Nov. 26, 1935. A. H. HEYROTH ET AL 2,022,314

ELECTRICAL RESISTOR AND ITS MANUFACTURE

Filed Dec. 29, 1933

Fig. 1.

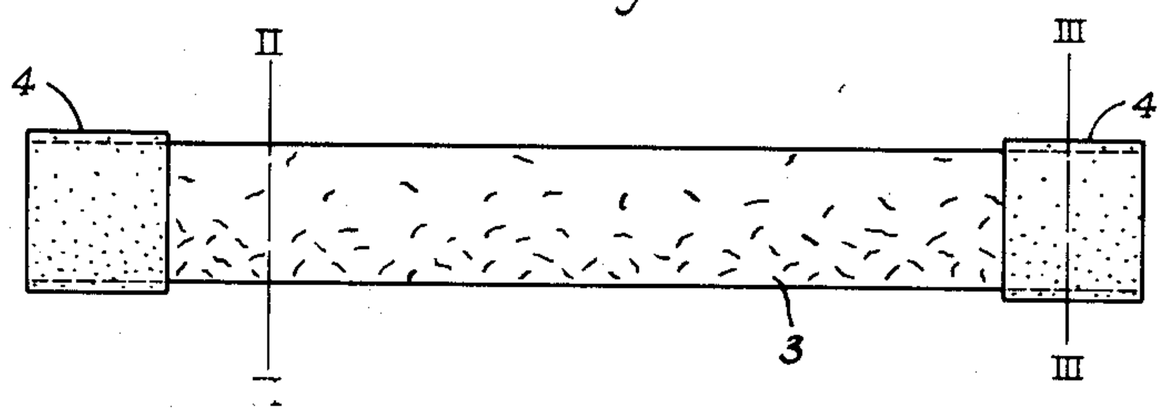


Fig. 2.

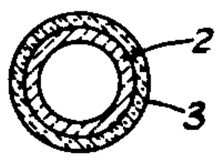


Fig. 3.

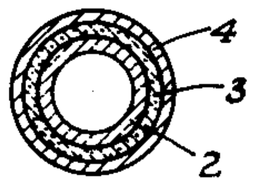


Fig. 4.

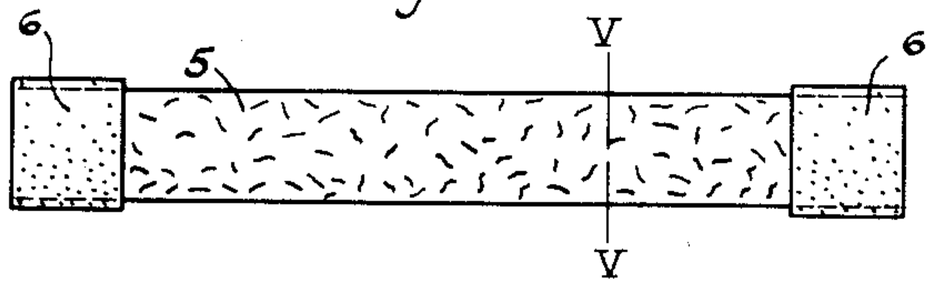


Fig. 5.

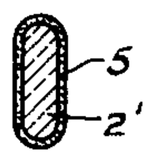


Fig. 7.

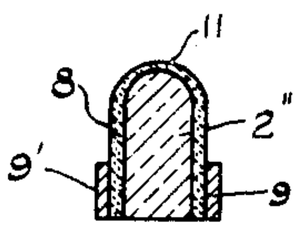
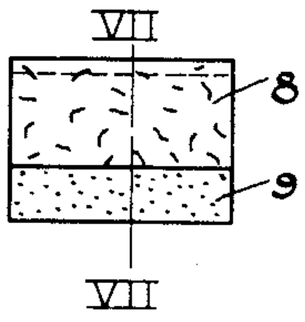


Fig. 6.



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ELECTRICAL RESISTOR AND ITS MANUFACTURE

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4 Claims. (Cl. 201—76)

This invention relates to electrical resistors, more particularly to resistors intended for use as heating elements and radiators, and to methods of making the same.

Electrical resistors for use in radiating heat are ordinarily made by wrapping wire composed of refractory metal on refractory supports. Very satisfactory non-metallic radiators are made in the form of rods composed mainly of silicon carbide. These rods require support only at their ends. Both the metal wire resistors and the resistor rods are ordinarily operated at temperatures in excess of 500°–600° C.; that is, at temperatures which produce a dull red to a bright red tint in the resistor.

One of the objects of our invention is to provide an electrical resistor for use at temperatures extending up to a dull red heat and in which the heat is distributed from a comparatively large area. Another object of our invention is to produce a resistor at low cost by simplification of the methods of manufacture.

The invention is illustrated by means of the accompanying drawing in which:

Figure 1 is a side view of a resistor made according to our invention;

Figure 2 is a section taken on the line II—II of Figure 1;

Figure 3 is a section taken on the line III—III of Figure 1;

Figure 4 is a side view of a resistor which is similar to that shown in Figure 1 except in the mounting or support for the resistor, a strip of ceramic material being substituted for the tube;

Figure 5 is a section on the line V—V of Figure 4;

Figure 6 is a side view of a U-shaped resistor which is mounted on a ceramic support; and

Figure 7 is a section on the line VII—VII of Figure 6.

Referring to the drawing in detail, 2 represents an insulating tube of refractory material such as is used, for example, in clay insulators. On the outside of this tube is a conducting coating composed principally of silicon and a form of clay known as bentonite. This is a clay-like material which has a large power of absorption of water and which is easily fusible after drying. On the terminal portions of the conducting coating are layers 4 of highly conducting metal. These may be produced, for example, by electroplating copper on the terminal portions of the resistor or by spraying brass or other conducting metal which is easily sprayed. The spraying can be performed with a Schoop gun.

As an illustration of a method of making our improved resistor, an unglazed clay tube or ceramic body of the shape and dimensions desired for heat distribution is selected. Metallic silicon is ground to about 200 mesh (meshes to the linear inch). About 84 parts of this finely divided silicon are mixed with 16 parts of bentonite, and the mixture of silicon and bentonite is dispersed in about twice the mass of water with the aid of an agitator until a slurry suitable for application to the unglazed clay tube (or other form of ceramic body) is formed. The slurry may be applied by dipping the ceramic body in the dispersion or the slurry may be painted on the surface of the tube. After the first coating has dried, a second coating can be applied and the process repeated a number of times depending on the degree of conductance which it is desired to obtain in the finished product. The coated tube is then placed, for example, in a muffle and fired at a temperature of about 2300° F. The silicon will remain substantially unaltered even in an oxidizing atmosphere if not heated too long at the temperature mentioned. About twenty minutes firing is needed for a tube six inches long and five eighths of an inch in diameter. The resultant coating has a hard, smooth surface which is not easily scratched. Terminals of highly conducting metal are provided by electroplating or by spraying as indicated above.

In the modification shown in Figures 4 and 5, an elongated strip of ceramically bonded refractory is coated along one or both of opposite sides 5 with a silicon-bentonite slurry which is matured as described above for the tubular resistor. Terminal coatings 6 of a highly conducting metal are deposited or sprayed on opposite ends of the resistor layer as in the case of the tubular resistor. With this type of mounting, heat can be distributed from a substantially plane surface which is heated more uniformly than is possible with the use of a wire grid, for example.

In the modification shown in Figures 6 and 7, a strip of ceramically bonded refractory is covered with a U-shaped resistor layer 8. The ends of the resistor layer are provided with terminal connections 9 and 9' at the respective ends by depositing or spraying highly conducting metal on the terminal portions of the resistor layer. The coating at the U-shaped bend 11 may be made narrower or thinner than the remainder of the resistor coating so that this area becomes red hot while the remainder of the resistor is cooler. This affords a convenient method of localizing heat on an outstanding area.

Our resistor has a number of advantages, both from the manufacturing point of view and as an electrical resistor.

From the manufacturer's point of view, some of the advantages are:

1. Simplicity and low cost of manufacture;
2. Uniformity of product; and
3. Wide range of choice in the selection of the slurry composition to meet specific requirements.

Considering the article illustrated in the drawing and described above as an electrical resistor, some of the advantages are:

1. Low cost of replacement;
2. Wide range of the specific resistances which may be obtained;
3. Substantial uniformity of radiation from the resistor surface (in the case of metal wire heaters, surfaces of lower temperature are distributed between the hot wires); and
4. Ease of cleaning. The resistor can be wiped to remove dust and the like without injury to a properly made resistor.

For the purpose of distribution of radiant energy from the resistor, it is mounted, for example, in such a position that its longitudinal axis approximately coincides with the focal axis of a reflector having a principal section which is a parabola.

While a number of changes may be made in the proportions of constituents and in the method of coating, our invention is defined within the compass of the following claims:

We claim:

1. An electric heater comprising a refractory base in the form of a non-conducting slab having a rounded end, a conducting layer of silicon and bentonite baked on the sides and on the curved end of the slab, the thickness of the conducting layer being least at the rounded end of the slab, and terminal metal strips attached to the sides of the U-shaped coating.

2. The method of making an electric heater which comprises making a slurry of approximately five parts of finely divided silicon and one part of finely divided bentonite in a mass of water which is greater than that of the finely divided solids, applying the slurry to the two opposite sides of a refractory slab which is an electrical insulator and applying also a thinner coating of the slurry to the curved surface which joins the said opposite sides, baking the coating on the mounting at a temperature exceeding 2000° Fahrenheit, and spraying highly conducting metal on the opposite sides of the U-shaped resistor thus formed.

3. An electric heater comprising a refractory base in the form of a non-conducting slab having a rounded end, a conducting layer composed of silicon and a self-fluxing binder baked on the sides and on the curved end of the slab, the thickness of the conducting layer being least at the rounded end of the slab, and terminal metal strips attached to the sides of the U-shaped coating.

4. The method of making an electric heater which comprises making a slurry of finely divided silicon and a smaller proportion of self-fluxing binder in a mass of water which is greater than that of the finely divided solids, applying the slurry to the two opposite sides of a refractory slab which is an electrical insulator, and applying also a thinner coating of the slurry to the curved surface which joins the said opposite sides, baking the coating on the mounting at a temperature exceeding 2000° Fahrenheit, and spraying highly conducting metal on the opposite sides of the U-shaped resistor thus formed.

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