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EMBEDDED RESISTANCE UNIT

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Fig. 1

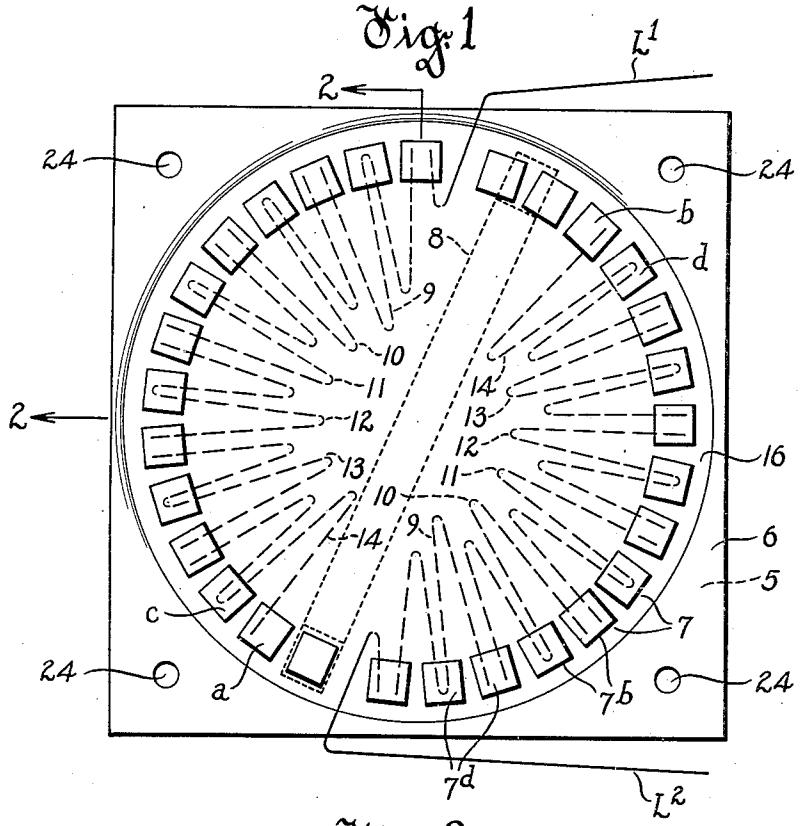


Fig. 2

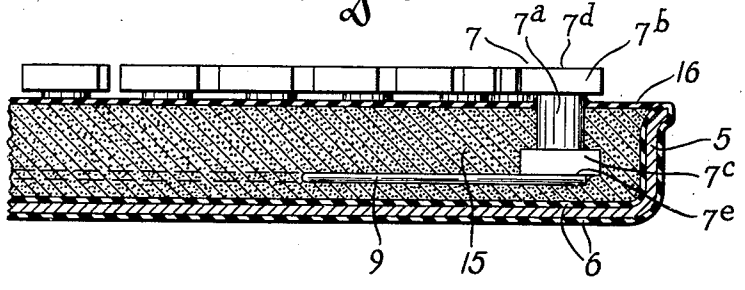
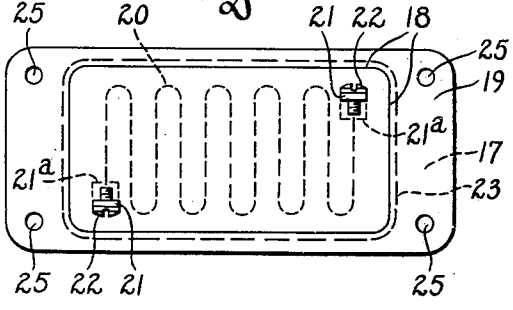


Fig. 3



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EMBEDDED RESISTANCE UNIT

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6 Claims. (Cl. 201—64)

This invention relates to improvements in embedded resistance units.

A primary object of the invention is to render such units moisture resistant and to insure a high ground resistance thereof.

Another object is to provide for attainment of the aforementioned desirable characteristics in such units by simple and relatively inexpensive means.

Another object of the invention is to provide an embedded resistance unit having a covering of water repellent material capable of withstanding temperatures up to 500 degrees F., whereby such unit is substantially unaffected by water or moisture or temperatures incident to use thereof.

Another object of the invention is to provide a metal backed embedded resistance unit wherein the cement surface is covered by a relatively thin layer of a siliceous resin which is substantially waterproof, is capable of withstanding high temperatures, is chemically inert, bonds well to such cement surface, increases surface smoothness, and may act as a vehicle for application of a pigment over the surface of the embedding cement.

Another and more specific object of the invention is to provide a cement-embedded, metal backed resistance unit wherein the cement surface is covered by a relatively thin layer of methyl silicone or a compound including such material.

Other objects and advantages of the invention will hereinafter appear.

Heretofore it was found practically impossible to provide for resistors a vitreous enamel coating which was free from crazing or cracks; and in those cases wherein the resistor was embedded in an insulating cement it was found that the cement was inherently very porous. In both cases water or moisture had more or less free access to the resistor, and destruction of the resistor by electrolysis or chemical action was likely to occur.

In accordance with our invention the resistive conductor and the associated contacts or terminal members are secured in their proper positions by the embedding cement, and by applying a relatively thin coating or layer of methyl silicone over the embedding cement and properly maturing it, the embedding cement is made highly repellent to water or moisture.

In the drawing, Figure 1 is a top plan view of one form of metal backed variable rheostat of the embedded resistor type wherein the normally exposed area of the embedding material is coated with a composition including methyl silicone to render the embedding material substantially proof against entrance of water or moisture.

Fig. 2 is a fragmentary sectional view, on the broken line 2—2 of Fig. 1, illustrating in greater detail the construction of the rheostat, and

Fig. 3 is a top plan view of a fixed resistance unit of the metal backed type, the resistor being embedded and the embedding material being coated in the manner shown in Fig. 2.

Referring first to Figs. 1 and 2, the numeral 5 designates a metal plate or pan which is drawn, spun or otherwise formed from a suitable blank to provide a relatively large concentric recess or depression (of circular form, as illustrated). Plate 5 is then provided (on both sides and on the edges) with a vitreous enamel coating, designated by the numeral 6. In practice we prefer to first provide plate 5 with a ground coating of vitreous enamel, and to then apply and fire over the first coating a second coating having good electrical insulating characteristics.

The foregoing procedure has been set forth merely by way of example; it being understood that for certain purposes and under certain operating conditions (of the rheostat or resistance unit) it may be desirable to limit the enameling of plate 5 to a ground coating only, or to apply two ground coatings, or to employ combinations of various enamels and to apply many coatings, each coating being preferably only five-thousandths to six-thousandths of an inch in thickness. However, we have found it desirable in practice to keep the enamel coating 6 as thin as possible, provided that the electrical insulating characteristics afforded thereby meet the particular requirements. As is well known by those skilled in the art, a thin vitreous enamel coating of the character specified retains a sufficient degree of elasticity or flexibility to prevent the same from cracking or crazing under the heat shock incident to use of the article.

In the device of Figs. 1 and 2 we prefer to employ a multiplicity of like elements 7 of approximately spool-shape. That is to say, each element 7 has an intermediate cylindrical portion 7^a and substantially square end portions 7^b and 7^c (see Fig. 2). The smooth upper surfaces 7^d of the respective end portions 7^b are adapted to serve as stationary contacts or contact buttons to be engaged in a predetermined sequence by the opposite ends of a bridging or circuit-completing contactor shown in dotted lines at 8 in Fig. 1. We prefer to form the elements 7 of brass; and in practice groups of the same have attached to the flat lower surfaces 7^e (Fig. 2) of their respective end portions 7^c (as by silver soldering, welding or in any other suitable manner) the ends and intermediate loop portions of a plurality of approxi-

mately W-shaped resistive conductors; two sets of such resistive conductors being illustrated, and the same being respectively designated by the reference characters 9, 10, 11, 12, 13, and 14. The two sets 9 to 14, inclusive, of resistive conductors are preferably of substantially the same shape or contour, but are composed of wires of different diameter or caliber, so that, for instance, the resistive conductors 9 will have the highest resistance values and the resistive conductors 14 will have the lowest resistance values.

Moreover, the stationary contact surfaces or buttons 7d associated with the two groups of resistive conductors 9 to 14 are offset from a true diametrically opposite relationship to each other, so that with the twelve resistive conductors employed an "off" position for contactor 8 is afforded as well as twenty-five other positions which respectively provide for inclusion of different values of resistance in the circuit to be controlled. Thus, as shown in dotted lines in Fig. 1, contactor 8 is in "off" position, whereas upon clockwise movement thereof the same will first engage the button which we have marked *a* and the same will thereafter simultaneously engage the button marked *b*, whereby all of the resistance is included in the controlled circuit. Upon continued clockwise movement of contactor 8 the button *c* will be engaged to exclude from circuit the larger loop portion of the lowermost resistive conductor 14. Thereafter the larger loop portion of the uppermost resistive conductor 14 will be excluded from circuit, after which the smaller loop portion of the lowermost resistive conductor 14 will be excluded from circuit; and so on, until in the final circuit-completing position of contacter 8 the same will bridge the contacts to which the circuit wires designated L^1 and L^2 are connected.

The contact members 7, certain of which have the resistors 9 to 14 and line wires L^1 and L^2 secured to the lower end portions thereof, as aforedescribed, are positioned in any suitable or well known manner within the recess in the enameled plate 5, and then the embedding material 15 is poured into said recess. The material 15 may consist of any suitable type or composition of insulating cement. However, we prefer to employ a cement composed of 62 per cent silica floats, 22 per cent water, and 16 per cent sodium silicate. After the cement is poured into said recess, to a level substantially below the upper end of the latter, a suitable quantity of quartz sand is distributed over the upper surface of the cement and the unit vibrated to effect removal of any entrapped air, and to effect a thorough coating of the sand grains by the cement.

The embedding material is then baked; the baking cycle preferably consisting of a six hour bake at a temperature of 180 degrees F., a three hour bake at 300 degrees F., and a one hour bake at 600 degrees F., at the end of which period the embedding material will be matured. The contact buttons and the resistive conductors associated therewith will then be rigidly positioned or held in place by the insulating cement. After the unit has cooled the exposed surfaces 7d of the contact buttons may, if necessary, be ground or otherwise jointly machined to insure a coplanar relationship thereof.

The resistance unit or rheostat is thereupon coated with the methyl silicone compound. We prefer to employ a compound having approximately the following percentages (by weight) of ingredients: 35 per cent of methyl silicone (having 71 per cent solids), 25 per cent of acetone, and 40 per cent of silica floats. These ingredients are mixed well and stirred constantly to maintain a substantially homogeneous mixture. The silica floats would tend to settle out of the mixture in the absence of constant stirring or agitation of the latter. This mixture which is quite liquid is then poured over the exposed surface of the embedding material of the resistance unit, the unit being preferably tilted and simultaneously rotated, or otherwise oriented, to insure complete coverage of the exposed surface of the cement, and to insure overlapping of the coating onto the inner enameled surface of the recess in plate 5; such coating being designated by numeral 16 in Fig. 2. The unit is then dried at about 80 degrees C. for about six hours, and the unit is then baked for about three hours at 250 degrees C. to effect complete curing of the aforementioned resinous coating.

Although we have herein described our preferred manner and means for moisture-proofing the embedding material or cement, it is to be understood that various modifications of the material and procedure may be employed without departing from the spirit and scope of our invention as defined by the appended claims. For instance, the percentages of the given ingredients of the resinous mixture may be varied throughout a relatively wide range. Pure or dilute methyl silicone may be employed without the other ingredients aforementioned, but with correspondingly lesss economy. Suitable materials other than silica floats may be employed as fillers; solvents other than acetone may be employed; the resinous coating composition may be painted, sprayed or otherwise applied to the embedding material; and the time and temperatures employed for curing the resinous coating may be substantially varied without sacrificing the advantages contemplated by us.

As heretofore stated, it is practically impossible to produce a vitreous enamel embedding material of the character described which is free of cracks and crazes; and in many instances where the vitreous enamel embedding material is initially free from such defects, it is found that after the resistance or rheostat units are placed in service cracks and crazes soon appear, due to the heat shock imparted to the embedding material by the hot resistive conductor. If a single drop of water is placed on one of such cracks and a resistance measurement taken a few minutes thereafter it is usually found that the ground resistance has dropped to quite a low value. In some instances the ground resistance has been found to have dropped below 5000 ohms under such conditions. Such a reading indicates that the crack in the cement embedding material has extended entirely through the thickness of the cement to the metal plate; and it further indicates that conduction between the resistive conductor and the metal of the plate is possible if the resistance unit is used in a highly humid or moist atmosphere.

When a coating of methyl silicone (or a composition including the same) is applied to such a unit the aforementioned cracks and crazes are filled with such coating material, and after maturing of the coating it is found that the ground resistance of the unit will remain very high, even though the coated surface of the embedding cement may be covered with water.

In a resistance unit wherein the resistive conductor is embedded in an insulating cement it

is found, as explained above, that the cement may absorb water or moisture because of the porous nature of such cement. However, with a construction of the character herein disclosed by us such porosity of the embedding cement will not affect the ground resistance because the metal plate is covered with a thin, crack-free vitreous enamel which insulates the plate from the embedding cement. On the other hand, it is possible for conduction to occur between resistance steps through a path in the embedding cement. Such secondary conduction, however slight, is likely to cause an electrolytic action which may in time eat away or weaken the resistive conductor. If a coating of methyl silicone (or a composition including the same) as disclosed herein is applied over the embedding cement and properly cured it will make the embedding cement water repellent, or even entirely water-proof. Resistance units with such a protective coating have been entirely immersed in water for several hours without showing any signs of absorbing water or changing their resistance characteristics in any way.

In Fig. 3 we have shown our invention similarly applied to a fixed resistance unit of the plate or pan type. In such a device the metal plate 17 of elongated rectangular contour may have formed therein an elongated substantially rectangular recess, as shown by the outline thereof at 18. Plate 17 is provided with a relatively thin complete covering of vitreous enamel 19, as described in connection with the device of Figs. 1 and 2. The resistive conductor is shown in dotted lines at 20 as being of zigzag or multiple-reflexed form, the diagonally positioned ends thereof being welded, brazed, soldered or otherwise suitably attached to the lower surfaces of foot portions 21a of terminal members 21, portions of which project upwardly from recess 18, which portions are provided with tapped openings to accommodate the shanks of binding screws 22 for attachment of circuit wires.

The resistance wire or ribbon 20 and the lower end portions of the attached terminal members 21 are embedded within the insulating cement in the manner described in connection with Figs. 1 and 2; and after baking of the unit as aforedescribed to mature the cement, a relatively thin coating of methyl silicone, or a composition including the same as aforedescribed, is applied to the upper or exposed surface of the cement to completely cover the latter and to overlap the peripherally adjacent portion of the enameled plate or pan, as indicated in dash lines at 23 in Fig. 3. Both the metal plate 5 of Fig. 1 and the metal plate 17 of Fig. 3 are preferably provided with a plurality of groups of openings 24 and 25, respectively, to provide for attachment of the units to suitable supports, as by means of screws or bolts.

The aforedescribed units when completed are found to have a good coating of the methyl silicone compound over the embedding cement. Such coating is tough, and is impervious with respect to water or moisture. The coating is found to be more than a mere surface phenomenon. That is to say, the coating material is soaked, or drawn by capillary action, into the cement adjacent the surface of the latter; and the coating is further characterized by its entire freedom from cracks or holes. Moreover, such characteristics of the coating are maintained throughout the range of temperatures to which the units will be subjected when in use.

As heretofore indicated, such coating material may be utilized as a vehicle for a suitable pigment, which may be mixed with the other ingredients thereof prior to application thereof to the cement surface. Thus, whereas a natural brown color is afforded by the methyl silicone such color may be changed by the addition of green, red, black, blue, or other pigments, which may be utilized to improve or enhance the appearance of the finished units, according to the particular color desired.

A metal backed rheostat or resistance unit of the character herein disclosed is unusually rugged, the mechanical strength thereof being such that it is able to withstand a shock of two thousand foot pounds without injury.

We claim:

1. A metal backed resistance unit of the cement-embedded resistor type, the cement surface being completely covered by a compound including essentially a relatively large proportion of a high temperature siliceous resin, whereby the same is adapted to withstand temperatures up to 500 degrees F. without crazing or cracking, and said compound being adapted to render said unit moisture resistant to thereby insure therefor a high ground resistance.

2. A metal backed resistance unit of the cement-embedded resistor type, the initially exposed surface of the embedding cement being completely covered by a compound consisting essentially of methyl silicone, said covering compound being characterized by its freedom from crazing or cracking when subjected to temperatures up to 500 degrees F., and the same acting to render said embedding cement highly resistant to moisture, whereby an unusually high ground resistance of the unit is insured under all conditions.

3. In a resistance unit, in combination, a sheet metal plate having a recess formed therein, all surfaces of said plate having a relatively thin coating of vitreous enamel of good electrical insulating character, a resistive conductor positioned within said recess, a vitreous insulating cement also positioned within said recess and adapted to embed said resistive conductor, said cement being baked in situ to mature the same, a relatively thin coating of a compound including a substantial quantity of methyl silicone as an essential ingredient completely covering the initially exposed surface of said cement, said compound being also baked in situ to completely cure the same, and said compound when cured being adapted to withstand temperatures up to 500 degrees F. without cracking or crazing, to thereby render said cement moisture resistant, whereby a high ground resistance of the unit is insured.

4. In a resistance unit, in combination, a sheet metal plate having a recess formed therein, all surfaces of said plate having a relatively thin coating of vitreous enamel of good electrical insulating character, a resistive conductor positioned within said recess, a vitreous insulating cement also positioned within said recess and adapted to embed said resistive conductor, said cement being baked in situ to mature the same, a relatively thin coating of a compound consisting essentially of methyl silicone completely covering the initially exposed surface of said cement, said compound being also baked in situ to completely cure the same, and said compound when cured being adapted to withstand temperatures up to 500 degrees F. without cracking or craz-

ing, to thereby render said cement moisture resistant, whereby a high ground resistance of the unit is insured.

5. In a resistance unit, in combination, a sheet metal plate having a recess formed therein, all surfaces of said plate having a relatively thin coating of a vitreous enamel of good electrical insulating character, a resistive conductor positioned within said recess, a vitreous, adhesive insulating cement also positioned within said recess and adapted to embed said resistive conductor, said cement comprising approximately 62 per cent silica floats, 22 per cent water and 16 per cent sodium silicate and the same being baked in situ to mature the same, a relatively thin coating of a compound consisting of approximately 35 per cent by weight of methyl silicone intimately mixed with a solvent and a filler completely covering the initially exposed surface of said cement and overlying the adjacent portions of said enameled plate, said compound being also baked in situ to completely cure the same, and said compound when cured being adapted to withstand temperatures up to 500 degrees F. without cracking or crazing to thereby render said cement moisture resistant, whereby an unusually high ground resistance of the unit is insured under all conditions.

6. In a resistance unit, in combination, a sheet metal plate having a recess formed therein, all surfaces of said plate having a relatively thin coating of a vitreous enamel of good electrical insulating character, a resistive conductor positioned within said recess, a vitreous, adhesive insulating cement also positioned within said recess and adapted to embed said resistive conductor, said cement comprising approximately 62 per cent silica floats, 22 per cent water and 16 per cent sodium silicate and the same being baked in situ to mature the same, a relatively thin coating of a compound, comprising approximately 35 per cent by weight of methyl silicone having 71 per cent solids, 25 per cent of acetone, and 40 per cent of silica floats, completely covering the initially exposed surface of said cement and overlying the adjacent portions of said enameled plate, said compound being also baked in situ to completely cure the same, and said compound when cured being adapted to render said cement moisture resistant, whereby an unusually high ground resistance of the unit is insured under all conditions.

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