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ELECTRICAL RESISTANCE PAINT CAPABLE OF FORMING A HEATING FILM

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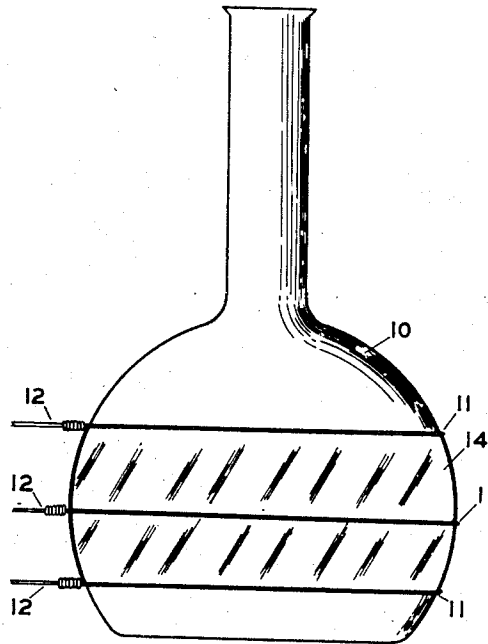


FIG. 1

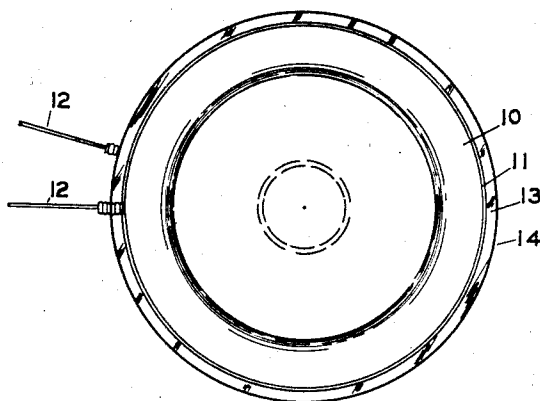


FIG. 2

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ELECTRICAL RESISTANCE PAINT CAPABLE OF FORMING A HEATING FILM

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10 Claims. (Cl. 117—216)

This invention relates to heating elements and more particularly to electrical resistance paint capable of forming a heating film.

In the past, electrical resistance elements have been made by coating a graphite carrying silicate of soda on a carrying material, and these elements have been used as resistors in radios and the like. Other electrical resistance coatings have been used for "printed circuits" and as elements carrying low currents or elements providing substantially small quantities of heat at reasonably low temperatures. No resistance paint, however, has been perfected heretofore which may be satisfactorily utilized to provide reasonably large quantities of heat at relatively high temperatures.

In most instances, the prior art coating materials are first painted on a suitable carrier, then the carrier is inserted in an oven where the resistance paint is dried at controlled temperatures. In the baking or drying process, the prior art resistance paints give off moisture which tends to blister or break the continuity of the coating, thereby reducing its conductivity. Further, the baking process is time-consuming and requires additional equipment in order to provide a resistance element.

In substantially all instances, if a resistance element formed from a resistance paint, produced according to the prior art, were utilized as a heating element to provide substantial quantities of heat at reasonably high temperatures, the element would soon break down due to a reaction between the conducting material and the oxygen in the air or through mechanical failure due to the formation of blisters. Thus it is apparent that the prior art resistance elements would have a reasonably short life; and, if substantial quantities of electricity were passed through these elements, the elements would gradually increase in resistance as the conducting material contained therein reacted with the air as described above.

Another disadvantage of the prior art resistance paints is that when the paint is coated on a carrier, rapid fluctuations of temperature will cause cracking and a breakdown of the conducting surface due to thermal expansion and contraction of the carrying element and resistance paint.

Accordingly, it is an object of my invention to provide a resistance element capable of contracting and expanding with rapid changes in temperature without appreciable change in resistivity thereof and without cracking.

Another object of my invention is to provide a resistance paint which may be coated on a carrying material and which will dry to become a serviceable heating element without additional treatment.

Another object of my invention is to provide a resistance paint which will adhere to a variety of materials such as ceramics, glass, mica, fiber and the like, to provide a resistance element which is not easily separated from the carrying material.

Another object of my invention is to provide a resistance paint which is capable of being stored in a liquid state for extended periods of time without appreciable oxidation, skinning or livering of the surface thereof.

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Another object of my invention is to provide a resistance paint which when coated on a suitable carrying element will provide a substantially uniform, hard, flexible surface that does not blister on drying and in use does not change its resistivity or color.

Another object of my invention is to provide a resistance element which is capable of conducting electricity for extended periods of time at elevated temperatures without appreciable change in conductivity and appearance.

Other and further objects and advantages of my invention will become apparent from the following description when taken in conjunction with the accompanying drawings, wherein like characters of reference designate corresponding parts through the several views, and wherein:

Fig. 1 is a side elevation showing my resistance paint coated on a carrying element, such as a Florentine flask.

Fig. 2 is a bottom plan view of the Florentine flask illustrated in Fig. 1.

Referring now in detail to the embodiment chosen for purpose of illustration, numeral 10 denotes a carrying element, such as a Florentine flask, normally used in laboratories for heating solutions and the like. Around the body portion of flask 10 are provided a plurality of spaced electrodes 11 which comprise wires circumscribing the body of flask 10 with portions of each projecting outwardly to form terminals 12 to which an external source of electricity may be connected. Any number of electrodes 11 may be placed between the two extreme electrodes to provide graduated resistances to be described in more detail later.

To form a heating element, resistance paint 13 is coated uniformly around the body of flask 10, between the extremes of electrodes 11, so that it forms a coat circumscribing flask 10 and contacting all electrodes. After resistance paint 13 has been coated on flask 10, the resistance paint should be allowed to dry in air; however, the resistance paint may be dried by the passage of electrical current therethrough.

In the event that the carrying element is an electrical conductor, it may be found desirable to coat the carrying element with a protective or insulating coating, and in most instances it will be found desirable to coat the outer surface of the resistance paint with such a protective coating. In the drawings, numeral 14 denotes such a protective coating which is painted or coated over the resistance paint, after sufficient time has elapsed for the resistance paint to dry.

While I have selected a Florentine flask formed of glass, for purpose of illustration, it will be apparent to those skilled in the art that substantially any surface, to which my resistance paint adheres, may be utilized as a carrying element, regardless of its shape; and my invention contemplates the use of my resistance paint on such surfaces as glass, mica, plastics, ceramics, and the like. It will be found that my resistance paint adheres easily to substantially any surface to which a normal paint will adhere and is sufficiently flexible that the coefficient of expansion of the specific material is not to be considered a determining factor in the selection of a carrying element.

Protective coatings formed according to my invention have been found to adhere to such widely varying materials as glass and copper. Further, the inclusion of a protective coating over the resistance paint, has materially increased the operable temperature of my resistance paint.

In utilizing my resistance paint and protective coating, each is separately compounded as hereinafter described. The resistance paint is then coated on a grease-free electrically non-conducting carrying element so as to form a continuous path between a pair of electrodes which are

located to include the region to be heated. Copper wires or strips are recommended for these electrodes. After the resistance paint is applied to the carrying element, the paint is dried. Another method of drying my resistance paint is to heat it in an oven at 104° C. for thirty minutes; then the temperature may be raised to about 130° and the paint dried for another thirty minutes.

After the resistance paint is dry, a protective coating may be applied to the surface of the resistance paint, and it may be dried in a manner identical to the drying of the resistance paint. Two or more protective coatings may be applied to the resistance paint, each coating being dried separately.

It is to be remembered that the oven drying process described above is not necessary to the practice of my invention but may be utilized to decrease the time necessary to prepare a heating element. When electricity is first applied to the resistance element after it is dry, it is suggested that a variable transformer be utilized and that current be applied to the resistance element so that the temperature does not increase more than about 10° per minute. This precaution upon initial heating permits gases and vapors to escape without disrupting the film and prevents the development of excessive strains which might cause cracking or breakage of the carrying element or the resistance paint or both.

A film of conducting compound formed from resistance paint having consistency of ordinary house paint, and covering a surface of one inch square, offers a resistance of the order of 30 ohms across opposite edges. The resistance figure of course is not constant since variation in the thickness of film and changes in the quantity of conductive material within the resistance paint will alter this figure.

To utilize the apparatus heretofore described, current from an external source (not shown) is supplied to any two of electrodes 11, it being obvious that in some instances it may be found desirable to supply current to more than two of the electrodes 11. The temperature and quantity of heat supplied by the electricity may be determined by the current passed through my resistance paint according to prior art calculations. Because of the uniform surface and thickness which my resistance paint provides, the space between any two electrodes 11 will determine the relative resistivity of that component part subtended between those two electrodes; thus it is apparent that different resistances of the resistance element may be selected by applying current to different combinations of electrodes 11.

In compounding resistance paint 13, according to my invention, an electrically conductive powder is mixed with a binder or vehicle together with certain modifying materials which impart to this mixture desirable characteristics. Substantially any conducting material which is finely divided or in powdered form may be used to form an electrical conductor which may be evenly dispersed throughout the binder or vehicle. Such materials as carbon, graphite, silver, platinum, gold, copper, nickel, and the like, in finely divided form, have been found satisfactory for this purpose. Under certain circumstances, aluminum may be used; however, since a non-conducting oxide coating is generally present on each aluminum particle, giving the aluminum a very low electrical conductivity, other materials, as described above, may be found more desirable.

One or a plurality of the conducting materials described above are incorporated with a binder such as sodium or potassium silicate, water solutions of magnesium chloride, phosphoric acid cements, polytetrafluoroethylene, and other similar materials which will withstand the required temperature. Generally, I have found that potassium silicate and graphite are preferable ingredients for forming a resistant paint according to my invention.

To impart flexibility to a resulting film formed by my resistance paint, and to retard sedimentation of the resistance paint when the paint is stored in a fluid condition for extended periods of time, bentonite is included in the ingredients as a modifying ingredient. Since bentonite gels are thixotropic, the ability of my resistance paint to be formed in films of different thickness is enhanced. Further, the bentonite makes the film resulting from my resistance paint somewhat porous, for purposes to be described in more detail hereinafter. The same but poorer structural modifications may be achieved by the substitution of diatomaceous earth for the bentonite. One diatomaceous earth material which has been found suitable is known by the trade name "Celite," a product of The Johns-Manville Company, New York, New York. Fuller's earth or clay may also be substituted for the bentonite in the formation of a resistance paint according to my invention.

Another modifying ingredient which serves to keep the conducting material in colloidal suspension while the paint is in liquid form and also serves appreciably to reduce the reaction between such binders as sodium silicate and the carbon dioxide of the air, is a finely divided carbonaceous material such as coal or bitumen. When this carbonaceous material is incorporated in the compounding of my resistance paint, it tends to react with the alkaline silicate causing the formation of small bubbles within the liquid resistance paint after the carbonaceous material is introduced therein. The carbonaceous material also serves another highly important function; namely, when the resistance paint is heated to high operating temperatures, the carbonaceous material decomposes, thereby depositing carbon in the resistance paint to supplement some of the conducting material which may have been burned out at high temperature. In addition, the carbonaceous material tends to react with the free oxygen entrained in the resistance paint much more readily than the electrical conductor, and thus it will "leach out" entrained oxygen within the paint. Further, upon the decomposition of the carbonaceous material, tar will be deposited within the resistance paint and acts as an additive binder which tends to choke out entrained gaseous particles. The carbonaceous material, such as coal, decreases the effervescence of sodium silicate and thus retards the formation of a chalk-like appearance which usually appears on the surface of resistance paint film containing sodium silicate. The reaction of the carbonaceous material with the alkali silicate also tends to facilitate the deposition of silica, thus adding to the stability of the resistance paint when dry and decreasing the alkalinity of the resistance paint.

A resistance paint according to my invention may be formed of the following materials in substantially the following proportions:

	Percent by weight
Sodium or potassium silicate (silicate having an approximate alkaline silica ratio of 1:3 and a density of from 40° to 50° Baumé) ..	30 to 80
Graphite (finely divided)	10 to 30
Bituminous coal (finely divided)	5 to 10
Bentonite (finely divided)	1 to 15
Water (in addition to that in the silicate) ----	0 to 50

In compounding my resistance paint, the bentonite should be commingled with the other ingredients as a bentonite gel. This gel is formed by mixing not more than about 18% by weight bentonite with water for a period of several hours. Except for the bentonite, the other materials may be mixed in any order, and for a sufficient length of time to provide thorough commingling of the ingredients. The resulting material develops its optimum properties two to three days after being mixed. Water is included as an ingredient in my resistance paint so that the resulting liquid may have the consistency of ordinary house paint. It is to be remembered that the

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elimination of water from the ingredients listed above will not detract from the desirable characteristics thereof, however, water is included as an agent to impart added fluidity to the resistance paint.

The following are examples of resistance paint mixtures compounded according to my invention:

Example I

Silicate of soda (alkali-silica ratio 1:2.90) -----	G.	
Water -----	20	10
Acheson graphite (a minimum of 98.5 percent by weight passes a 200-mesh screen) -----	8	
Coal (100% thru a 325-mesh screen) -----	8	
Bentonite gel (17.6% by weight bentonite) -----	5	
	2.5	15

Example II

Potassium silicate (Kasil No. 6 of Philadelphia Quartz Co.) -----	20	20
Water, to give consistency of paint.		
Graphite (natural product of Joseph Dixon Co., No. 1107) -----	10	
Coal (100% thru a 325-mesh screen) -----	1.5	
Water and bentonite gel (containing 17.6 percent by weight bentonite) -----	1.5	25

Example III

Potassium silicate (Kasil No. 6 of Philadelphia Quartz Co.) -----	20	30
Acheson graphite (a minimum of 98.5% by weight passes a 200-mesh screen) -----	7.5	
Water, to give consistency of paint.		
Coal (100% thru a 325-mesh screen) -----	2	
Bentonite gel (containing 17.6 percent by weight bentonite) -----	2	35

Example IV

Potassium silicate (Kasil No. 6, Philadelphia Quartz Co.) -----	40	
Acheson graphite (a minimum of 98.5% passes a 200-mesh screen. Product of National Carbon Co., Buffalo, N.Y.) -----	20	
Coal (100% thru 325-mesh screen) -----	7.5	45
Bentonite gel (17.6 percent by weight bentonite) -----	5	
Water, to give consistency of paint.	2	

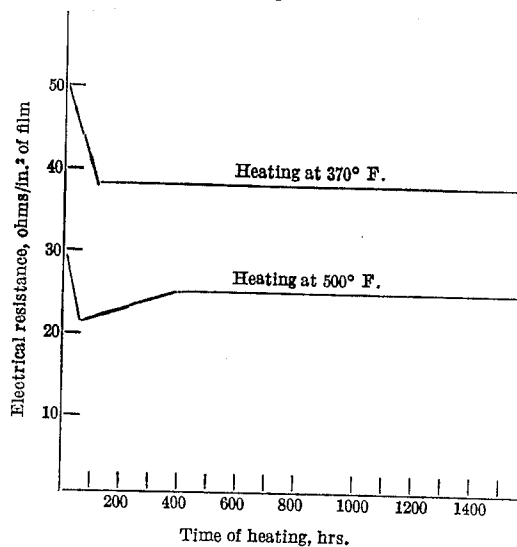
Example V

Sodium silicate (K brand of Philadelphia Quartz Co.) -----	31.2	
Colloidal graphite (from Acheson Colloids Co., and having a maximum particle size with few exceptions) of 4 microns -----	6	55
Water -----	18.6	
Bentonite gel (17.6 percent by weight bentonite) --	2	
Coal (100% thru 325-mesh screen) -----	2	

The formation of a resistance paint utilizing the ingredients of Example IV, has been found to be most generally useful, although its superiority over the other examples is small. Because of the expense of potassium silicate and because the inclusion of coal or bitumen, by reducing the reaction between sodium silicate and the carbon dioxide of the air as described herein, makes sodium silicate acceptable, formulations employing sodium silicate would probably be more practical from an economic standpoint.

Two specimens of resistance paint formulated according to Example I hereof were tested by coating a one inch square film on a flat sheet of glass while maintaining the temperature at a substantially constant figure. The graphs below illustrate the resistance of this film on a day-by-day test.

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As described above, a protective or insulating coating or film may be included in the formation of a heating element, according to my invention, and it is to be remembered that when coating on a conducting surface, the protective film must be applied to the surface of the material prior to the application of the resistance paint.

A suitable protective film may comprise the following:

	Weight percent
(1) Sodium or potassium silicate (silicate having an approximate alkali-silica ratio of 1:3 and a density of 40 to 50 degrees Baumé) --	30 to 80
(2) Alumina (finely divided) -----	25 to 35
(3) Aluminum (finely divided) -----	2 to 5
(4) Bentonite (finely divided) -----	0.5 to 10
(5) Water (in addition to that in the silicate) -----	0 to 50

As described above, the bentonite of the protective coating is made up as a bentonite gel and is then thoroughly commingled with the other ingredients.

Other examples of the protective films are as follows:

Example I

Silicate of soda (N Brand of the Philadelphia Quartz Co.) -----	G.	
Alumina (for abrasive purposes, about 4 microns in diameter or less of the Linde Air Products Co., lot No. P-52, Type A-5175) -----	39.6	
Aluminum (pigment, Albron, No. 322 of Aluminum Co. of America) -----	17.4	
Water -----	2.1	
Potassium dichromate, $K_2Cr_2O_7$ -----	24.3	
	0.025	

Example II

Silicate of soda (N Brand of the Philadelphia Quartz Co.) -----	18	
Alumina (for abrasive purposes, about 4 microns in diameter or less of the Linde Air Products Co., lot No. P-52, Type A-5175) -----	8.7	
Aluminum (pigment, Albron, No. 322 of Aluminum Co. of America) -----	2.9	
Water -----	16.6	

Example III

Sauereisen cement (Paste No. 1 of the Sauereisen Cements Co., Pittsburgh, Pa.) -----	20	
Silicate of soda (N Brand of the Philadelphia Quartz Co.) -----	5	
Aluminum (pigment, Albron, No. 322 of Aluminum Co. of America) -----	4	
Water, to give consistency of paint.		

The aluminum in each compound gives flexibility so that expansion and contraction will not disrupt the films. The potassium dichromate probably inhibits reaction between the alkali and the aluminum. Since a protective oxide film exists about each aluminum particle, the aluminum does not significantly increase the electrical conductivity of this protective paint.

It is obvious to those skilled in the art that many variations may be made in the embodiments chosen for purpose of illustration without departing from the scope of my invention as defined by the appended claims.

I claim:

1. An electrically resisting reaction product film resulting from the drying and heating to a temperature up to 500° F. of a conducting paint applied in a homogeneous layer to a surface, said conducting paint consisting essentially of by weight approximately 30% to approximately 80% a silicate water solution having an initial density equivalent to from about 40° to about 50° Baumé and selected from the group consisting of sodium silicate water solution and potassium silicate water solution, from approximately 10% to approximately 30% a finely divided conducting material, from approximately 5% to approximately 10% a carbonaceous material selected from the group consisting of coal and bitumen, from approximately 1% to approximately 15% a modifying agent selected from the group consisting of bentonite, fuller's earth clay and diatomaceous earth and up to approximately 50% water.

2. An electrically resisting film resulting from a reaction caused when sufficient electricity is passed through a conducting paint to heat the same, said conducting paint initially being applied in a homogeneous layer to a surface for the manufacture of heating elements comprising mixture from approximately 30% to approximately 80% by weight a silicate water solution having an initial density equivalent to from about 40° to about 50° Baumé and selected from the group consisting of sodium silicate water solution and potassium silicate water solution, from approximately 10% to approximately 30% by weight graphite, from approximately 5% to approximately 10% by weight coal, from approximately 1% to approximately 15% by weight bentonite and from 0% to approximately 50% by weight water.

3. A free flowing electrically conducting paint adapted to be applied in a homogeneous layer to a surface for the manufacture of heating elements consisting essentially of proportions approximately equivalent to 20 grams of silicate of soda, 8 grams of water, 8 grams of graphite, 5 grams of coal and 2.5 grams of bentonite gel.

4. A free flowing electrically conducting paint adapted to be applied in a homogeneous layer to a surface for the manufacture of heating elements consisting essentially of proportions approximately equivalent to 20 grams of potassium silicate, 10 grams of natural graphite, 1.5 grams of coal, 1.5 grams of bentonite gel and water to give the consistency of paint.

5. A free flowing electrically conducting paint adapted to be applied in a homogeneous layer to a surface for the manufacture of heating elements consisting essentially

of proportions approximately equivalent to 20 grams of potassium silicate, 7.5 grams of graphite, 2 grams of coal, 2 grams of bentonite gel, and water to give the consistency of paint.

6. A free flowing electrically conducting paint adapted to be applied in a homogeneous layer to a surface for the manufacture of heating elements consisting essentially of proportions approximately equivalent to 20 grams of potassium silicate, 7.5 grams of graphite, 5 grams of coal, 2.0 grams of bentonite gel and water to give the consistency of paint.

7. A free flowing electrically conducting paint adapted to be applied in a homogeneous layer to a surface for the manufacture of heating elements consisting essentially of proportions approximately equivalent to 31.2 grams of sodium silicate, 8.6 grams of water, 6 grams of colloidal graphite, 2 grams of coal and 2 grams of bentonite gel.

8. A method of making a resistance element for heating purposes, which includes mixing from approximately 30% to approximately 80% by weight a silicate water solution selected from the group consisting of sodium silicate and potassium silicate, from approximately 10% to approximately 30% by weight a finely divided conducting material from approximately 5% to approximately 10% by weight coal, from approximately 1% to approximately 15% by weight bentonite and up to approximately 50% by weight water to make a free flowing resistance paint, coating an insulation carrying element with a thin film of said resistance paint and drying said film in air.

9. A method as claimed in claim 8 wherein an electrically insulating film is coated over said film of said resistance paint after said film of said resistance paint has dried.

10. A protective coating material for electrical resistance elements comprising by weight from approximately 30% to approximately 80% a silicate selected from the group consisting of sodium silicate and potassium silicate, from approximately 25% to approximately 35% alumina, from approximately .5% to approximately 10% bentonite and up to approximately 50% water.

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