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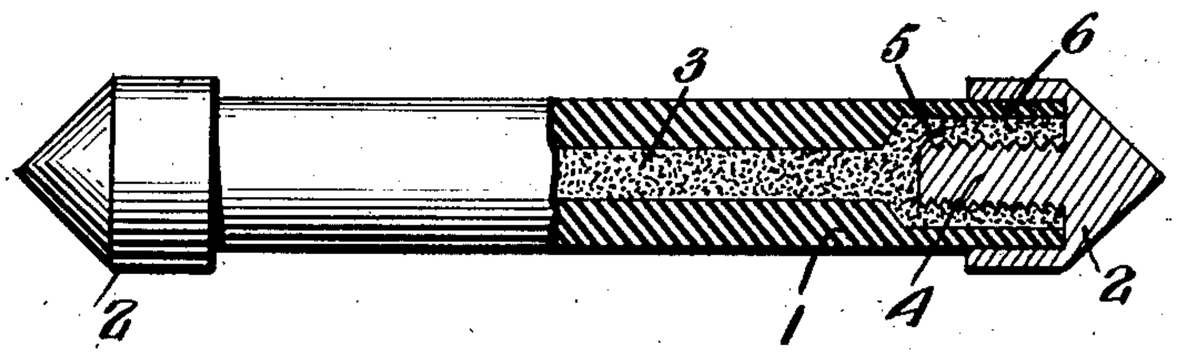

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RESISTANCE DEVICE AND METHOD OF MAKING SAME.

Application filed September 18, 1924. Serial No. 738,422.

My invention relates to electrical resistance devices of the type disclosed in my copending application Serial Number 665,039, filed September 27, 1923. This invention includes both an improved resistance device of the same general character, and an improved method of making such resistance devices.

For many electrical purposes resistances, ranging from a few thousand ohms to several megohms are required. These resistances should have relatively high current-carrying capacity, and should not change materially with a rise or fall in temperature. In other words, the resistances should be substantially constant. It is desirable to provide a simple and easily manufactured resistance device of this nature, capable of presenting and maintaining a resistance having the required and predetermined value; also to originate a method by which such devices can be readily and inexpensively produced. The present invention has been made with a view to obtaining these results.

I have found that a very satisfactory resistance device can be made by inserting a quantity of suitable material, preferably in the form of a paste, into an insulating casing, and then subjecting the device to further treatment. Preferably the casing should be porous, to enable it and its contents to be thoroughly dried and then coated and sealed.

The nature of my invention will be apparent from the following detailed description, which is to be considered in conjunction with the accompanying drawings, in which:

Figure 1 is a longitudinal elevation, partly in section, of the completed resistance device according to my invention.

The same numerals identify the same parts throughout.

The numeral 1 on the drawing indicates a tube or spool of some suitable porous insulating material such as wood. This tube may have its ends bored out larger for a purpose to be explained later. The ends of the tube are closed by caps 2 of some conductive material such as metal, and the inside of the tube is filled with a treated resistance material 3. Each cap 2 has a projection 4 which can be thrust into the adjacent enlarged end of the bore of the tube, this projection 4 being in the form of a shank or boss having threads 5 or being otherwise roughened on its exterior surface.

The resistance material 3 contains a binder which is of such a nature that it not only causes the material 3 to cohere, but also makes it adhere tightly to the metal projections 4 of cap 2, which the material 3 completely surrounds; and to the inside of the tube 1.

Hence the caps are firmly cemented to the ends of the tube and efficient and permanent electrical contact between the cap and the resistance material 3 is obtained.

The material 3 consists preferably of a mixture of manganese dioxide, lamp-black and glue. The manganese dioxide is ground to powder and mixed with lamp-black in approximately equal proportions. Le Page liquid glue can then be added, the entire mass being agitated in a stirring vessel to intermix the ingredients thoroughly; while the operation of filling a number of tubes like the tube 1 is performed. After mixing the manganese dioxide and lamp-black in equal proportions, the glue can be added in such quantity that, for example, for every twenty parts by weight of the manganese dioxide and lamp-black 125—145 parts of glue will be present. When the mixture has been made, it is utilized to fill a selected number of tubes or spools 1, by means of a squirt gun or any other apparatus. As each tube or casing 1 is filled up to both ends, the caps 2 are put on immediately and in this condition, the tube is air dried for about one week.

While drying, the filled tubes with their caps in place are put in suitable holders to prevent the caps from working off the ends of tubes while the caps are becoming set in the process of drying. After drying for about seven days they are heated at 125° to 150° for 2 to 3 hours, and then placed in a paraffin bath under a vacuum for some minutes to remove all air and all traces of remaining moisture. Then air is again admitted under any desired pressure until all interior spaces are thoroughly filled with paraffin.

Next each of the devices are treated electrically by testing at 800 volts and then allowed to lie one week for aging. The resistance devices are now segregated and classified according to the different values of the resistance which they present, by measure-

ment, for example, at 220 volts, and then after another week these measurements can be checked at a lower voltage, such as six volts. This precaution is taken to detect any changes in the value of the resistance which may have taken place. All of the devices which are satisfactory are then taken and labeled and packed, the other ones which are not satisfactory can be treated further in the same way until they attain the condition required.

When finished, the resistance devices having the structure and character above indicated are perfectly dried and entirely moisture-proof. Their resistance is constant and will not change in service, and each device will have sufficient mechanical strength to enable it to withstand handling and avoid damage when subjected to the ordinary careless manipulation frequently given to appliances of this sort.

By the method above described, I can make resistance devices from 1200 to 100,000 ohms or in higher resistance values from 100,000 to 20 megohms. The devices are particularly useful as grid leaks for radio sets and their resistance remains constant. They are not subject to the gradual increase of resistance values so marked in most types of high resistances, usually due to poor contact between resistance material and metal ends. The resistance of the manganese dioxide is always high; while that of the carbon which is preferably in the form of lamp-black is relatively low and by intermixing these with the adhesive or glue and treating as described, the finished device is given the value of resistance which is required and this resistance is maintained.

The end caps 2 do not fit the exterior of the tube 1 tightly, but have a slight clearance (about 1/100 of an inch) to enable resistance material 3 after being inserted in the tube 1 to escape when caps 2 are pushed on; and at the same time give better electrical contact. The resistance material after drying becomes stony yet somewhat resilient, like hardened glue.

Glue is used advisedly rather than shellac, lacquer, etc., as it has a better conductivity.

The attainment of good and lasting electrical contact by the adhesion of the resistance material 3 to the metal caps 2 is an important feature of this invention.

The same constant resistance can be obtained with different aging periods but I find that the seven day periods give the desired results and permit a systematic and easy method to be employed.

The projections 4 require an enlarged recess 6 at each end of the bore of the tube 1 of a certain diameter to allow space around the projections 4 for the resistance material to cement the projections 4 to the inside of the tube 1. If higher resistances are desired with a given mixture, the middle section of the tube can be bored out to any required smaller diameter.

Having described my invention, what I believe to be new and desire to secure and protect by Letters Patent of the United States is:—

1. A resistance device comprising a porous insulating casing, electrically conductive caps on the casing, conductive material in the casing connecting the caps and capable of presenting a constant resistance to a current flowing therethrough, and a coating on said casing, the device being dried and airtight.

2. A resistance device comprising a casing in the form of an open-ended tube of porous insulating material, electrically conductive caps engaging the ends of said tube, a conductive substance in said tube comprising manganese dioxide mixed with carbon capable of offering a constant resistance to the passage of current flowing therethrough, the device and contents being thoroughly dried, and thoroughly impregnated with a waterproof and insulating material.

3. A resistance device comprising an open-ended tube of insulating material filled with an electrically conductive substance, and end caps affixed to the tube, each of said caps having a roughened projection which extends into the tube and adheres to the resistance material which surrounds it in the tube.

4. A conductive substance of constant resistance, consisting of manganese dioxide and carbon in equal parts by weight, and containing a binder or adhesive, mingled to afford a uniform plastic mixture.

5. A conductive substance capable of maintaining a uniform resistance, said substance containing equal parts by weight of manganese dioxide and powdered carbon mixed with an adhesive in the proportion of twenty parts of the manganese dioxide and carbon to 125 or more parts of the adhesive, mingled to afford a uniform mixture.

6. The process of manufacturing resistance devices which consists in making a mixture of a conductive substance with an adhesive, forcing said mixture into a tube, closing the ends of said tube with caps of electrically conductive material, subjecting said tube and contents to the action of heat and then coating the entire device to render it impervious to moisture and at the same time, extracting all of the air and moisture therefrom.

7. The process of manufacturing electrical resistance devices which consists in making a mixture of manganese dioxide and lamp-black with the addition of an adhesive, forcing said mixture into a porous insulating tube, capping the ends of said tube, drying said device, subjecting the device to the ac-

tion of heat and then impregnating the device to make it water-tight; while at the same time, extracting all of the air and moisture therein, and finally aging the device.

8. The process of manufacturing resistance devices which consists in the making of a mixture of manganese dioxide and lamp-black in powdered form, in equal parts by weight, adding a relatively large quantity of an adhesive and thoroughly intermingling the adhesive with the lamp-black and manganese dioxide, forcing said mixture into a porous insulating casing, closing the ends of said casing with electrically conductive caps, subjecting it to the action of heat, and then extracting the air in the casing and contents, impregnating said device with melted wax, to make the same air-tight and water-proof.

9. A resistance device comprising a casing, resistance material capable of being forced in the form of a paste into the casing, and terminals on the ends of the casing to be engaged by said material to cause the terminals to adhere to the casing upon the drying of said material to make efficient electrical contact with said material.

10. A resistance device comprising a casing, plastic resistance material filling said casing and terminals on the ends of the casing connected to said material by adhesive engagement therewith, to cause said terminals to be maintained upon the casing and make efficient electrical contacts with said material.

Signed at Philadelphia in the county of Philadelphia and State of Pennsylvania this 29th day of August A. D. 1924.

CHARLES E. VAWTER.