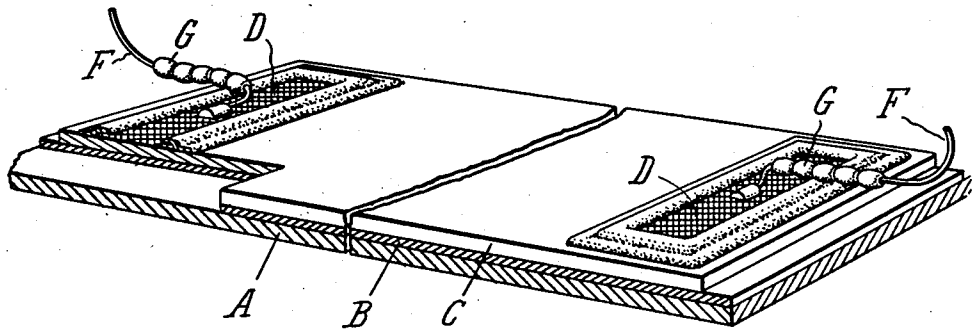
R. W. REYNOLDS.

ELECTRICAL HEATER RESISTANCE ELEMENT.

APPLICATION FILED FEB. 18, 1921.

1,422,130. Patented July 11, 1922.



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UNITED STATES PATENT OFFICE.

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ELECTRICAL HEATER RESISTANCE ELEMENT.

1,422,130. Specification of Letters Patent. Patented July 11, 1922.

Application filed February 18, 1921. Serial No. 446,079.

201-63

To all whom it may concern:

Be it known that I, ROBERT WOOLRIDGE REYNOLDS, a subject of the King of Great Britain and Ireland, residing at 61 Roslyn Street, Darlinghurst, near Sydney, New South Wales, Australia, have invented new and useful Improvements in Electrical Heater Resistance Elements, of which the following is a specification.

This invention relates to electrical heater resistance elements of the film type, that is to say, the type in which a film of substance having low electrical conductivity, as contradistinguished from a resistance constructed of convolutions of a thin metallic wire or tape, is raised in temperature by means of an electrical current passing through it.

The invention consists in an electrical resistance element constituted of a film of greater or less thickness and superficial dimensions, composed of powdered graphite and chemically precipitated aluminium silicate or certain other chemically precipitated silicates.

Resistance films according to the present invention are applied as a paint which is adhesive to a support surface. Usually they are applied over a protective surfacing of electrically insulating enamel on a metallic sheet or plate, such for instance as the bottom of a water kettle. But they may be applied to a strip of mica or like electrically non-conductive and heat tolerant material, and protected against short circuiting by an appropriate insulating covering or jacket to form a self-contained "unit" which may be fixed either permanently or detachably in a heater device such as a kettle or water boiler.

To minimize heat losses, it is usually desirable to apply the resistance film directly to the surface to be heated so long as such surface is protected by a fire enamelled glaze or like effective electrical insulator skin to prevent short-circuiting of the current therethrough. Films manufactured in the manner hereinafter described are homogeneous and possess the property of setting evenly on the adhering tenaciously and permanently to smooth surfaces, such as the surfaces of enamel or mica; under conditions of use in which they suffer repeated heating and cooling, they do not granulate, craze, or scale, and they do not substantially change in specific electrical resistance after initial use.

In carrying out the invention, powdered graphite is incorporated with a minor proportion of sodium silicate or potassium silicate in a silicic vehicle which has been chemically precipitated from an aqueous solution of sodium silicate or potassium silicate, to form a paint-like mixture which is adapted for application my means of a brush to form a film. Such film when applied to and dried and set on an electrically insulating surface provides a conductive path having appropriate resistance for the production of heating effects when it is traversed by an electrical current.

In practice I take an aqueous solution of commercial sodium silicate and gradually add thereto sulphate, chloride, or other soluble salt of aluminium, in aqueous solution. A white gelatinous precipitate is thus produced. The addition of the aluminium salt is continued only as long as precipitation continues, and then the precipitate is permitted to settle for ten to fifteen minutes, more or less. After removal of the bulk of the supernatant liquor by siphoning, or otherwise, the precipitate is washed in water several times—usually five times—with the object of removing water-soluble salts. At the end of each such washing, the precipitate is allowed to settle and the waste water removed by siphoning or decanting, care being taken to prevent loss of precipitate. To the final washed precipitate, very fine flour graphite and a minor proportion of sodium silicate are added and thoroughly incorporated by mixing. The mixture so obtained, is immediately usable. It is applied by means of a brush, and the applied film is air dried in a water bath and preferably stoved to set it hard and to remove free moisture before current is passed through it.

For the making of heater resistances for use on circuits carrying an electrical pressure of about 240 volts, a satisfactory mixture is obtained by taking about 8 oz. of commercial "water glass" (containing about 35% of sodium silicate), diluting and thoroughly mixing it with 8 oz. water, completely precipitating the solution with aqueous solution of aluminium sulphate, allowing the precipitate to settle, decanting or siphoning off the supernatant liquor repeatedly washing the precipitate with fresh water, and after decanting or siphoning off the final wash water, adding to the clean precipitate and thoroughly intermixing therewith

4 oz. of fine flour graphite and one fluid ounce of commercial "water glass". The product thus obtained is suitable for immediate application as a paint, to form a "film" resistance.

It has been determined that an effective method of applying this "paint" to form a heater resistance film is to apply it in two or more superposed coats, drying off each coat before applying the next one, and crossing the brush lines in the successive coats. A one-thickness coat of adequate thickness is liable to be less regular than a multiple-thickness coat.

The conductivity of the film augments during its first electrical heating to about 25% over its conductivity when the first passing of current occurs; thereafter it remains practically constant. Experience shows that it is desirable to make the length of the film strip not less than five inches, though quite effective results may be got with films of shorter length. No difficulty is found in determining with approximate accuracy the current capacity of a painted-on film of this product with a current of known constants. Inasmuch as the thickness of the film will depend upon the fluidity of the material, which naturally will vary to some extent according to the proportion of wash water left with the precipitate after the final washing, a little experience must be gained by practical test to enable a workman, however skilled, to determine with approximate accuracy the dimensions and coat thickness of the film required to produce a certain desired heating effect. Contact is made with the thickened end portions by a strip of wire gauze fixed thereon, a current conducting terminal being attached to the gauze.

The accompanying drawing shows in perspective section a heater element according to this invention. The element is shown applied to a metal plate over fire enamel glaze. The thicknesses of the plate, the glaze, the film, and the gauze connector are shown in greatly exaggerated proportion to facilitate explanation.

A is a metal plate to which heat is to be applied; B fire enamel glaze thereon; C film of resistance material painted over the glaze B; D strips of wire gauze set on the ends of the film C; E painted-on edging of resistance material securing the gauze strips D to the film C; F wire connectors soldered or otherwise permanently secured to the middle part of the gauze strips D to provide a permanent electrical connection. The wires F are led to pin plugs or other suitable electrical coupling devices, and may be encased in strung bead insulators G.

The gauze connector strips D are set in position after the film C is dry and they are attached around the edges only by painting on a strip E of the resistance material, to bind the edges to the film and provide a good electrical connection. The middle portions of the strips B should not be attached to the film C. If they are attached to it as by painting the edging material C all over the strips, the strips are liable to peel off.

As a rough guide to indicate the dimensions of a film required to obtain effective results on a water kettle bottom, I say that test films five inches long used in a 240 volt circuit safely carry one ampere of current for every inch in width, and that the current flux can be increased by one half ampere per inch width for each additional inch of length beyond five inches; thus a film strip seven inches long by two inches in width will effectively carry a current of 4 amperes. It is found undesirable to increase the current density substantially beyond the ranges indicated by these figures.

I have also experimentally established the fact that when an aqueous solution of sodium silicate or potassium silicate is precipitated by a soluble salt of an alkaline earth metal, or by a soluble salt of zinc or iron, a product is obtained which can be used in the same manner (though with inferior results) as the product which is obtained as hereinbefore described by the reaction of an aluminum salt on sodium silicate.

What I claim as my invention and desire to secure by Letters Patent is:—

1. An electrical heater resistance element consisting of an electrically insulating support, terminal wiring attachments mounted on said support, a painted on and dried out film surface containing a water-washed chemically precipitated silicic vehicle, and powdered graphite incorporated in said silicic vehicle.

2. An electrical heater resistance element comprising a conducting base, an electricity insulating surface, a painted on and dried out film containing a water-washed chemically precipitated silicic vehicle, powdered graphite and alkali silicate, and metallic terminal attachments contacting with said film surface at opposite edges thereof.

3. In an electrical heater resistance element as set forth in claim 2 a film surface comprising a water-washed chemically precipitated aluminous silicic vehicle, powdered graphite and alkali silicate.

4. In an electrical heater resistance element as set forth in claim 2 a film surface comprising a water-washed chemically precipitated alkaline earth, iron or zinc silicic vehicle, powdered graphite, and alkali silicate.

In testimony whereof I have signed my name to this specification.

ROBERT WOOLRIDGE REYNOLDS.