United States Patent

[11] 3,624,594

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[54] **ELECTRICAL CONNECTOR ASSEMBLY**
1 Claim, 15 Drawing Figs.

[52] **U.S. Cl.** ..... **339/116 C,** 339/117 R
[51] **Int. Cl.** **H01r 7/00**
[50] **Field of Search** 339/116, 213, 94, 143, 218, 102; 156/306

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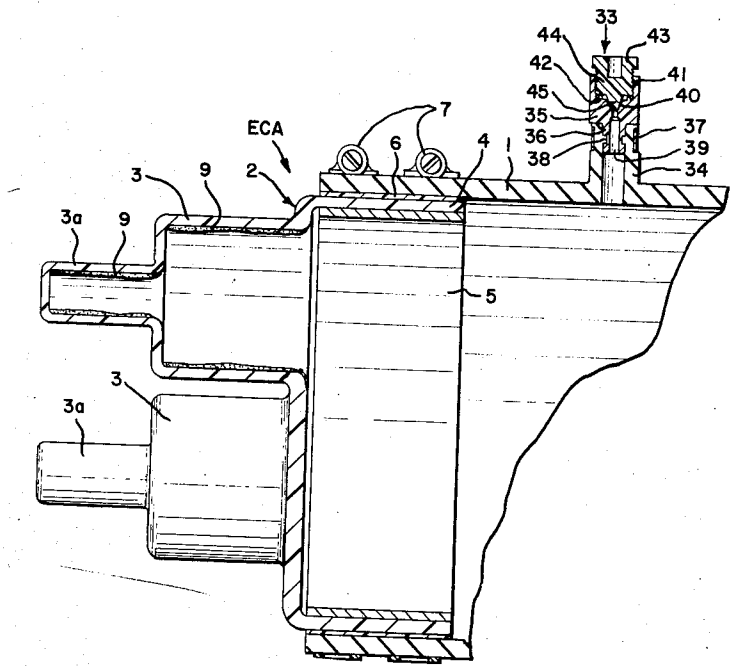
ABSTRACT: An electrical connector assembly comprises a sleeve within which electrical terminals effect electrical connections between conductors of cables. The cables enter the sleeve through heat-shrinkable members that are heat shrunk and sealed onto the cables.



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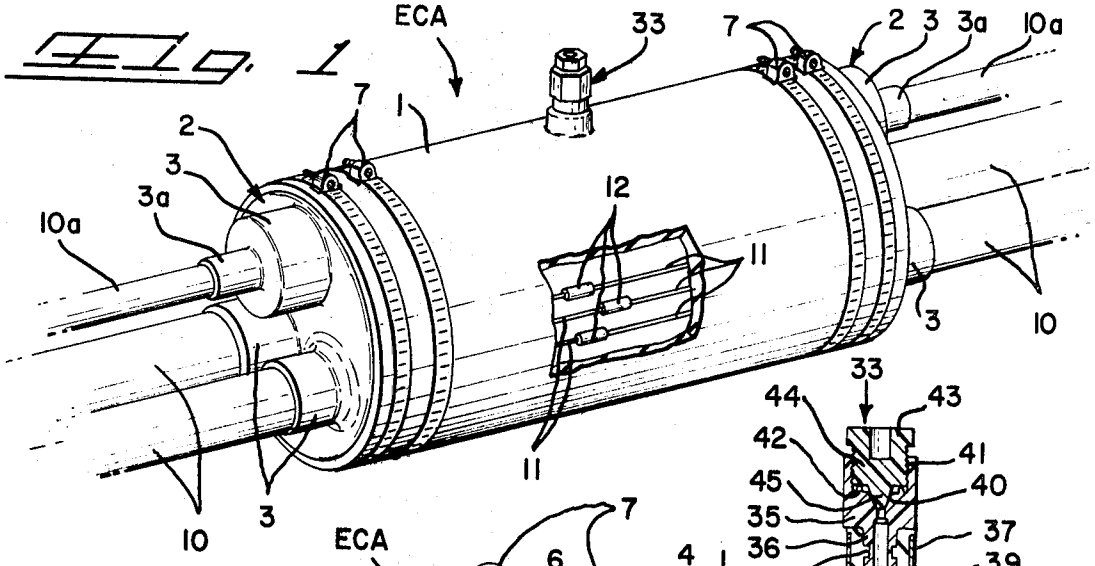
SHEET 1 OF 4

Fig. 1



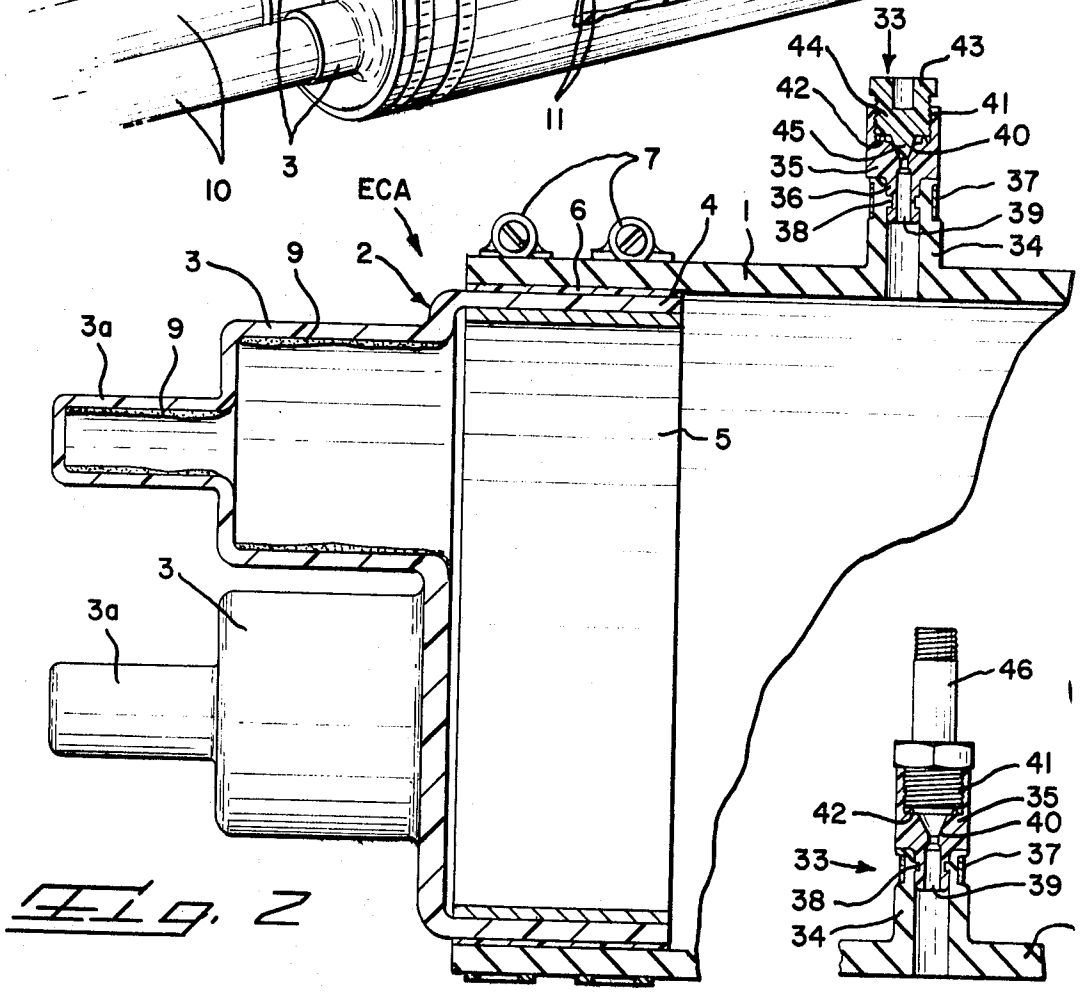


Fig. 2

Fig. 2a

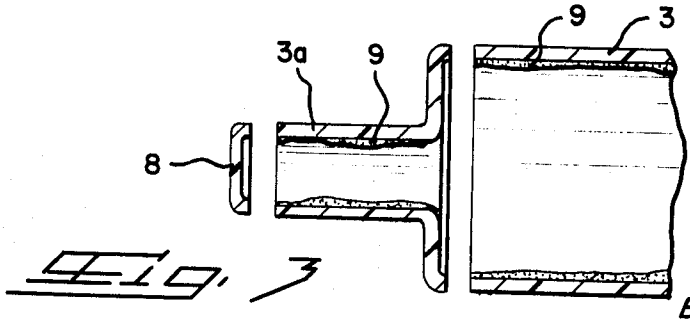


Fig. 3

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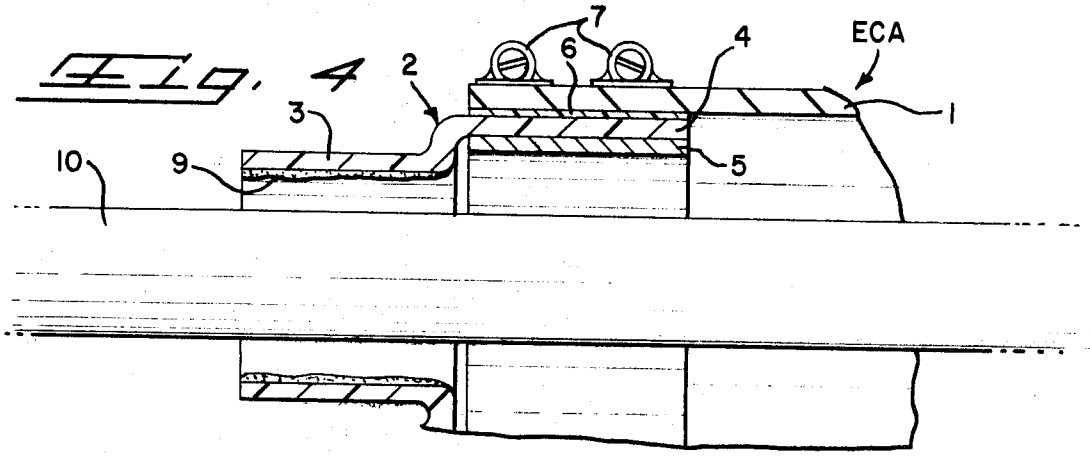
Fig. 4



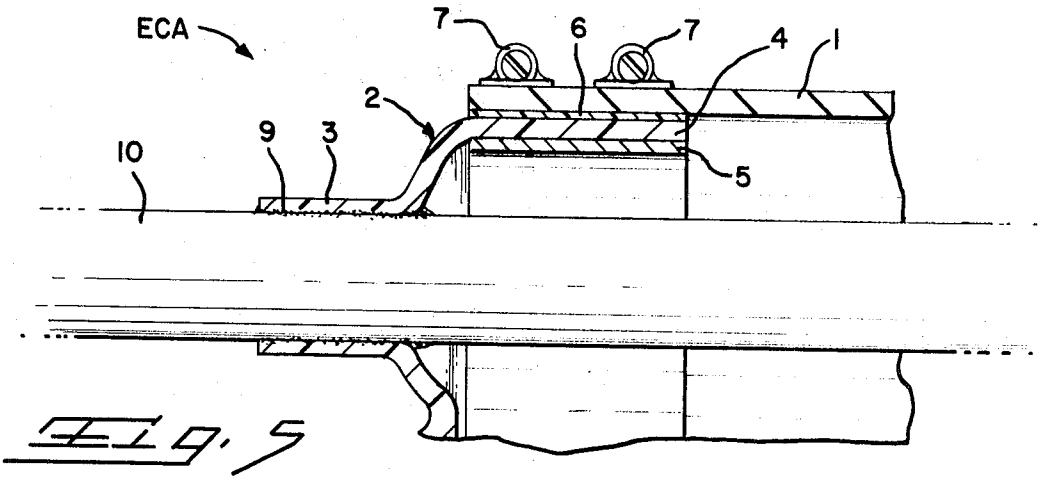


Fig. 5

Fig. 6

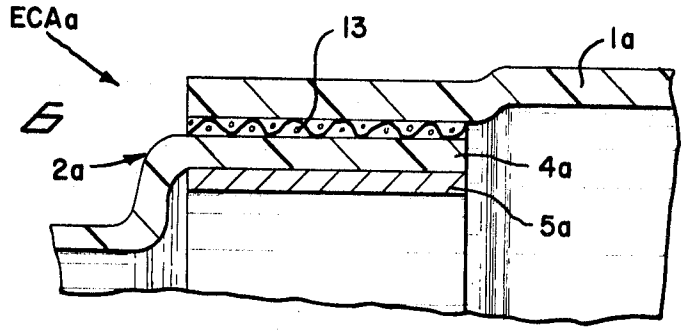
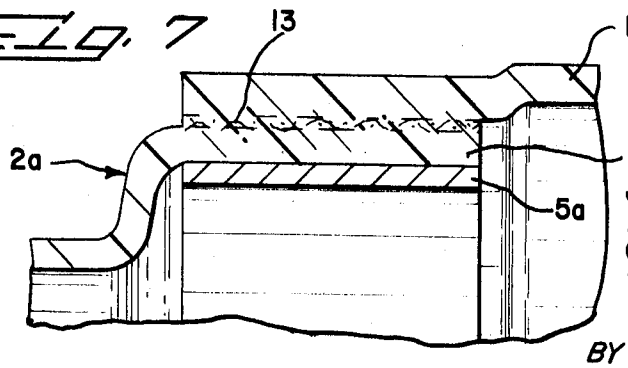


Fig. 7



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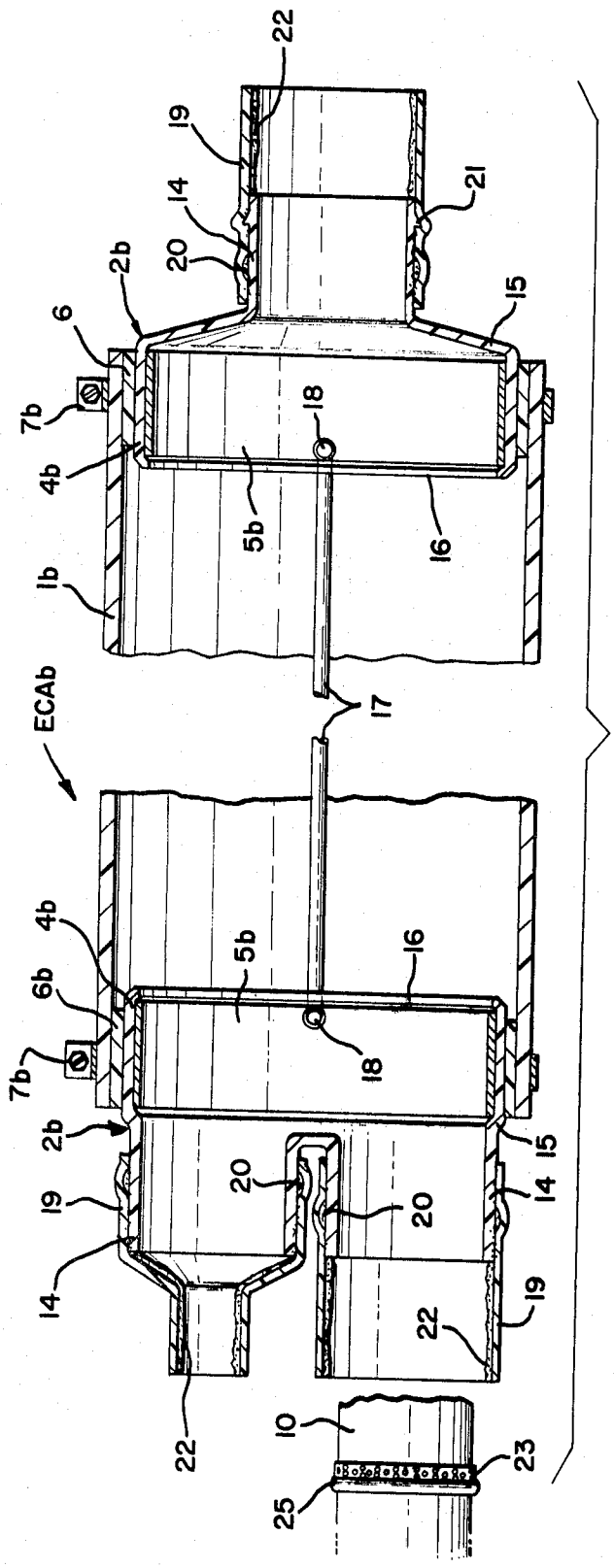

FIG. 8

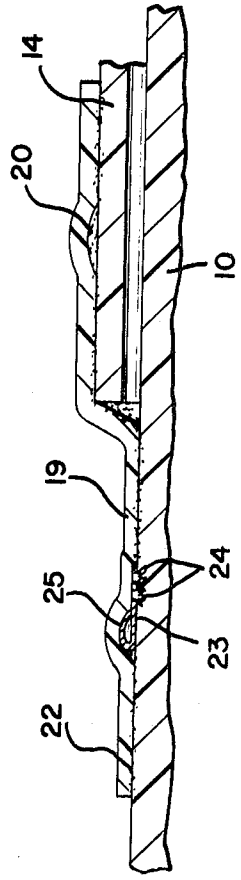

FIG. 10

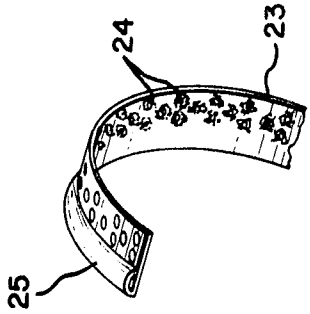

FIG. 9

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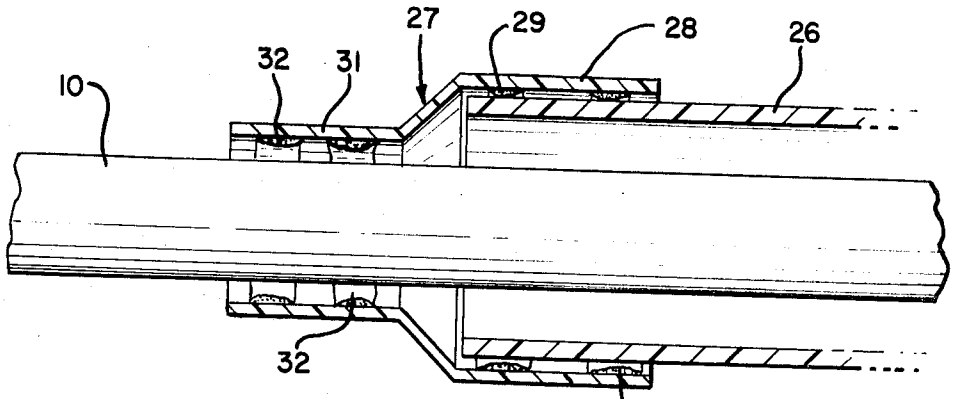

FIG. 13

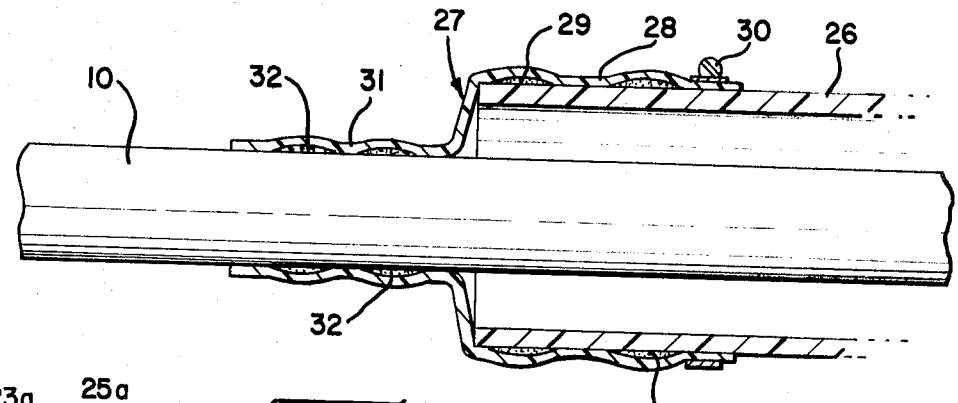

FIG. 14

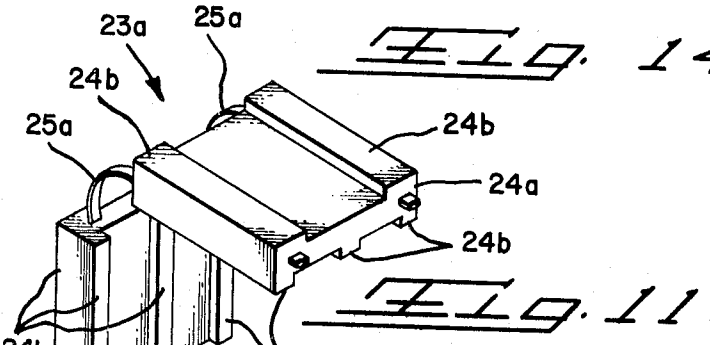

FIG. 11

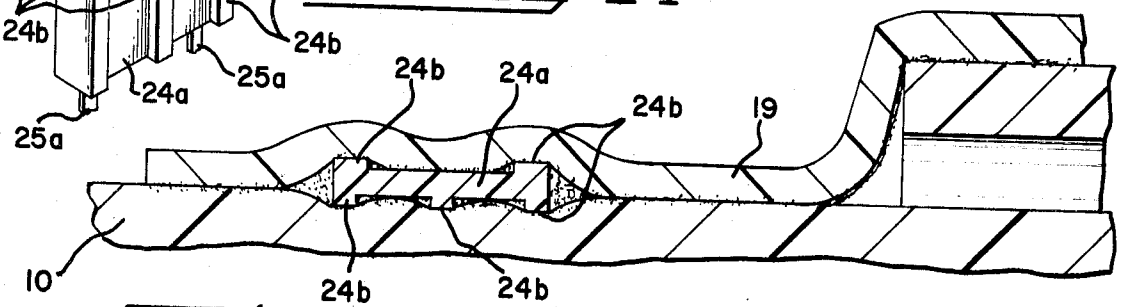

FIG. 12

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ELECTRICAL CONNECTOR ASSEMBLY

SPECIFICATION

This invention relates to an electrical connector assembly and more particularly to a connector assembly for hermetically sealing a plurality of electrical connections between conductors or wires.

In the utility and communication fields, cables and wires are being buried underground because equipment is available today to bury the cables or wires in an economical manner and the ground provides better protection so long as the electrical connections between cables and wires are maintained in a sealed connector assembly to prevent damage, corrosion, or shorting. The connector assemblies have to be watertight and airtight, and, in most cases, they have to reenterable in order to make new connections between existing wires or to add new cable means. Also, in some cases it is necessary to provide entrance of cable means into buildings and large junction boxes and retain the integrity of the seal.

An object of the invention is to provide an electrical connector assembly for housing electrical conductors in a hermetically sealed chamber.

Another object is the provision of an electrical connector assembly wherein one or more cables can be sealingly introduced into the chamber.

A further object is to provide means connected between end seals of the electrical connector assembly to maintain the end seals in position.

An additional object is the provision of end seal means in an end of a sleeve of the electrical connector assembly which is adapted to be sealingly shrunk down onto a cable means when heat is applied to a section thereof.

A still further object is to provide end seal means in an end of a sleeve of the electrical connector assembly which is provided with heat-shrinkable members for sealing engagement therewith and cable means when heat is applied thereto.

Still another object is the provision of stepped sections of a heat-shrinkable part of end seal means to accommodate a range of cable sizes.

A still additional object is to provide cleats for disposition on the cable means within a heat-shrinkable part of an end seal means which is provided with means for digging or embedding into the sheath of the cable means when the heat-shrinkable part is heat shrunk onto the cable means or into both the cable sheath and the heat-shrinkable part to increase the tensile strength therebetween.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there are shown and described illustrative embodiments of the invention; it is to be understood, however, that these embodiments are not intended to be exhaustive nor limiting of the invention but are given for purposes of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the conditions of a particular use.

In the drawings:

FIG. 1 is a perspective view of an electrical connector assembly in position on electrical cables with part of the sleeve broken away;

FIG. 2 is a cross-sectional view of one end of the electrical connector assembly prior to being assembled on electrical cable means;

FIG. 2*a* is a cross-sectional view showing a valve member in position in the test member;

FIG. 3 is an exploded cross-sectional view of a heat-shrinkable section of an end seal;

FIG. 4 is a cross-sectional view of one end of the electrical connector assembly showing a heat-shrinkable section of an end seal prior to being heat shrunk onto an electrical cable means;

FIG. 5 is a view similar to FIG. 4 with the heat-shrinkable section heat shrunk into position on the electrical cable means;

FIG. 6 is a part cross-sectional view of an embodiment of the electrical connector assembly prior to the end seal being secured to the sleeve;

FIG. 7 is a view similar to FIG. 6 illustrating the end seal being secured to the sleeve;

FIG. 8 is a cross-sectional view of another embodiment of the electrical connector assembly;

FIG. 9 is a part perspective view of a retaining cleat;

FIG. 10 is a part cross-sectional view of a heat-shrinkable member heat shrunk onto electrical cable means;

FIG. 11 is a part perspective view of an alternative embodiment of the retaining cleat;

FIG. 12 is a view similar to FIG. 10 using the retaining cleat of FIG. 11;

FIG. 13 is a part cross-sectional view of a further embodiment of the invention prior to being heat shrunk into position on an electrical cable and a rigid pipe; and

FIG. 14 is a view similar to that of FIG. 11 illustrating the heat-shrinkable member heat shrunk into position.

Turning now to the drawings and more particularly FIGS. 1 through 5, an electrical connector assembly ECA is illustrated and it comprises sleeve 1 and end seals 2. Sleeve 1 is made of any suitable dielectric material whereas end seals 2 are formed of electrically insulating materials such as, for example, thermally stabilized modified polyolefin with heat-shrinkable sections 3 modified so as to be shrinkable upon application of heat thereto. A cross-linked material has been found to provide the heat-shrinking characteristics. Any heat-recoverable material having a property of elastic memory can be utilized. End seals 2 are also provided with semirigid sections 4 within which a metal ring 5 is positioned. Ring 5 is preferably made of aluminum but it can, of course, be made from any other suitable material.

Sections 4 of end seals 2 with metal rings 5 disposed within sections 4 are positioned within the ends of sleeve 1 with an annular member 6 disposed therebetween, material such as, for example, rubber, neoprene or the like. Clamps 7 are positioned on sleeve 1 overlying sections 4 of end seals 2 to clamp sleeve 1 overlying sections 4 of end seals 2 to clamp 1 to end seals 2 with annular members 6 providing a sealed connection between sleeve 1 and sections 4 and metal rings 5 provide backup pressure for effecting the sealed connection.

Heat-shrinkable sections 3 are provided with other heat-shrinkable sections 3*a* which are stepped inwardly from sections 3 and are coaxial therewith. Depending upon the size cable to extend through heat-shrinkable sections 3 or 3*a*, an end 8 of section 3*a* can be severed therefrom and section 3*a* is shrunk into engagement with the cable upon the application of heat thereto or section 3*a* can be severed from section 3 so that section 3 can be heat shrunk onto the cable as shown by FIGS. 1 and 3. Thus, the stepped configuration of heat-shrinkable sections 3 and 3*a* provides a wide range of cables that can be accommodated thereby.

A sealant 9 characterized as a nonsetting, nonsagging sealant adhesive such as a semithermoplastic sealant is coated on the inside surface of sections 3 and 3*a* so that upon application of heat to sections 3 or 3*a*, the sealant softens and the sections 3 or 3*a* shrink onto the electrical cables 10 or 10*a* so that the sealant flows around the sections of the cable onto which the sections 3 or 3*a* engage thereby forming a mechanical seal therewith.

In assembly, section 3 or 3*a* are prepared to accommodate electrical cables 10 or 10*a* and the cables are passed through respective sections 3 and 3*a*. Sleeve 1 is positioned along the cables containing one of end seals 2 or it can be secured to this one end seal. Electrical conductors 11 of the electrical cables are interconnected via electrical connectors 12 to effect the proper connections therebetween. After the electrical conductors 11 are electrically connected via electrical connectors 12, , sleeve 1 is positioned thereover and end seals 2 are

moved into the ends of sleeve 1 with annular members 6 positioned over sections 4 of end seals 2 whereupon clamps 7 are tightened to sealingly connect the ends of sleeve 1 to end seals 2. Heat is then applied via electrical heating means or in any other suitable manner to heat-shrinkable sections 3 or 3*a* thereby causing these sections to shrink into engagement with electrical cables 10 or 10*a* with sealant 9 providing a sealed connection therebetween and the sealant flows around the cables and partially out through the outer ends of sections 3 or 3*a* thereby forming a seal.

The seal between cables 10 or 10*a* and sections 3 or 3*a* and between sleeve 1 and sections 4 of sealing end seals 2 provides a hermetically sealed chamber within electrical connector assembly ECA so that the cables can be maintained under pressure if they are to be subjected to pressure and to protect the connections from an ambient environment to prevent corrosion or damage to the connections. Heat-shrinkable sections 3 and 3*a* can be left intact if no cable is to be sealed therein and they can be used at some later date to add a cable when desired.

If it is necessary to reenter the electrical connector assembly, clamps 7 are loosened and sleeve 1 is moved to one side to make new connections or disconnections as desired. Once this has been accomplished, sleeve 1 is moved back into position over end seals 2 and clamps 7 tightened to reinstitute the hermetically sealed chamber of the electrical connector assembly. Sleeve 1 can be provided with one end closed so that cables enter only one end seal 2.

The materials of the sleeve 1 and the annular members 6 while under pressure from the clamps 7 effect a cohesive affinity for each other over a period of time, i.e., these materials become united to the extent that they will form and maintain a seal even after the clamps have been removed. Such an arrangement assures an excellent seal and can be disconnected and reconnected time and again whereby the seal is effected each time. To disunite the sleeve 1 from members 6, heat is applied thereto.

FIGS. 6 and 7 illustrate electrical connector assembly ECA*a* which is a modified embodiment of the electrical connector assembly ECA of FIGS. 1 through 5. In this embodiment, the structure thereof is identical with that of the embodiment shown in FIG. 1 with the following exceptions: annular members 6 are in the form of annular grids of wires 13 located between sleeve 1*a* , which is similar to sleeve 1 of FIG. 1, and semirigid sections H*a*, similar to the section 4 of FIG. 1. Grids of wires 13 are of the type that when connected to an electrical source of supply they become heated so as to cause the ends of sleeve 1*a* and sections 4*a* to become flowable to weld them together to provide a permanently sealed connection therebetween. In order that the ends of sleeve 1*a* and sections 4*a* are capable of being heat-sealed together via wires 13, the mating surfaces have to be noncross-linked so as not to be thermally stabilized heat-shrinkable material in these areas, otherwise no flowability of the material will result to effect a weld therebetween. Metal rings 5*a* are preferably disposed within sections 4*a* to lend strength to the electrical connector assembly. Thus the rings 5*a* are similar to the rings 5 of FIG. 1. Once the sleeve 1*a* has been permanently connected to sections 4*a* of end seals 2*a*, electrical connector assembly ECA*a* is nonreenterable as opposed to the embodiment of FIGS. 1 through 5, so that this electrical connector assembly is permanent. With reference to FIG. 6, no clamps, such as the clamps 7, are shown or described. Since the remaining structure of the embodiment shown in FIG. 6 is identical to that of the embodiment shown in FIG. 1, further illustration or description thereof is eliminated as unnecessary.

Electrical connector assembly ECA*b* is illustrated in FIGS. 8 through 10 and this is another embodiment of the invention. End seals 2*b* are molded from a suitable material to provide rigid structures provided with tubular sections 14 through which the electrical cables 10 pass. Metal rings 5*b* are disposed within end seals 2*b* and they are maintained therein via inwardly directed areas 15 from which tubular sections 14 are formed and inwardly directed ends 16. As can be discerned, sleeve 1*b* via annular members 6*b* and clamps 7*b* as disclosed in FIGS. 1–5 or they can be permanently connected together as disclosed in conjunction with FIGS. 6 and 7.

Plastic-coated steel rods 17 (only one being shown but with preferably three in number being used) have their ends disposed in openings 18 in sections 4*b* and metal rings 5*b*. Rods 17 maintain end seals 2*b* in position when sleeve 1*b* is secured to sections 4*b* via clamps 7*b* so that end seals 2*b* are not displaced and remain in position during the clamping operation. Rods 17 maintain end seals 2*b* in proper position during assembly of sleeve 1*b* thereto as well as during shrinking operation being performed on the end seals if they are heat shrinkable. Rods 17 also maintain end seals 2*b* in position when the assembly is pressurized.

Tubular sections 14 of each end seal 2*b* can be any number to accommodate the number of cables to be connected to the electrical connector assembly such as one section 14 as illustrated in end seal 2*b* at the right-hand side of FIG. 8 and two sections 14 as illustrated by end seal 2*b* at the left-hand side of FIG. 8 so that two cables are connected to a single cable as illustrated by the electrical connector assembly ECA*b* of FIG. 8, but this is merely illustrative of the combinations of cables to be connected since any combination can be interconnected via the electrical connector assembly.

Tubular members 19 of heat-shrinkable dielectric material are heat shrunk upon the application of heat thereto to tubular sections 14 with rings 20 of sealant material disposed on tubular sections 14 prior to tubular members 19 being heat shrunk thereon to form a sealed connection therewith. In order to secure tubular members 19 onto tubular sections 14, annular barbs 21 can be provided on tubular sections 14 to increase the tensile strength between tubular sections 14 and tubular members 19. Sealant 22 is applied to the interior surface of tubular members 19 to sealingly engage the dielectric sheaths of electrical cables 10 when tubular members upon the application of heat thereto are shrunk into engagement with the dielectric sheaths of the electrical cables.

In order to increase the tensile strength between the dielectric jackets of electrical cables and tubular members 19, sheath cleats 23 are disposed around the cable sheaths so as to be positioned within the sections of the tubular members to be heat shrunk into engagement therewith so that barbs 24 of the sheath cleats bite into the cable sheaths when the tubular members are shrunk down onto the cables and the tubular members in the areas of the cleats conform thereto thereby locking the cleats in position. Bent-over sections 25 of cleats 23 enable the locking action to take place due to sections 25 defining a means to effect the locking.

An alternative sheath cleat 23*a* is illustrated in FIG. 11 and this cleat comprises segments 24*a* having projections 24*b* extending outwardly from top and bottom surfaces thereof and interconnected via flexible members 25*a* so that a cleat 23*a* of appropriate length can be applied around a cable sheath of cable 10 within a tubular member 19 and the heat applied to shrink member 19 onto the cable sheath causes the member 19 and the cable sheath in the area of heating to be softened whereby projections 24*b* are embedded within the cable sheath and member 19 as illustrated in FIG. 12 thereby providing excellent tensile strength therebetween as a result of the necking down of member 19 onto the cable sheath. Cleat 23*a* is arranged on the cable sheath so that projections 24*b* extend normal to the axis of the cable to provide the optimum retention characteristics.

Segments 24*a* can be metal or metal-coated plastic having good heat-conducting characteristics to readily conduct the heat being applied to member 19 to shrink same to the cable sheath and member 19 so that projections 24*b* are embedded therewithin when member 19 is shrunk onto the cable sheath.

FIGS. 13 and 14 illustrate an additional embodiment of the invention wherein the assembly is to be used for providing a sealed connection between a cable and a conduit 26 for passing the cable into a building structure or an outlet box.

Heat-shrinkable member 27 is provided with a first section 28 for heatkshrinking engagement with conduit 26 when heat is applied thereto to cause spaced annular rings 29 of sealant material disposed on the inside surface of section 28 to form spaced sealing areas between section 28 and conduit 26. Once section 38 has been heat shrunk onto conduit 26, clamp means 30 is applied thereto as illustrated in FIG. 14 to secure section 28 of heat-shrinkable member 27 in position on conduit 26 so that it cannot be easily removed therefrom or moved therealong.

Second section 31 of heat-shrinkable member 27 is provided with spaced sealing rings 32 along the inside surface thereof so that when heat is applied to section 31, section 31 is sealingly shrunk into engagement with the dielectric sheath of the cable 10 as illustrated in FIG. 14 so that spaced annular sealed areas are provided along section 31.

In the event that cable 10 is moved relative to conduit 26 and member 27, cable 10 is slidable relative to section 31 with the spaced sealed areas provided by sealing rings 32 maintaining their sealing capacity. The embodiment of FIGS. 13 and 14 is useful in areas prone to earthquake disturbances so that the communication or power cables or water and sewage conductors can be provided with movement without disrupting these essential services.

A flash test member 33 is provided on sleeve 1 as illustrated in FIGS. 1, 2 and 2*a* in order to place the electrical connector assembly under pressure after it has been assembled to test for leaks by applying a soapy solution to all potential leak areas to check for positive leaks.

Member 33 comprises a tubular projection 34, which can be formed as part of sleeve 1 or it can be a tubular member welded to sleeve 1, and a sealing insert 35. A tubular section 36 is provided by insert 35; it fits into projection 34 and is secured therein via ferrule 37 being decreased in diameter to frictionally engage section 36 and extrude material of section 36 into channel means 38 to provide an excellent sealed connection therebetween in accordance with the disclosure in U.S. Pat. No. 3,378,282. A passageway 39 extends through insert 35 and includes a conical section 40 which merges into threaded cavity 41. A annular arcuate-shaped projection 42 is located at the bottom of cavity 41. A sealing plug 43 has a threaded section 44 threadably in engagement with threaded cavity 41 and a conical projection 45 sealingly in engagement with conical section 40 when plug 43 is threaded tightly into insert 35. The angular configuration of conical projection 45 is just slightly less than that of conical section 40 in order to provide effective sealing capabilities therebetween due to the loading therebetween which causes cold-flowing of the material thereby resulting in a large area of contact instead of a line contact.

A spring-biased valve member 46 in the form of a tire valve can be threadably mounted in threaded cavity 41 with the annular projection 42 engaging the bottom of valve member 46 to form a seal therebetween. Thus, test member 33 has two sealing areas which are to form a seal between conical section 40 and conical projection 45 and between valve member 46 and annular projection 42. Valve member 46 enable the electrical connector assembly to be pressurized and sealing plug 43 maintains the pressurized integrity or the sealed condition thereof.

It will, therefore, be appreciated that the aforementioned and other desirable objects have been achieved; however, it should be emphasized that the particular embodiments of the invention, which are shown and described herein, are intended as merely illustrative and not as restrictive of the invention.

The invention is claimed in accordance with the following:

1. An electrical connector assembly comprising:

a sleeve member, end-sealing means positioned along one end of said sleeve member,

cable-receiving means provided on said end-sealing means and having graduated-sized portions for accommodating different diameter cable therethrough,

a rigid ring internally of said end-sealing means,

a ring grid of heater wires between said sleeve member and said end-sealing means,

outer clamping means clampingly engaging said sleeve member, said ring grid and said end-sealing means to said rigid ring,

said graduated-sized portions of said cable-receiving means having a cross-linked and heat-shrinkable portion shrunk over said cable in sealing relationship therewith,

said cable-receiving means having a non-cross-linked and meltable portion integral with said cross-linked and heat-shrinkable sized portions in meltable fused sealing relationship with respect to said sleeve member upon heating by said ring grid.

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