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CORONA RESISTANT LEAD AND TERMINAL ASSEMBLY

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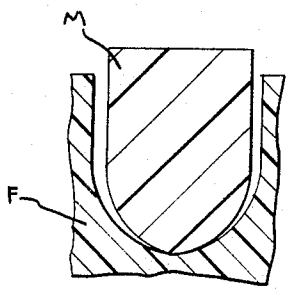


Fig. 1A

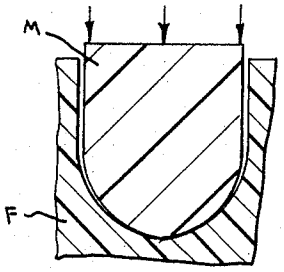


Fig. 1B

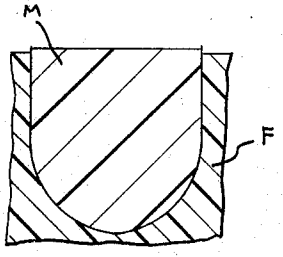


Fig. 1C

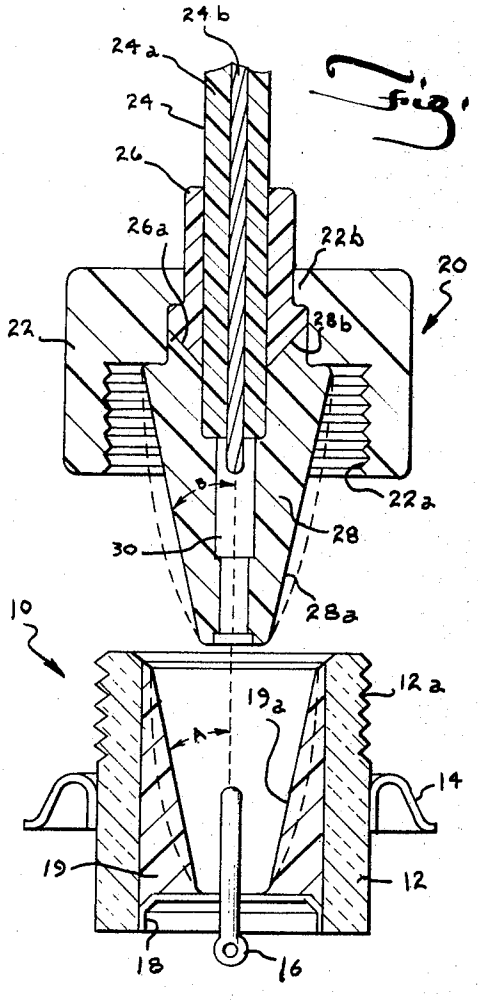
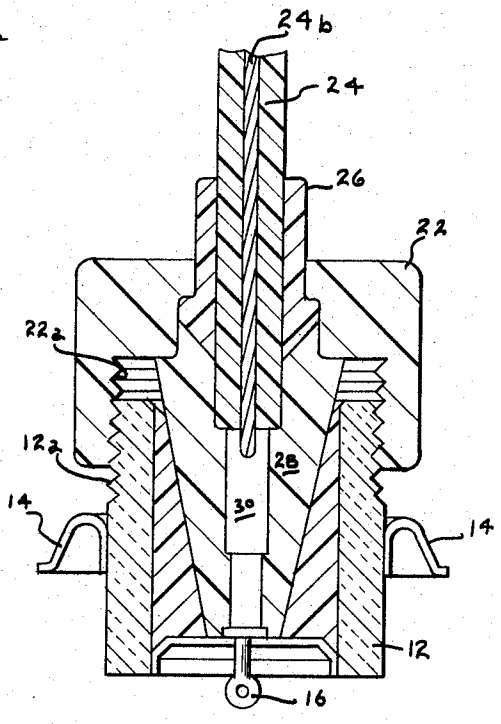


Fig. 2A

Fig. 2B



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CORONA RESISTANT LEAD AND TERMINAL ASSEMBLY

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This invention relates to a lead and terminal assembly adapted for use in high voltage power and signal applications.

It is one object of the invention to provide a lead and terminal assembly of a construction adapted to impede formation of corona.

It is a further object of the invention to provide a novel lead and terminal assembly having a configuration adapted to forcibly exclude air or other contaminants from component intermating surfaces.

It is yet another object of the invention to provide a novel means for intermating connector devices which operate to minimize the presence of spaces, voids and pockets within zones of high voltage gradient in such devices.

It is a further object of the invention to provide a high voltage corona resistant connector device which may be rapidly and easily disconnected without an undue strain on the device components.

High voltage requirements are increased by the effect of altitude which permits ionization of air at lower potential gradients. Because of this, connectors and leads adapted to supply equipment at voltages of five or ten thousand volts at altitude frequently carry a specification calling for continuous corona free operation at voltages of twenty thousand or fifty thousand volts at one atmospheric pressure. Prior art efforts have centered on constructions which attempt to exclude all gas from the areas of high potential gradient and in instances utilize an insulating silicone grease for this purpose. Two problems have arisen which represent shortcomings in such efforts. First, the attempt to exclude all air or gas has been through constructions wherein a tapered or cylindrical plug member is forced axially in compression within a complementary mating receptacle. Due to production and assembly tolerances carried in practice, it has been found that the plug member is either not adequately driven home within its receptacle or is driven to a point of folding to still leave small, but definite pockets of air. When such devices are used with a heavy coating of silicone grease it has been found that the disconnect procedure is complicated due to the development of a vacuum tending to hold the plug portion within the receptacle with a resulting high incidence of lead and component breakage. Continued use of an assembly affected with these faults results in corona discharge and even arcing which causes circuit malfunction and ultimately destruction of the connector.

It is a general object of the present invention to overcome the immediately foregoing problems.

In the drawings:

FIGURES 1A–1C are sections of a plug and receptacle schematic representation demonstrating the operation of the device of the invention;

FIGURE 2 is a section of an embodiment of the device of the invention shown in the disconnect position; and

FIGURE 3 is a section of the device of FIGURE 2 shown in the connect position.

Referring now to FIGURES 1A–1C, the representations M and F may be taken to indicate respectively, male and female portions of a connector and in use, M is plugged into and withdrawn from F. As will be described

hereinafter, M would normally carry a male or female contact member centrally disposed in the body thereof and terminated to a lead and F would normally carry a complementary contact member aligned for engagement with the contact member of M and connected in the circuit of use. As will be elaborated on further in the specification, F may be constituted of a relatively hard dielectric material such as ceramic, glass or the like, and M may be constituted of a dielectric material of a lesser durometer including characteristics whereby the member is readily compressible. A typical material suitable for M may be found in that class of flexible dielectric material known as Silastic, which is a synthetic rubber material treated with silicone. It is contemplated that both members M and F may be of materials having flexible characteristics with the durometer of the member M being held to be less than that of F to permit the operation to be hereinafter described.

The members M and F, shown in FIGURES 1A–1C are shaped so that any cross-section through the member longitudinal axis defines a substantially circular shape with portions thereof being of progressively reduced circular diameters to define an essentially tapered configuration. A given cross-section of the receptacle formed in F is made to be slightly larger in both taper and maximum diameter than corresponding sections of the member M, so that upon the point of first engagement as shown in FIGURE 1A the center bottom portion of M engages the center bottom portion of F with a space therebetween increasing progressively upwards from the point of engagement. In this position then, with an axial load applied as indicated by the arrows to the top of the member M, as shown in FIGURE 1B, a compression of the member M within the receptacle of F occurs, increasing the area of contact between the surfaces of M and F in a widening circle rising toward the top of the members. This then serves to close the air space between members M and F upwardly from the inner point of contact to the outer portion. Following a sufficient application of force to member M, the space between the surfaces of M and F is completely closed as indicated in FIGURE 1C. At this point the member M is axially compressed and relative to a given cross-section, the material thereof is radially expanded. Upon a release of the force holding M within F, an axial expansion with a radial contraction of the material occurs through a given cross-section in a reverse manner to first open up a space at the point of entry of M within F, which progresses down within the receptacle of F until M is completely relaxed and is restored to the configuration shown in FIGURE 1A. Viewing the foregoing operation of the component members, it will be observed that in closure a pumping action occurs which tends to force out any air or gas between the surfaces of the members M and F to assure a voidless interface between the surfaces of the members in engagement. If silicone or other insulating grease is utilized with the device, it will be forced out in the same manner.

Now during release or disengagement, since the contraction of the cross-sectional areas of M occurs progressively downward, any vacuum which might occur if the parts were of the same configuration in the relaxed states will be avoided and member M will separate from F without any undue strain upon either the member or the lead.

Referring now to FIGURE 2, a more detailed embodiment of the foregoing is shown in the form of a bushing or receptacle **10** adapted to receive and cooperate with a lead assembly **20**. The bushing **10** is comprised of a member **12** of dielectric material externally threaded as at **12***a* and secured to a ring **14** which serves as a flange to mount the bushing to an equipment chassis or housing. In a preferred embodiment, the member **12** is

of a fired ceramic or glass with the ring **14** of metal brazed to the outside surface of **12**. In use with a sealed power pack can, the lower portion of **12** is fitted within an aperture in the can with ring **14** extending over the aperture onto the surface of the can and soldered thereto to effectively seal the assembly. Within the member **12** and centrally disposed thereof is a center contact member **16** of brass or the like supported by a metallic disc **18** affixed to the inner surface of **12**. In a typical construction the member **16** includes a contact portion extending upwardly within **12** and a further portion extending below the bushing **10** and adapted to be terminated to a lead of the power pack circuit. The disc **18** in a typical unit is secured to **16** as by soldering or brazing and is secured to the inner bore of **12** as by brazing to rigidly mount and seal the member within the assembly. Surrounding the contact portion of **16** and extending through the volume of the bore of **12**, is a further insert shown as **19**, formed of dielectric material having the characteristics of F mentioned above to define a receptacle surface **19***a*, tapering outwardly from the bottom of the insert by an angle of taper shown as A.

The lead assembly adapted to cooperate with the bushing **10** includes a nut **22** internally threaded as at **22***a* to cooperate with the threading **12***a* of member **12** and affixed to a lead **24** comprised of an outer insulation and dielectric material **24***a* and a center core **24***b*, which is usually stranded conductive wire. In FIGURE 2, nut **22** is affixed to the lead through a ferrule shown as **26**, which extends outwardly of the nut in engagement with the outer surface of the lead. Ferrule **26** is bonded to the lead surface and its forward portion includes a beveled or tapered face **26***a* in engagement with and preferably bonded to an end member **28** having material characteristics similar to that described with respect to member M in FIGURES 1A–1C. Disposed within member **28** is a center contact member **30** affixed as by crimping or soldering to the core **24***b* of the lead **24**.

The outer surface **28***a* is tapered outwardly from the end of the member at an angle shown as B to a maximum diameter somewhat less than the bore defined by threading **22***a*. The taper B is, in accordance with the present invention, held to be less than that of the taper defined by angle A in member **10**. In a typical unit if the angle A may be carried in production at an amount equal to $8°\pm\frac{1}{2}°$, then the angle B would preferably be made $6.50\pm\frac{1}{2}°$. This is to assure that no combination of deviations due to production tolerances can result in the angle A being less than the angle B and that the space defined relative to FIGURES 1A–1C will be maintained. With the parts so shaped an engagement thereof will result in a closure as depicted in FIGURE 3, the nut **22** being threaded down on member **12** as indicated. The space left surrounding the widest portion of member **28** between the inner surface of the threading **22***a* operates to allow for air or gas expelled from the volume defined by the difference in tapers of **28** and **19**. Such space will also accommodate any grease pumped out from between members **28** and **19**. Since such space is at a section wherein the radial thickness of the dielectric material of **28** is quite substantial, the electric field present will not cause corona at this point.

In the embodiment of FIGURES 2 and 3, the engaging members **19** and **28** which are analogous to F and M in FIGURES 1A–1C are shown as of a constant taper rather than curved. The specific configuration of FIGURES 1A–1C is also contemplated and can be achieved in the embodiment of FIGURES 2 and 3 in the manner indicated by the dotted line shown relative to each member.

In the foregoing embodiment, the mating insert **19** is shown as a separate part relative to the bushing **12**. It is contemplated that insert **19** may be integrally formed as part of **12**; of glass, ceramic material or the like. If ceramic material is used to define the surface **19***a*, the material of **28** may be of somewhat harder durometer than previously mentioned, but should in any event still be relatively flexible and compressible to provide the action heretofore described. For lower voltage applications, it is also contemplated that the member **12**, flange **14**, and insert **19** could be formed of epoxy material having the conductive pin member **16** molded or locked therein by any suitable means. In such use the upper assembly would be provided with a nut of epoxy material with the member **28** being formed of Silastic or the like.

I claim:

1. In a lead assembly for providing a corona-resistant union of high voltage circuits, a receptacle having a bore tapering outwardly at a given angle with respect to the center axis thereof and having a first contact member therein and a plug member having a projecting portion of resilient material tapering inwardly at an angle with respect to the center axis thereof less than said given angle and having a second contact member therein, said plug member being adapted to be fitted within said receptacle with said contact members in engagement, a conductive lead having a relatively thick outer sheath of dielectric and insulating material and an inner core of conductive material, said core being connected to said second contact member, said plug member forward portion being of relatively compressible dielectric material extending entirely over said second contact member except at the ends thereof and extending over a portion of said sheath, said plug member having a rearward portion including a ferrule of relatively hard dielectric material fitted over and bonded to said sheath and including a projecting flange portion at the forward end thereof, a plug securing member having an aperture therein to slidingly fit over a portion of said ferrule and to engage the flange portion thereof, said securing member including a bore larger than said plug member and means to engage said receptacle and drive and hold said plug member therein by an engagement of said securing member bearing against the flange portion of the ferrule to in turn axially force the plug member forward portion into said receptacle to effect a progressive compression of said forward portion operating to progressively close the space defined by the differential taper between said plug member and said receptacle from the forward end of the forward portion of the plug member upwardly in the bore of said receptacle.

2. In a lead assembly for use in providing a corona-resistant union of high voltage circuits the combination comprising a plug member and a receptacle, a portion of a conductive lead having a relatively thick outer sheath of dielectric and insulating material and an inner core of conductive material, said plug member having a rear portion including a ferrule of relatively hard dielectric material bonded to the outer sheath of the said conductive lead, said ferrule extending axially along said lead and including at its forward end a radially extending flange portion, a plug securing member having an aperture therein adapted to receive the ferrule and the lead therethrough, said plug securing member including an inwardly directed flange portion adjacent the aperture therein adapted to engage the outwardly extending flange portion of said ferrule, the said plug member including a forward portion of compressible material tapered along its length with a projecting portion of the said conductive lead made to extend through said ferrule and into said forward portion to be secured thereto, a centrally disposed contact member in the said forward portion of said plug member connected to the core of said conductive lead and surrounded by the material of the forward portion of said plug member except at its forward end, the said receptacle including a bore tapered along the length thereof in a taper slightly larger than that of the taper of the plug member forward portion and of a length greater than that of the length of the said forward tapered

portion of the plug member, a center contact member affixed to said receptacle and extending within said bore to be engaged by the contact member of said plug member and means on the outside of said receptacle to engage the said plug securing member whereby to force the forward portion of said plug member into said receptacle, the said ferrule operating to load the forward portion of said plug member in compression to exclude air from said receptacle as said plug member is forced therein.

3. In a connector adapted to provide a corona-resistant union for high voltage circuits, the combination including a high voltage lead having a center conductive core surrounded by a relatively thick dielectric sheath, a center contact member attached to the conductive core of said lead and projecting from the end of such core, a plug member including a forward portion of compressible dielectric material extending over said contact member and over a portion of the end of the dielectric material of said lead, said forward portion being tapered along a length thereof extending from the end of said contact member back over the outside of a portion of said dielectric sheath for a distance several times that of the thickness of said sheath, a ferrule member of a relatively hard dielectric material fitted over the dielectric material of said sheath and bonded thereto, said ferrule member being in engagement with the forward portion of said plug member, a plug securing member of insulating material having an aperture therein and fitted over the said ferrule member to engage portions thereof, a receptacle of dielectric material having a bore therein tapered along the length thereof, said bore having an axial length several times greater than the thickness of the dielectric sheath of said lead and being formed of a material substantially harder than the forward portion of said plug member with a taper slightly greater than the taper of said forward portion of the plug member, said receptacle including centered therein a contact member adapted to be inserted within the contact member of the said plug member and including on its outer surface means to be engaged by said securing member whereby said plug member may be plugged into said receptacle with said securing member being caused to engage said means on the outer surface of said receptacle to axially force the plug member to be compressed progressively from the forward end thereof to exclude air from the interior of said plug member and extend the leakage path of said contact members to a distance several times the thickness of said sheath.

4. In a connector adapted for use with high voltage circuits, the combination comprising a high voltage lead including a center conductive core surrounded by a relatively thick dielectric sheath, a plug member attached to the end thereof including a center contact member attached to the conductive core of said lead and an outer body of relatively compressible dielectric material covering over the center contact member and extending over a portion of the outer dielectric sheath of the lead, the said body having a generally conical portion and an axial length several times greater than the thickness of the dielectric sheath of said lead, a receptacle for said plug member having a bore therein and formed of a dielectric material, the bore of said receptacle having a generally conical shape and having an axial length substantially less than the axial length of the conical portion of said plug member with the cross-section of the receptacle bore as measured from the smaller end diameter thereof being slightly greater than a given cross-section of the conical portion of said plug member as measured from the smaller diameter end thereof, the said receptacle having a center contact member adapted to be inserted within the center contact member of the plug member and there being included means adapted to engage said plug member and the outside of said receptacle member to drive the conical portion of said plug member into the bore of said receptacle and axially compress the conical portion of said plug member to radially expand such member to effect an engagement of the surfaces of said bore and said conical portion progressively upward from the smaller diameter ends thereof to close the space therebetween and exclude air therewithin whereby to effect a corona-resistant union between the conductive core of said lead and the center contact member of said receptacle.

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