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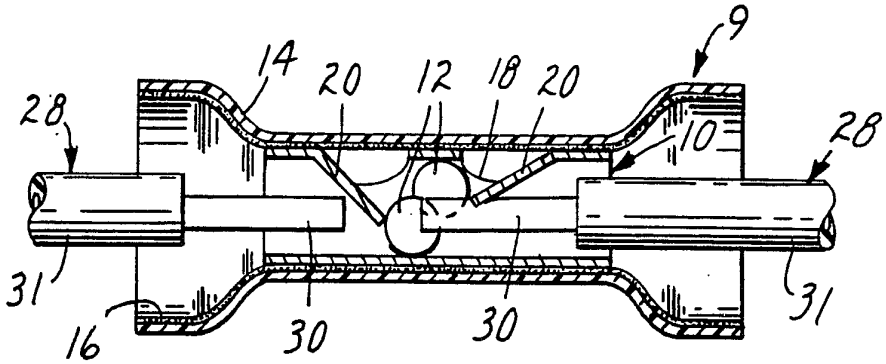

(57) Abstract

A wire connector having a conductive barrel with a solder mass disposed in the barrel is formed with wire retaining means to hold the wires in place during heating and melting of the solder to form a permanent connection. A shrinkable sleeve formed around the barrel and extending beyond the ends of the barrel is also shrunk down onto the wires to insulate the connection and hold the wires.

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WIRE CONNECTOR

Field of the Invention

This invention relates to wire connectors and in one aspect to a wire connector for making low profile butt splices between two conductors wherein the conductors are connected end to end.

Background of the Invention

The prior art is replete with connecting devices for joining two or more wires in electrical contact to splice the same into a given circuit. The devices that are considered relevant to the background of this invention are not the insulation displacement connectors or the wire nut twist-on connectors but connectors where the wires are placed in end-to-end relationship for making a butt splice and maintained in electrical connection by a crimp connector, a weld or similar connection. Often the electrical connections will be insulated using heat-shrinkable tubular components. There are many examples of electrical connection devices which include heat-shrinkable components. Often the heat-shrinkable portion will be in the form of a tube or sleeve. The inner wall of the tube may be coated with an adhesive or sealant. When, positioned within the shrinkable tube, the means for joining conductors is found usually close to the central portion of the heat-shrink sleeve. The joining means is frequently a ring or band of solder as described, for example, in GB 1,149,125; US 4,940,179 and WO 9,007,207. (Other related patents are: US 4,722,471; US 4,300,284; GB 2,020,922; US 4,832,248; WO 8,809,068; US 4,505,421 and US 4,883,924). The use of bands or rings of solder are referred to as solder inserts or preforms. Such inserts perform the conventional function of soldering electrical conductors to provide an electrical connection. In some cases, the solder may be rendered susceptible to and melted using, high frequency alternating currents as described in US 4,987,283 and US 4,852,252. While the solder inserts

have a well defined shape, in some cases they may be replaced by an undefined quantity of solder as disclosed in US 4,654,473 and US 4,384,404.

As an alternative, the solder components may be replaced by crimp barrels within the heat-shrink sleeves. Connectors which rely upon crimp barrels are described, for example, in US RE 33591 and US 4,993,149.

Another means of making electrical connection between conductors is revealed in US 5,006,286. In this case the solder is replaced by a conductive gel medium. The gel, located centrally within a heat shrink sleeve, provides a conductive path between conductors which are inserted into and surrounded by, the conductive gel. When heat is applied, the heat-shrink sleeve recovers, gripping the insulation of the conducting wires. This prevents the conductors from withdrawing from the conductive gel.

All of the foregoing examples suffer from a common problem. This problem is associated with the positioning of the wire conductors, insulated or otherwise, before they are joined by soldering, crimping or penetration of a conductive gel. This problem is especially acute in the latter case since the wires must be held in the desired relationship until the shrinkage and gripping action of the heat-shrink sleeve is complete. Therefore, to successfully connect conductors, using prior art devices, it is necessary to provide auxiliary clamping means to hold conductors in position, within the connector, prior to soldering, crimping, etc.

One piece of prior art, GB 2,020,922, teaches the use of an additional insert within a heat-shrink sleeve. This insert is used to hold and position wires which are inserted into the heat-shrink sleeve. However, this connecting device is useful only for connecting wires which are inserted from the same end of the connector. Also, it seems that the insert does not effect a gripping action while holding the wires in position nor does it appear

useful in providing a reliable electrical connection. Thus, wires inserted and positioned in the connector are not reliably secured and electrically connected until soldering or twisting and heat-shrink procedures have been performed.

The present invention significantly simplifies the process of joining conductors by eliminating the need for auxiliary clamping. It also provides an improvement over crimp connectors which are subject to damage by crimping tools which may cut through the heat-shrinkable insulating layer during the crimping process.

Summary of the Invention

The connector of the present invention is adapted for making an electrical connection between a plurality of wires and insulating the connection. The connector comprises a conductive tubular member or sleeve, a mass of solder and a shrinkable sleeve. The conductive sleeve of an electrically conductive metal is formed with wire retaining means formed from the sleeve for gripping the wires upon insertion into the sleeve. The wire retaining means extend from the inner surface of the cylinder in the form of tabs. The tabs are located to extend into the sleeve from one side toward the other and toward the center portion of the sleeve from opposite ends. A mass of solder is positioned within the sleeve between the tabs to be later melted to electrically join the ends of the wires. A shrinkable sleeve is positioned about the conductive sleeve with the conductive sleeve positioned generally midway between the ends of the shrinkable sleeve. The inner diameter of the shrinkable sleeve fits on the outside diameter of the conductive sleeve to enclose the sleeve and retain the mass of solder in the conductive sleeve.

In a preferred embodiment, the tabs are formed from the conductive sleeve and the tabs have a length sufficient to extend past the longitudinal axis of the conductive sleeve and are stamped from the material of the

sleeve to engage a bare wire inserted into the sleeve from either end and resist the retraction of the wire.

The mass of solder is of a size to fit through a hole or interruption formed in the surface of the sleeve and may be one or more balls of solder.

The shrinkable sleeve is preferably heat shrinkable and the center portion of the sleeve is shrunk down onto the conductive sleeve and the opposite ends are not reduced significantly and are thus bell-shaped beyond the ends of the conductive sleeve to receive the insulative sheath of the wire.

The present invention also provides a new method of making a wire connector comprising the steps of cutting into a sheet of electrically conductive material, having two opposite sides and two ends, to make a pair of generally U-shaped cuts with the open ends of the U-shaped cuts positioned oppositely of each other and opening toward the ends of the sheet, forming the sheet into a hollow tubular member, joining the opposite sides to form a seam to hold the sheet in the tubular shape, depressing the section of material within each of the pair of U-shaped cuts into the tubular member to form tabs directed toward each other within the tubular member, placing a mass of solder into the tubular member through the cut and depressed area of the material to position the solder between the tabs, and inserting the tubular member into a shrinkable sleeve to be positioned between the ends thereof. The method can further include the step of shrinking the central portion of the shrinkable sleeve onto the tubular member to restrict the displacement of the tubular member from the open ends of the shrinkable sleeve and to retain the solder mass in the tubular member.

An important feature of the aforementioned connector is the dual function it provides by gripping or clamping inserted conductors and holding them in electrical contact prior to the formation of a more permanent

connection e.g. soldering. Wires may be inserted from either end of the connector. The connector of this invention includes means for connecting and environmentally sealing and insulating both stranded and solid wire conductors in a range of wire gauge sizes. Connections between one wire and another may be made. Alternatively it is possible to connect multiple wires up to a limit defined by the available space within the connector. An adhesive may be placed within the shrinkable sleeve to further seal the sleeve to the wires.

Description of the Drawing

The present invention will be further described with reference to the accompanying drawing wherein:

Figure 1 is a perspective view of a tubular member forming part of the connector of the present invention;

Figure 2 is a longitudinal sectional view of the tubular member of Figure 1, showing also the placement of a mass of solder in the tubular member;

Figure 3 is a longitudinal sectional view of a connector according to the present invention;

Figure 4 is a longitudinal sectional view of a connector according to the present invention illustrating the insertion of wires into the connector;

Figure 5 is a longitudinal sectional view of a completed electrical splice using a connector according to the present invention;

Figure 6 is a perspective view of a connector of the present invention and of wires having conductors exposed at the ends,

Figures 7 and 8 are end views of the tubular member illustrating the seam formed between the sides of the plate forming the tubular member to hold it in the tubular shape and illustrating the tabs depending from the inner surface of the tubular member; and

Figure 9 is a side elevational view of a further embodiment of the connector according to the present invention.

Detailed Description of the Presently Preferred Embodiment

The invention will be described with reference to the drawing wherein like reference numerals refer to like parts throughout the several views. In Figure 1, a tubular member or cylindrical member 10 is illustrated which provides the connection device of the connector, which is generally indicated by the reference numeral 9. The connector 9, see Figure 3, comprises the tubular conductive sleeve 10, having self actuated wire retaining means formed from the conductive member, a mass of solder 12 and an outer shrinkable sleeve 14, which may have a coating of adhesive material 16 disposed on the inner surface thereof.

The conductive sleeve 10 is formed from a rectangular sheet of conductive metal such as copper, brass, beryllium copper, etc. which is tin plated. The sheet has opposite ends and sides and is cut or stamped to form the wire retaining means. As illustrated, the wire retaining means are formed by two U-shaped or horseshoe shaped cuts 18 made in the sheet. The sheet is then formed into a generally cylindrical shape to form the conductive sleeve 10. The area of the sheet within the cuts 18 are depressed into the sleeve 10, or bent along the un-cut edge, and this bending forms two window openings or interruptions in the sleeve 10 and two tabs 20 which extend down into the sleeve 10. As illustrated in Figures 7 and 8, the sheet is formed into a tubular member and the sides of the sheet are joined by a bead of solder 22, see Figure 7, or by an interlocking seam, including a C-shaped or rolled edge 23 on one side and a tongue 24 on the other side, see Figure 8.

The interruptions formed in the surface of the sleeve 10, form the tabs 20 but they also form windows which serve the function of allowing visual inspection of

the inside of the sleeve 10. Through the interruptions are placed a mass of solder 12, illustrated in the drawing as two spherically shaped masses of solder, which are preferably coated with flux, to provide for the permanent connection of the wires to each other, to the wall of the metal sleeve, or both. The connection is achieved by heating the solder to a temperature in the range at which the solder melts.

The sleeve 10 of the present invention, unlike earlier products, provides the wire retention tabs 20 which serve to provide wire retention in the sleeve. The die cutting or stamping of the horseshoe shaped cuts leaves the edges of the tabs rough and sharp, and the angle of the tabs extending into the sleeve afford the wire retention for two or more wires to be positioned and held in the sleeve 10, under friction, or the mechanical gripping of the tab into the wire, before the heat is applied to complete the soldered connection. The free end of each retention tab 20 extends past the axis of the sleeve 10 and is located close to the inner surface of the sleeve opposite the side to which the tabs remain connected, see Figures 7 and 8. Any object, e.g. a wire, passing underneath the tab 20 from a direction from an end toward the nearest tab 20, will engage the tab and displace it resiliently, causing the wire to be gripped by the tab 20 and held under friction. The known connectors discussed above were incapable of securely holding the wires and required careful hand support or special jigs to complete a soldered connection.

While the sleeve 10 performs the desired function of connecting wires, it is necessary to provide an outer sleeve 14 of shrinkable material, preferably heat shrink material, if insulating the connection is desired. The insulative sleeve 14 is a dual wall heat shrink tube. The sleeve 14 is preferably made of a translucent or transparent heat shrinkable material. A transparent sleeve

is desired so that a completed, soldered connection may be viewed after the connector 9 has been heated sufficiently to shrink the outer sleeve and melt the solder mass.

Reference is now made to the dual wall nature of the heat shrink sleeve 14. This sleeve 14 is composed of two layers of material. The inner layer 16 of the sleeve 10 is a clear hot melt adhesive. This material becomes tacky with the application of heat. The outer sleeve 14 is formed preferably, of a transparent polymer identified by the tradename "Kynar" and available from Pennwalt Corporation, Philadelphia, Pennsylvania. The sleeve 10 and the solder mass or balls 12, are positioned within the sleeve 14. The sleeve 14 fits against the exterior of the sleeve 10 to restrict the solder mass 12, described earlier, from becoming displaced from between the tabs 20, and the sleeve 10 is centrally located within the shrinkable sleeve 14. Enough heat is applied to shrink the central portion of the "Kynar" tube so that it grips the metal cylinder and holds it securely. This relationship exists by the sleeve 10 and the shrinkable sleeve 14 having the proper sizes, internal diameter and outside diameter, or by using a heat shrinkable sleeve 14 and heating the central portion of the sleeve, and by localizing the heat, shrinking the central portion of the sleeve down onto the sleeve 10 to secure it in place prior to the use of the connector 9. This shrinking procedure leaves the ends of the sleeve 14 bell-mouthed, as illustrated in Figures 3, 4 and 6, to accept the wire sheath introduced into the connector.

Connection of wires to the connector 9 is achieved, according to Figures 4, 5 and 6. The wires 28 are stripped at the ends to expose the conductor 30 beyond the end of the sheath 31. The wire end, or wire ends, are then inserted into each end of the conductive sleeve 10 a distance sufficient for the end to pass the free end of the respective tab 20 such that an initial connection, between

the exposed conductor and the tab is formed. The wire thereafter cannot be easily withdrawn against the bracing force of the tabs 20. Displacing the tabs 20 to allow entry of the conductors 30 may move the mass of solder 12 but it is maintained centered between the tabs and at the ends of the conductor 30. When a permanent connection is desired, heat is applied to the outer surface of the sleeve 14. As the temperature increases to the melt temperature of the solder, e.g. above 150°C, the solder mass 12 coated with the flux melts and contacts the exposed conductors positioned in the middle of the conductive sleeve 10. This forms a permanent connection within the conductive sleeve, as shown by Figure 5 wherein the mass 12 has changed from the form of balls of solder to a reformed mass joining the wire ends and the tabs 20. At the same time the application of heat causes the heat shrinkable sleeve 14 to recover and close around the insulative sleeve 31 of the wires as also shown in Figure 5. The heating also softens the hot-melt adhesive coating 16, if present, causing it to flow around the insulative sheath 31 and to seal to the wires 28. After application of the connector 9 the wires are connected, entry of moisture to the junction between the wires is restricted by the adhesive seal and it is still possible to view the completed, soldered connection through the outer protective sleeve 14.

If the adhesive coating is not present on the sleeve, but the sleeve 14 is heat shrinkable, the sleeve 14 will recover, under the influence of sufficient heat, and it will grip the outer insulative sleeve of the inserted wires 28 but the seal may not restrict moisture penetration into the sleeve.

Figure 6 illustrates the transparent nature of the shrinkable sleeve 14. This figure also illustrates the use of the connector 9 with a plurality of wires 35 being inserted at one end of the conductive sleeve 10 and a

single wire at the opposite end as is quite normal in the construction of wire harnesses.

It is possible to use the connector of the present invention with the addition of thermoplastic inserts placed inside the ends of the heat shrink sleeve 14. When wires 28 are placed inside the connector and through the thermoplastic inserts, the heat to shrink the sleeve 14 will cause the inserts to melt. As the heat shrink tube recovers around the wires the thermoplastic insert material will flow around the sheath of the wires. This provides the desired seal to prevent ingress of moisture or other contaminants.

The formation of the conductive sleeve 10 is partially described above but includes the steps of cutting into a sheet of electrically conductive material, having two opposite sides and two ends, to make a pair of generally U-shaped cuts with the open ends of the U positioned oppositely of each other and opening toward the ends of the sheet. The sheet is then formed into a hollow tubular member and held in that form by joining the opposite sides of the sheet to form a seam to maintain the sheet in the tubular position. The center cut portions of the sheet are depressed into the tubular member past the center axis of the tubular member. A mass of solder is placed through the windows formed upon bending or depressing the cut out portions of the sheet into the tubular member. The placing of the mass of solder into the tubular member through the cut portions positions the solder between the inturned tabs. The tubular member is then inserted into a shrinkable sleeve to be positioned between the ends of the shrinkable sleeve. The shrinkable sleeve can be heated locally to shrink down onto the outer surface of the sleeve 10 to restrict the displacement of the cylinder from the open ends of the shrinkable sleeve and to retain the solder mass in the tubular sleeve 10. The assembled connector is clearly shown in Figure 3.

A specific example of the connector is as follows:

Example 1. One connector of the present invention is comprised of a heat shrink tube, a cylindrical metal connector, and two solder inserts in the form of small spheres. The heat shrink tube is a two layer construction comprising an outer transparent heat shrink sleeve which is coated internally with a transparent layer of hot melt adhesive.

Assembly of the connector of the present invention is achieved via a series of steps.

Step 1. The tin plated metal sheet is cut or stamped, and formed into a cylindrical form. The cylinder is positioned, horizontally on a fixture, with the interruptions or observation holes or "windows" disposed on its upper surface or facing upwards.

Step 2. Two flux coated solder balls of low temperature solder of 43 percent lead, 43 percent tin and 14 percent bismuth, with a melt temperature of 163°C, are placed in the cylinder by inserting one through each of the observation holes.

Step 3. The heat shrink sleeve component is slipped over the connecting cylinder until it reaches a stop associated with the assembly fixture. At this point the conductive cylinder is centrally located with respect to the longitudinal axis of the heat shrink sleeve.

Step 4. During this stage, the connector enters a heat tunnel where it is selectively heated only in the center section covering the conductive sleeve. This attaches the heat shrink sleeve to the outer surface of the cylinder but leaves opposite ends of the sleeve expanded to receive wires for connection.

Figure 9 illustrates a further embodiment of the connector 9. In this embodiment the conductive sleeve 10, having the tabs 20 and solder mass 12, is disposed in a transparent shrinkable sleeve 40. The sleeve 40 is heat

shrinkable and has an inside diameter substantially the same as the outside diameter of the sleeve 10 or can be shrunk down onto the sleeve 10 as explained above. At each end of the sleeve 40 an additional hollow, cylindrical thermoplastic sleeve of a hot melt adhesive, see sleeves 41 and 42, is inserted into the sleeve 40 against opposite ends of the sleeve 10. Just beyond the sleeves 41 and 42, the sleeve 40 can be crimped, as at 44, by localized heating sufficiently to hold the sleeves 41 and 42 in the sleeve 40 within the ends thereof as well as the conductive sleeve 10.

The thermoplastic sleeves 41 and 42 comprise ethylene vinyl acetate, polyvinylidene fluoride and other additives such as fillers, pigments, antioxidants, etc. The thermoplastic sleeves are preferably opaque such that upon the connector 9 being placed over wires entering the sleeve 10 from opposite ends, the connector is subjected to heat sufficient to shrink the sleeve 40, melt the solder mass 12 and the hot melt sleeves 41 and 42. It can thus be seen that the solder has been able to flow about the wire ends in the sleeve 10 and that the sleeves have become molten and seal the ends of the sleeve 40 to the insulation about the wire ends.

A distinguishing feature of the connector is the incorporation of a wire insert and retention or clamping component adjacent to each opening of the connector itself. This clamping component is metallic in nature and performs a dual function. Firstly, it is designed to grip the bare wires which are inserted into the connector. This eliminates the need for auxiliary holding equipment such as special jigs or fixtures. In addition, the metal to metal contact assures the formation of electrical continuity. A more reliable electrical connection is then made by uniting the conductors by soldering. By joining the conductors at two points within the connecting component an extremely reliable electrical junction is obtained.

Electrical connectors according to the present invention are useful for joining current carrying wires in a variety of applications. There is interest especially in making connections in e.g. wiring harnesses which are useful in automotive applications and domestic appliances.

Having described the present invention, with specific reference to the preferred embodiment and variations, it is to be understood that other modifications can be made by those skilled in the art without departing from the spirit of scope of the invention as defined by the appended claims.

Claims:

1. A wire connector for making an electrical connection between a plurality of wires and forming an insulated connection, the connector comprises a hollow tubular member formed to receive wire ends and a shrinkable sleeve positioned about the tubular member with the inner diameter of the shrinkable sleeve fitted to the outside surface of the tubular member to provide an insulative cover for the conductive member characterized by the feature that the tubular member (10) is formed of an electrically conductive metal having self actuated wire retaining means (20), formed from the material of the tubular member (10) and positioned adjacent the ends of the tubular member and extending into the tubular member for affording wire retention for wires inserted into the tubular member, and that a mass of solder (12) is positioned within the tubular member generally centrally thereof between its ends and the wire retaining means (20) to flow around the wire ends and electrically connect the same upon shrinking said shrinkable sleeve 14.

2. A connector according to claim 1 characterized in that said wire retaining means (20) comprises tab means (20) formed from the tubular member and bent into the tubular member, said tab means having a length sufficient to extend past the longitudinal axis of the tubular member and formed to engage a bare wire inserted into the tubular member from either end and resist the retraction of the wire.

3. A connector according to claim 1 characterized in that said mass of solder (12) is of a size to fit in the tubular member through an interruption (18) formed in the tubular member to form the tab means.

4. A connector according to claim 1 characterized in that said tubular member (10) is cylindrical in shape and the shrinkable sleeve (14) is heat

shrinkable and the central portion thereof is shrunk onto said tubular member and the ends are bell shaped beyond the ends of the tubular member.

5. A connector as defined in claim 1 characterized in that the shrinkable sleeve (14) is heat shrinkable and the sleeve has a coating (16) of adhesive disposed on the inner surface of the shrinkable sleeve.

6. A connector according to claim 5 characterized in that the adhesive (16) is a hot melt adhesive.

7. A connector as defined in claim 1 characterized in that the shrinkable sleeve (40) is heat shrinkable and a pair of hollow tubular sleeves (41,42) of a thermoplastic are inserted into the sleeve (40), one tubular sleeve at each end of the sleeve (40) and against either end of the tubular member (10) for sealing the ends of the shrinkable sleeve to the wires.

8. A connector according to claim 7 wherein the tubular sleeves (41,42) are opaque.

9. A connector according to claim 1, 5 or 7 characterized in that the shrinkable sleeve (14) and the adhesive (16) are transparent.

10. A connector according to claim 1 or 5 characterized in that said mass of solder (12) is spherical and is coated with flux.

11. A method of making a wire connector comprising the steps of

cutting into a sheet of electrically conductive material, having two opposite sides and two ends, to make a pair of generally U-shaped cuts with the open ends of the U positioned oppositely of each other and opening toward the ends of the sheet,

forming the sheet into a hollow cylinder,

joining the opposite sides to form a seam to hold the sheet in the cylindrical shape,

depressing the section of material within each of the pair of U-shaped cuts into the cylinder to form tabs directed toward each other within the cylinder,

placing a mass of solder into the cylinder through the cut and depressed area of the material to position the solder between the tabs, and

inserting the cylinder into a shrinkable sleeve to be positioned between the ends thereof.

12. The method of claim 11 characterized in that the method includes the step of shrinking the central portion of the shrinkable sleeve onto the cylinder to restrict the displacement of the cylinder from the open ends of the shrinkable sleeve and to retain the solder mass in the cylinder.

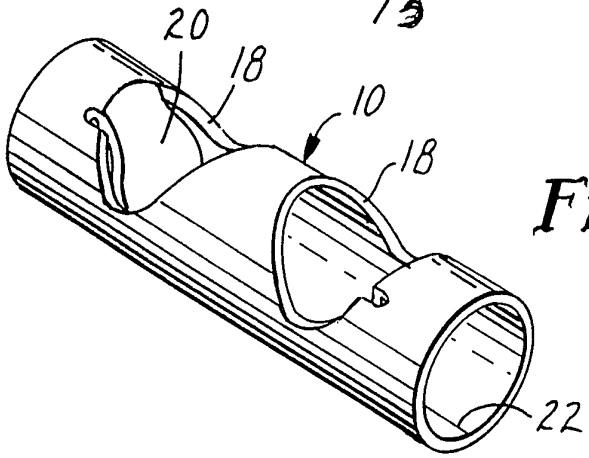

FIG. 1

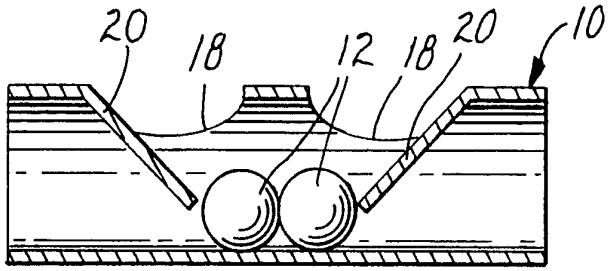

FIG. 2

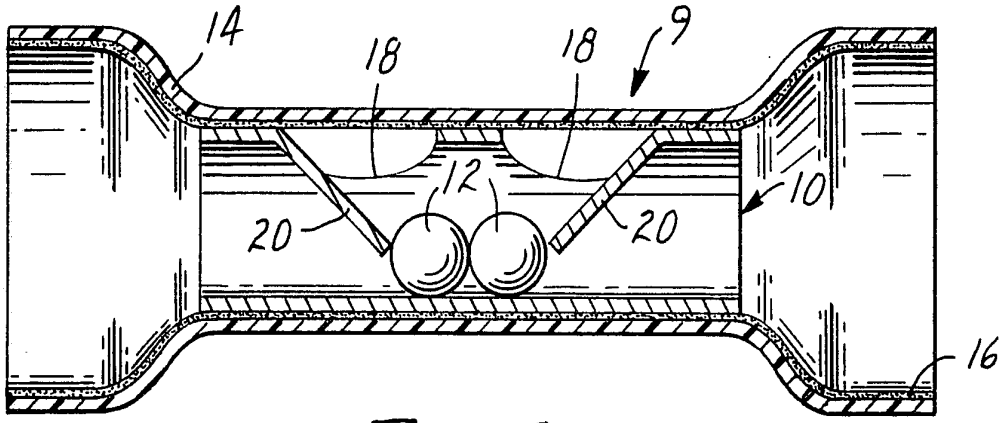

FIG. 3

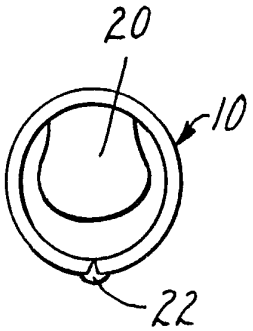

FIG. 7

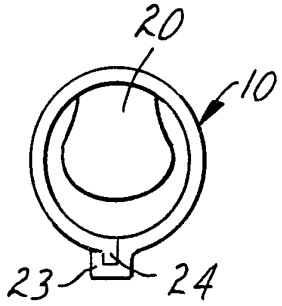

FIG. 8

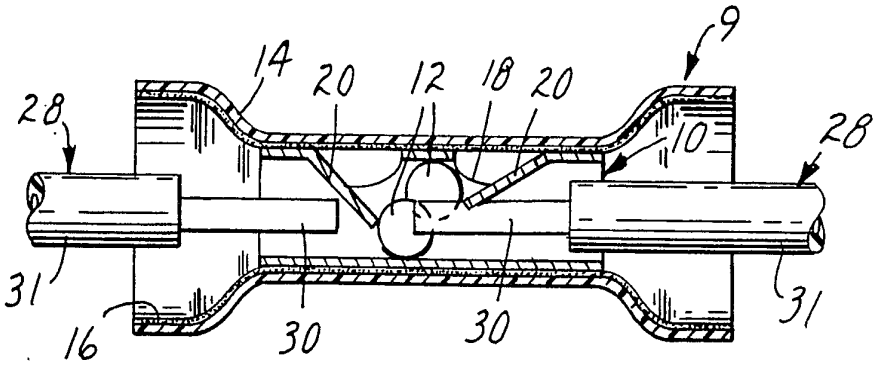

FIG. 4

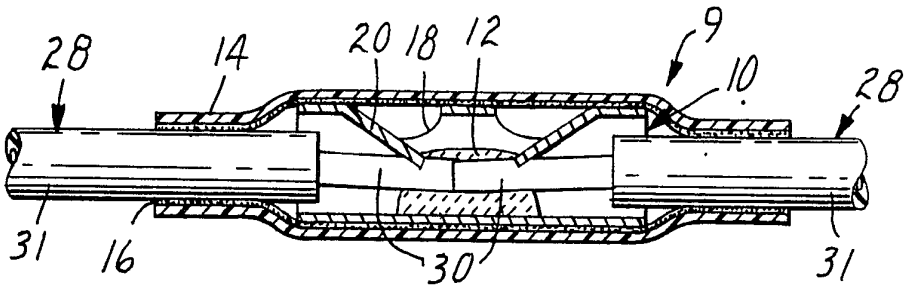

FIG. 5

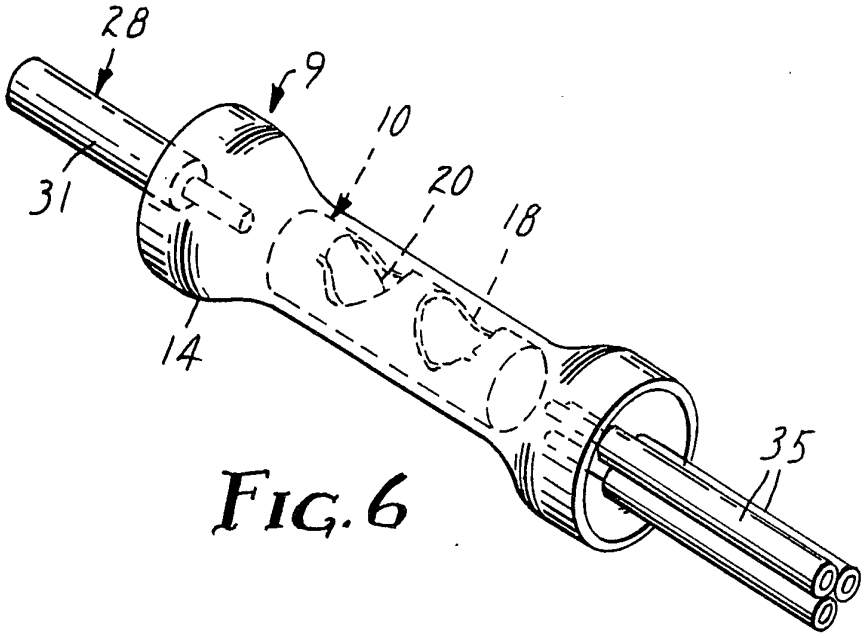

FIG. 6

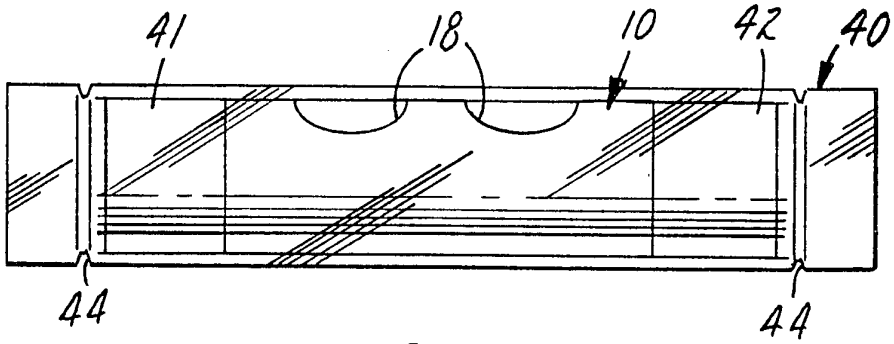

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 93/00096

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: H01R 4/02, H01R 4/72
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)

IPC5: H01R

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 practicable, 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.
A	US, A, 4084876 (LEON DINGER), 18 April 1978 (18.04.78), see the whole document --	1,11
A	GB, A, 1246543 (KENNETH JOHN STARTIN ET AL), 15 Sept 1971 (15.09.71), page 2, line 84 - line 94 --	1
A	WO, A1, 9016092 (RAYCHEM CORPORATION), 27 December 1990 (27.12.90), page 9, line 5 - page 10, line 9 -- --------	1

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Date of the actual completion of the international search	Date of mailing of the international search report
16 April 1993	07.05.93
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Håkan Sandh

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Information on patent family members

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International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4084876	18/04/78	NONE	
GB-A- 1246543	15/09/71	AT-A,B- 308924	15/06/73
		BE-A- 744818	01/07/70
		DE-A- 2002038	30/07/70
		FR-A- 2029630	23/10/70
		NL-A- 7000661	31/07/70
		SE-B,C- 376122	05/05/75
WO-A1- 9016092	27/12/90	EP-A- 0478709	08/04/92
		US-A- 4940179	10/07/90