ABSTRACT OF THE DISCLOSURE

A high voltage, high altitude connector and lead assembly is disclosed which features a receptacle having a contact pin therein to mate with a contact carried by the lead assembly and surrounded by a first sleeve of corona resistant resilient material inserted within the receptacle. The lead assembly includes a nut internally threaded to mate with threading on the outside of the receptacle. The first sleeve is made of the lead out along the conductive core of the lead through the nut and is surrounded by a second sleeve made to extend thereover and along the insulating sheath of the lead for a distance sufficient to permit withdrawal of the lead assembly by grasping the second sleeve. The second sleeve is comprised of an insulating material which is substantially stiffer than that of the first sleeve and is resistant to deterioration caused by certain materials found in aircraft fuels such as Coolanol. The first and second sleeves are bonded together and the second sleeve is provided with a plastic ferrule shrunk down at the end thereof driving the material thereof against the sheath of the lead.

Summary of the invention

This invention relates to a connector and lead assembly of the type adapted for high-voltage, high-altitude applications, wherein electrical corona discharge is a problem.

Accordingly, it is an object of the present invention to provide a high-voltage, high-altitude corona resistant connector and lead assembly which is improved with respect to insertion and withdrawal and in use wherein the lead is forced to have a radial entry into the assembly. Another object is to provide an improved lead assembly for applications wherein the assembly must be protected against certain substances found in and about aircraft.

It is a further object of the invention to provide a corona resistant lead assembly which features a positive placement of the forward end of the lead for insertion within a mating receptacle to prevent air pockets being formed within the receptacle of use.

It is another object of the invention to provide a lead assembly of a configuration and material characteristics to eliminate the need for noxious materials such as silicone grease employed in the receptacle of use.

Still another object of the invention is to provide an inexpensive high-voltage, high-altitude lead assembly which prevents conductor breakage upon removal from a mating receptacle.

It is yet another object of the invention to provide a high-voltage lead assembly for use in environments which include ingredients incompatible with standard high-voltage lead insulating materials.

The invention achieves certain of the foregoing objectives by a lead assembly wherein the insulating portions thereof which fit into the receptacle of use are of a relatively soft and flexible material with adjacent and exposed insulating portions being of a stiffer material. The soft, flexible material is made of a configuration to completely fill the receptacle cavity and the stiffer material is arranged to be axially loaded to drive the softer material in compression to exclude substantially all air from the receptacle of use. Additionally, in another aspect, the stiffer material is made resistant to deteriorating ingredients and to overfill and protect the corona resistant material. In yet another aspect, the assembly is made to accurately position the lead for full insertion in the receptacle.

In the drawings:

FIGURE 1 is a perspective of connectors and lead assemblies included to demonstrate uses of the invention;

FIGURE 2 is a section showing the details of the receptacle and of the lead assembly, prior to connection;
FIGURE 3 is a section showing the receptacle and lead assembly at first contact; FIGURE 4 is a section showing the receptacle and lead assembly fully mated; and FIGURES 5 and 6 are sections showing portions of the lead during preferred steps in manufacture. Turning now to FIGURE 1, the numeral 10 represents a power supply chassis from which it is desired to supply a high-voltage signal to drive some load, such as a cathode ray tube or a magnetron. Loads of this type are usually associated with navigational or search equipment such as radar. The chassis 10 would be found mounted in the electronic compartment of aircraft or other airborne vehicles. A pair of receptacles 12 and 14 are shown secured to 10 and contain output terminals carrying the high-voltage signal. Lead assemblies such as 18 shown disconnected with respect to its mating receptacle 12 and 19 shown connected with respect to its mating receptacle 14, carry the high-voltage signal to the particular load driven by the supply. With loads of the type mentioned, it is frequently necessary to disconnect these leads, replace some component in the load and reconnect the leads for continued circuit use. As will be appreciated, the principal point of wear and therefore of expected deterioration occurs at a point near or at the connection. Indeed, experience has shown that failure results most frequently at the point of connection or in a portion of the lead proximate thereto. As one example, when the lead assembly such as 18 is positioned for insertion within 12, the portion of the lead extending from the nut is not long enough to fill the cavity of the receptacle to thus leave an air space. In use this air space permits the existence of corona discharge which causes an immediate deterioration of the end of the lead as well as causing radiations which interfere with communication equipment proximate to the chassis 10. As a second example, pulling upon the lead 18 after the nut has been backed off for removal of the assembly from 12 may cause some or all of the strands of the lead to break such as at the point X shown in FIGURE 1. If this breakage is not prevented, the lead will experience arcing in use and eventual failure at a time which could be quite critical to the operation of the equipment served by 10.

A third example is when some substance such as Coolanol is allowed to come in contact with portions of a standard lead such as at point Y to cause the insulating material to swell and burst. Resulting corona discharge when the equipment is air borne will then cause a breakdown of the connector as well as radio interference by radiation.

FIGURE 2 shows the invention solution to the foregoing problems carried out by the detailed structure of the receptacle 12 and the lead assembly 18. Turning first to the receptacle, it will be seen to be mounted in an aperture of chassis 10 with a portion thereof 12a extending within the chassis and a portion thereof 12b forming a flange which is soldered or otherwise affixed in a sealed manner to the chassis housing. The outer portion of 12 includes a sleeve 12c which is threaded on its outside surface as at 12d. In the embodiment shown, the outer portions of 12 are formed of metal machined to the configuration of FIGURE 2. The body of 12 could also be formed of glass or epoxy.

Within 12 is a bore 12e having therein an insulating plug and liner 12f relaxed in the forward end to define the cavity of the receptacle which receives the forward end of the lead assembly 18. Coxially affixed within 12f is a center contact member 16 having at one end a portion 16a which is crimped to or soldered to the high voltage conductor of the power supply and at the other end having a pin portion 16b which is made to project through the cavity and well out of the receptacle. This center contact member is made of a conductive material sufficiently hard to provide a relatively rigid structure to hold the pin portion in alignment. The end portion which is made to protrude out of the end of the receptacle consists in insertion of the lead assembly by making it possible for the end of the lead to be inserted on the end of the pin prior to entry into the cavity of the receptacle. The interior of the chassis 10 may be considered as sealed against environment and it is frequently at this point filled with an insulating fluid such as oil. The critical breakdown path with respect to voltage and arcing is then on the exterior of the receptacle. The zone or area of criticality with respect to corona is also on the exterior of the receptacle or at some point within the cavity thereof.

The lead assembly 18 includes the conductive lead 20 which in a preferred embodiment comprises an outer conductive sleeve 20a made of Teflon surrounding a center conductive core 20b comprised of stranded copper wires. In an actual application for a 15,000 volt supply to be used at 70,000 feet altitude, the lead 20 was 18 gauge 19 strand Teflon coated wire manufactured by Gore and Co. This wire is corona resistant and is impervious to Coolanol and most other substances which cause a deterioration in standard insulating materials.

Fitted over the end of the lead assembly 18 is a nut 22 apertured as at 22a to receive the lead and including interiorly disposed threads 22b of a diameter and pitch to mate with the threads 12d of the receptacle. Teflon washers 23 are fitted within the nut about the lead extending within the nut to a point just outside of the open end thereof is the forward portion of the lead assembly. This forward portion is comprised of a pair of sleeves of insulating material bonded together to form an integral piece. The outer sleeve 24 is made to extend well back on the lead through the nut to an end shown as 24c. Around the end near 24c is a ferrule 25 comprised of Teflon tubing of the type which may be shrunk onto the sleeve 24 and bonded thereto to provide support at the entry of 20 within the outboard portion of the sleeve. At the opposite end of 24 there is included an outer flange portion 24b which is radiused in its forward surface and has a transverse face in its rearward surface. Just forward of 24b is a further and short sleeve portion 24d which is made to abut a further sleeve member 26. Sleeve member 26 is disposed about the center conductor portion of the lead assembly and extends from one end of the lead through 24a to a point near 25. The forward end of 26 is enlarged to the diameter of 24 and is made to be in length just short of the length of the cavity of 12.

Positioned within 26 is the center contact member 30 for the lead assembly which is crimped or otherwise attached to the conductive strands of lead 20 and includes in its forward end a female receptacle adapted to mate with pin portion 16b of contact member 16 of the receptacle. The lead assembly including the sleeves is made as is indicated in FIGURES 5 and 6. The lead 20 is first trimmed such that the insulation thereof has the taper shown in FIGURE 5 and then it is inserted within the contact member 30 and crimped or soldered thereto. Then the sleeve 26 is molded thereon with care being taken such that the material of the sleeve does not interfere with the spring portion of the receptacle and does not overlap the end thereof to block entry of the pin of the receptacle. Next the outer sleeve 24 is molded over the inner sleeve to the configuration shown in FIGURE 6 with the Teflon sleeve 25 then being applied.

In an actual unit the sleeve 26 was formed of a soft and flexible silicone rubber manufactured by General Electric Company and identified as their material No. SE 4611 U. The outer sleeve 24 was formed of fluorosilicone rubber manufactured by Dow Corning Company and identified as their LS-63 material. Both were molded. The outer end of the sleeve 24 was coated with a fluorosilicone adhesive and the outer Teflon shrink tubing ferrule was applied therewith.

After molding, the outer sleeve 24 is relatively still as compared with the usual Silastic rubber material. The
sleeve 26 is, however, made quite soft and flexible. The sleeve 26 which has excellent corona resistant characteristics is susceptible to deterioration caused by ingredients like Coolanol. The outer sleeve 24 is only fairly resistant to corona but is particularly resistant to deterioration caused by ingredients like Coolanol.

The composite assembly of the two sleeves forming the lead is fairly rigid and is quite resistant to bending at the point of entry with the lead. Bending loads applied to the lead assembly are taken up in a gradual radius provided by the composite of the two sleeves out toward the ferrule 25. The length of the forward portion of the lead assembly including particularly the enlarged part of the sleeve 26 is made such that when the nut 22 is drawn up so that the washers 23 engage the rear surface of 249, the forward portion is of the right length for insertion within the receptacle and may be easily engaged with the center contact pin member 16b of the receptacle. The first engagement is shown in FIGURE 3. Complete engagement is shown in FIGURE 4. With the nut 22 turned down tightly into the receptacle, the end of the lead is forced in compression to substantially fill the cavity of the receptacle leaving no air space which could cause a corona problem. Because of the stiffness of the assembly, it is not necessary to use uncured material and the problems with vacuum and withdrawal are thereby alleviated. As the nut is tightened down through the final turn, the inner face thereof engages 246 which tends to force the forward end of the lead in compression. This last turn of the nut also compresses the material of 245 which is flexible and loads it in compression axially and radially. The forward face of 246 then seals the interior of the receptacle over a substantial area. The outer end of 24 shown as 247 is made so that it just enters the cavity of the receptacle so that during the last turn of the nut the loads transmitted through 24 are applied to 26 at a point of confinement within the receptacle.

With the assembly secured as shown in FIGURE 4, there is no possibility that sources of contamination may accidentally deposit some substance such as Coolanol upon any portion of the assembly which is subject to deterioration by such substance. The assembly is free of air in the zone wherein corona can or could cause a problem and is resistant to bending loads applied at a point which could cause damage to the assembly. Upon withdrawal after the nut has been removed from the receptacle, the pulling load applied to the lead through contact with the outer sleeve 24 will not be applied to the conductive strands of the lead or portions of the conductive path in the assembly, but will rather be applied to the stiff sleeve and will tend to stretch and constrict on the forward soft portion of the sleeve of the lead to permit an easy removal from the receptacle.

Having now described the invention in a mode intended to enable its practice as preferred, we define the invention through the following claims.

We claim:

1. In a connector assembly for high voltage, high-altitude use the improvement comprising a receptacle having a cavity therein and a contact member disposed in said cavity, a lead assembly adapted to mate with said receptacle including a locking member adapted to fit over the outside of said receptacle and to be secured thereto, said lead assembly further including a conductive portion thereof being comprised of first and second sleeves of insulating material, said first sleeve including a contact member adapted to mate with the contact member of the receptacle and having a forward portion of an axial length approximately equal to the axial length of the member, said second sleeve including a forward portion extending over the rear portion of said first sleeve and through said locking member out along a length of said lead sufficient to permit said second sleeve to be grasped for removal of said lead assembly, said second sleeve including a further portion extending radially outward of said first sleeve to be engaged by said locking member upon application of said lead assembly to said receptacle to be forced inwardly toward said receptacle against the walls of said receptacle under axial compression to seal the forward end of said lead assembly and to force the forward portion of the said first sleeve into said cavity under compression to exclude air therefrom and to provide a corona resistant sealed connection between the contact members of said receptacle and said lead assembly.

2. The assembly of claim 1 wherein said first sleeve is comprised of a flexible, corona resistant material and said second sleeve is comprised of a material substantially stiffer than the material of said first sleeve.

3. The assembly of claim 1 wherein said first sleeve extends from the forward end of said lead assembly through said locking member to a portion out along a length of said lead beneath said second sleeve and said second sleeve is comprised of material resistant to substances which cause a deterioration in the corona resistant properties of standard insulating materials.

4. The assembly of claim 1 wherein said first sleeve is comprised of silicone rubber and said second sleeve is comprised of an insulating material resistant to substances such as Coolanol.

5. In a lead assembly for use in high-altitude applications, the improvement comprising a lead having a conductive core surrounded by an insulating material with the end of said lead including a first sleeve carrying a center contact member terminated to the conductive core of said lead and including a forward portion of resilient material and a further portion integral therewith extending along said lead conductive core, a second sleeve of a flexible material substantially stiffer than that of the material of the first sleeve and bonded thereto, said second sleeve extending over a substantial portion of the first sleeve and over a length of the insulating material of the lead to permit said assembly to be grasped by grasping the second sleeve, said second sleeve including an outer flange portion, a nut member adapted to be fitted over said second sleeve and over the said further portion of the first sleeve and of a length to substantially overlie the forward portion of said first sleeve whereby when said nut member is in engagement with said locking member of said second sleeve the exposed length of said first sleeve and of said lead assembly is of a length proper for mating in the cavity of a receptacle, and where the first sleeve is of a diameter to slidingly fit within a receptacle cavity to engage the surfaces thereof in its relaxed state whereby to be compressed against said surfaces upon said nut being engaged with said flange portion, and said flange portion is of a diameter to engage the end of said receptacle to seal the said receptacle.

References Cited

UNITED STATES PATENTS

2,280,711 4/1942 Machlett et al. 339--85
2,357,800 12/1944 Cassen 339--85
2,626,299 1/1953 Rick 339--77
3,040,284 6/1962 Connell 339--61
3,321,733 5/1967 Thomas 339--90
3,328,744 6/1967 Fiske 339--61

RICHARD E. MOORE, Primary Examiner.

J. H. McGlynn, Assistant Examiner.