Sept. 24, 1963 J. KOZINSKI 3,105,219

ELECTRIC RESISTOR

Filed Feb. 19, 1962 2 Sheets-Sheet 1

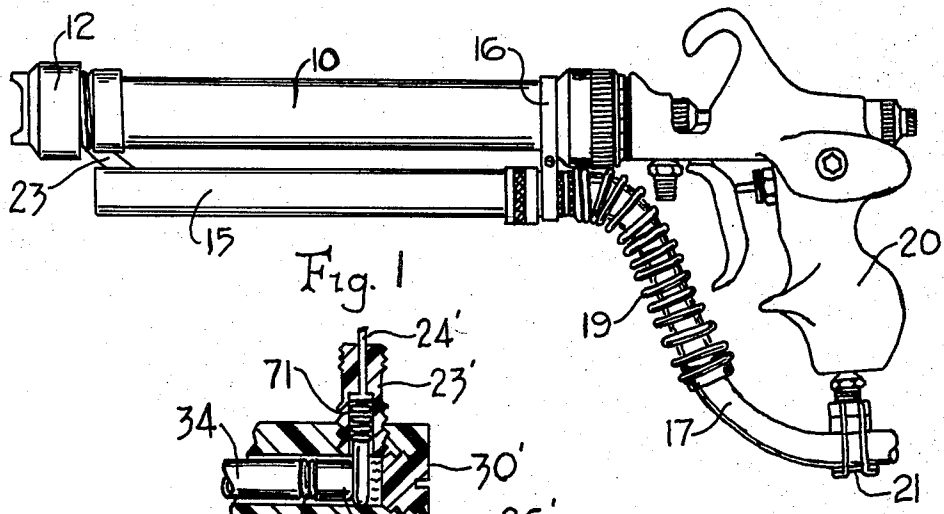


Fig. 1

Fig. 8

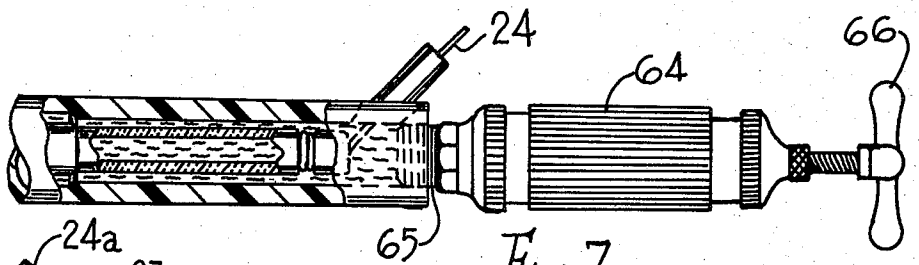


Fig. 7

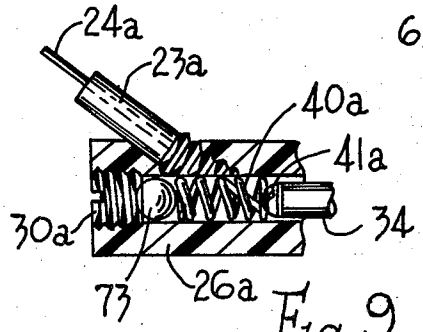


Fig. 9

INVENTOR.
JOSEPH KOZINSKI
BY Robert L. Kahn
ATTORNEY

Sept. 24, 1963 J. KOZINSKI 3,105,219

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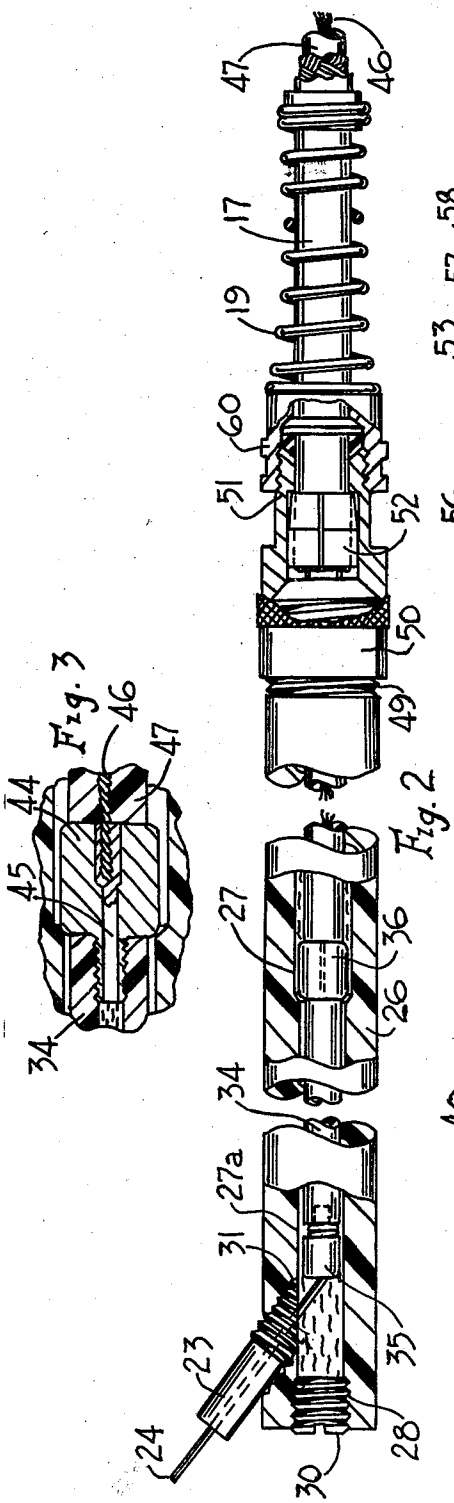


Fig. 2

Fig. 3

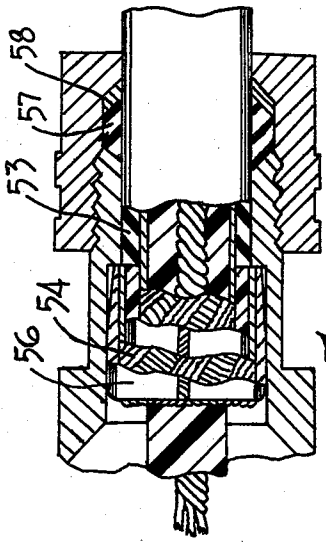


Fig. 5

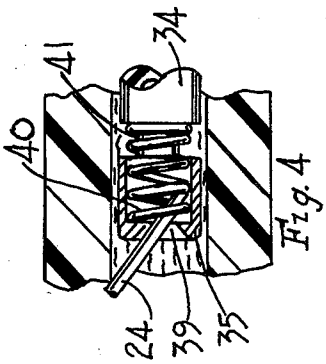


Fig. 4

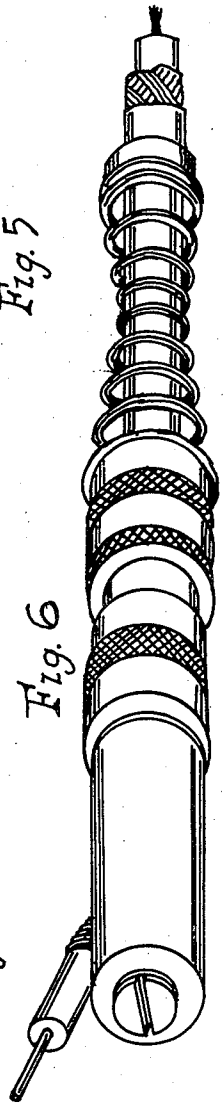


Fig. 6

INVENTOR.
JOSEPH KOZINSKI
BY Robert L. Kahn
ATTORNEY

United States Patent Office

3,105,219

Patented Sept. 24, 1963

3,105,219

ELECTRIC RESISTOR

Joseph Kozinski, Chicago, Ill., assignor to H. G. Fischer & Co., Inc., Franklin Park, Ill., a corporation of Illinois

Filed Feb. 19, 1962, Ser. No. 174,235
5 Claims. (Cl. 338—214)

This invention relates to an electrical apparatus and is an improvement upon the invention disclosed and claimed in my application Serial No. 120,987, filed June 30, 1961. In the application referred to above, I have disclosed means for incorporating a resistor in support means to be used in connection with high voltage low current systems such as, for example, in electrostatic coating systems, X-ray systems, and the like. In systems of this character, potentials of the order of 50,000 volts up to as much as 150,000 or 200,000 volts are frequently used. The currents in such systems are low and are usually measured in milliamperes (ma.). As a rule, such currents may range anywhere from one half ma. up to three or four ma.

In electrostatic coating systems it is frequently desirable to incorporate a dropping resistor in the high potential lead. Such a dropping resistor may range from a fraction of a megohm up to as much as 1,000 megohms or more. The value of the dropping resistor depends in some measure upon the type of service required and this may vary from job to job. Consequently, it is desirable to be able to supply an electrostatic coating system and particularly the gun portion thereof with one or more dropping resistors having desired values to be used as occasion demands. It is desirable to mount these dropping resistors close to the gun. It is also necessary to provide sufficient electrical insulation for the dropping resistors to withstand the full potential applied to the system. An objective of this invention, therefore, is to provide a dropping resistor body or support wherein any desired dropping resistor may be disposed with a minimum of difficulty while providing high potential insulation for the dropping resistor.

It is customary in such high potential systems to use cable having a central conductor of copper wire, usually stranded wire, and to insulate this copper wire with polyethylene insulation at least about a quarter of an inch thick. This material is an excellent insulator and has many desirable properties. Thereafter, such polyethylene insulation is covered with a braided metal shield, usually of copper, and finished with a hard surfaced thin flexible material such as plastic for providing protection against abrasion, weather, and the like. The braided shield is grounded. When the cable is at high potential an electric field exists between the stranded conductor and the grounded shield.

It is well known in connection with high potential cables that care must be taken in introducing discontinuities and changes in the insulator structure. It is important that in connecting a dropping resistor in a high potential lead, adequate safeguards be taken to insure that the excellence of the insulation is maintained throughout the entire high potential system.

To work with and adapt polyethylene insulation, it has been considered necessary to use special moulds for melting the polyethylene and providing an adequately insulated construction for enclosing the dropping resistor to be used. As a rule, such dropping resistors are in the form of ceramic tubes or other insulating tubes about which a high resistance material is disposed. Such dropping resistor bodies may have a length of eight or nine inches and can be obtained in diameters of about one-half or three-quarters of an inch. It is possible to obtain resistors having a variety of values and with similar outside dimensions. The terminals of such resistors are usually at the ends of the bodies. The full high potential may exist across the ends of the dropping resistor, so that adequate high potential insulation must be provided along the length of the dropping resistor as distinguished from the radial insulation provided for the cable generally. It is therefore necessary to provide such insulation around the outside of the resistor body and accomplish this in such manner that undesirable discontinuities are avoided.

It is well known that the potential impressed across each of two or more dielectrics in series is inversely porportional to the dielectric constant as well as directly proportional to the dimension of each dielectric. Thus air, which has a low dielectric constant and may be present in the form of an air pocket, may have a high potential stress impressed across it if this air pocket is part of an insulating structure across which there is an electric field. Because of this, it is of the utmost importance that air pockets or pockets of moisture be avoided in mounting a resistor in an insulator structure. This is doubly important in the case of a dropping resistor which is mounted as an accessory to a spray gun used in coating. In such cases, an operator may be handling the gun and accessories and should be protected against dangerous potentials.

In the patent application referred to above, I have disclosed a simple means for moulding dropping resistor bodies within a body of polyethylene, so that the dropping resistor body may be incorporated as part of the cable structure. The present invention to be described constitutes an improvement upon the invention referred to above in that this invention makes it unnecessary to melt polyethylene and perform any moulding operation. In general, the present invention contemplates a sleeve of solid material having excellent electrical insulation, such as Bakelite, rubber, glass, or the like. This sleeve is adapted to function as a housing for the dropping resistor body to be used. Conventional polyethylene insulated cable is connected to the dropping resistor at the terminals thereof. The invention provides a construction whereby a viscous, gelatinous insulation may be forced into the region around the resistor body to fill all air pockets in the insulation system and is maintained indefinitely. The cable portions extending into and from the insulating sleeve cooperate with it to provide a tight seal preventing the escape of said viscous insulating medium.

The viscous insulating medium which is used is silicone grease and is forced in under pressure to displace any air which may be present in the structure.

Silicone grease is particularly desirable for the reason that it does not tend to escape or ooze out as is true of ordinary hydrocarbon grease. Silicone grease adheres strongly to polyethylene or other plastic compounds such as polypropylene or plastics generally. In addition, silicone grease has a substantially constant viscosity over a range of from about —40° F. to as much as about 500° F., and will have no tendency to ooze out in hot weather. Another advantage of silicone grease is the fact that it is not soluble in water or many alcohols, and retains its stability under a great variety of conditions.

For a full description of the invention, reference will now be made to the drawings wherein:

FIGURE 1 is a side elevation of a spray gun provided with the invention.

FIGURE 2 is a side view with certain parts broken away, illustrating one form that the invention may assume.

FIGURE 3 is a detail with certain parts broken away, illustrating the manner in which the high potential con-

ductor is connected to one terminal of the dropping resistor.

FIGURE 4 is an enlarged detail with certain parts broken away, illustrating the manner in which electrical contact is established with the other end of the dropping resistor.

FIGURE 5 is an enlarged sectional detail with certain parts broken away, illustrating the manner in which the high potential cable is attached to the rear end of the dropping resistor housing.

FIGURE 6 is a perspective view of the assembled housing for the dropping resistor body.

FIGURE 7 is a view with certain parts broken away, illustrating the manner in which insulating grease is forced into the dropping resistor housing.

FIGURE 8 is a detail with parts broken away to show a modification at the forward end of the dropping resistor housing.

FIGURE 9 is a detail with parts broken away, illustrating a further modification of the forward end of the housing.

Referring now to the drawings, a spray gun generally indicated by 10 can be used for applying finely divided coating material on work in accordance with conventional practice. Spray gun 10 has a barrel terminating in nozzle head 12 from which a stream of atomized coating material is discharged. The spray gun can be of any desired construction and will discharge the coating material in an atomized form, this usually being accomplished by compressed air. However, so called high pressure atomization may also be used wherein the coating material, fed under high pressure of the order of 1000 pounds per square inch, is suddenly discharged into atmosphere whereupon it atomizes. As a rule, however, most systems feed the coating material in the gun to the nozzle under low pressure and have air at a pressure of from 10 pounds to 100 pounds for atomizing purposes. Inasmuch as the details of the gun and its operation do not form any part of the present invention, further description of the gun or operation are not considered necessary.

Disposed adjacent and parallel to the barrel is elongated tubular member 15 providing a housing for a high potential dropping resistor within the same. Housing 15 of the dropping resistor may be attached to the gun by clamp means 16 and the dropping resistor is in series with a high potential cable system, the cable proper being indicated by 17. Where high potential cable 17 leads into housing 15, coil spring 19 around the cable is provided to prevent sharp bends. High potential cable 17 is supported from handle 20 of the gun by clamp 21. Housing 15 for the dropping resistor has its forward end portion 22 adjacent nozzle head 12 of the gun. Forward end portion 22 of the housing has high potential cable 23 extending laterally from housing 15 with wire 24 connected to the metal of nozzle head 12. Gun 10 may be constructed as set forth in the copending application of A. C. Walberg, Serial No. 827,587, filed July 16, 1959. It is understood that housing 15 for the dropping resistor can be applied to any type of spray gun and since such spray guns have metal to be charged to a high potential, it is only necessary to connect wire 24 to the metal part of the gun to be charged at high potential. Wire 24 may be of copper and may be solid or stranded and may be covered with a sleeve of insulation material to make up cable portion 23. The sleeve insulation material may be of rubber, either natural or synthetic or of silicone rubber, or may be of nylon, polyethylene or any plastic, either flexible or rigid. In practice, the length of cable portion 23 is quite short, of the order of a few inches. The length of this cable portion is unimportant and it may be as long as necessary.

Referring now to housing 15, this includes cylindrical body 26 of material which is an excellent electrical insulator and which is mechanically strong and can be readily shaped or machined. For example, body 26 may consist of Bakelite, nylon, hard rubber, quartz, glass, high impact polystyrene or any other synthetic or natural material having excellent electrical insulation. Body 26 has bore 27, which with reduced bore 27*a*, extends for the full length thereof. At end portion 22 of the body, bore 27*a* is tapped at 28 to accommodate screw plug 30. Screw plug 30 is also of electrically insulating material. Body 26 has laterally tapped passage 31 into which insulating sleeve portion 23 of the cable extends. Sleeve portion 23 may be of rigid or flexible material and has the end portion provided with threads moulded to conform to the tapped threads within body 26. As shown in FIGURES 1 to 7 inclusive, tapped portion 31 extends at an acute angle to the axis of body 26.

Loosely disposed within body 26 is dropping resistor body 34 having terminals 35 and 36 at the ends thereof. Dropping resistor body 34 is rod shaped and of suitable length. The resistor body may be of ceramic or other material and has resistor material to make up a dropping resistor whose electrical terminals are 35 and 36 respectively. Such resistors are readily available in the market in various dimensions, both electrical and mechanical. For convenience, dropping resistor body 34 and terminal 35 may both have substantially the same diameter, this being somewhat less than the diameter of bore portion 27*a*. Terminal portion 36 of the resistor body has a somewhat larger diameter than the resistor body proper so that terminal portion 36 will be too large to enter reduced bore portion 27*a* but small enough to lie within bore portion 27*a*. Terminal portion 36 of the resistor body has a somewhat larger diameter than the resistor body proper so that terminal portion 36 will be too large to enter reduced bore portion 27*a* but small enough to lie within bore portion 27.

In the form of the invention illustrated in FIGURE 2, terminal portion 35 consists of a metallic cap having a cup shape with opening 39 in the bottom of the cup. The cup-shaped terminal has tightly disposed therein helical coil spring 40 of metal such as steel, brass or copper. Coil spring 40 has an end thereof tightly gripping contact portion 41 of the resistor body. The arrangement is such that wire 24 within insulating sleeve 23 can extend through opening 39 and be caught in the coils of spring 40. Wire 24, or at least the portion extending within insulating sleeve 26, is stiff enough to permit firm contact to be established.

Returning now to resistor terminal 36, this may consist of metal head 44 rigidly attached to insulator body 34. Metal head 44 is preferably of brass or copper and has axial bore 45 within which conductor 46 of high potential cable 17 may extend and be anchored, as by solder. Conductor 46 of the high potential cable may be solid or stranded. Conductor 46 is disposed within layer 47 of flexible high potential insulation, such as polyethylene for example. Insulation 47 may conveniently have an outside diameter about equal to the diameter of resistor body 34, and in practice, such insulation may have a diameter of about ¼" or ⅜". The actual diameter is unimportant and may vary with the nature of the insulation.

Body 26, which is of electrically insulating material, has threaded thereon at 49 metal sleeve 50. Metal sleeve 50 has end portion 51 externally threaded and within region 52 defined by the sleeve, an end portion of cable 17 is disposed. The end portion of the cable within sleeve 50 includes outer sheath 53 of thin plastic material such as vinyl for covering braided metal grounding layer 54. Outer sheath 53 of the cable does not extend beyond the inside of externally threaded portion 51. However, braided copper grounding layer 54 and polyethylene layer 47 do extend into region 52 of the sleeve. Copper braid 54 has ring 56 disposed over the same and excess length of the braid is turned back over ring 56. Ring 56 may

be of metal or insulation and may conveniently be of polypropylene. The actual sealing is accomplished by ring 57 which is disposed over outer sheath 53 of the cable. Ring 57 is small enough to fit against shoulder 58 of nut 60 and against the end of threaded portion 51 of sleeve 50. The end of threaded portion 51 may be tapered at the inside. Ring 57 is of neoprene, although other materials which are inert to silicone grease may be used. Nut 60 fits snugly over the cable and when tightened over sleeve 50, will compress ring 57 tightly to provide a seal.

In order to charge the insulator structure with silicone grease, nut 60 is left loose with the parts assembled, as illustrated in FIGURE 2. Plug 30 is removed from the forward end of the insulator housing. Pressure grease gun 64 has its outlet 65 provided with external threads to permit the grease gun to be threadedly coupled to the insulator housing. Grease gun 64 is filled with silicone grease of the type desired. As an example, Dow Corning Company No. 11 compound can be used. After the grease gun is coupled to the insulator housing, handle 66 of the grease gun is operated to expel silicone grease. With nut 60 loose, air within the insulating structure can leak out as the grease is forced into the insulating structure. When silicone grease begins to come out through the threads at nut 60, the pressure gun is uncoupled and plug 30 replaced. Nut 60 is now tightened and the entire structure is ready for use. Insulating sleeve 24 and wire 23 should be tight enough to provide a satisfactory grease seal.

Referring now to FIGURE 8, a modification is illustrated wherein forward end 22 of insulator body 26 has cable portion 23′ extending laterally at right angles to the axis of body 26. Cable portion 23′ has conductor portion 24′ provided with terminal fitting 70 engaging resistor terminal 41′ of resistor 34. Terminal member 70 may be spring pressed by spring 71. In this modification, it will be necessary to have insulating portion 23′ of the cable loose so that the same may be threaded into sleeve portion 26′ without turning terminal member 70.

Referring to FIGURE 9, a still further modification is illustrated wherein cable portion 23*a* extends at an angle from body 26*a* in a manner generally resembling the structure illustrated in FIGURE 2. Wire 24*a* extends into coil spring 40*a* which bears against terminal portion 41*a* of the resistor body 34. End plug 30*a* of insulating material has metal ball bearing 73 lying within the bore of body 26*a*, the ball bearing being between plug 30*a* and coil spring 40*a*. The ball bearing may be of any suitable metal and will be at high potential when the resistor is in a live circuit. The diameter of ball bearing 73 is large in comparison to the thickness of wire 24*a* or the wire of spring 40*a* or the conductor within the high potential cable. Consequently, the electric field around ball bearing 73 will not be intense. The plug can press the ball bearing against the coil spring.

It is understood that the modifications illustrated in FIGURES 8 and 9 show the forward end of the structure in each case. The remainder of the structure will be as illustrated in FIGURE 2 and will be provided with the metal sleeves as illustrated.

What is claimed is:

1. The combination of a high potential cable and a dropping resistor assembly, said cable comprising a central conductor covered with a layer of solid insulation, which in turn is covered with a layer of braided grounding wire, said solid insulation being able to insulate for the full working potential between the central conductor and grounding layer, said resistor assembly comprising a housing tube, a dropping resistor within said tube, said resistor having its terminals at the ends thereof and lying within said tube, an insulating sleeve extending from said tube adjacent one tube end, a conductor within said sleeve extending into said housing tube and making electrical contact with one resistor terminal, said insulating sleeve and conductor providing a tight seal for said housing tube,

a fitting carried by said housing tube at its other end, said fitting accommodating said high potential cable including the grounding layer of wire, said fitting including clamping ring means threadedly secured to said fitting and serving, when tight, to anchor said grounded layer of wire within said fitting, said housing tube having sufficient room within to accommodate an end portion of said high potential cable minus the grounding wire layer, said central conductor being connected to the other terminal of said resistor, a removable plug for said housing tube adjacent said one tube end and an insulating grease within said housing tube, said plug permitting introduction of grease into the housing tube and the clamping ring means, when loose permitting air to escape during introduction of said grease, said resistor assembly, when said plug and clamping ring are tight, retaining said grease within said tube and providing thorough electrical insulation around said resistor.

2. The combination of a high potential cable and a dropping resistor assembly, said cable comprising a central conductor covered with a layer of solid insulation, which in turn is covered with a layer of braided grounding wire, said solid insulation being able to insulate for the full working potential between the central conductor and grounding layer, said resistor assembly comprising a housing tube of rigid insulation, a dropping resistor within said tube, said resistor having its terminals at the ends thereof and lying within said tube, an insulating sleeve extending from said tube adjacent one tube end, a conductor within said sleeve extending into said housing tube and making electrical contact with one resistor terminal, said insulating sleeve and conductor providing a tight seal for said housing tube, a fitting carried by said housing tube at its other end, said fitting accommodating said high potential cable including the grounding layer of wire, said fitting including clamping ring means threadedly secured to said fitting and serving, when tight, to anchor said grounded layer of wire within said fitting, said housing tube having sufficient room within to accommodate an end portion of said high potential cable minus the grounding wire layer, said central conductor being connected to the other terminal of said resistor, a removable plug for said housing tube adjacent said one tube end and a silicone insulating grease within said housing tube, said plug permitting introduction of said grease into the housing tube and the clamping ring means, when loose permitting air to escape during introduction of said grease, said resistor assembly, when said plug and clamping ring are tight, retaining said grease within said tube and providing thorough electrical insulation around said resistor.

3. The combination of a high potential cable and a dropping resistor assembly, said cable comprising a central conductor covered with a layer of solid insulation, which in turn is covered with a layer of braided grounding wire, said solid insulation being able to insulate for the full working potential between the central conductor and grounding layer, said resistor assembly comprising a housing tube of rigid insulation, a dropping resistor within said tube, said resistor having its terminals at the ends thereof and lying within said tube, an insulating sleeve extending laterally from said tube adjacent one tube end, a conductor within said sleeve extending into said housing tube and making electrical contact with one resistor terminal, said insulating sleeve and conductor providing a tight seal for said housing tube, a fitting carried by said housing tube at its other end, said fitting accommodating said high potential cable including the grounding layer of wire, said fitting including clamping ring means threadedly secured to said fitting and serving, when tight, to anchor said grounded layer of wire within said fitting, said housing tube having sufficient room within to accommodate an end portion of said high potential cable minus the grounding wire layer, said central conductor being connected to the other terminal of said resistor, a removable plug for said housing tube at said one tube end and an insulating

grease within said housing tube, said plug permitting introduction of grease into the housing tube and the clamping ring means, when loose permitting air to escape during introduction of said grease, said resistor assembly, when said plug and clamping ring are tight, retaining said grease within said tube and providing thorough electrical insulation around said resistor.

4. The combination of a high potential cable and a dropping resistor assembly, said cable comprising a central conductor covered with a layer of solid insulation, which in turn is covered with a layer of braided grounding wire, said solid insulation being able to insulate for the full working potential between the central conductor and grounding layer, said resistor assembly comprising a housing tube of rigid insulation, a dropping resistor within said tube, said resistor having its terminals at the ends thereof and lying within said tube, an insulating sleeve extending laterally from said tube adjacent one tube end, and a conductor within said sleeve extending into said housing tube and making electrical contact with one resistor terminal, said insulating sleeve and conductor providing a tight seal for said housing tube, a fitting carried by said housing tube at its other end, said fitting accommodating said high potential cable including the grounding layer of wire, said fitting including clamping ring means threadedly secured to said fitting and serving, when tight, to anchor said grounded layer of wire within

said fitting, said housing tube having sufficient room within to accommodate an end portion of said high potential cable minus the grounding wire layer, said central conductor being connected to the other terminal of said resistor, a removable plug for said housing tube at said one tube end and silicone insulating grease within said housing tube, said plug permitting introduction of said grease into the housing tube and the clamping ring means, when loose permitting air to escape during introduction of said grease, said resistor assembly, when said plug and clamping ring are tight, retaining said grease within said tube and providing thorough electrical insulation around said resistor.

5. The construction according to claim 4 wherein said housing tube has a metal spring and metal ball within the same disposed adjacent said removable plug, said spring making electrical contact with the adjacent terminal of said dropping resistor and the metal ball serving to reduce the electric field adjacent the end of the tube housing.

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