

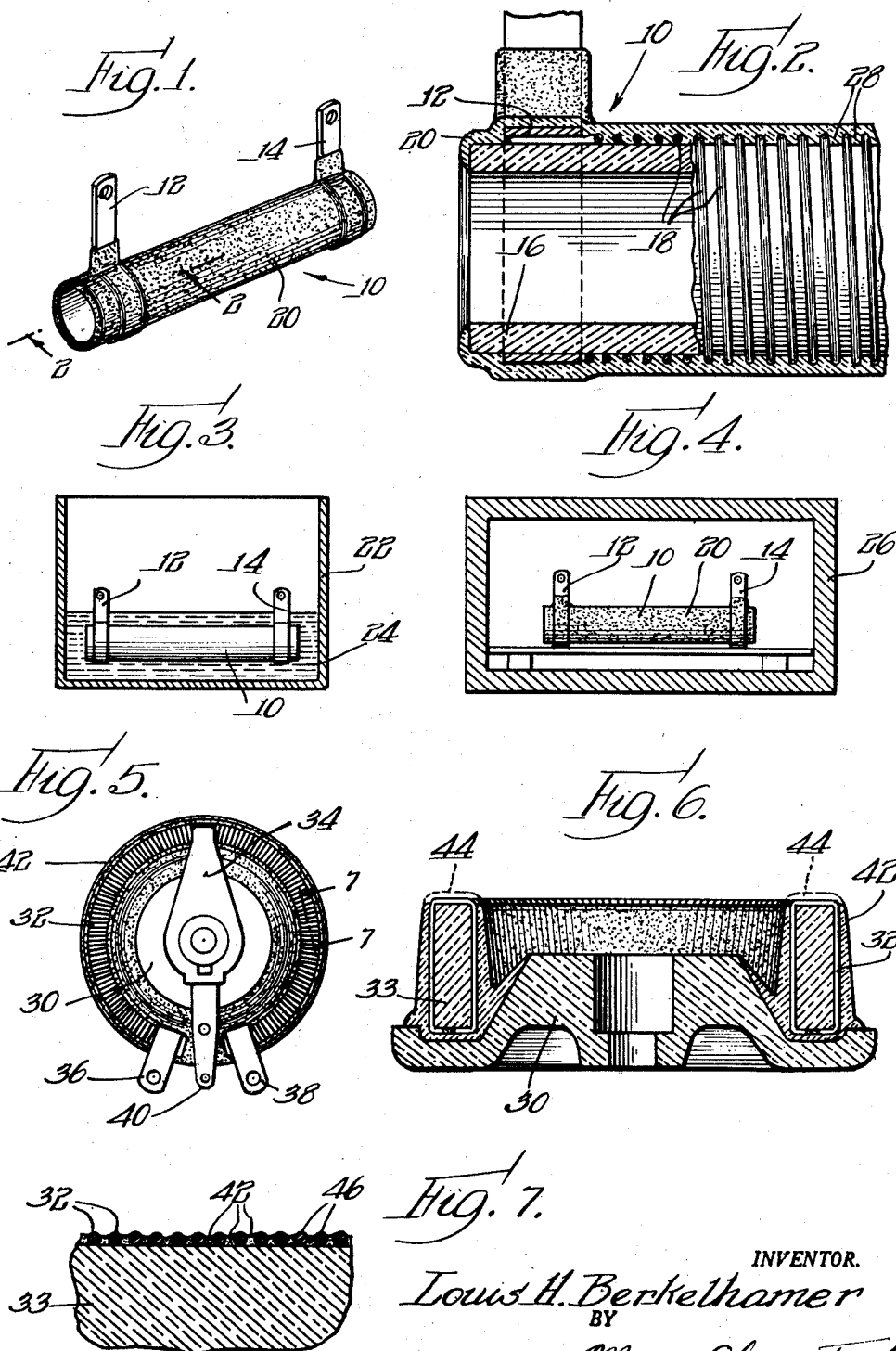
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ELECTRICAL ELEMENT

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ELECTRICAL ELEMENT

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This invention relates to electrical elements and to methods for effecting the manufacturing thereof. It concerns particularly electrical circuit elements of the wire coil resistive type such as wire coil resistors and rheostats.

Wire coil resistive circuit elements, such as resistors and rheostats, as heretofore manufactured have basically been of two types, viz., those coated with vitreous enamel, and those coated with organic lacquers and varnishes. The lacquer or varnish coated elements, while relatively easily fabricated, have the disadvantage that they are not resistant to high temperature, which precludes their use in many circuit installations. The vitreous enamel coated elements have high thermal resistivity, and thus are capable of a greater range of use, but require high firing temperatures to bake the enamel which in turn results in certain marked disadvantages both in the case of resistors and in the case of rheostats. In the instance of resistors the high firing temperatures may, particularly in the case of certain alloy wire coil resistors, result in the tempering of the wire or in effecting of other physical or chemical changes in the wire which result in a change in the resistance coefficient of the wire body. As a result, the resistor after the baking of the vitreous enamel no longer has its precalculated resistive value, which in installations requiring high accuracy precludes the use of the resistor or various testing, selecting, or compensating operations as will be understood. As to rheostats, the conventional physical form of a rheostat entails the use of a slidable contactor along an exposed portion of the resistive wire coil, the remainder of the coil, or parts thereof, being encased within the vitreous enamel material. The baking of the vitreous enamel, at the high firing temperatures required, frequently oxidizes the exposed metal portions of the wire coil so that these portions must be cleaned after the firing process. In instances wherein the coil is formed of relatively fine wire, the cleaning which generally entails buffing or the like, frequently damages or breaks the small and frangible wire so that the rheostat must be discarded or repaired.

Various other materials and manufacturing processes may be utilized for the fabrication of resistive coil electrical elements, each however having its own disadvantages. Among the materials possessed of dielectric properties are so-called silicones, which are organo-silicon oxide polymers. While silicones are possessed of dielectric properties, and are sufficiently heat resistant and mechanically strong for certain electrical in-

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stallations, difficulties are encountered in their attempted use with wire coil resistive circuit elements such as hereinabove mentioned.

In accordance with the present invention, applicant has devised ways and means for effecting the satisfactory application of silicone material to wire coil resistive circuit elements, such as resistors and rheostats; and has further provided certain materials of addition, with the silicone, which it has been found impart to the elements the desired and necessary characteristics of accuracy, heat resistance, and mechanical strength.

It is accordingly an object of the present invention to provide an improved and satisfactory wire coil resistive element, such as a resistor or rheostat, and to provide satisfactory methods of fabrication of such elements, wherein a silicone material forms a part of the protective coating for the resistive wire coil.

A further object of the invention is to provide an electrical resistive element, embodying a silicone in a protective coating for the wire coil, and wherein the coating is possessed of the requisite and improved qualities of insulation, thermal resistance, and physical strength.

Various other objects, advantages and features of the invention will be apparent from the following specification when taken in connection with the accompanying drawings wherein certain preferred embodiments are set forth for purposes of illustration.

In the drawings, wherein like reference numerals refer to like parts throughout:

Fig. 1 is a perspective view of a wire coil resistive circuit element and specifically a resistor, constructed in accordance with and embodying the principles of the present invention;

Fig. 2 is an enlarged partial longitudinal sectional view of the resistor of Fig. 1, on the line 2—2 thereof;

Figs. 3 and 4 are views illustrating method steps in the fabrication of the resistor, according to the present invention;

Fig. 5 is a top or plan view of a resistive circuit element in the form of a rheostat, constructed in accordance with the invention;

Fig. 6 is an enlarged sectional view of the rheostat body, forming a part of the rheostat structure of Fig. 5; and

Fig. 7 is a detail sectional view of the rheostat structure of Fig. 5, taken as indicated by the line 7—7 thereof.

Referring more specifically to the drawings, and first to Figs. 1 to 4 thereof, in Fig. 1 there is illustrated a wire coil resistor comprising a body portion 10 provided with terminal lugs 12 and 14 at

the opposite ends thereof. The terminal lugs comprise projecting fine portions to which various circuit elements may be secured, and band portions embracing the body portion of the resistor and to which the opposite ends of the resistive wire coil are electrically connected, as will be understood.

As best shown in Fig. 2, the resistor body portion comprises a ceramic tube 16 upon which is wound the resistive wire coil 18, the various convolutions of which are maintained in predetermined spaced relation. In accordance with the present invention the wire coil, its several convolutions, and the band portions of the terminal lugs are completely covered by a coating 20, the constituency and manner of application of which will be presently described.

Silicones, in general, are classified as compounds and greases, fluids, varnishes and resins, and rubbers. Of these silicones, some of which may be properly designated as liquids at room temperatures, the rubbers have the highest molecular weight. Silicone rubbers are marketed by various manufacturers, those made by Dow Corning being designated as "Silastic." Dow Corning designates its Silastic 121-122 as heavy paste, its Silastic 123-126 as thin paste, and its Silastic 150-160, 161, 167, 180 and 181 as stock.

In compounding and applying the coating 20, a silicone liquid is given the desired viscosity by mixing with a thinner such as toluene or naptha. The silicone liquid, thus treated, is then mixed with a powdered mineral filler, specifically silica in the particular embodiment disclosed, and the mix is stirred or beaten to form a suspension. The suspension mix, thus formed, is then placed within a suitable tank 22, Fig. 3, as indicated at 24, and the electrical unit may be immersed therein, as shown, preferably in a manner so as to leave the projecting fine portions of the terminals 12 and 14 exposed so as to remain uncoated.

The unit, thus coated, is then placed within an oven 26, as indicated in Fig. 4, so as to cure the silicone material. If desired, the unit may be subjected to several repeated immersion and heating operations so as to build up the coating 20 as a plurality of layers. For economy the coating may be precluded from formation within the inner bore of the tubular ceramic body 16 by plugging the ceramic tube or wiping the coating therefrom, as desired.

The heat cure temperature to which the coating is subjected by the oven 26, may vary somewhat depending upon the length of time of the heating operation, but is in any event within a resistor curing range and time substantially above a condensing range but materially below the firing temperature of vitreous enamel, and sufficiently low to preclude a chemical or physical change within the metal of the resistive wire coil 18, and resultingly any change in the electrical resistive coefficient thereof.

While the coating 20 has been illustrated as applied by immersion of the unit within the suspension mix 24, it will be understood that the mix may be applied by other physical means such as pouring or otherwise, if desired. A method is employed, however, which insures that the mix will penetrate between the convolutions of the wire coil, as indicated at 28 in Fig. 2, so as to insure the insulation of the convolutions from each other, and so as to permit the coating 20 to adhere directly to the outer surface of the ceramic tube 16 as well as to the wire surfaces.

It has been found that the mixing of the sili-

cone liquid with a powdered mineral filler, as heretofore described, so as to make a suspension mix, results in an insulation coating which is possessed of desired properties of electrical insulation, thermal resistance, and physical strength; and a coating which is materially superior to silicone alone particularly as to the thermal resistance and physical strength characteristics. The coating 20 which comprises a cured mix of silicone liquid and the powdered mineral filler is sufficiently resistant to mechanical abrasion for most installations, and imparts an adequate electrical insulation and thermal resistivity to the unit; while at the same time the fabrication and application of the coating as herein described preserves the original predetermined electrical resistive coefficient of the wire coil so that the resistor in its completely fabricated form will be possessed of the desired predetermined resistance value.

In Figs. 5-7 the principles of the invention are illustrated as applied to an electrical resistive element of the wire coil rheostat type. Referring to Fig. 5, a rheostat is illustrated comprising a ceramic body 30, a resistive wire coil 32, and a rotary contactor 34 arranged to selectively engage exposed portions of the wire along the length of the coil. The opposite ends of the resistive wire coil are secured to suitable terminal lugs as indicated at 36 and 38, whereas the rotary contactor is electrically connected to a companion terminal lug 40, the resistance values between the lugs 38 and 40 thus being selectively variable by the rotation of the contactor 34 in a manner characteristic of rheostat structures.

Referring to Fig. 6, the ceramic body 30 and the resistive wire coil 32, together with the ceramic ring 33 upon which the coil is wound, are illustrated in enlarged detail. In accordance with the invention the wire coil is embedded within and secured with its mounting ring 33 to the ceramic body 30 by means of a material mass or coating 42 of the same character as the coating 20 of the resistor unit previously described.

In fabricating the rheostat of Figs. 5-7 the mass 42 may be formed by mixing the silicone liquid, the powdered mineral filler, and the thinning solvent in such proportions of the thinner as to make a relatively heavy paste, the mix being stirred or beaten as previously described to form a suspension of the coating body. The coating or body 42 may be applied to and around the wire coil by suitable means such as a putty knife, or by dipping or the like, the wire coil and its mounting ring 33 then being disposed upon the ceramic body 30, as shown, and the coating material heat cured as hereinbefore described. Prior to the heat curing operation the excess coating material is wiped from the upper portions of the wire coil as indicated in dotted lines at 44 in Fig. 6. The manner in which the coating material remains embedded between the convolutions of the wire coil, after the wiping operation, is illustrated in enlarged detail in Fig. 7.

During the curing of the coating 42 within a suitable oven such as previously described, the curing temperature is maintained sufficiently low so as to avoid oxidation of the exposed wire coil surfaces as indicated at 46, Fig. 7, which have been wiped clean of the coating material, whereby the further cleaning or treatment of the exposed wire surfaces after the heat curing operation is unnecessary. By this means the wire coil is at no time subjected to the action of abrasion cleaning members or the like so that the spacing of the

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coil convolutions is not disturbed and breakage or damage of the wire is precluded. In the rheostat structure of Figs. 5-7, the coating material or body 42 into which the wire coil is embedded acts not only as a protecting, insulating, and spacing medium for the convolutions of the coil, but also as an adhesive medium for bonding the wire coil and its mounting ring 33 to the main ceramic base 30 of the rheostat structure.

The desirable mechanical, electrical, and thermal characteristics of the coating 42 have been previously described in reference to the coating 26 of the resistor, as will be understood.

It is obvious that various changes may be made in the specific method steps and structures as heretofore described without departing from the spirit of the invention. The invention is accordingly not to be limited to the specific embodiments shown and described, but only as indicated in the following claims.

The invention is hereby claimed as follows:

1. A wire coil electrical resistive element comprising a base, a flexible uncovered wire coil wound on and in direct mutual contact with said base, and an insulating material comprising a mix of silicone and powdered mineral filler forming the immediate insulating coating both for the wire coils and for the base and heat cured thereon at a temperature materially below the firing temperature of vitreous enamel to adhere to the coils and to the base therebetween for positioning the coils and providing physical resistance to abrasion and thermal shock.

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2. A wire coil electrical resistive element as claimed in claim 1, wherein the filler consists of powdered silica.

3. A wire coil electrical resistive element as claimed in claim 1, wherein the resistive element is in the form of a rheostat in which a portion of the wire coils is exposed between marginal edges of the insulating coating to provide contact surfaces.

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