Sept. 28, 1943. O. J. MORELOCK ET AL 2,330,783

RESISTANCE ELEMENT

Filed July 1, 1942

Fig. 1.

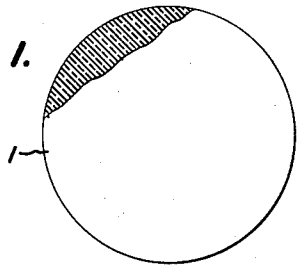


Fig. 2.

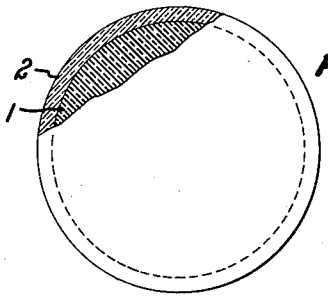


Fig. 3.

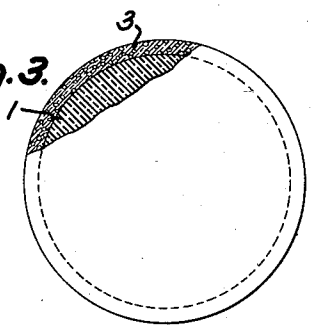


Fig. 4.

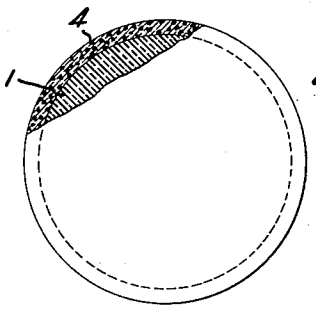
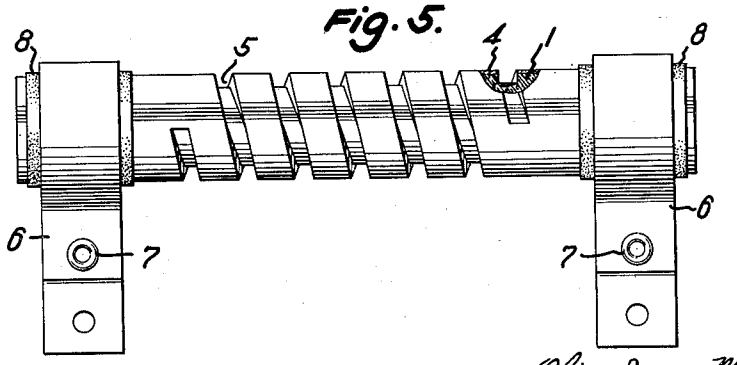


Fig. 5.



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UNITED STATES PATENT OFFICE

2,330,783

RESISTANCE ELEMENT

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Application July 1, 1942, Serial No. 449,300

10 Claims. (Cl. 201—75)

This invention relates to resistance elements and more particularly to highly stable resistors of intermediate ohmic value and high accuracy, and to novel methods of producing the same.

A resistance element of high ohmic value may be made by the known method of depositing carbon on a ceramic base that is preferably in the form of a rod. The rod, which may be solid or hollow, is placed in an atmosphere of a hydrocarbon gas and heated to the dissociation temperature of the gas whereupon carbon deposits upon the ceramic material to form a continuous conducting path thereon. The ohmic resistance of the unit is adjusted by grinding a spiral groove into the carbon layer to form a helical path of resistance material.

Owing to the hardness of the ceramic base and of the deposited carbon layer, these resistance elements will withstand high temperatures and a considerable amount of rough usage without damage. They also possess high stability, low inductance and negligible capacity which make them well suited to almost any type of service. However, the deposited carbon layer is very thin with a result that resistance elements produced in this manner have a high ohmic value, that is, in the megohm range.

The present invention resides in the special pretreatment of the ceramic rod prior to the carbonizing process, whereby the known method of forming the resistance path may be employed to produce a resistance element of relatively low ohmic value which, nevertheless, possesses all the desirable characteristics of the present megohm resistors.

An object of this invention is the provision of a method for making a durable resistance element of the deposited carbon type which is adjustable to a final ohmic value of relatively low range.

An object of this invention is the provision of a resistance element comprising a ceramic base having a relatively thick layer of carbon particles thereon.

An object is to provide a resistance element comprising a hard ceramic base, and a layer of relatively porous material intimately united to the ceramic surface, the porous layer being impregnated by carbon particles.

An object is the provision of a method for making resistance elements comprising the steps of applying a coating of relatively porous material to a hard ceramic base, impregnating the porous material with carbon particles to form a high resistance current conducting path, and grinding a spiral groove in said resistance path.

These and other objects and advantages will become apparent from the following description when taken with the accompanying drawing which illustrates the essential steps in the process of making a resistance element in accordance with this invention. In the drawing:

Fig. 1 is an end elevation, partly in section, of the ceramic insulating base suitable for the manufacture of an electrical resistor embodying the invention;

Fig. 2 is a similar end elevation, not to scale and partly in section, of the insulating base after the application of a coating that may be transformed into a porous layer;

Fig. 3 is a similar end elevation, with parts in section, of the resistor blank after the formation of the porous layer;

Fig. 4 is an end elevation of the resistor blank after the deposition of carbon on and within the porous layer; and

Fig. 5 is an elevation of a resistor element at the completion of the grinding operation to adjust the resistance to a desired value.

A resistance element made in accordance with this invention comprises a rod or tube 1 of hard ceramic, such as the material sold under the trade-mark "Isolantite," porcelain or the like. The length and diameter of the rod are prechosen within rather broad limits depending upon the desired resistance range of the finished resistor. Prior to the carbonizing operation, the ceramic base is pretreated by dipping it one or more times into a solution of sodium silicate to form an outer coating 2. The dried rod is then immersed in a solution of hot ammonium chloride until the sodium has been removed to leave a porous coating 3 of silica on the ceramic surface. The thickness of the silica coating is determined by the specific gravity of the sodium silicate solution and the number of alternate dipping and drying operations. As the sodium silicate solution fills the surface pores of the ceramic, the resulting silica coating adheres tenaciously thereto.

The resistor blank is then heated in a furnace, in the presence of a hydrocarbon gas, to the dissociation temperature of the hydrocarbon whereupon carbon particles are deposited upon, and in the pores of, the silica coating to form a carbon impregnated layer 4. The hard porcelain rod is relatively impervious to penetration by the deposited carbon particles whereas the silica coating is relatively porous; consequently, the carbon particles penetrate through the silica to trans-

form the coating into a current conducting path. Although the silica coating is relatively porous it is, at the same time, very hard and the resulting current conducting path is uniform, tough and capable of withstanding high temperatures.

The final ohmic value of the resistance element may be adjusted in known manner by grinding down the end sections of the rod or by grinding down the carbon-silica layer to reduce the diameter of the active material. Such adjustments are satisfactory when a high degree of accuracy is not required but it is preferable to employ the known method of grinding a spiral groove 5 through the conductive material to form a helical ribbon of resistance material as this procedure permits accurate adjustment within narrow limits.

The thermal deposition of carbon particles upon a porcelain rod, to form a resistance element, is old in the art. However, the deposited carbon particles do not appreciably penetrate into the porcelain and the resulting carbon layer is of about molecular thickness and the prior resistors have a high ohmic resistance in the range of megohms. By pretreating the porcelain rod as described hereinabove, the porous silica coating may have a thickness of several thousandths of an inch or more, and the ohmic resistance of the thermally deposited carbon layer will, therefore, be much lower than that of similar units made according to the prior practice. The stability, durability, heat resistance, etc., of the new resistance elements compare favorably with resistors made according to present methods, and they possess the added advantage that they may conveniently be made to resistance values within the intermediate range of 500 to 50,000 ohms.

Resistance elements of this type are provided with metal terminal connectors 6 by which the unit may be connected into an electrical circuit. The connectors are usually in the form of flat metal strips which are staked tightly around the rod by rivets 7. Prior to the attachment of the connector strips, the extremities of the rod are coated with narrow bands 8 of good electrical conducting material such as, for example, graphite. This may be done by brushing, spraying or dipping in "Aquadag." Upon drying, preferably under the action of heat in a furnace, the graphite coatings form a good, electrical contact with the resistance material 4. The relatively soft graphite bands 8 also provide a resilient cushion to assure good electrical contact with the terminal connector strips 7. The intermediate bands 8 may also be provided by spraying on a conducting metallic paint, as is well known in the art.

As a final operation, the resistor unit is heated in a furnace to drive out absorbed moisture after which the entire surface is coated with a protective lacquer or enamel coating that is preferably baked to permanently seal the unit.

Having now described the invention, those who are skilled in the art will be able to make certain variations and alterations without departing from the scope and spirit of the invention as set forth in the following claims.

We claim:

1. In the manufacture of resistance elements by depositing carbon upon a substantially non-porous base of a refractory insulating material, the process which comprises forming a porous refractory coating of insulating material upon said base, and thermally depositing carbon on said refractory coating and within the pores thereof.

2. In the manufacture of resistance elements by depositing carbon upon a substantially non-porous base of a refractory insulating material, the process which comprises forming a porous refractory coating of insulating material upon said base, and heating the coated base in an atmosphere of a hydrocarbon vapor to above the dissociation temperature of the hydrocarbon, thereby to deposit carbon on and within the pores of said coating.

3. In the manufacture of resistance elements, the process which comprises forming a porous coating of silica on a substantially non-porous ceramic base, and heating the coated base in the presence of a hydrocarbon vapor and to above the dissociation temperature of the hydrocarbon, thereby to deposit carbon on and within the porous silica coating.

4. In the manufacture of resistance elements, the process which comprises coating a substantially non-porous ceramic base with a solution of a silicate, drying the coated base, transforming the silicate coating to a porous silica coating, and thermally depositing carbon on and within the pores of said silica coating.

5. In the manufacture of resistance elements, the invention as recited in claim 4, wherein the silicate-coated base is immersed in a solution of ammonium chloride to reduce the silicate coating to a porous silica coating.

6. In the manufacture of resistance elements by heating a ceramic base in an atmosphere of a hydrocarbon vapor to deposit carbon upon the ceramic base, the process which comprises coating the ceramic base with sodium silicate, reducing the sodium silicate coating to a porous silica coating, and depositing carbon on and within said silicate coating.

7. In the manufacture of resistance elements by heating a ceramic base in an atmosphere of a hydrocarbon vapor to deposit carbon upon the ceramic base, the process which comprises forming a relatively thick porous coating of silica upon said ceramic base by a plurality of cycles of coating the base with sodium silicate and then reducing the sodium silicate coating to silica, and depositing carbon on and within the porous silica coating.

8. An electrical resistor comprising a substantially non-porous base of insulating material, a porous insulating coating upon said insulating base, and thermally deposited carbon extending continuously over the surface of and into the pores of said coating.

9. An electrical resistor comprising a substantially non-porous ceramic base, a porous coating of refractory insulating material upon said base, and thermally deposited carbon extending continuously over the surface of and into the pores of said coating.

10. An electrical resistor as recited in claim 9, wherein said porous coating comprises silica.

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