Oct. 11, 1932. J. A. FLANZER 1,881,446

RESISTOR

Filed Dec. 5, 1929

Fig. 1.

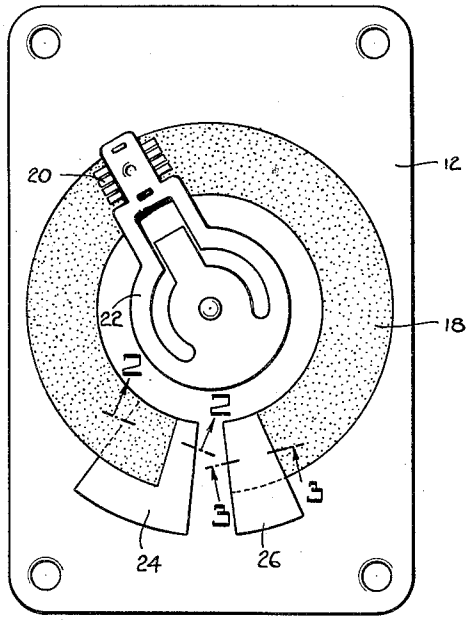


Fig. 2.

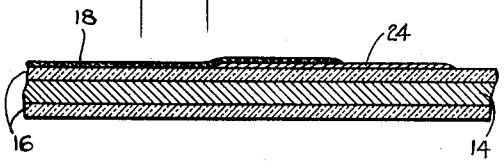
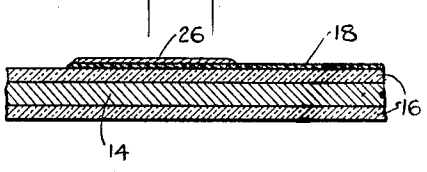


Fig. 3.



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UNITED STATES PATENT OFFICE

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RESISTOR

Application filed December 5, 1929. Serial No. 411,736.

This invention relates to resistors, and more particularly to the metallic terminals thereof and a metallic paint for making the same.

It is frequently convenient to obtain fixed metallic terminals for resistors, particularly those of high resistance utilizing a film of resistance material, by painting the ends of the resistance film with a metallic paint, and subsequently baking the resistor in order to fuse the metallic particles in the paint together. One object of the present invention is to provide a metallic paint which will require only a relatively low baking temperature not injurious to the resistance film or the insulation base upon which it is painted. Another object of the present invention is to provide such a metallic paint, the baking temperature for which will not be critical.

Further objects of the present invention are to provide a metallic paint which will be adherent to the resistance film, and more particularly which will be adherent to a film of resistance paint including finely divided graphite held in a binding vehicle of a metallic phosphate in an excess of phosphoric acid, and which will further be adherent to an insulation base, and more particularly to an enamel insulation base.

Heretofore the metallic terminal obtained by the use of a paint has been of uncertain mechanical properties, and in order to improve the terminal it has been the practice to burnish the terminal and so to compact the metallic particles together. This requires a troublesome manufacturing step which frequently leads to injury of the resistors, and accordingly a further object of the present invention resides in the provision of a metallic paint which will result in terminals having a uniformly low resistance and good mechanical strength and appearance without necessitating burnishing or other externally applied compacting.

A still further object of the present invention is to provide, in the case of variable resistors, metallic terminals embodying the foregoing advantages, and yet having a thinness of film such that there will be no perceptible obstruction when the sliding contact of the resistor passes from the resistance film to the terminal.

To the accomplishment of the foregoing and such other objects as will hereinafter appear, my invention consists in the metallic paint and the resistor elements and their relation one to the other as hereinafter are more particularly described in the specification and sought to be defined in the claims. The specification is accompanied by drawing in which:

Fig. 1 is a plan view of a potentiometer resistor embodying my invention;

Fig. 2 is an enlarged section taken in the plane of the line 2—2 in Fig. 1; and

Fig. 3 is an enlarged section taken in the plane of the line 3—3 in Fig. 1.

Referring to the drawing, the resistor, which is generally similar to that disclosed in the copending application of Lester L. Jones, Ser. No. 350,731, filed March 28, 1929, comprises an insulation base 12, preferably formed by coating a suitably perforated metallic plate 14 with enamel insulation 16, an open circuited ring of resistance film 18 painted on said base, a freely oscillatable silver sliding contact 20 mounted at the end of a rotatable resilient contact arm 22, and metallic terminals 24 and 26 for the resistance film. The resistance film is preferably made of resistance particles held in a binding vehicle, and more specifically may be made of colloidal graphite held in a binding vehicle of a metallic phosphate, such as aluminum, or nickel phosphate in an excess of phosphoric acid. This paint is described in detail in the copending application of Lester L. Jones, Alois Schmidt, and Joseph Jones, Ser. No. 167,583, filed February 11, 1927, since issued on August 19, 1930, as U. S. Patent No.

1,773,105, and the copending application of Joseph Flanzer and Emil Reisman, Ser. No. 393,573, filed September 18, 1929.

The particular resistor here disclosed is designed to provide a gradual growth of resistance, and accordingly the resistance film 18 is arranged on top of the initial terminal 24 in accordance with the invention of Emil Reisman, disclosed in his copending application, Ser. No. 350,478, filed March 28, 1929, since issued on June 9, 1931 as U. S. Patent No. 1,808,790. It will be clear that if the unit is to be used solely as a resistor and not as a potentiometer, the terminal 26 may be omitted, and further, that if it is not necessary to obtain a very small initial resistance the terminal 24 may be coated on top of the resistance film 18 like the terminal 26. It should further be observed that in the case of terminal 24 the terminal must adhere to the insulation base, and that with either kind of terminal it should preferably adhere to the insulation base because it is desirable to have a depending terminal portion located out of the path of the sliding contact 20 with which the desired external connections may be made.

Heretofore the terminal was obtained by the use of a metallic paint consisting of a suspension of very finely divided silver particles in an oil or a mixture of oils. This paint was subsequently baked to a temperature of about 600 degrees C., resulting in a fairly tough film, the quality of which, however, was rather critical, depending upon the baking temperature. For example, if the temperature was too low, the silver deposit could easily be removed, and if the temperature was high the enamel of the insulation base would soften with deleterious results. If the terminal was rubbed as by burnishing, the resulting effect on the silver would cause it to peel from the resistance paint, leaving the layer of paint therebeneath intact, and thus showing that there was insufficient adhesion between the resistance film and the silver deposit.

In accordance with the present invention, the foregoing difficulties are surmounted by the use of a metallic paint consisting of metallic particles, preferably silver, suspended in a binding vehicle of a metallic phosphate in phosphoric acid. The phosphate may be of the same metal as the metal particles, and in any case is preferably in the form of a saturated solution of the metallic phosphate in dilute phosphoric acid.

This paint need only be baked at a relatively low temperature, say 350 degrees C., and the baking temperature is not at all critical, being variable between 300 degrees C. and 400 degrees C., without changing the quality of the resulting terminal. This baking temperature is lower than the baking temperature of the resistance film, which is about 450 degrees C., so that the terminal may be baked without injury to the resistance film and without injury to the insulation base.

The present resistance paint is characterized by an extremely strong bond or adhesion to insulation such as enamel, and to a resistance film, particularly a film which itself uses a binding vehicle consisting of a metallic phosphate and phosphoric acid. In consequence of this strong union, the silver deposit may be made upon the insulation, or upon the resistance film, or upon both, or between both, as the necessities of any particular case may dictate.

In the prior practice the metallic terminal obtained after baking the silver paint was imperfect and varied in strength, tenacity, and appearance. It was therefore necessary to burnish the terminal in order to smooth and compact the metal thereof, and so to obtain the desired properties and quality of terminal. In the case of the present paint, I find that in general the terminal may have a very uncertain resistance value ranging say from zero to several megohms which may be brought down to a fraction of an ohm by burnishing. Burnishing the present metallic paint is less difficult than burnishing the prior metallic paint because the silver does not peel from the resistance paint. But burnishing is undesirable in production because it adds an additional manufacturing step, and also because this step is a troublesome one because it is likely to unintentionally rub away some of the resistance film. However, I have further found that if the vehicle of the present paint is mixed in a range of optimum proportions the natural cohesive and compacting action of the vehicle makes it posible to obtain terminals of excellent mechanical properties and having a resistance of the order of only one-tenth of an ohm, and showing no weak spots, without burnishing the terminal.

The desired concentration of the vehicle may be expressed in terms of its specific gravity, and the aforesaid optimum range of concentration extends from a specific gravity of 1.26 to a specific gravity of 1.4. If the specific gravity of the vehicle is less than 1.26 the resulting terminals require burnishing, and the film is apt to be soft. If the specific gravity of the vehicle is greater than 1.4 the paint is inconvenient to work with because it will not dry sufficiently rapidly in air.

Particular examples may be outlined as follows. A nickel phosphate vehicle having a specific gravity of 1.4 may be made by mixing 100 cc. of phosphoric acid (85% syrupy), 103 grams of nickel phosphate, and 250 cc. of water. The specific gravity may readily be reduced by the addition of more water. For example, the addition of an equal quantity of water will reduce the specific gravity

to about 1.2, while the addition of half that amount of water will reduce the specific gravity to a value within the preferred range specified above. A silver phosphate vehicle having a specific gravity of approximately 1.3 may be made by mixing 10 grams of silver phosphate, 27 cc. of phosphoric acid (85% syrupy), and sufficient additional water to make a total volume of 110 cc. Of course, this specific gravity may also be varied by varying the quantity of water used.

The paint may be made by mixing dry silver powder with the above vehicle in the ratio of 2 grams of silver powder to one cc. of vehicle. When using the nickel phosphate vehicle with the high specific gravity of 1.4 as above specified, an excellent paint may be obtained by mixing 25 grams of silver powder with 12.5 cc. of nickel phosphate vehicle with the addition of 5 cc. of water, the added water being equivalent to initially using a vehicle of lower specific gravity.

With the silver paint heretofore employed it was necessary to strengthen the silver deposit by applying the silver in a thick layer, say from 10 to 15 thousandths of an inch thick. By reference to Figs. 1 and 3 of the drawing, and by further visualizing such an increased thickness of silver to be in use, it will be obvious that the prior resistor, instead of being perfectly smooth in operation, necessarily possessed a perceptible and annoying obstruction when the sliding contact passed from the resistance film up onto the terminal. This obstruction caused injury to the delicate fingers of the silver sliding contact, and consequently undue wear thereof. Furthermore, the adhesion between the silver paint and the resistance film not being very great, and the silver film representing a rather abrupt obstruction, there was a tendency to chip off the edge of the terminal in the course of long wear. In the case of a low initial resistance terminal, such as the terminal 24 illustrated in Figs. 1 and 2 of the drawing, the resistance film was apt to rub off in a comparatively short time because, first, the union between the resistance film and the silver film was not as great as desired, and, second the thickness of the silver film placed unnecessary abrasion and wear on the transition segment of resistance film at the shoulder of the silver terminal.

The present invention overcomes the foregoing difficulties because the contact material adheres equally firmly to the enamel and to the resistance film, and may be applied in a very thin film of the order of 1 thousandth of an inch thick. The precise thickness of the silver film and, in general, the spread or workability of the silver paint depends upon the ratio of metal to vehicle in the paint. A good proportion of silver to vehicle is in the ratio of 10 grams of silver to 5 cc. of vehicle, resulting in a comparatively thick paint which, however, spreads very nicely and covers well. This ratio may obviously be varied as desired over a comparatively wide range until the extreme limits of too dilute or too thick a paint for practical use are reached.

The presence of a small quantity of an acid radical like nitrate in the silver paint is harmful. The nitrate radical in the presence of phosphoric acid becomes nitric acid which slowly dissolves the metallic silver to form silver nitrate. The silver nitrate combines with the phosphoric acid to form silver phosphate which precipitates. This action tends to remove phosphoric acid from the paint and adds silver phosphate, thereby upsetting the proportions of the paint. In twenty-four hours this reaction may be sufficient to cause the paint to lose its adhesive properties.

From the foregoing description the manner of making and using the present invention will be clear, as well as the numerous advantages thereof, such as its low and uncritical baking temperature, its strong bond with the resistance film and with an insulation base, the low resistance even without burnishing, and the thinness of the resulting coating without sacrifice of strength.

It will be apparent that while I have shown and described my invention in the preferred forms, many changes and modifications may be made in the structures disclosed, such as the application of the invention to ends of cylindrical fixed resistors without departing from the spirit of the invention, defined in the following claims.

I claim:

1. A low resistance metallic paint for electrical terminals comprising finely divided metallic particles suspended in a vehicle consisting of a solution of a metallic phosphate in phosphoric acid.

2. A low resistance metallic paint for electrical terminals comprising finely divided metallic particles suspended in a vehicle consisting of a saturated solution of a metallic phosphate in dilute phosphoric acid.

3. A low resistance metallic paint for electrical terminals comprising finely divided metallic particles suspended in a vehicle consisting of a saturated solution of the phosphate of the same metal in dilute phosphoric acid.

4. A low resistance metallic paint for fixed electrical contact terminals comprising finely divided metallic silver suspended in a vehicle consisting of a saturated solution of metallic phosphate in dilute phosphoric acid.

5. A low resistance metallic paint for fixed electrical contact terminals comprising finely divided metallic silver suspended in a vehicle consisting of a saturated solution of metallic phosphate in dilute phosphoric acid,

the vehicle having a specific gravity between 1.26 and 1.4.

6. A low resistance metallic paint for fixed electrical contact terminals comprising finely divided metallic silver suspended in a vehicle consisting of a saturated solution of metallic phosphate in dilute phosphoric acid, the ratio of silver to vehicle being approximately 10 grams of silver to 5 cc. of vehicle, and the vehicle having a specific gravity between 1.26 and 1.4.

7. In a resistor, the combination with a resistance film including resistive particles held in a binding vehicle comprising a metallic phosphate in phosphoric acid, of a fixed contact terminal film arranged directly in contact with said resistance film and including metallic particles held in a binding vehicle comprising a solution of a metallic phosphate in phosphoric acid.

8. In a resistor, the combination with a resistance film including graphite particles held in a binding vehicle comprising a metallic phosphate in an excess of phosphoric acid, of a fixed contact terminal film arranged directly in contact with said resistance film and including silver particles held in a binding vehicle comprising a saturated solution of a metallic phosphate in dilute phosphoric acid.

9. In a resistor, the combination with a resistance film including colloidal graphite held in a binding vehicle comprising aluminum phosphate in an excess of phosphoric acid, of a fixed contact terminal film arranged directly in contact with said resistance film and including silver particles held in a binding vehicle comprising a saturated solution of metallic phosphate in dilute phosphoric acid.

10. In a resistor, the combination with an enamel insulation base of a fixed contact terminal coated on said enameled base and including metallic particles held in a binding vehicle including a saturated solution of the phosphate of the same metal in dilute phosphoric acid.

11. In a resistor, the combination with an enamel insulation base of a fixed contact terminal coated on said enameled base and including silver particles held in a binding vehicle comprising a saturated solution of metallic phosphate in dilute phosphoric acid.

12. A resistor including an enamel insulation base, a resistance film comprising resistance particles held in a binding vehicle of a metallic phosphate in phosphoric acid, and a fixed contact terminal film arranged in contact with said enamel base and said resistance film comprising metallic particles held in a binding vehicle of a metallic phosphate in phosphoric acid.

13. A resistor including an enamel insulation base, a resistance film comprising graphite particles held in a binding vehicle of a metallic phosphate in an excess of phosphoric acid, and a fixed contact terminal film arranged in contact with said enamel base and said resistance film comprising silver particles held in a binding vehicle of a saturated solution of a metallic phosphate in dilute phosphoric acid.

14. A resistor including an enamel insulation base, a resistance film comprising colloidal graphite held in a binding vehicle of aluminum phosphate in an excess of phosphoric acid, and a fixed contact terminal film arranged in contact with said enamel base and said resistance film comprising silver particles held in a binding vehicle of a saturated solution of a metallic phosphate in dilute phosphoric acid.

15. A resistor including an enamel insulation base, a resistance film comprising graphite particles held in a binding vehicle of a metallic phosphate in an excess of phosphoric acid, and a fixed contact terminal arranged between said enamel base and a portion of said resistance film comprising silver particles held in a binding vehicle of a metallic phosphate in dilute phosphoric acid.

16. A resistor including an enamel insulation base, a resistance film comprising graphite particles held in a binding vehicle of a metallic phosphate in an excess of phosphoric acid, and a fixed contact terminal arranged on top of a portion of said resistance film comprising silver particles held in a binding vehicle of a metallic phosphate in dilute phosphoric acid.

Signed at New York in the county of New York and State of New York this 30 day of November A. D. 1929.

JOSEPH A. FLANZER.