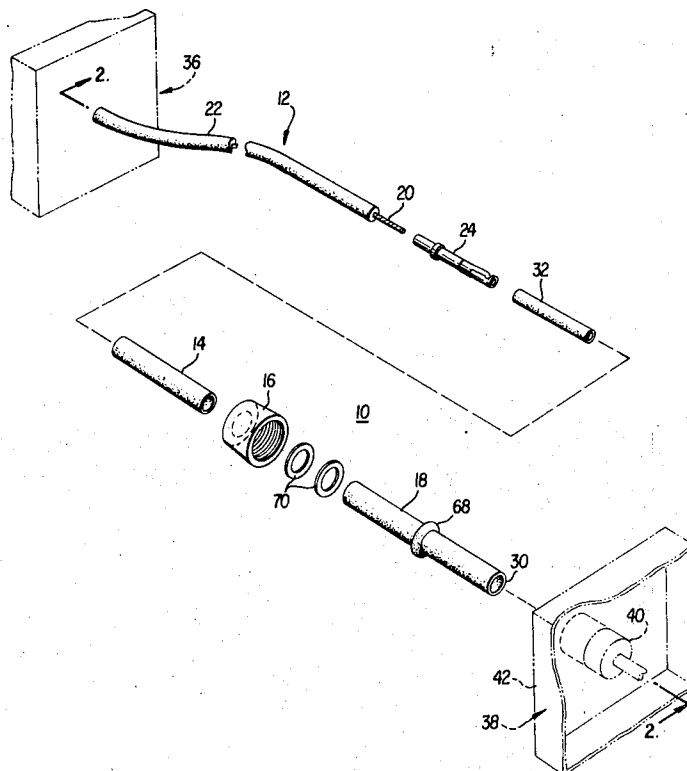
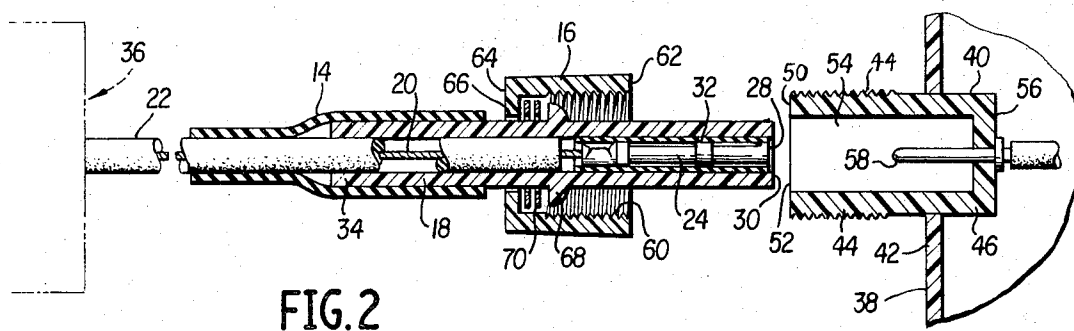
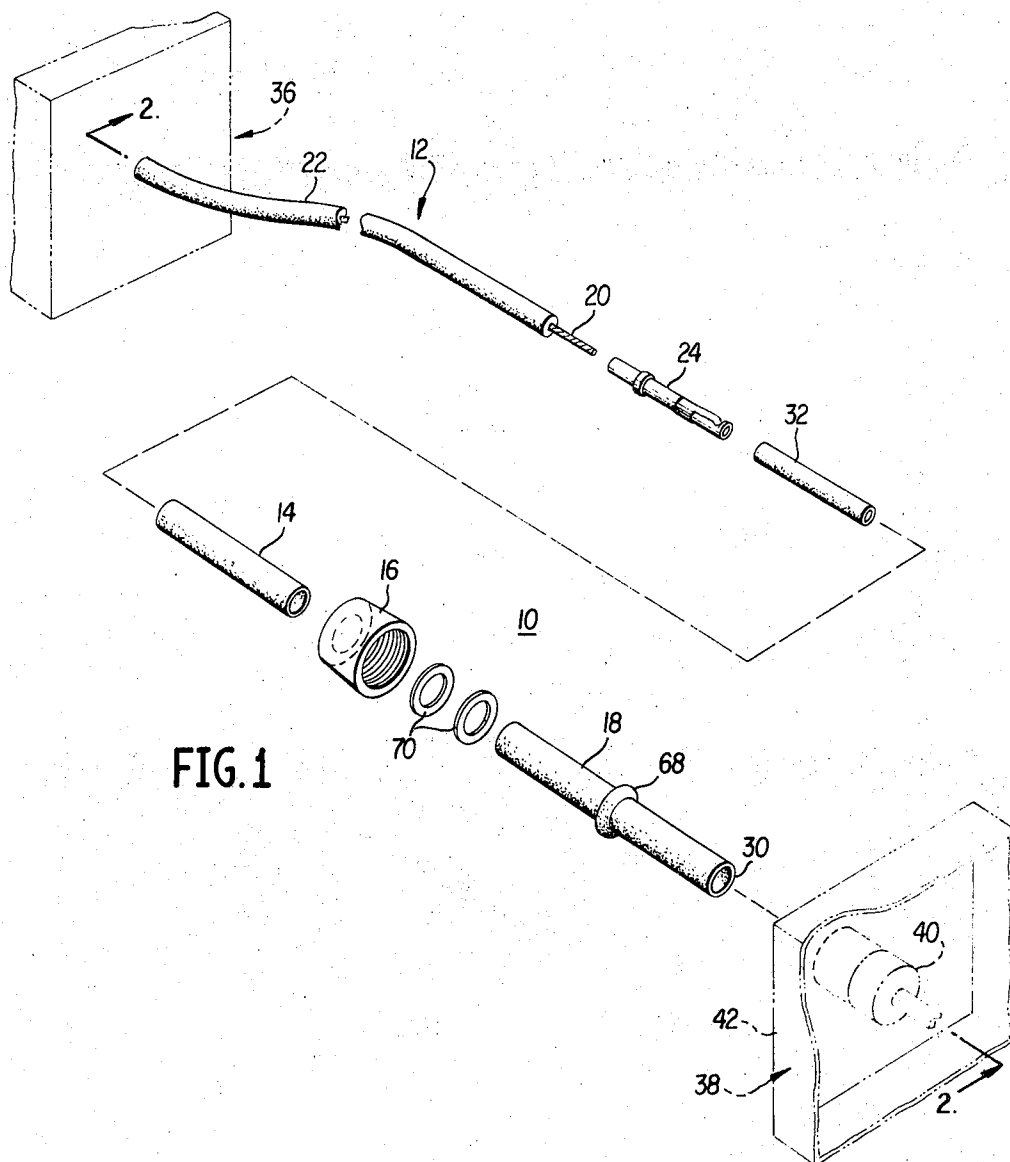


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8 Claims, 2 Drawing Figures





APPARATUS AND METHOD FOR FIELD-REPAIRING HIGH-VOLTAGE ELECTRICAL CONNECTOR LEAD ASSEMBLIES

BACKGROUND OF THE INVENTION

The present invention relates generally to electrical connectors and more particularly to a field-repairable high-voltage electrical connector lead assembly kit and a method of field-repairing high-voltage electrical connector lead assemblies. Conventional high-voltage electrical connector lead assemblies ordinarily comprise an insulated high-voltage conductor wire, one end of which is stripped of its insulation so as to provide for a connection with a contact pin socket. The contact pin socket may be crimped upon or soldered to the bared conductor wire, after which an insulating sheath or boot is permanently molded upon the conductor wire and contact pin socket in a surrounding, encapsulating fashion.

As may be expected, continual commercial utilization of such leads in various electrical systems and circuitry often results in a deterioration or breakdown in the electrical connections, for a multitude of reasons, such as, for example, fluid seepage or short circuiting either or both the stripped conductor wire and the contact pin socket may become damaged or cracked, and may even deteriorate or disintegrate. Under such conditions, the leads must necessarily be repaired or replaced if further operation of the various electrical systems is desired.

Repair of such connections however, has been found to be quite tedious and time-consuming, for the reason that such connections cannot be repaired in situ. To the contrary, if the conductor wire or contact pin socket has been impaired or has degenerated, the fact that the assembly constitutes in effect, a sealed unit, necessitates the replacement of the entire unit, i.e., the entire lead or the entire lead in addition to the electrical component to which it is attached. Heretofore, such could not be accomplished in the field, and thus, valuable time is dissipated in rectifying the damaged system, not to mention the period of time throughout which commercial utilization of the system cannot be realized. Thus, not only are repair costs increased, but operating costs are also multiplied, many times over.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a field-repairable high-voltage electrical connector lead assembly kit.

Another object of the present invention is to provide a field-repairable high-voltage electrical connector lead assembly kit which will permit the field-repair of high-voltage electrical lead connections, thereby reducing maintenance or repair time, and consequently, the attendant costs.

Still another object of the present invention is to provide a field-repairable high-voltage electrical connector lead assembly kit which will facilitate rapid repair of the particular system, thereby maintaining operating costs at a minimum.

Yet another object of the present invention is to provide a field-repairable high-voltage electrical connector lead assembly kit, which is adaptable for use with conventional lead assemblies.

It is a further object of the present invention to provide a method for the rapid field-repairing of high-voltage electrical connector lead assemblies.

The foregoing objectives are achieved according to this invention through the provision of a field-repairable high-voltage electrical connector lead assembly kit having the various electrical component parts corresponding to those incorporated into the system being repaired, the component parts of the kit being readily assembled in situ so as to immediately replace the damaged lead assembly. Upon verification of a damaged lead assembly, and the need for repair thereof, the lead assembly may be severed at a point to the rear of the insulating sheath or boot, thereby leaving exposed the remainder of the undamaged insulated conductor lead. The end portion of the insulation of such conductor lead may then be stripped away, exposing the conductor wire, to which a new contact pin socket from the kit may be crimped or soldered. Shrink tubing may then be slid over the contact pin socket and conductor wire, after which a new retention cap and insulation boot may be slid upon the conductor wire and contact pin socket in a fashion similar to that of the shrink tubing. A bonding agent may then be applied to the various components so as to secure them in relative positions. The shrink tubing may subsequently be moved forward so as to partially cover the insulation or boot, and may then be shrink-fitted with respect to such by conventional heat-shrinking means, thereby securing together the various components of the lead assembly. A new lead assembly is thus available for replacement into the electrical circuitry, without the necessity of having to replace the entire lead and the electrical components or systems to which the lead is attached.

BRIEF DESCRIPTION OF THE DRAWING

Various other objects, features, and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description when considered in connection with the accompanying drawings, in which like reference characters designate like or corresponding parts throughout the several views, and wherein:

FIG. 1 is an exploded perspective view of a field-repairable high-voltage electrical connector lead assembly kit constructed according to this invention and showing its component, cooperative parts; and

FIG. 2 is a cross-section view of an assembled high-voltage electrical connector lead assembly kit as illustrated in FIG. 1, taken along line 2—2 of FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, there is shown a field-repairable high-voltage electrical connector lead assembly kit generally indicated by the reference character 10 comprising an insulated high-voltage lead 12, a piece of shrink tubing 14, a tubular retention cap 16, and an elongate insulation boot 18. High-voltage lead 12 is composed of a wire conductor portion 20 and an insulating sheath portion 22 which surroundingly encapsulates wire conductor portion 20. One end of high-voltage lead 12 may be stripped of its insulation sheath 22 so as to expose a portion of the wire conductor 20 in order to facilitate the connection of the wire conductor 20 with a cylindrical contact pin socket 24, contact

pin socket 24 being either crimped upon or soldered to the wire conductor 20.

An elongate, substantially flexible molded tubular boot 18 is provided to serve as insulation means for the connection between the high-voltage wire conductor 20 and contact pin socket 24. The inside diameter of insulation boot 18 is slightly greater than the outside diameter of insulation sheath 22 of high-voltage lead 12, the difference being great enough such that high-voltage lead 12 may be inserted within insulation boot 18 through one end of its axial cylindrical opening 26, yet the difference being small enough so as to provide a snug fit between insulation boot 18 and high-voltage lead 12. High-voltage lead 12 is inserted within boot 18 to extent that an annular end face 28 of socket 24 is in the same plane as annular end face 30 of boot 18. It will be noted with particular reference to FIG. 2, that contrary to the tolerance fit existing between boot 18 and high-voltage lead insulation sheath 22, a tolerance fit may not exist between the inside diameter of boot 18 and the outside diameter of socket 24. In order to assure such a fit, in addition to providing additional insulation, a flexible insulation sleeve 32, which may be made of various insulative materials, such as, for example, silicone-rubber or natural rubber, is fitted over socket 24, and as well, may fit over any portion of the conductor wire 20 remaining between socket 24 and high-voltage lead wire conductor insulation sheath 22, and may be secured thereto by the utilization of a bonding agent applied to socket 24 and the wire between socket 24 and sheath 22. To additionally secure boot 18 relative to socket 24 and insulation sleeve 32, as well as high-voltage lead 12, the exterior surface of insulation sheath 22 of lead 12, which will be in contact with boot 18, and the exterior surface of insulation sleeve 32, are both coated with a suitable bonding agent. Similarly, the bonding agent is applied to the rear exterior cylindrical surface 34 of boot 18, as well as the exterior surface of insulation sheath 22 which lies to the rear of boot 18, whereby flexible shrink tubing 14, which may be made of various materials, such as for example, a silicone elastic, may be secured to, and will secure together, in surrounding, encapsulating fashion, high-voltage lead 12 and boot 18. Shrink tubing 14 may be heat cured by conventional heat-shrinking methods. In addition to securing together the aforementioned component parts, shrink tubing 14 performs a strain relief function for the assembly, which will decrease the possibility of failure of the connections, as well as eliminating electrical tracking.

It will of course be understood from an examination of the drawings, that the assembled high-voltage electrical connector lead assembly is usually permanently secured at one end, such as, for example, by potting, to various electrical components generally indicated by the reference character 36, while being detachably secured at its other end to various other electrical components generally indicated by the reference character 38. The means provided for detachably securing the lead assembly generally comprises a cylindrical bushing 40. Bushing 40 may be of a suitable dielectric material, preferably of a type which can be threaded and molded in plastic, such as for example, a laminated phenolic-base resin, steatite ceramic, or the like. It is seen that in order to facilitate assembly between the lead assembly and the electrical components 38, bushing 40 extends through casing 42 of, for example, a particular

sealed electrical unit housing components 38, thereby defining an end portion 44 which projects from the electrical unit and an end portion 46 which is interior of the unit. Projecting portion 44 is externally threaded as at 48, threads 48 extending almost the full length of portion 44 or approximately one-half the length of bushing 40, and is also centrally open. Annular end face 50 of portion 44 defines an axial aperture 52 which serves as an entranceway to recess 54 which extends substantially over the entire length of bushing 40, recess 54 being terminated by end face 56 of end portion 46.

Inserted within end face 56 by conventional means, and located along the longitudinal axis of bushing 40, is a contact pin 58, which extends axially within recess 54 of bushing 40. Contact pin 58 makes electrical contact with electrical components 38 by conventional connectors, not shown. It is of course apparent upon examination of FIG. 2, that contact pin 58 will make electrical contact with socket 24 upon being friction-fitted therein, whereas boot 18 will be tolerance-fitted within bushing 40, the outside diameter of boot 18 corresponding to the inside diameter of bushing 40.

To finally secure the assembly to bushing 40, a tubular retention cap 16 is provided, cap 16 being partially internally threaded as at 60 at its open end 62 for cooperation with external threads 48 of bushing 40. Cap 16 is closed at its end 64, although a central aperture 66 is defined within end wall 64, aperture 66 being of such diameter that cap 16 is able to fit snugly in surrounding fashion, with respect to boot 18. In conjunction with cap 16, a resilient O-ring 68 is provided, which may be movable upon the exterior surface of boot 18, or integrally molded therewith. The diameter of O-ring 68 is such that it is enabled to be seated within cap 16 against the interior face of end wall 64, while at the same time being in tight surrounding engagement with boot 18, in the instance where it is not integrally molded therewith. Lastly it is noted that a pair of anti-friction washers 70, are provided for the purpose of preventing wear between cap 16 and O-ring 68, due to the threading action of cap 16 relative to bushing 40, as will become more apparent hereinafter.

In utilizing the kit of the present invention to perform field repairs upon high-voltage electrical connector lead assemblies, previously being integrally molded units, as hereinbefore mentioned, upon the detection of a damaged assembly, the assembly may be removed from bushing 40. The damaged assembly may then be severed from high-voltage lead 12 at a point directly to the rear of the integrally molded boot 18, and with the kit of the present invention, a new assembly may be constructed in situ. According to the method of the present invention, after severing the damaged assembly from the remainder of high-voltage lead 12, the free or severed end of high-voltage lead 12 is partially stripped of its insulation sheath 22 so as to expose its wire conductor portion 20. Socket 24 in the kit may then be secured to wire conductor portion 20. Socket 24 in the kit may then be secured to wire conductor portion 20 by means of soldering or crimping. At the conclusion of this step, shrink-tubing 14, tubular cap 16, anti-friction washers 70, and boot 18 all provided in the kit, are then slipped over socket 24 and high-voltage lead 12, in the precise order recited. A bonding agent may then be applied to socket 24 as well as any remaining portion of wire 20 between socket 24 and high-voltage

lead insulation 22, whereby flexible insulation sleeve 32 may be positioned and secured relative to socket 24 and lead 12. After securing sleeve 32, a bonding agent may then be applied to the external surfaces of sleeve 32, as well as to appropriate portions of the exterior surface of insulation sheath 22 of high-voltage lead 12 and rear exterior cylindrical surface 34 of boot 18, whereby boot 18 is secured to high-voltage lead 12 and insulation sleeve 32, while shrink tubing 14 is secured to boot 18 and high-voltage lead 12. The tubular cap 16, with its associated washers 70 is of course properly positioned between shrink tubing 14 and O-ring 68. Shrink tubing 14 may subsequently be shrink-fitted, the bonding agent being cured, and the new, replacement assembly is completed. The completed assembly may then of course be inserted within bushing 40, boot 18 being inserted within bushing recess 54, whereupon bushing contact pin 58 is ultimately inserted within contact pin socket 24 of the repaired assembly. Simultaneously with the seating of the relative component parts, O-ring 68 will abut annular end face 50 of bushing 40, where, upon the screw-threading engagement of tubular cap 16 with bushing 40, O-ring 68 will be axially compressed between tubular cap end face 64 and bushing annular end face 50, while at the same time being radially expanded whereby O-ring 68 will act as a fluid-tight seal.

Thus, it may be seen that the high-voltage electrical connector lead assembly kit of the present invention has important advantages over the known prior art structures in that the kit permits the rapid field repair of high-voltage electrical connector lead assemblies which thereby greatly reduces maintenance and operating costs. Furthermore, the kit of the present invention may be utilized in conjunction with conventional high-voltage electrical connector lead assemblies. For further versatility, boots of various sizes and sleeves may be made so as to be adaptable to various applications.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is to be understood, therefore, that within the scope of the appended claims the present invention may be practiced otherwise than as specifically described herein. Accordingly,

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A field-repairing kit for repairing high-voltage sheathed electrical connector lead assemblies in the field, comprising:

a contact pin socket for securement to said high-voltage electrical connector lead extending from the sheath;

an insulation boot means of internal diameter to snugly receive said contact pin socket and of a length to extend over and snugly receive an adjacent portion of the sheath;

a section of shrink-tubing for closely surrounding that end of the boot furthest from the socket and for also closely surrounding an adjacent portion of the sheath; and

an internally threaded retention cap for loosely sur-

rounding said boot and having an end wall, said boot having a radially projecting wall for engagement by the end wall.

2. A field-repairing kit for repairing high-voltage sheathed electrical connector lead assemblies in the field, as set forth in claim 1, wherein said shrink-tubing has an initial inside diameter at least as great as the outside diameter of said boot.

3. A field-repairing kit for repairing high-voltage sheathed electrical connector lead assemblies in the field, as set forth in claim 1, wherein said insulation boot means comprises an insulation sleeve for surrounding said contact pin socket and an adjacent length of sheath and a separate sleeve therewithin substantially the length of said contact pin socket.

4. A field-repairing kit for repairing high-voltage sheathed electrical connector lead assemblies in the field, as set forth in claim 1, wherein said kit additionally comprises anti-friction washers for being disposed upon said boot between said retention cap and said radially projecting wall.

5. A method of field-repairing defective high-voltage sheathed electrical connector lead assemblies comprising the steps of:

severing said high-voltage electrical connector lead from said defective high-voltage electrical connector lead assembly;

stripping said high-voltage electrical connector lead of its insulation sheath at said severed end so as to expose its wire conductor;

securing a contact pin socket to said exposed wire conductor;

sliding a piece of shrink-tubing onto the sheath of said high-voltage electrical connector lead;

sliding a tubular threaded retention cap onto the sheath of said high-voltage electrical connector lead;

sliding an insulation boot onto said high-voltage electrical connector lead sheath and contact pin socket through said tubular retention cap;

securing a portion of said shrink-tubing upon said boot; and

heating said shrink-tubing to shrink-fit it onto said high-voltage electrical connector sheath and said insulation boot.

6. A method of field-repairing defective high-voltage sheathed electrical connector lead assemblies as set forth in claim 5, wherein said shrink-tubing, retention cap, and boot are slid onto said high-voltage electrical connector lead from said severed end.

7. A method of field-repairing defective high-voltage sheathed electrical connector lead assemblies as set forth in claim 5, wherein said boot is slid onto said high-voltage electrical connector lead until one end of said boot lies flush with one end of said contact pin socket while the other end of said boot overlaps said insulated portion of said high-voltage electrical connector lead.

8. A method according to claim 7 including the further step of sliding an insulation sleeve into the said one end of the boot and onto the outer surface of the contact pin socket.

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