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(54) Plug for retaining and sealing cables

(57) A plug (18) (Fig. 6) is made of hot melt adhesive material and has passages through it to accommodate cables 15 and 16. A heat sink is provided in the form of a plate or wire of copper or other conductive metal. The assembly of cables put in the plug, as shown in Fig. 6, a heat-shrink sleeve is then applied over the outside, heat is applied both to the heat-shrink sleeve and to the plate 19 thus heat sealing and retaining the cables 15 and 16 within the plug and within the heat-shrink sleeve. By using hot melt adhesive for the plug the cables and the heat-shrink sleeve are fully adhered together without any cavities or holes forming. The heat sink 19 enables the heat applied, by flame, to the outside to be transferred into the interior of the adhesive plug thus melting the interior and ensuring that a good adhesion takes place with the cables.

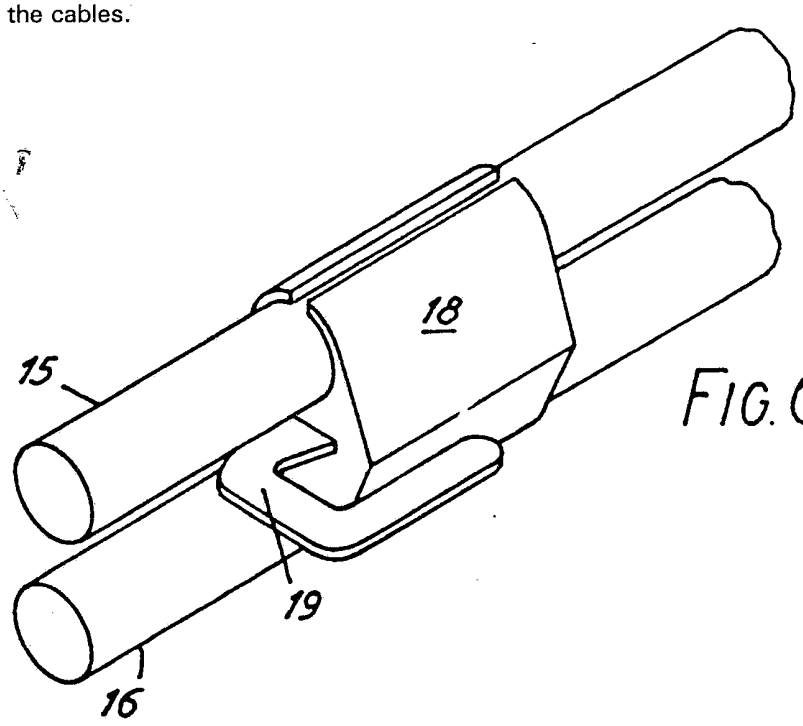

FIG. 6

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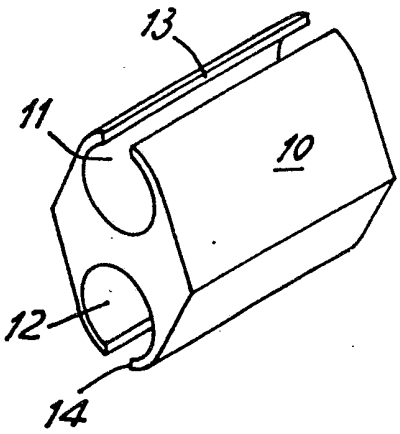

FIG. 1

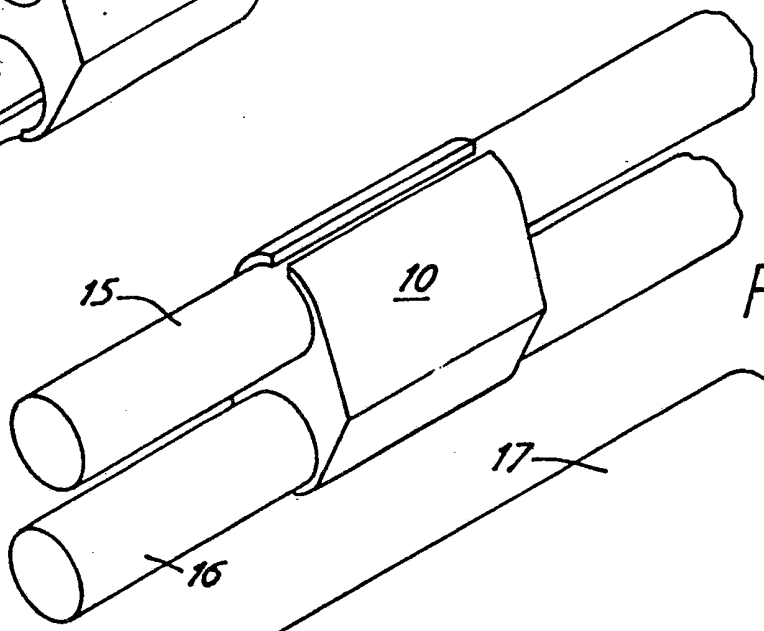

FIG. 2

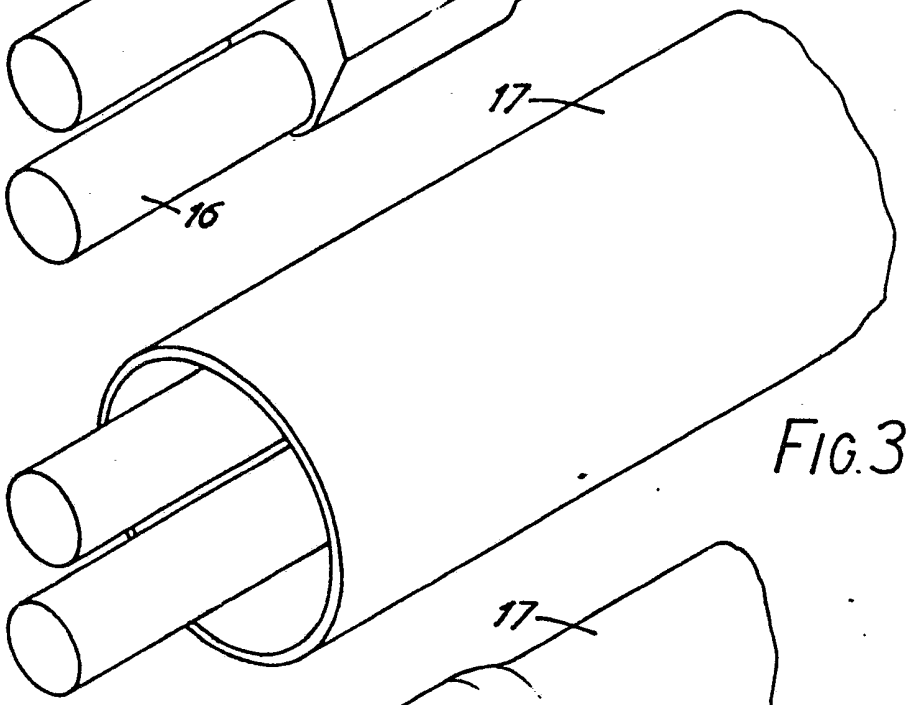

FIG. 3

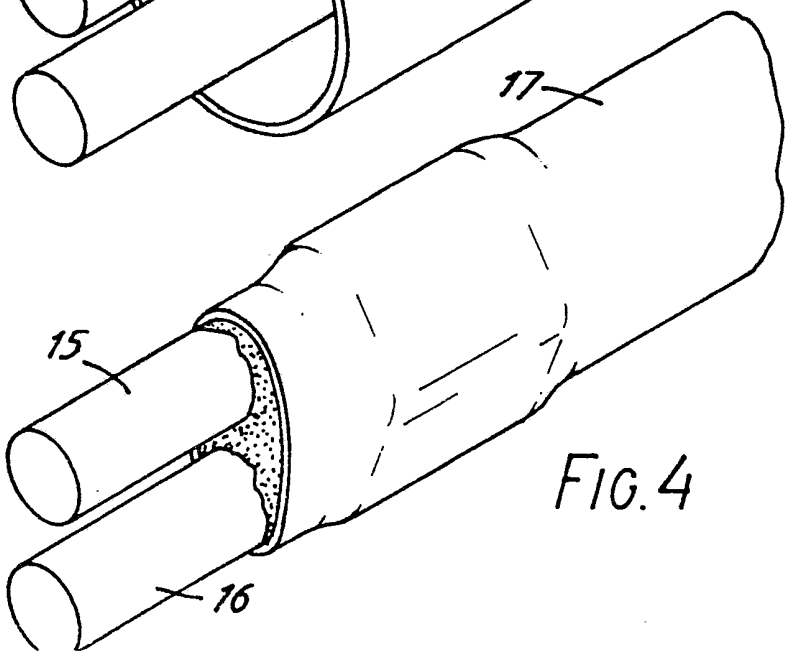

FIG. 4

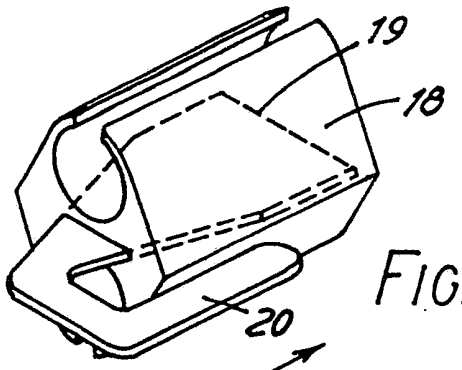

FIG.5

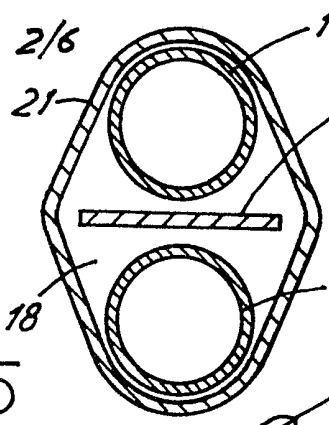

FIG.5A

FIG.5

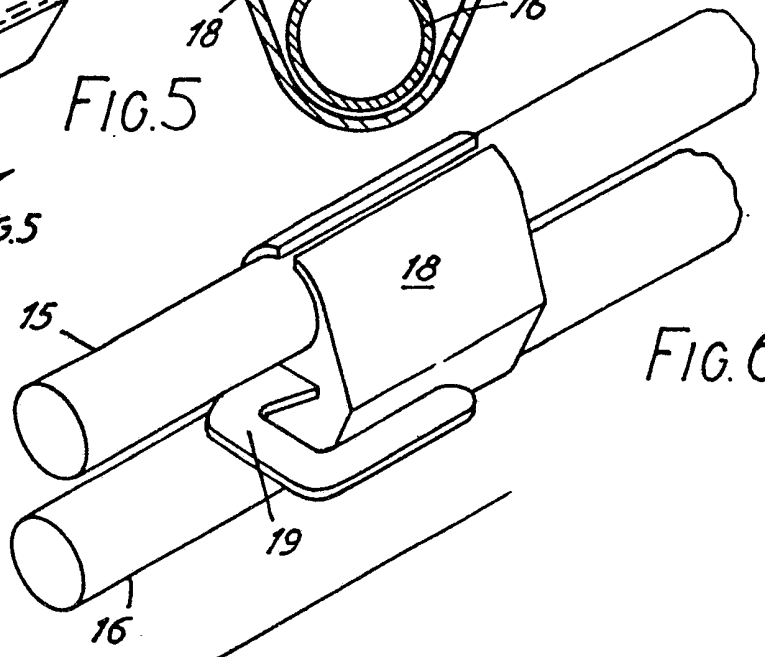

FIG.6

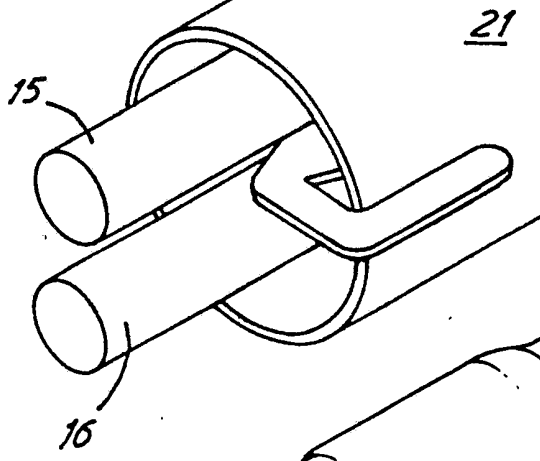

FIG.7

FIG.8

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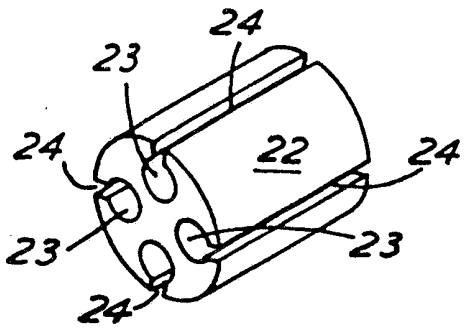

FIG. 9

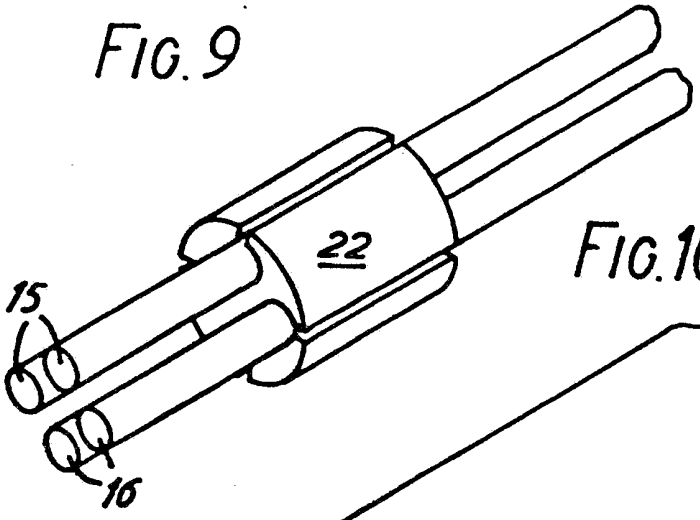

FIG. 10

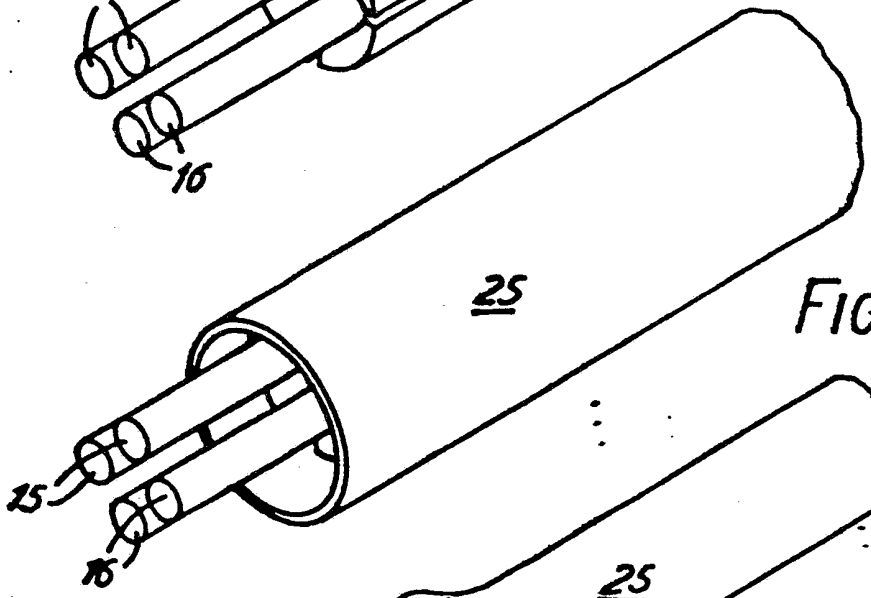

FIG. 11

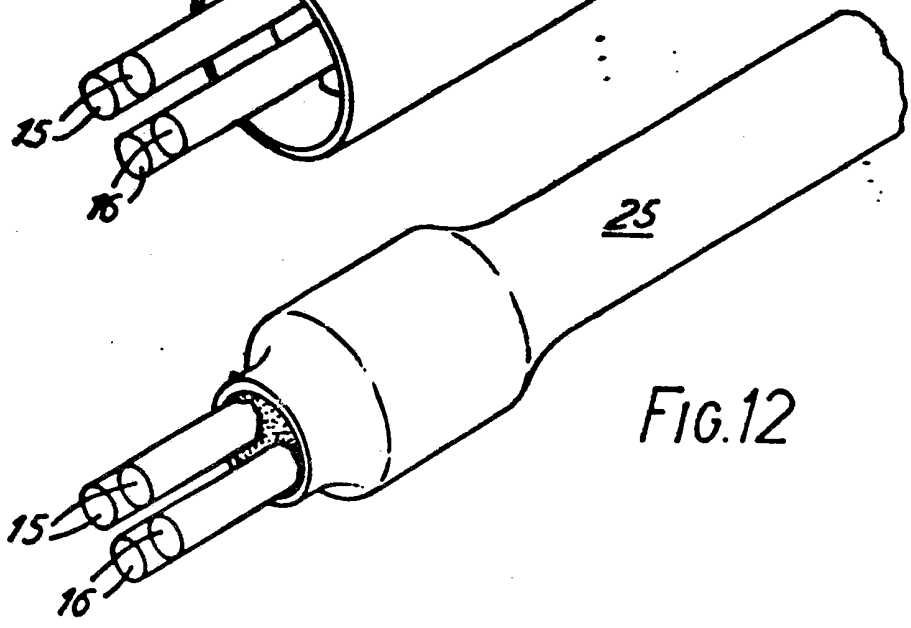

FIG. 12

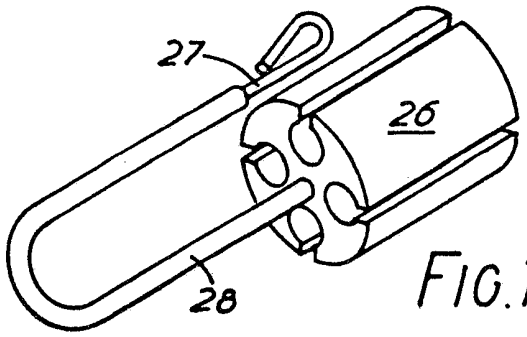

FIG.13

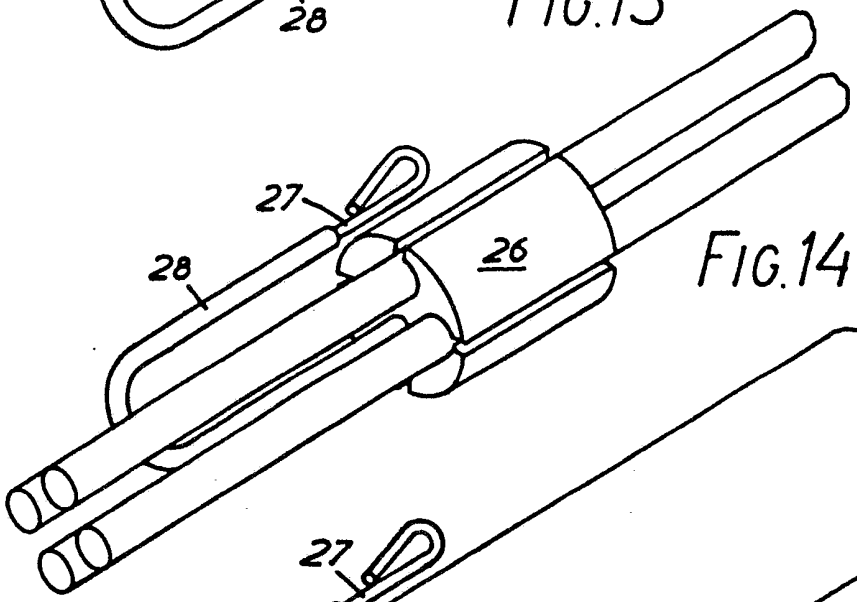

FIG.14

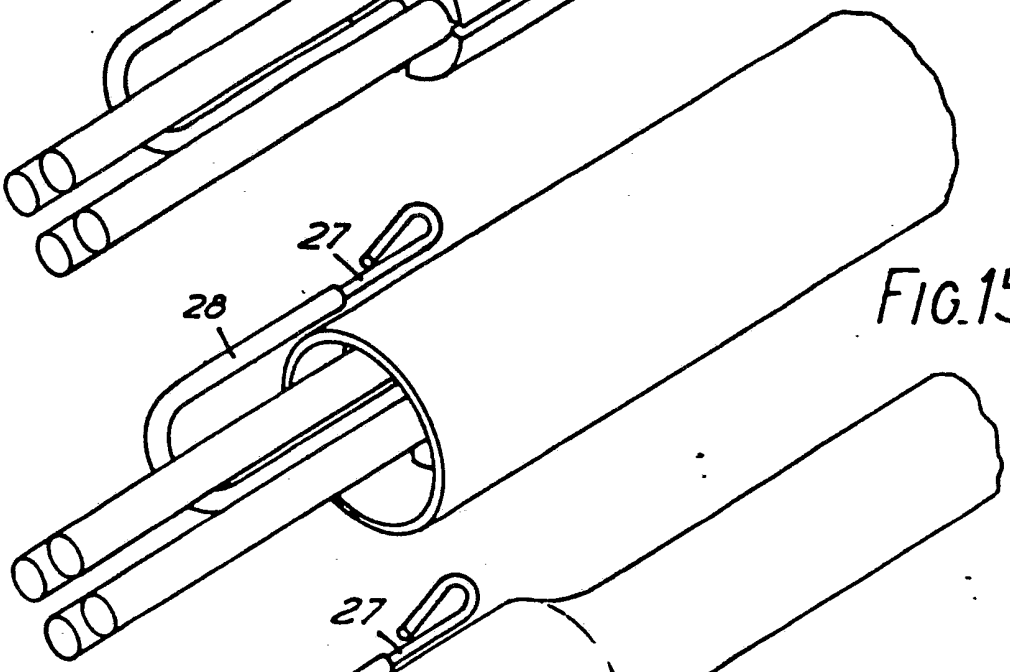

FIG.15

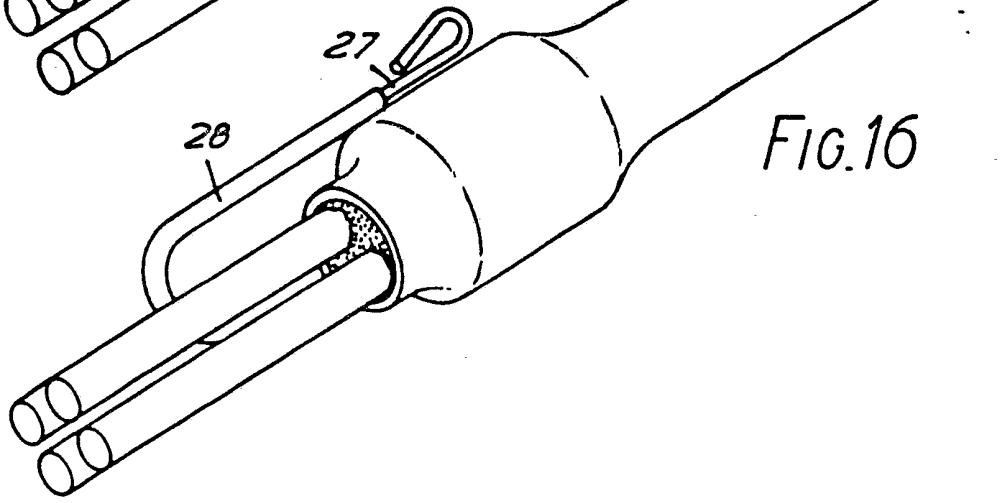

FIG.16

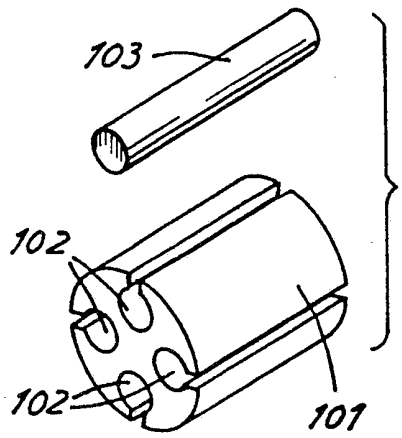

FIG. 17

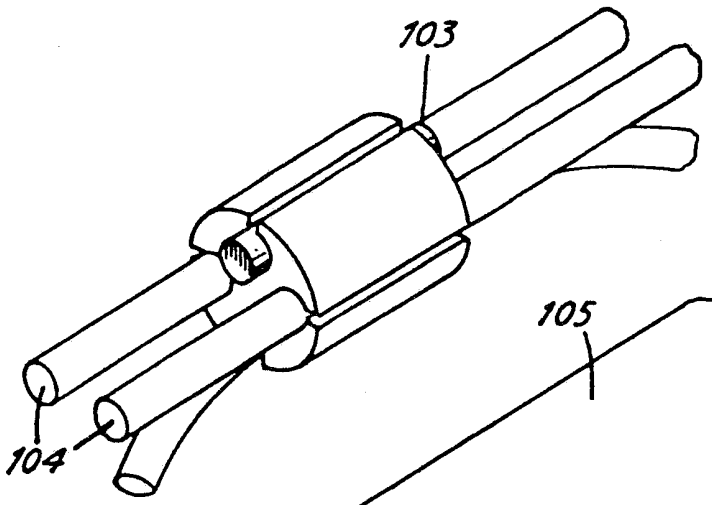

FIG. 18

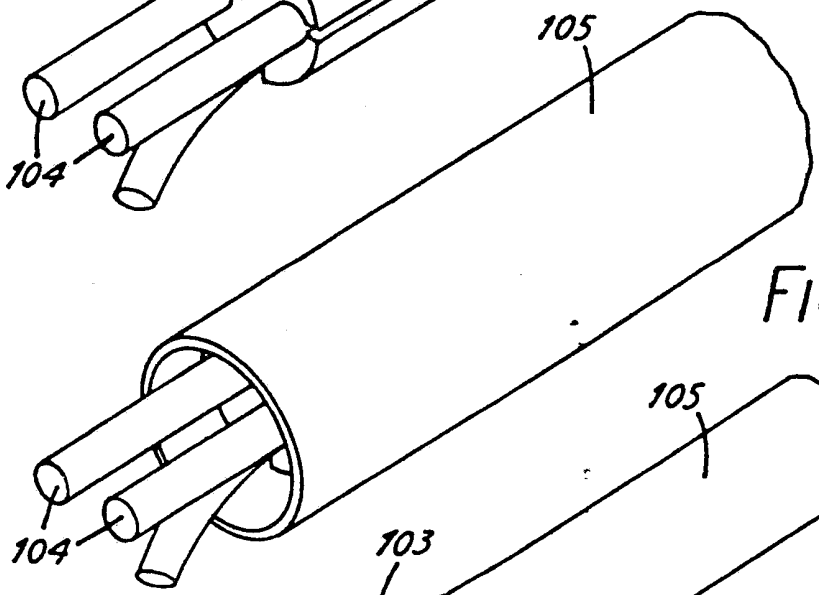

FIG. 19

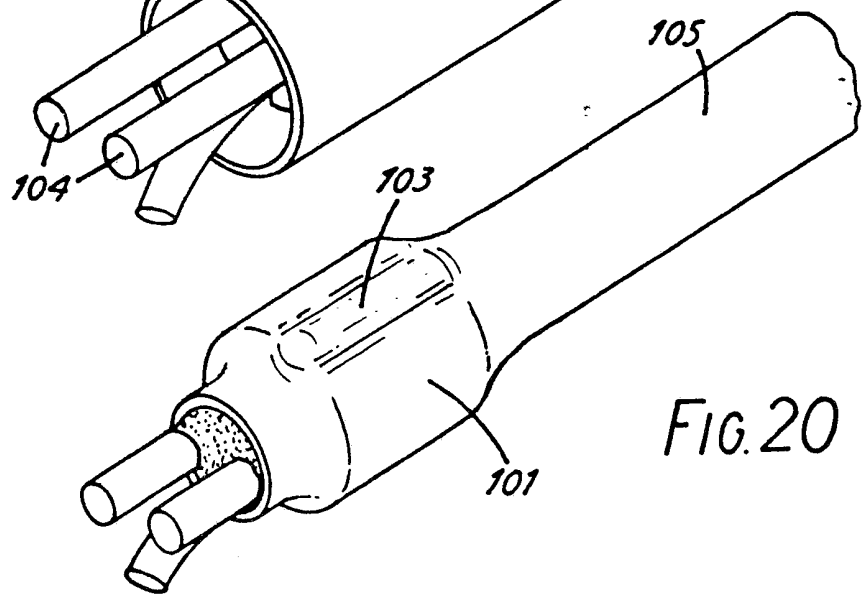

FIG. 20

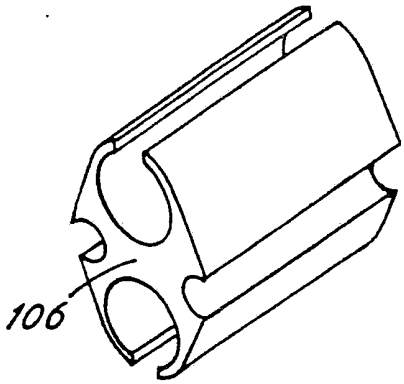

FIG. 21

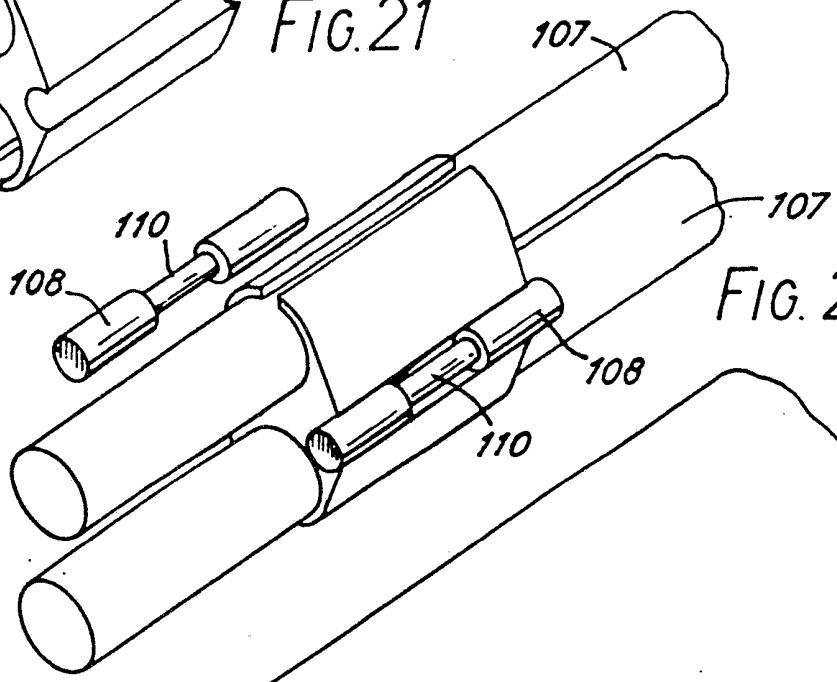

FIG. 22

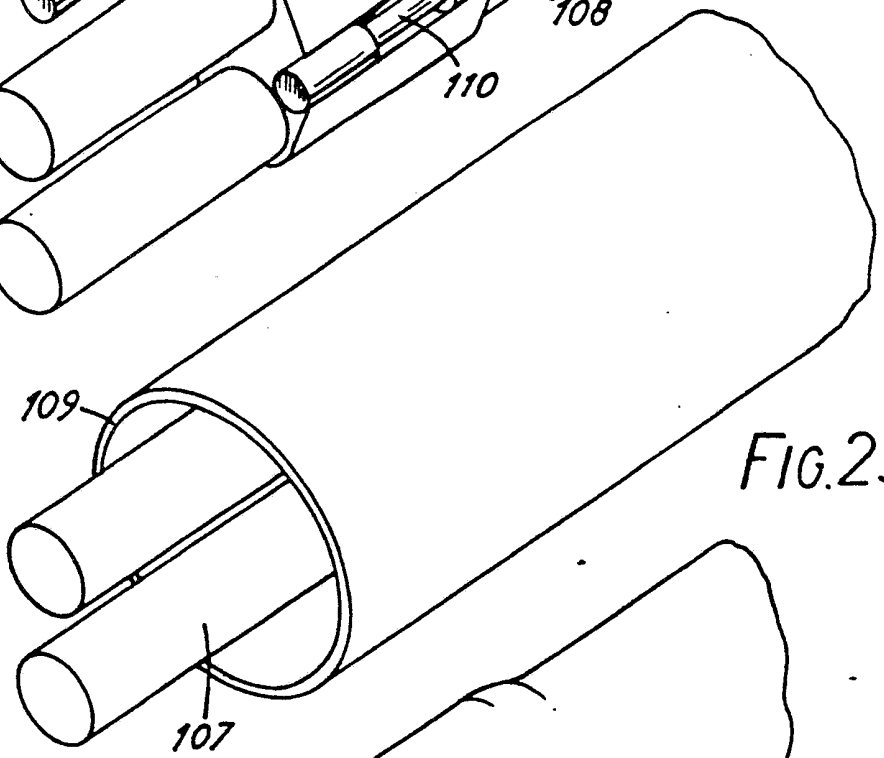

FIG. 23

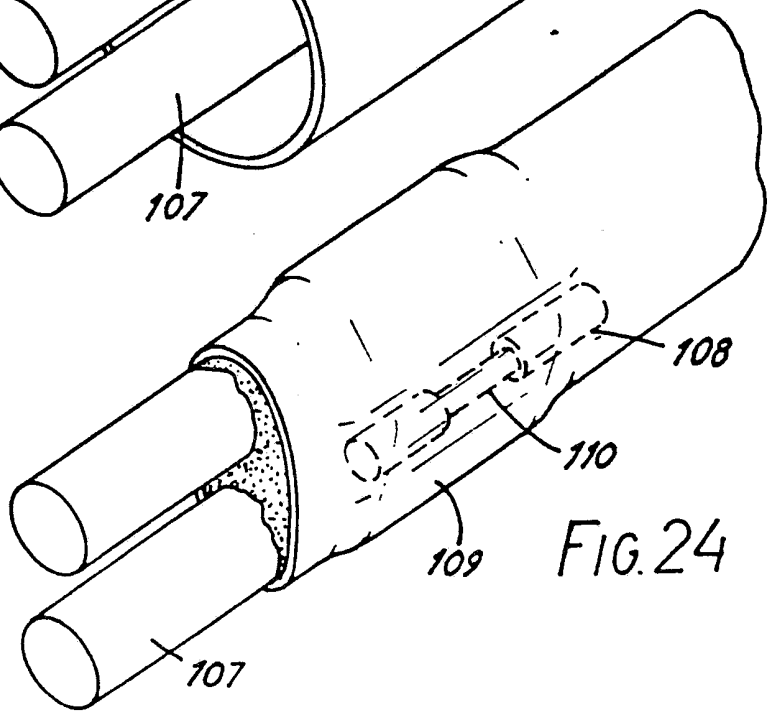

FIG. 24

SPECIFICATION

Plug for retaining and sealing cables

This invention relates to a plug for retaining and sealing two or more cables within a sleeve of heat-shrink material.

It is known to enclose cables in a sleeve of heat-shrink material and to put two or three prong retaining clips over the ends of the heat-shrink material to assist in forming and retaining the joint between the cables and the heat-shrink material.

This method suffers from the disadvantage that spaces or voids can occur inside the sleeve if the sleeve does not fully contact the cables. The known method is also susceptible to "milking-off", i.e. the clip is forced off the end of the sleeve in the course of heating due to the reactive force on the clip exceeding the frictional force between the clip and the heat-shrink sleeve.

It is an object of the present invention to provide a plug for forming a seal between cables and a heat-shrink sleeve and for retaining these cables in position thereby to dispense with the need to use a conventional two or three prong clip.

According to the present invention in one aspect, there is a provided plug for retaining and sealing two or more cables within a sleeve of heat-shrink material the plug being made of or coated with a thermal reactive or hot melt adhesive material and being formed with passages or recesses to receive the cables.

Preferably, the plug includes one or more means to convey heat to the centre of the plug. Such heat conveying means includes, for example, a metallic wire rod, bar or plate extending through the plug and projecting beyond the end of the plug; alternatively, the heat conveying means may comprise a heat pipe.

Alternatively, a quantity of heat conductive particles may be mixed with the adhesive from which the plug is made. These particles are preferably metallic and may comprise aluminium oxide particles.

The metallic heat conveying means is preferably subtantially U-shaped.

The metallic heat conveying means may be made of copper or other metal such as aluminium and may be coated with a suitable finish such as epoxy resin coating or clear anodised.

The part of the heat conveying means which projects beyond the plug may be coated with thermochromic paint.

The plug may be, for example, of substantially diamond-shaped cross-section with passages adapted to receive cables which break into opposite apices of the diamond.

Alternatively, the plug may be of circular cross-section with two or more passages extending axially through the plug and equally spread around the plug periphery, each passage being joined by a slot to the longitudinal peripheral surface of the plug.

The plug may be made of any suitable hot melt adhesive such as polyamide material or cross-linkable E.V.A.

The plug may be formed by a moulding or extruding process.

From another aspect, the invention lies in the combination of a hot melt plug with a heat-shrink sleeve which embraces the plug, a plurality of cables extending through the plug.

The invention also lies in a method of forming a cable seal using such a plug comprising inserting a plurality of cables into the passages or recesses in the plug, enclosing the plug in a sleeve of heat-shrink material and heating the heat-shrink material and the metallic heat conveying means so that the hot melt adhesive will melt and form the cable seal both within the plug and between the plug and the heat-shrink material.

The heat-shrink material preferably has an internal coating of hot melt adhesive.

In the accompanying drawings:

Figure 1 is an isometric view of an adhesive plug embodying the present invention;

Figure 2 shows the same plug with two cables clipped in it;

Figure 3 shows the initial application of a heat-shrink sleeve over the cables and plug;

Figure 4 shows the recovered heat-shrink sleeve after heating so as to seal and retain the cables;

Figure 5 shows a similar plug to that shown in Figure 1 with a metallic conductor incorporated in it;

Figure 6 shows the same plug as in Figure 5 but with two cables clipped in the plug;

Figure 7 shows the heat-shirnk sleeve loosely applied over the plug and cables;

Figure 8 shows the recovered heat-shrink sleeve and the sealed in cables;

Figure 9 shows a different form of adhesive plug embodying the invention and adapted to receive four smaller cables;

Figure 10 shows the same plug with the cables in position;

Figure 11 shows the heat-shrink sleeve loosely applied over the plug and cables;

Figure 12 shows the recovered heat-shrink sleeve and sealed in cables and plug;

Figure 13 shows an adhesive plug similar to that shown in Figure 9 but with a conductor in the form of a copper wire with an insulated sleeve over it;

Figures 14, 15 and 16 show the steps in incorporating the cables into a heat-shrink sleeve with the plug of Figure 13;

Figure 17 is an isometric view of an alternative form of metal conductor and plug arrangement;

Figure 18 shows the plug of Figure 17 with conductor and cables in position;

Figure 19 shows the assembly of Figure 18

enclosed in a heat-shrinkable sleeve;

Figure 20 shows the completed heat-shrunk assembly; and

Figures 21 to 24 show a similar sequence of isometric views in which the conductor is dumbell-shaped.

The adhesive plug 10 shown in Figure 1 may be made of a hot melt adhesive material, such as a polyamide or E.V.A. based material or it may be coated with an adhesive material. The plug has two cable receiving passages 11 and 12 which open via slots 13 and 14 into the surface of the plug. It will be noted the plug is of substantially diamond-shaped section.

In Figure 2, cables 15 and 16 are shown clipped into the plug 10 and in Figure 3 a heat-shrink sleeve 17 is applied over the assembly of the plug and cables.

Heat is applied to the heat-shrink sleeve at both ends to cause it to shrink onto the plug 10 and also to cause the plug 10 to melt sufficiently fully to embrace and seal the cables 15 and 16 without leaving any cavities or gaps between the cables and the plug or between the plug and heat-shrink sleeve.

In Figure 5 a modified plug 18 is shown which has a metallic conductor 19 embedded in it. The metallic conductor 19 is substantially U-shaped, the leg 20 of the U extending generally parallel to the adhesive plug but spaced therefrom to allow room for a heat-shrink sleeve to be inserted as shown in Figure 7 between the arms of the U.

The metallic conductor is preferably of copper or aluminium coated, although it may be of any other metal having a high thermal conductivity.

After the cables have been clipped in the plug 18 as shown in Figure 6 the heat-shrink sleeve 21 is applied as shown in Figure 7. Heat is then applied both to the heat-shrink sleeve 21 and to the conductor 19 and its arm 20 and the heat thus applied will be transferred into the interior of the adhesive plug as well as heating the heat-shrink sleeve. The result of this is that the plug will be caused to melt adjacent the cables and adjacent the heat-shrink sleeve, thus ensuring that full contact between the plug and the cables and the plug and sleeve takes place throughout the length of the plug. The purpose of the metallic conductor is to convey heat into the centre of the adhesive plug thus ensuring that the central area melts where it is in contact with the cables.

The recovered heat-shrink sleeve is shown in Figure 8 and it is seen that the plug 18 has melted so as to embrace completely the cables and the interior of the heat-shrink sleeve.

The heat-shrink sleeve may itself be coated on its interior with an adhesive which may be a thermal melting type adhesive, so as to add to the strength of the bond formed with the adhesive plug. Figures 9 to 12 show an alternative embodiment in which the adhesive plug 22 is of circular section and has four axially extending bores 23 with slots 24 which connect the bores to the exterior of the plug.

Figure 10, 11 and 12 show the steps in forming a four cable branch using the adhesive plug 22, the steps being similar to those described with reference to Figures 1 to 4. Again, as seen in Figure 12, the heat-shrink sleeve 25 fully embraces the melted plug and the plug in turn fully embraces the cables 15 and 16 so that no cavities or gaps are present.

In Figure 13, an adhesive plug 26 is shown which is similar to the plug shown in Figure 9 but has inserted in it a copper conductor 27 encased in an insulative e.g. plastic sleeve 28, preferably a heat resistant thermal insulation sleeve of silicon rubber, or similar matrial. The copper heat conductor 27 again acts as a heat conductor in the same manner as described with reference to Figures 5 to 8.

The steps involved in forming a four way branch are similar to those described with reference to Figure 5 to 8.

An advantage of using the metallic conductor is that, if appropriately shaped, i.e. in the shape of a dumbell, it prevents "milking-off", i.e. sliding off in either direction of the heat-shrink sleeve from the cables during heating of the sleeve. The heating commences at the open end of the sleeve so driving the plug up the sleeve until stopped by the conductor 19.

By using a plug of the form shown in the drawings, either diamond-shaped or round or any other suitable shape, the heat-shrink sleeve is not drawn into the spaces between the cables but embraces the outside of the plug. This is more economical in terms of use of heat-shrink sleeve than existing methods where, when a clip is used and a heat-shrink sleeve, the heat-shrink sleeve is drawn into the spaces between the cables. This means that the heat-shrink sleeve has to be larger than is necessary with the present invention and also that proper sealing does not take place in the known method using a clip. Also the installer has to judge an allowance of heat-shrink tube for each cable in the joint which can be of different diameters.

The use of a plug also enables a variety of cables to be accommodated. An earthing cable can easily be inserted in addition to the cable shown and there is room for larger and smaller cables to be inserted into a suitably formed plug. Also the four way plug can be fitted to one hole in the two way plug allowing one large cable in and four small cables out. If the cables are uneven in diameter, the axial bores through the plug can be made of suitable sizes to accommodate the uneven diameter cables and accommodate earth wires etc. Alternatively, an earthing wire may simply be placed along the outside of the adhesive

plug so that, when it is enclosed in the heat-shrink sleeve it is encapsulated within the sleeve and sealed with the plug.

Where a plug is used which already has four passages through it and only three cables are required, the additional passage may be plugged with a simple plug of the same adhesive which is used for the body of the plug.

The metallic conductor may be painted with thermochromatic paint to indicate when the required temperature is reached for treatment of the thermal adhesive from which the plug is made. The adhesive used may be adapted to the particular temperatures which are likely to arise during heating. For instance, the interior of the plug could be made of different adhesive to the exterior, the interior adhesive melting at a lower temperature than the exterior adhesive.

Another method of conducting heat to the centre of the cable is shown in Figures 17 to 24.

Figures 17 and 18 show the components prior to their being placed in a heat shrinkable sleeve and to the application of heat. A plug 101 of hot melt adhesive is formed in such a manner as to allow three cables 104 and a metal conductor 103 of circular section of the same diameter as the cables to be inserted into cavities 102.

In use, the cables 104 and the metal conductor 103 are inserted into the cavities, the assembly placed inside a heat-shrinkable sleeve 105 and heat applied to the sleeve. As the sleeve shrinks it comes into contact with the external surfaces of the assembly and heat is transmitted through the wall of the heat-shrinkable sleeve and into the metal conductor 103 thereby melting the centre section of the plug and bonding the cables and conductor in the manner illustrated in Figure 20.

Figure 21 illustrates a hot melt sealant plug 106 formed to accept two large diameter cables 107 and two smaller diameter heat conductors 108.

Figure 22 illustrates the cables 107 and "dumbell"-shaped conductors 108 fitted into the adhesive plug 106. Figure 23 shows the assembly of the cables, plug and dumbell conductors inserted into a heat-shrink sleeve 109. Figure 24 shows the assembly encapsulated by the recovered heat-shrinkable sleeve after heating.

The cylindrical metal part or conductor can be manufactured from any metal or material which is a good conductor of heat. The cross-sectional shape of the metal part or conductor is preferably formed with rounded edges; a central reduced diameter minimises the chance of the conductor moving longitudinally during the application of heat. It also enables a material of higher melting point to that of the adhesive to be applied to the reduced diameter region of the conductor and for the presence of this higher melting point material to provide an indication of the state and condition of the assembly during the heating procedure.

Hot melt adhesive can also be applied over the whole surface of the conductor or in the reduced diameter section only.

In an alternative embodiment of the invention to that shown in Figures 21 to 24, the conductor is manufactured from metal tube with a cut-away section in the centre, the tube being filled with hot melt adhesive. On placing the conductor in the plug, inserting the assembly of the plug and conductor into a heat shrinkable sleeve tube and heating, the adhesive is forced from the extremities of the tubular conductor contributing to the seal.

Adhesive tape made of a hot melt adhesive material similar to the material of which plug 6 is made may be wrapped around the cut-away section 110 of each dumbell-shaped conductor 108. When the hot melt adhesive of the plug melts during shrinkage of the heat-shrinkable sleeve 109 the adhesive tape formed round the recess will also melt and form a continuous mass with the plug and the heat-shrinkable sleeve, thus ensuring that there are no voids or air passages present in the assembly. This helps to prevent ingress of moisture etc.

When the adhesive wrapped around the cut-away begins to melt, the heat-shrinkable sleeve will form a slight recess where is it in contact with the tape and this provides a practical indication that the hot melt adhesive has, in fact, melted. This indication is additional to the indication provided by thermochromic paint on the outside of the heat-shrinkable sleeve.

By using the metal parts 103 and 108, the complete assembly of cables, plug and heat-shrink sleeve has no flat exterior surfaces. The rounded exterior surfaces result in good hoop strength all round the joint.

Although the metal parts 103 and 108 are shown as being of round cross-section, they could be any other suitable section such as pear-shaped.

In an unillustrated embodiment, a plug is formed from a mixture of heat conductive particles (e.g. an aluminium poweder) and adhesive. In this embodiment, heat is conducted to the plug interior by means of these added conductive particles.

This invention has been described with reference to specific examples and, it will be appreciated that the invention can be embodied in many other forms without regard to size and the number of cable entries involved.

CLAIMS

1. A plug for retaining and sealing two or more cables within a sleeve of heat-shrink material, the plug being made of or coated with a thermal reactive or hot melt adhesive material and having passages or recesses formed

in it to receive the cables.

2. A plug according to claim 1 including one or more means to convey heat to the centre of the plug.

3. A plug according to claim 2 in which such means is in the form of a wire rod, bar or plate extending through the plug and projecting beyond the end of the plug.

4. A plug according to claim 2 and in which said means is a substantially U-shaped bar or rod or plate.

5. A plug according to claim 1 or claim 3 or claim 4 and in which the said means is made of copper of aluminium.

6. A plug according to any of claims 2 to 5 in which the part of the means which projects beyond the plug is coated with thermochromic paint.

7. A plug according to claim 2 wherein the heat conveying means comprises heat conductive particles present within the plug material.

8. A plug according to any preceding claim which is of substantially diamond-shaped cross-section with passages adapted to receive cables which break into appropriate apices of the diamond.

9. A plug according to any of claims 1 to 4 which is of circular cross-section with two or more passages extending axially through the plug and equally spaced around the plug periphery, each passage being joined by a slot to the longitudinal peripheral surface of the plug.

10. A plug according to any preceding claim made of an adhesive polyamide material or E.V.A.

11. A plug according to any preceding claim formed by a moulding or extruding process.

12. The combination of a plug according to any preceding claim with a heat-shrink sleeve which embraces the plug a plurality of cables extending through the plug.

13. A method of forming a cable seal using a plug according to any of claims 2 to 10 comprising inserting a plurality of cables into the passages or recesses of the plug, enclosing the plug in a sleeve of heat-shrink material and heating the heat-shrink material and the heat conveying means so that the hot melt adhesive will melt and form the cable seal both within the plug and between the plug and the heat-shrink material.

14. A method according to claim 12 and in which the heat-shrink material has an internal coating of the melt adhesive.

15. A plug for retaining and sealing two or more cables within a heat-shrink sleeve substantially as hereinbefore particularly described and as illustrated in the accompanying drawings.

16. A method of retaining and sealing two or more cables within a sleeve of heat-shrink material, the plug being made of or coated with a hot melt adhesive material and having passages or recesses formed in it to receive the cables.

17. A plug according to claim 1 in combination with one or more metallic heat conductors of elongate form adapted to be retained in one or more recesses in the plug.

18. A plug according to claim 17 in which the or each metallic heat conductor is an elongate tubular metal rod or bar.

19. A plug according to claim 18 in which the or each heat conductor has a cut-away portion between its ends.

20. A plug according to claim 18 in which the or each heat conductor is of dumbell form.

21. A plug according to claim 19 or claim 20 in which the or each heat conductor has a wrapping of adhesive tape made of thermally reactive or hot adhesive material around the cut-away portion.

22. A method of retaining and sealing two or more cables comprising inserting the cables into recesses in a plug of thermally reactive adhesive material, inserting one or more metal conductor elements into recesses in the plug, enclosing the assembly in a heat-shrink wrapper and heat-shrinking the wrapper to complete a joint.

23. A method as claimed in claim 22 wherein the conductor elements are of dumbell shape.

24. A plug for retaining and inserting cables as hereinbefore particularly described and as illustrated in Figures 1 to 16 of the accompanying drawings.

25. A plug for retaining and inserting cables as herinbefore particularly described and as illustrated in Figures 17 to 24 of the accompanying drawings.

26. A method of retaining and sealing cables using a plug made of thermally reactive adhesive material substantially as hereinbefore particularly described and as illustrated on Figures 1 to 16 of the accompanying drawings.

27. A method of retaining and sealing cables using a plug made of thermally reactive adhesive material substantially as herinbefore particularly described and as illustrated on Figures 17 to 24 of the acompanying drawings.

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