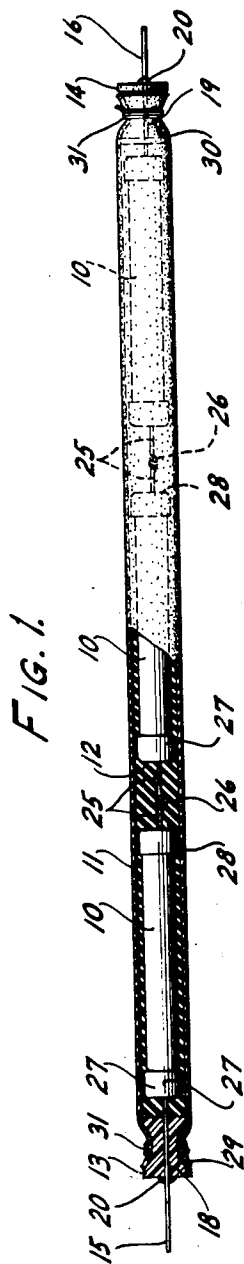
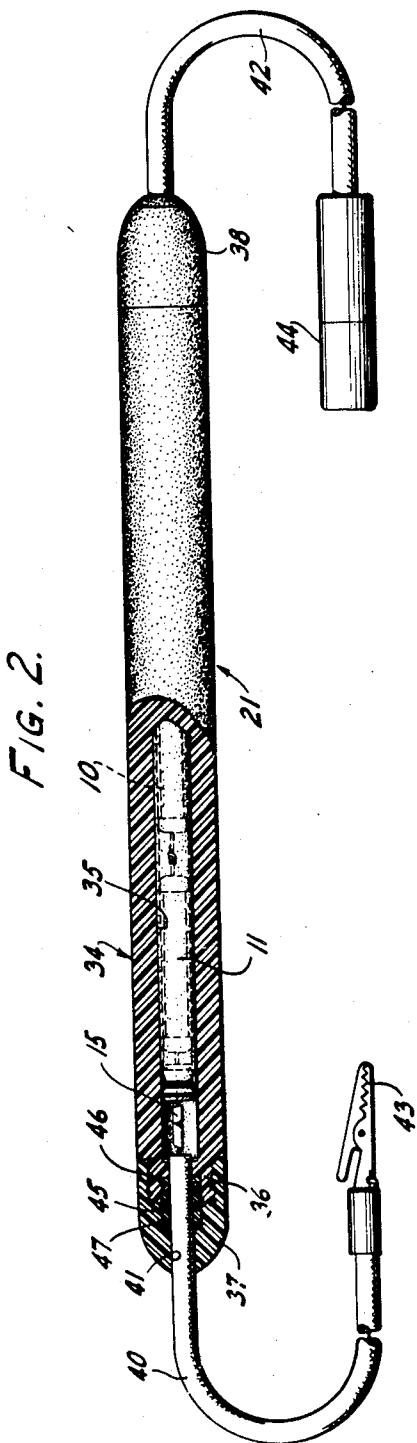


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HIGH VOLTAGE RESISTOR

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2,466,211



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UNITED STATES PATENT OFFICE

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HIGH-VOLTAGE RESISTOR

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This invention is concerned with high voltage resistors, and more particularly to insulating enclosures for such resistors.

More specifically, the invention is concerned with providing corona-resistant means for housing high voltage resistors of the so-called pyrolytic type. This type of resistor comprises a cylindrical dielectric core of ceramic, or some other suitable material, having deposited upon the surface thereof a thin coating of resistance material such, for example, as granular or cracked carbon. This carbon film may be applied in a manner to cover the ceramic core completely, or, where it is desired to have a resistance of long length in a short space, may be formed in a helical path upon the surface of the core.

The type of corona with which the invention is concerned is that which occurs through leakage of current due to conductance by the ambient gas (air in this particular instance) in contact with the surface of the resistors.

It has been found that resistors of this type, when used in freely circulating air can withstand extremely high potentials, 30,000 volts, for example, without serious corona discharge or breakdown, but when housed in a confined space, such as testing instruments and other similar apparatus, in which the air is not freely circulating over the surface of the resistor, the still air surrounding the resistors ionizes and thereby becomes conductive to an extent causing leakage of current resulting in a corona discharge. In addition to increasing the temperature within the instrument to an unduly high degree which results in a breakdown of the resistors, corona causes deterioration of the insulating housing, by thermal oxidation or corona cutting.

For the reasons set forth hereinabove, it is an important object of the invention to provide improved means so enclosing or housing high voltage resistors that extremely high voltages may be safely applied thereto without the occurrence of corona.

Another object of the invention is the provision of such means characterized by its simplicity and inexpensive construction.

The manner in which the aforesaid, and other objects, are attained, will become apparent from the following specification and the accompanying drawings illustrating a preferred embodiment of the invention, and in which:

Figure 1 is an elevational view, partly in section, of a plurality of series-connected high voltage resistors enclosed in accordance with the invention; and

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Figure 2 is an elevational view, partly in section, of a high voltage testing device, or probe, incorporating the principles of the invention.

With reference to Figure 1 of the drawings in which the preferred embodiment is illustrated, the invention comprises, generally, a plurality of series-connected resistors 10 enclosed, or housed, in a fluid impervious member or envelope 11 in which the remaining space is filled with a suitable dielectric material 12. The opposite ends of housing 11 are plugged, or sealed, with dielectric elements or plugs 13 and 14, thus completely enclosing the resistors.

Means for connecting the resistance unit to associated apparatus is provided by end leads 15 and 16 which extend through the walls of the housing, apertures 18 and 19 in electric elements 13 and 14 being provided for this purpose. The apertures 18 and 19 may be sealed in any suitable manner, as, for example, by soft solder shown in the drawing at 20.

While the drawing illustrates three resistors in series circuit relation, it will be understood, of course, that the number of resistors used may range from one to any number required, as determined by the physical size most convenient for each given application, the power rating of each resistor, and the total resistance required for each particular use. As a practical matter, and for the following reasons, it has been found much more satisfactory to use short resistors of a single resistance and power rating. Firstly, being short, they are less subject to breakage; and secondly, they provide more flexibility in application with a minimum inventory and expense. In other words, by using multiples of resistors of one standard rating it is possible to obtain a large range of resistance values without the expense of manufacturing and stocking resistors of different types.

The invention has found particular usefulness with high voltage testing apparatus and, therefore, has been illustrated as comprising the resistance element of a high voltage probe 21 normally used with high voltage testing apparatus (not shown) for determining unknown voltages in electrical apparatus. The probe is commonly known as a "voltage multiplier" as it increases, or multiplies the range of the volt-meter or other test instrument.

More specifically, and in particular accordance with the present invention as illustrated, the resistors 10 have their leads 25, between adjacent ends thereof, securely twisted together and soldered, as indicated at 26, thereby connecting

the resistors in a manner forming a single continuous conductive path. To facilitate connection of the resistor leads to the body of the resistor, each resistor is provided with metallic end caps 27 and 28 in conductive contact with the conductive coating on the surface of the resistor.

The housing member 11 comprises a sleeve which may be formed in any desired shape, and may be of any desired material having suitable dielectric characteristics; however, in the preferred form of the invention use of transparent tubing of resinous plastic composition is contemplated. Preferably one of the transparent vinyl resins is used, because of their stability under the conditions of use of the present apparatus. While it is not necessary to use a transparent material, transparency aids in detecting air bubbles which may inadvertently be formed while assembling the unit, as described hereinafter.

Plugs 13 and 14 may also be formed of any suitable dielectric material, but it has been found that one of the plastics of the polystyrene type best serves the purpose. The mid-portion of each of these plugs is provided with an annular recess, 29 and 30, in which the ends of sleeve 11 are secured by suitable means. As shown at 31, ordinary string may serve this purpose, the string being wrapped tightly around the ends of the sleeve, thereby drawing it snugly into the recess in such a way as to secure the sleeve to the plugs, in a fluid-tight condition.

The dielectric material 12 may be of several suitable types, the important consideration being that it have the necessary dielectric characteristics. However, a dielectric material having the following characteristics, best serves the purposes of the invention. It should possess satisfactory dielectric properties in the presence of high voltages, be substantially chemically inert and stable over a wide range of temperatures, should be non-hygroscopic, and should be substantially impermeable to moisture.

A dielectric having the aforesaid characteristics as described in detail in the patent to S. L. Bass, Number 2,428,608, is known commercially as "D C 4 Compound," and is manufactured by Dow Corning Corporation, Midland, Michigan. "D C 4 Compound" is one of the silicone compounds characterized as a heat stable, organo-silicon oxide polymer, and is ideally suited to replace air as a dielectric, to prevent corona discharge.

As described in the aforesaid patent, the dielectric comprises a composition of finely divided inorganic aerogel, e. g., of silicon dioxide, aluminum oxide, or iron oxide or a mixture of such oxides, which may be mixed, as by grinding, in suitable proportions with liquid polymers of organo-silicones to obtain homogeneous mixtures which are far more viscous than the polymers alone and are well adapted for use in sealing the space around an electric conductor. A characteristic of such a mixture, which makes it especially adaptable to the above use, is its stability, or in other words its ability to retain its smooth consistency (not unlike that of petroleum jelly) even when heated to high temperatures, that is, the liquid organo-silicone polymers do not flow away from the aerogel filler in the presence of heat.

As illustrated in Figure 2, the body of the probe comprises a thick-walled tubular dielectric casing member 34 having an axial aperture 35 of substantially the same diameter as that of resistor sleeve 11, in order that the resistor assembly may

be slipped within the aperture in snug relationship with the walls thereof. As shown at the left-hand end of Figure 2, body member 34 is provided with a threaded reduced end portion 36 with which a closure member 37 is engaged, thus closing that end of the inner chamber and maintaining it in a substantially air-tight condition. In like manner the right-hand end of member 34 is closed by closure member 38, it being understood that both ends of the housing are similarly constructed.

Means for connecting the resistors to apparatus to be tested is provided by an insulated wire 40 which passes through an aperture 41 in closure member 37, and is connected to the exterior lead 15 extending out of the left-hand end of the resistor assembly. Means for connecting the probe to associated testing apparatus, a volt-meter, for example, takes the form of an insulated wire 42 which passes through closure member 38, and is connected to exterior lead 16 of the resistor assembly. Wire 40 is provided at its free end with a clamp 43 adapted for attachment at any desired point in a circuit under test, while wire 42 is provided with a plug 44, through which it may be attached to the volt-meter. Both wires are so secured to the housing as to prevent relative movement therebetween, a strain relief bushing (see the left-hand end of Figure 2) being used for this purpose. This bushing comprises a plurality of resilient washers 45 pressed between a recessed portion 46 of housing 34, and a recessed portion 47 in closure member 37, in a manner causing the washers to bulge inwardly and thus exert pressure against the wires.

In assembling the resistors within housing member 11, as seen in Figure 1, one end of sleeve 11, for example the left end, is tied to end plug 13, as described above. Aperture 18, through which resistor lead 15 is to pass is then held closed, and the sleeve is filled with the viscous dielectric material 12. After twisting the resistor leads together and securely soldering them—taking care that no sharp ends are present after the soldering—the resistors 10 are threaded into the sleeve until lead 15 extends the desired distance through the plug aperture. In threading the string of resistors in the sleeve, care must be taken that no air bubbles remain in the sleeve and that all the surface of each of the resistors is wetted by direct contact with the viscous dielectric 12. The opposite end plug 14 is now threaded over the other end lead 16, into the right-hand end of the sleeve, to an extent permitting the end of the sleeve to be tied tightly over the recessed mid-portion of said plug. By soldering around the wire leads 15 and 16 at the ends of the assembly, as indicated at 20, there is produced a fluid-tight housing wherein all the resistors are wetted by the viscous dielectric and air is excluded from contact therewith.

Thus, it is evident that the invention provides an inexpensive, easily assembled, resistance assembly characterized by its ability to withstand extremely high voltages without the occurrence of corona, thereby preventing breakdown of the resistors and deterioration of the housing thereof.

I claim:

1. A corona-resistant high-voltage testing assembly comprising a pyrolytic resistor, an elongate flexible dielectric housing completely surrounding said resistor in spaced relation therewith, said housing being composed of a resinous plastic substance, conductors extending from opposite ends of said housing in fluid-tight

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relation therewith and connected in series with said resistor, a viscous dielectric substance completely filling the remaining space within said housing to the exclusion of all gaseous elements, said viscous dielectric substance comprising an organo-silicon oxide polymer substantially stable over a wide range of temperatures, and a casing of high dielectric strength enclosing said housing.

2. A corona-resistant high-voltage testing assembly comprising a plurality of high-voltage series-connected resistors, a substantially fluid-impervious flexible membranous housing surrounding said resistors in spaced relation therewith, said housing being composed of a vinyl resin, means including a pair of plugs, said plugs being disposed within the end portions of said housing, means securing end portions of said membranous housing in fluid-tight relation with said plugs, means for connecting said resistors to associated apparatus, said last-mentioned means comprising conductors connected to the opposite ends of said series-connected resistors and extending through said plugs in fluid-tight relation therewith, and a viscous dielectric substance completely filling the space remaining in said housing to the exclusion of all gaseous elements, said viscous dielectric substance comprising an organo-silicon oxide polymer substantially stable over a wide range of temperatures.

3. A corona-resistant high-voltage testing assembly comprising a plurality of high-voltage series-connected resistors, a substantially fluid-impervious transparent flexible membranous housing surrounding said resistors in spaced relation therewith, said housing being composed of a vinyl resin, means including a pair of plugs, said plugs being disposed within the end portions

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of said housing, means securing end portions of said membranous housing in fluid-tight relation with said plugs, conductors connected to the opposite ends of said series-connected resistors and extending through said plugs in fluid-tight relation therewith, a viscous dielectric substance completely filling the space remaining in said housing to the exclusion of all gaseous elements, said viscous dielectric substance comprising an organo-silicon oxide polymer substantially stable over a wide range of temperatures, a rigid tubular dielectric casing enclosing said housing, and lead means connected to said conductors and extending exteriorly of said casing.

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Certificate of Correction

Patent No. 2,466,211.

April 5, 1949.

JOHN G. CROCKETT

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 2, line 17, for the word "electric" read *dielectric*;
and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of September, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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