

[54] RESISTOR FILM

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[58] Field of Search 117/227, 226, 161 KP, 145, 117/218, 212, 64 C, 201; 338/308; 29/610, 620

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[57] **ABSTRACT**

Coatings of a dispersion of carbon black or silver dust in a cellulose acetate resin or a polyurethane resin are locally formed on an electrical resistor film consisting of a cellulose acetate resin base having dispersed therein carbon black to give a local variation in the resistivity or to give terminals providing good electrical contact to the metallic electrodes of an electrical source. A process for forming said coatings is also disclosed.

12 Claims, 2 Drawing Figures

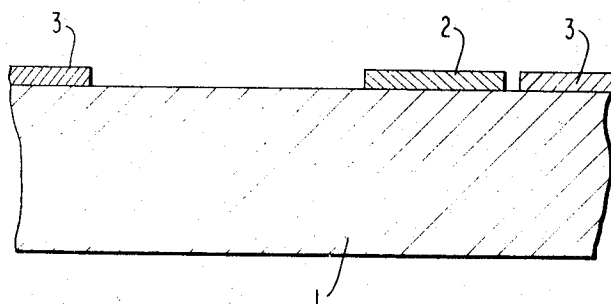


FIG 1

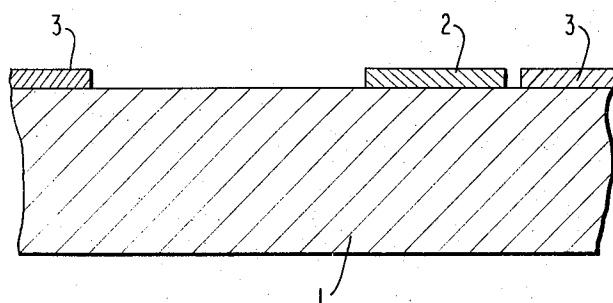
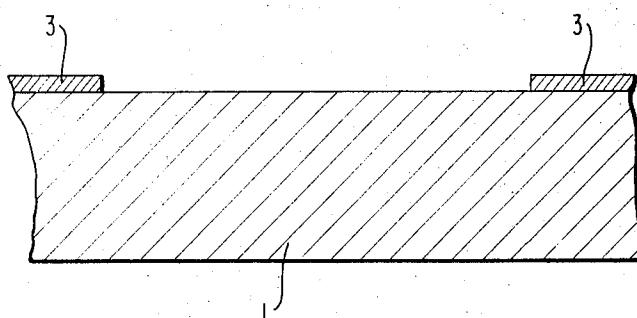


FIG 2



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RESISTOR FILM

This application is a continuation of S. N. 776,189 filed Nov. 15, 1968, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a resistor film, and more particularly to a resistor film having areas of the desired resistivity at the desired portions thereof and/or having electrode terminals firmly attached to the base resistor.

2. Description of the Prior Art

Resistor films are being used for volume and tone control of television, radio, tape recorder and telegraphic apparatus. They are also used for the adjustment of the picture of a television or in meters or the like. These films are manufactured by spraying or applying a liquid containing an epoxy (or the like), thermosetting resin as binder and an electrically conductive material such as carbon black, or the like, to a single surface of a sheet of a phenolic resin. Those resistors, however, have some shortcomings, namely, a small current capacity (wattage is usually less than 0.5 W), a deviation in the value of resistance, to a great extent due to a change in environmental humidity.

Applicants in copending U.S. Ser. No. 745,691, now abandoned are partial coinventors of a resistor-base film which is free from the shortcomings as mentioned above, i.e., it has only a small deviation in the value of the resistance, especially exhibiting little change in the value of resistance with a change in the environmental humidity, and it has a large current capacity (over 2 watts). This resistor base film illustrates a rectilinear relationship between the value of resistance and the distance between electrodes.

The resistor base material described above is obtained by casting, followed by drying, a solution in an organic solvent of a cellulose acetate resin having uniformly dispersed therein 1-20 percent by weight, based on the weight of the resin, of carbon black, silver dust or a similar electrically conductive material.

However, since the resistor base material thus obtained has a uniform resistivity throughout the whole body, the resistor film cannot practically be used in the case of a resistor requiring a varied resistivity, that is, higher or lower resistivities locally at specific or desired areas, such as, in televisions, radios, tape recorders, telegraphs or other electronic appliances. Moreover, with the abovementioned resistor film, selected areas must be contacted with metallic electrodes, such as silver foils connected to an electric source and in this case there are problems with maintaining proper contact between them.

SUMMARY OF THE INVENTION

The invention comprises a resistor film which is formed of a resistor base film comprising a cellulose acetate resin having dispersed

Still another object of this invention is to provide a resistor film having varied resistivities at desired areas of the base film and also having terminal portions strongly attached to the base film, said portions showing an improved contacting property to metallic electrodes.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic cross sectional view of an embodiment of the resistor film of this invention; and

FIG. 2 is a schematic cross sectional view of a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The above objects of the present invention have been accomplished by forming on a resistor base material (consisting of a resistor supporting base material comprising a cellulose acetate resin having dispersed therein from 1 to 20 percent by weight, based on the weight of the resin, of an electrically conductive material, such as carbon black or graphite), resistor coatings comprising a cellulose acetate resin, a polyurethane resin or a mixture thereof having dispersed therein an electrically conductive material such as a carbon black, graphite and silver dust, said coatings having been applied to the desired areas of the surface of said base material.

The resistor film of the present invention is obtained by spraying or otherwise applying a solution of a cellulose acetate resin, polyurethane resin or mixture thereof having dispersed therein carbon black, graphite, silver dust and the like, to the desired areas of the surface of a resistor base member having a smooth surface and uniform thickness, therein from about 1 to about 20 percent by weight, based on the weight of the resin, of an electrically conductive material, and at least one coating formed on the surface of said base film, the coating comprising a binder selected from the group consisting of a cellulose acetate resin, a polyurethane resin and a mixture thereof, having dispersed therein an electrically conductive material.

Preferred conductive materials are carbon black, graphite and silver dust.

The resistor film may be utilized to vary the local resistivity of the film base, or the coating may be utilized to form an electroterminal.

The process for manufacturing a resistor film which comprises forming a resistor base film comprising a cellulose acetate resin having dispersed therein from about 1 to about 20 percent by weight, based on the resin, of an electrically conductive material, and then coating said base film with a material comprising a binder selected from the group consisting of a cellulose acetate resin, a polyurethane resin and mixtures thereof, having dispersed therein an electrically conductive material is also disclosed.

Therefore, an object of the present invention is to provide a resistor film having specific local, varied resistivities at desired areas of the film.

Another object of this invention is to provide a resistor film having terminal portions strongly attached to the base film, said portions having an improved contacting property with respect to the metallic electrodes of an electric source. obtained by casting and drying an organic solvent solution of a cellulose acetate resin having uniformly dispersed therein 1 to 20 percent by weight, based on the weight of resin, of a carbon black, powdered graphite, silver dust or the like. The resistor film thus obtained exhibits excellent adhesion between the resistor base member and the coating film. On the other hand, if a thermosetting resin such as is conventionally used for the binder of resistor films, such as a phenol resin or an epoxy resin, is employed as the

binder for the coatings of this invention, the adhesion property between the film base and the coatings is very poor.

The present invention will be explained in more detail by referring to the accompanying drawings, in which:

FIG. 1 is a schematic cross sectional view of an embodiment of the resistor film of this invention, and

FIG. 2 is a schematic cross sectional view showing a second embodiment of the present invention.

In FIGS. 1 and 2, numeral 1 indicates a resistor base film comprising a cellulose acetate resin having uniformly dispersed therein an electric conductive material such as carbon black, powdered graphite, and silver dust or powder. On the surface of the base film 1 there are formed resistor coatings 2 and terminal coatings 3 (only coating 3 is shown in FIG. 2). Coating 2 comprises a binder such as a cellulose acetate resin, a polyurethane resin or a mixture thereof, and carbon black or graphite powders uniformly dispersed therein, while coating 3, the terminal coating which will be contacted to a metallic electrode, comprises a binder such as a cellulose acetate resin, a polyurethane resin or a mixture thereof and silver dust or powder uniformly dispersed therein.

The cellulose acetate resin being used in the practice of the present invention is excellent for use as a resin for the resistor coating film because it combines all the requisite characteristics to meet the objects of the present invention. Specifically, it is completely soluble in ordinary organic solvents, has a good thermal resistance, has a small hygroscopicity and a good surface hardness. The polyurethane resin utilized gives excellent adhesion between the cellulose acetate film containing an electric conductive material and the coating film.

The polyurethane resin to be used in the present invention is exemplified by Desmocer 176, Desmolin N, Desmophen 1,100 and Desmophen 2,200 (Farbenfabriken Bayer A. G.), Nippoli L-75 (Nippo Polyurethane K.K.) and Elastosun (Thiocol Chemical Co.).

Resins other than the cellulose acetate resin and the polyurethane resins described are inadequate as the resins used in the coating film. For instance, polyvinyl chloride and polystyrene are inferior in thermal resistance and polyethylene terephthalate and polypropylene are inferior in solubility.

The electric conductive material dispersed in the resin includes carbon black, powdered graphite, silver dust and the like, though the most desirable is carbon black because it has a low apparent specific gravity and it can be uniformly dispersed in large volume in the resin without deviations in the value of resistance. Finally, it is inexpensive. Powdered graphite and silver dust are conveniently used in the manufacture of resistor films having a low volume resistivity as they have high conductivities, and silver dust is suitably used for forming electrode terminals.

The resistor base member used in the present invention, the cellulose acetate film containing an electric conductive material, has a uniform thickness and a smooth surface because it is prepared by a solution casting process in which a resinous solution is cast on a rotating casting surface. It is free from deviations in the value of its resistance due to the uniform dispersion therein of a carbon black, powdered graphite, silver

dust or like which serves as an electrically conductive material.

In order to vary the value of resistance or for use as electrode terminals, a layer of a coating film is formed on the resistor base member by applying a solution of a cellulose acetate resin, a polyurethane resin or mixture thereof, containing dispersed therein a carbon black, silver dust, or a similar electrically conductive material onto the desired portions of the surface of the base member. The coating film thus formed will be firmly bonded to the resistor base member.

Specifically, the resistor film of the present invention is prepared in the following manner.

A cellulose acetate resin is dissolved in a solvent, such as methylene chloride, ethylene chloride, trichloroethylene or a similar halogenated hydrocarbon, methanol or similar alcohols, acetone, methyl ethyl ketone, cyclohexanone or similar ketones, or mixtures thereof. To the resulting solution there is added triphenyl phosphate, diethyl phthalate or a similar plasticizer, and from 1 to 20 percent by weight, based on the weight of resin, carbon black, powdered graphite, silver dust or a similar electrically conductive material. Thereafter, the mixture is milled in a ball mill or attritor, filtered and cast and dried on a moving casting surface to obtain the resistor base member of the present invention.

The thickness of the resistor base member may be varied within a wide range, though a thickness of at least 200 microns is desirable. Onto the desired areas of a single surface of the resistor base member there is sprayed an electrically conductive solution. To form this "solution" a cellulose acetate resin, a polyurethane resin or mixture thereof, is dissolved in a solvent (as mentioned above), and to the resulting solution there is added from 1 to 50 percent by weight, based on the weight of the resin, of a carbon black, a silver dust, or a similar electrically conductive material. After milling in a ball mill or attritor and filtering, the solution is sprayed onto the desired areas on a single surface of the base member and dried. It is desirable when spraying, to mask the areas not to be coated. The coating film thus formed is firmly bonded to the resistor base member. The resistor film having a coating film thus obtained has various desirable properties, namely, minimized deviation in the value of resistance, rectilinearity with respect to the increase in the value of resistance with increase in the distance between electrodes, very little change in the value of resistance with a change in the environmental humidity, a large current capacity (more than 2 watts), a high surface hardness and good durability. The product is of great utility for use in television, radio, tape recorders, telegraphs and other electronic appliances for control purposes, e.g., sound volume and the tone or brightness of a picture.

The present invention will now be further illustrated by the following examples, in which all the parts are by weight.

EXAMPLE 1

To 100 parts of a cellulose triacetate resin (degree of acetylation of 60.8 percent) there was added 450 parts of methylene chloride, 50 parts of methanol and 15 parts of triphenyl phosphate. The resulting mixture was stirred to attain solution. The solution was then mixed with 8 parts of carbon black, milled for 72 hours in a

ball mill, and filtered. The solution thus obtained was cast onto a rotary casting surface and dried to obtain a film of a thickness of 350 microns. The resistor base member thus obtained had a volume resistivity of 3.5×10^5 ohm-cm. To an area of a single surface of the resistor base member there was sprayed a solution of the following formulation (1) to form a coating film, and to another area there was sprayed a solution of the following formulation (2).

Formulation (1): 100 parts of a cellulose triacetate (degree of acetylation of 60.8 percent) and 15 parts of a polyurethane resin (Desmocer 176, Bayer A.G.) were dissolved, with stirring, in a mixture of 1,200 parts of methylene chloride and 100 parts of methanol. To the resulting solution there was added 18 parts of carbon black. After milling for 72 hours in a ball mill, the mixture was filtered. The solution was sprayed (by means of a spray gun) onto an area of the resistor base member to form a coating film having a small resistance value (surface resistivity = 50×10^3 ohm-cm).

Formulation (2): 100 parts of cellulose triacetate (degree of acetylation of 60.8 percent) and 15 parts of a polyurethane resin (Desmocer 176, Bayer A.G.) were dissolved, with stirring, in a mixture of 1,200 parts of methylene chloride and 100 parts of methanol. To the resulting solution, there was added 20 parts of a silver dust. After milling for 72 hours in a ball mill, the mixture was filtered. The solution was sprayed (by means of a spray gun) onto an area of the resistor film to form a coating film which would serve as an electrode. The resistor films thus obtained had various excellent properties, namely, when used as film resistors in radios, tape recorders, telegraphs, or similar electronic appliances, the resistor film had very little deviation in the value of the resistance, the value of the resistance increased rectilinearly with increase in the distance between electrodes, there was little change in the value of the resistance with a change in the environmental humidity, the current capacity was large (about 2 W or more) and the resistor film had good durability due to its high surface hardness.

EXAMPLE 2

To 100 parts of a flaked cellulose triacetate (degree of acetylation of 61.4 percent) where were added 450 parts of methylene chloride, 50 parts of cyclohexanone and 12 parts of triphenyl phosphate. After being dissolved with stirring, there was further added 6 parts of carbon black and the mixture was milled for 72 hours in a ball mill and filtered.

The solution thus formed was cast on a rotary casting surface and dried to obtain a cast film of 400 microns thickness. The volume resistivity of the resistor base member thus obtained was 4.8×10^6 ohm-cm.

Onto the desired areas of a single surface of the resistor base member there was sprayed (to form a coating film which would serve as electrodes) a solution which had been prepared by dissolving 100 parts of cellulose triacetate (degree of acetylation of 61.4 percent) in a mixture of 920 parts of methylene chloride and 80 parts of methanol. After the addition of 20 parts of silver dust, the resulting solution was milled for 72 hours in a ball mill and then filtered. The bonding strength between the coating film thus formed and the resistor base member was excellent. The resistor film had excellent properties similar to the film prepared in Example 1.

EXAMPLE 3

To 100 parts of a cellulose diacetate (degree of acetylation of 55.5 percent) there were added 460 parts of methylene chloride, 40 parts of methanol and 12 parts of triphenyl phosphate. After being dissolved with stirring, there was further added 12 parts of carbon black and the mixture was milled for 100 hours in a ball mill and filtered.

The resulting solution was cast onto a rotary casting surface and dried to form a film of a thickness of 300 microns. The volume resistivity of the resistor base member thus obtained was 8×10^4 ohm-cm. To a desired area of a single surface of the resistor base member there was sprayed a solution of the following: formulation (1) to form a coating film; to another area there was sprayed another solution of the following formulation (2).

Formulation (1) 100 parts of a flaked cellulose diacetate (degree of acetylation of 55.5 percent) was dissolved with stirring in a mixture of 920 parts of methylene dichloride and 80 parts of methanol. There was then added thereto 10 parts of carbon black and 5 parts of graphite. The resulting mixture was then milled for 72 hours in a ball mill and filtered. The solution thus obtained was sprayed (by means of a spray gun) onto a desired area of the resistor film to form a coating film having a surface resistivity of 5.6×10^3 ohm-cm.

Formulation (2) 100 parts of a cellulose diacetate flake (degree of acetylation of 55.5 percent) was dissolved in a mixture of of methylene chloride and 80 parts of methanol with stirring. There was then added thereto 20 parts of silver dust. The mixture was then milled in a ball mill for 72 hours and filtered. The solution thus obtained was sprayed (by means of a spray gun) onto a desired area of the resistor base member to form a coating film which would serve as an electrode. The resistor coating films thus obtained had excellent properties as like as the coating films in Example 1 had.

What is claimed is:

1. A resistor film consisting of a resistor base film comprising a plasticized cellulose acetate resin having dispersed therein from about 1 to about 20 percent by weight, based on the weight of the resin, of an electrically conductive material and at least one local coating formed on selected areas of the surface of said base film, said coating comprising a binder selected from the group consisting of a cellulose acetate resin, a polyurethane resin and a mixture thereof having dispersed therein an electrically conductive material.

2. The resistor film as claimed in claim 1 wherein said conductive material is selected from the group consisting of carbon black, graphite powder and silver dust.

3. The resistor film as claimed in claim 1 wherein said local coating is a resistor coating for varying the local resistivity of the film base and said electrically conductive material dispersed in the coating is selected from the group consisting of carbon black and graphite powder.

4. The resistor film as claimed in claim 1 wherein said local coating is an electrode terminal and said electrically conductive material dispersed in the coating is silver dust.

5. The resistor film as claimed in claim 1 wherein the proportion of said electrically conductive material dis-

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persed in said binder is from about 1 to about 50 percent by weight, based on the weight of the binder.

6. The resistor film as claimed in claim 1 wherein said resistor base film has a thickness of at least 200 microns.

7. The resistor film as claimed in claim 1 wherein both a resistor coating and an electrode terminal are formed on selected areas of the surface of said base film.

8. A resistor film consisting essentially of a resistor base film comprising a plasticized cellulose acetate resin having dispersed therein from about 1 to about 20 percent by weight, based on the weight of the resin, of an electrically conductive material and at least one local coating formed on selected areas of the surface of said base film, said coating comprising a binder selected from the group consisting of a cellulose acetate resin, a polyurethane resin and a mixture thereof having dispersed therein an electrically conductive material, whereby the resistivity of said base film can be varied to obtain a large current capacity.

9. The resistor film as claimed in claim 8 wherein said binder is a cellulose acetate resin.

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10. The resistor film as claimed in claim 8 wherein said binder is a polyurethane resin.

11. The resistor film as claimed in claim 8 wherein said binder is a mixture of a cellulose acetate resin and a polyurethane resin.

12. Process for manufacturing a resistor film which comprises:

forming a resistor base film by solution casting an organic solvent solution of a plasticized cellulose acetate resin having dispersed therein from about 1 to about 20 percent by weight, based on the weight of the resin, of an electrically conductive material, and

coating selected areas of the surface of said base film by solution casting, while masking the remaining areas of the surface, with a material comprising a binder selected from the group consisting of a cellulose acetate resin, a polyurethane resin, and mixtures thereof, having dispersed therein an electrically conductive material, whereby the resistor film comprises coated and uncoated areas.

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