein the two substrates have substantially different cross-sectional areas, and said one substrate has the smaller cross-sectional area of the two substrates.

7. A method of forming a branch-off seal as claimed in claim 6 wherein said one substrate is a ground wire and the other substrate is a cable.

8. An elongate substrate having an electrically insulating outer sheath at least a portion of which is surrounded in a layer of hot-melt adhesive enclosed within a discontinuous spacer.

9. A substrate as claimed in claim 8 wherein the discontinuous support comprises a fabric or net formed of polymeric material.

10. A substrate as claimed in claim 9, wherein the spacer is made from cross-linked polyethylene.

11. A kit for making a seal between an elongate substrate and a heat-shrinkable sleeve and which comprises a sleeve of hot-melt adhesive for sliding onto the substrate, and a discontinuous spacer for placing around the adhesive material sleeve.

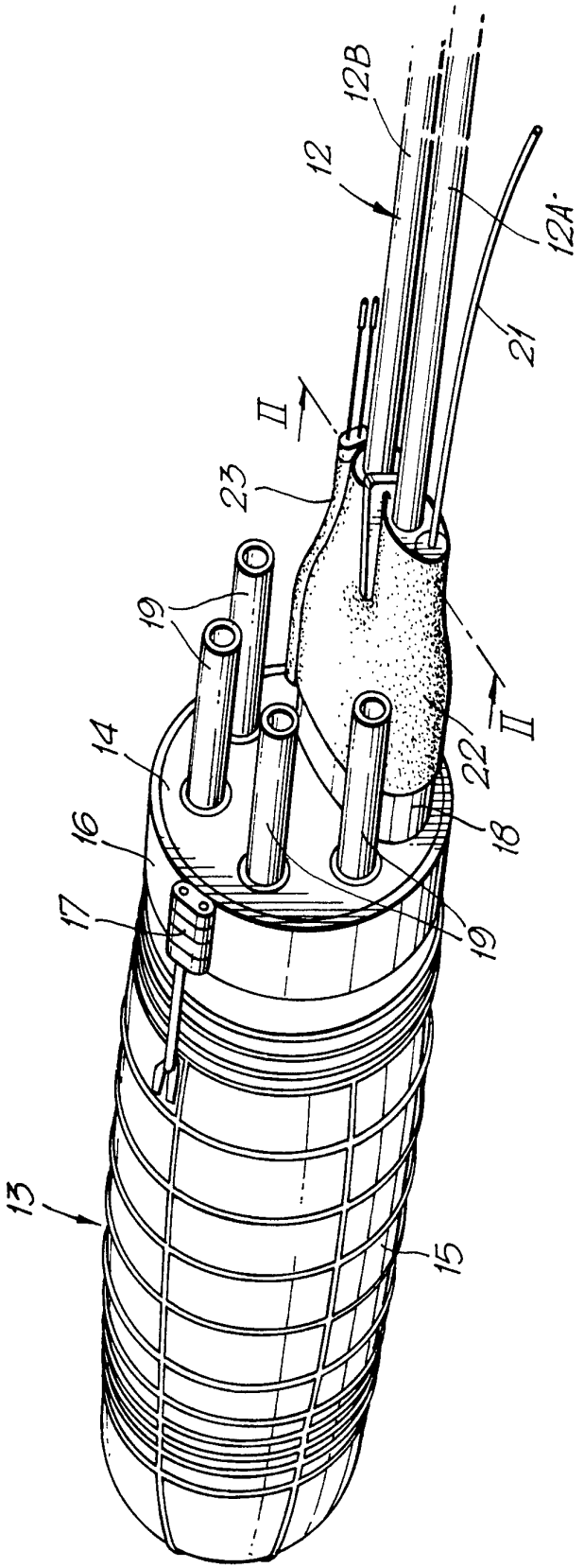


Fig.1.

Fig.2.

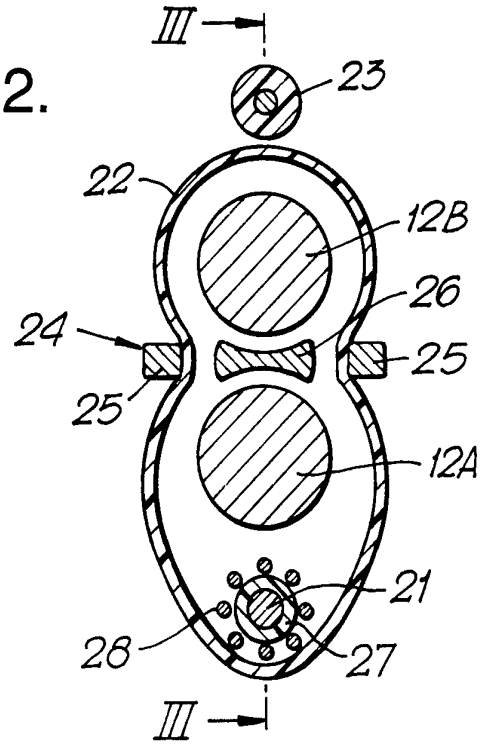
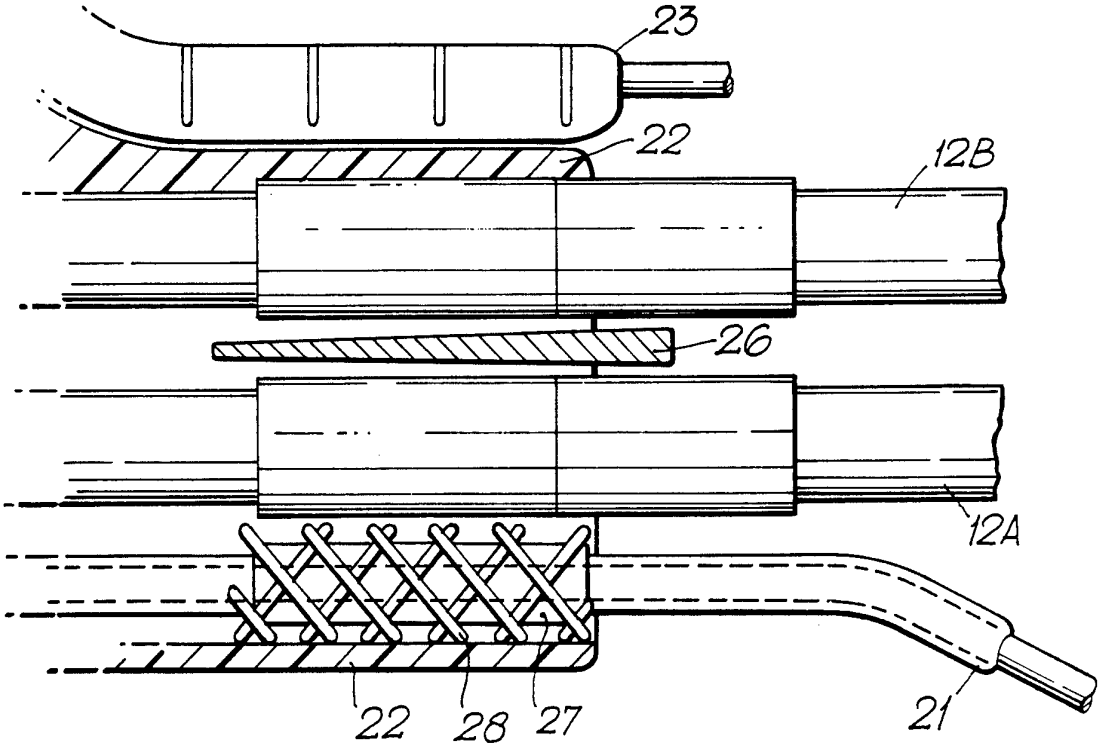

III
23
22
12B
26
24
25
25
12A
21
28
27
III

Fig.3.


23
22
12B
26
12A
22
28
27
21

INTERNATIONAL SEARCH REPORT

Inter ›nal Application No
PCT/GB 94/00593

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 H01R4/72 H02G15/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 H01R H02G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB,A,2 173 052 (COAL INDUSTRY LIMITED) 1 October 1986	1,2,8,11
A	see page 1, line 123 - line 130 see page 3, line 6 - line 18; figures	3
A	GB,A,1 604 981 (N.V. RAYCHEM S.A.) 16 December 1981 cited in the application see page 2, line 28 - line 53; figure 15A	1,8,11

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

information on patent family members

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