

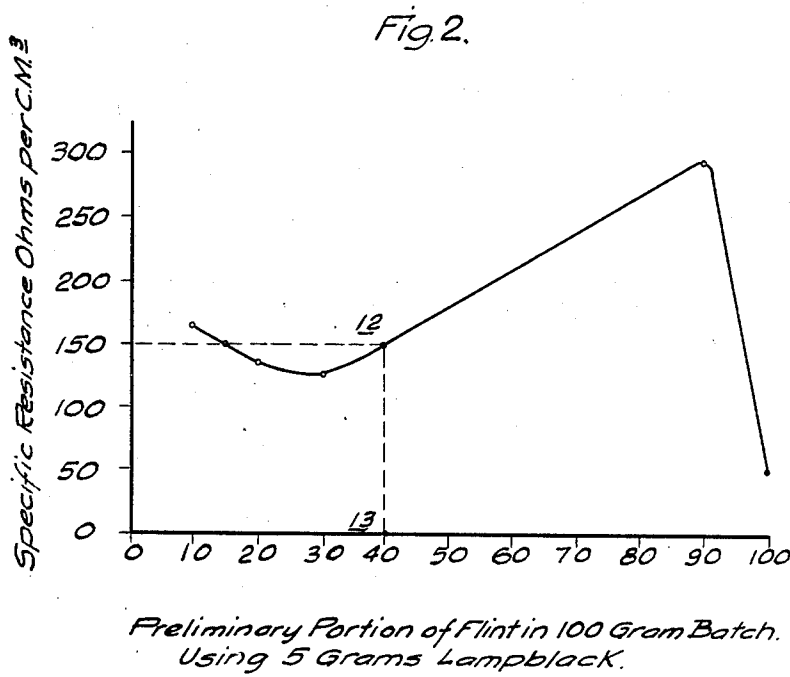
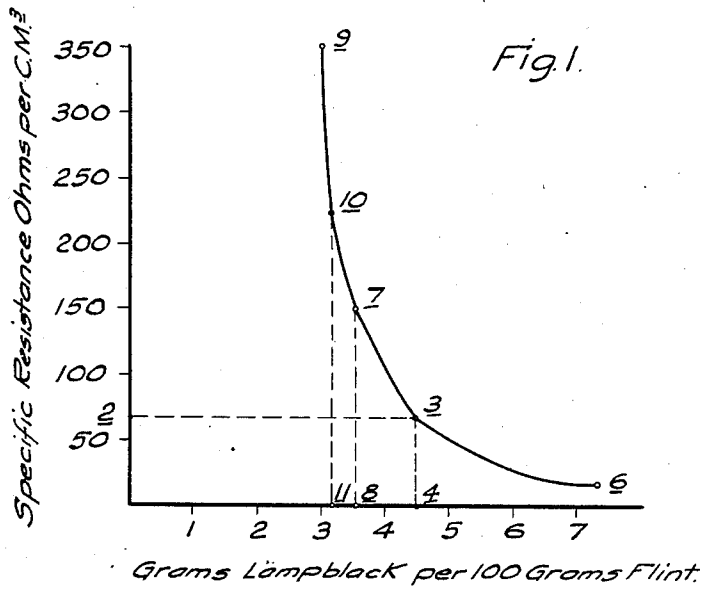
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RESISTANCE MATERIAL AND METHOD OF MAKING SAME

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RESISTANCE MATERIAL AND METHOD OF MAKING SAME

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My invention relates to resistor material and particularly to a method of manufacture whereby the specific resistance of the resistor material may be fixed at any given value.

An object of my invention is to provide a resistor material, the resistance of which may, in manufacture, be closely controlled over a wide range.

A further object of my invention is to provide a resistor material which shall be stable and permanent in its operating characteristics and easily and inexpensively manufactured.

It has been common practice to make non-metallic resistors of ceramic materials, including kaolin or other binders; conducting materials, such as graphite or carborundum; and filler materials such as silica, in such proportions as to provide the proper resistance.

It has been found in practice that resistors designed to give a resistance of 70 ohms per centimeter cube and above were difficult of control in the process of manufacture with regard to the resistance of the finished product. This difficulty rapidly became more troublesome in resistors having a resistance above 100 ohms per centimeter cube. This condition made the satisfactory manufacture of resistors with a resistance of over 150 ohms per centimeter cube extremely difficult, if not impossible.

It was, therefore, necessary that some method of manufacture be found that would allow better control of the product. My invention provides a process whereby the disadvantages of prior methods are minimized.

My invention utilizes a peculiar action which takes place upon mixing two materials. If we take a given quantity of flint and mix in a given quantity of lamp black, the resulting resistor material will have a certain specific resistance. If, however, we take only a part of the given quantity of flint, mix in the given part of lamp black and then mix in the remaining part of flint, we obtain another specific resistance, yet the quantities of flint and lamp black are the same as before. This unexpected action in mixing

constitutes an important part of my invention.

The probable explanation of this action is as follows:

If two powders of different size are mixed together the one of larger diameter will be coated by the other. It is evident from this fact that if we mix two materials, one an inert, the other a conducting material and of smaller diameter than the first, the conducting material tends to coat the inert material. If for any given percentage composition, all the conducting material is mixed with a portion of the inert material, particles of a larger diameter than the original particles will be formed. Upon addition of the remainder of the inert material, it will tend to coat these larger particles and have the effect of increasing the resistivity of the final mix.

My invention may be better understood by reference to the accompanying drawings, in which the curves of Fig. 1 and Fig. 2 show relations between the amounts of flint and lamp black and the resistance of the resulting mixture.

Fig. 1 represents the results obtained by methods of the prior art. The number of grams of lamp black per 100 grams of flint is plotted against resistivity in ohms per cubic centimeter.

Referring to Fig. 1 suppose a resistor is desired having a resistance of 70 ohms per centimeter cube as indicated at point 2. Passing horizontally to the curve at point 3 and vertically downward to point 4, we find that in order to obtain the desired resistivity we must use a ratio of 4.5 grams of lamp black per 100 grams of flint. It will be noted that at this point 3, and, in fact, along the portion of the curve between points 3 and 6, for a certain mix we obtain a relatively definite resistivity. If, however, we take some point 7 along the steeper portion of the curve between points 3 and 9, say, corresponding to a resistivity of 150 ohms per centimeter cube, a small change in the mix, corresponding to the space between 8 and 11, produces a relatively large change in resistivity, as indicated by point 10. It can readily be understood

that mixtures along the portion of the curve between points 7 and 9 are difficult to control, and it is for this reason that my invention has been devised.

5 Fig. 2 is a curve showing the results obtained by using my method. In this case 5 grams of lamp black were used. Similar curves will be obtained with other proportions of lamp black and other inert materials, such as flint. The 100-gram portion of the inert material which in the example given is flint is now divided into two parts. The curve indicating the portion in grams of flint to be mixed at the first mixing with a given quantity of lamp-black to obtain, when mixed with the remaining portion of flint, a certain desired resistance. Suppose, as before, a resistivity of 150 ohms per centimeter cube is desired. Passing horizontally to the curve at point 12 and vertically downward to point 13 we see that 40 grams of flint are used in the first or preliminary portion, 5 grams of lamp-black are added to this portion. A small amount of water is added to facilitate mixing. It is to be noted that 5 grams of lampblack are used instead of 3.4 as in Fig. 1, point 8. This increase in the amount of the coating material is advantageous as it provides a better coating and thus more uniformity is secured. After the preliminary mix is completed, the remaining portion, or 60 grams of flint, is added and the final mix completed. This material may be treated with water glass, formed, again heated and baked to form resistors as described in the copending application of Joseph Slepian, Serial No. 637,147 or my application Serial No. 637,376, both filed May 7, 1923, and both of which are assigned to the within named assignee. By reference to the curve at point 12, it will be readily understood that the resistance of the resistors formed according to my process may be relatively accurately predicted.

My invention thus provides a method whereby, in manufacture, the resistance of the resulting resistor may be readily controlled. The range of dependable resistances is greatly increased. In making a resistor of a desired resistance it is only necessary to choose the portions of material best suited therefor, as shown by the curves.

I have described a preferred method of utilizing my invention and have mentioned preferred materials. However, other materials may be used, such as silica, flint, carborundum and other silicious materials, on the one hand, and lampblack, graphite or other finely divided carbonaceous materials, on the other, and will act in the same way. It is understood that I do not wish to limit myself to the specific methods and materials described and that variations thereof may be made without departing from the spirit

and scope of my invention as defined in the appended claims.

I claim as my invention:

1. A method of manufacturing a resistor consisting of first mixing a portion of flint with a portion of lampblack and water, then adding another portion of flint, mixing, adding a binder, forming and baking. 70

2. A method of manufacturing a resistor consisting of first mixing a portion of flint with a portion of lampblack and water, second, mixing in another portion of flint, and third, adding a binder, forming and baking. 75

3. A method of manufacturing a resistor consisting of mixing successive portions of flint, lampblack and flint with each other. 80

4. A method of manufacturing a resistor by mixing successive portions of flint, lampblack and flint with each other, adding a binder, forming and baking. 85

5. The method of controlling the resistivity of a resistor element consisting of a composite mixture of lampblack and finely divided flint which comprises adding lampblack to a part of said flint, preliminarily mixing said flint and lampblack, mixing said preliminary mixture with the remainder of said flint, adding an adhesive binder and molding. 90

6. The method of controlling the resistivities of composite resistor bodies which consists in mixing together powdered substantially non-conductive material and a conducting material in such manner that the conductive material becomes coated upon the surface of the loose particles of the substantially non-conductive material, adding to the resulting mix some more powdered substantially non-conductive material, mixing the same in with the first mix in such manner that some of the added non-conducting material becomes coated upon the surface of the previously coated loose particles, and causing said doubly coated particles to be bonded together into a solid. 95

7. The method of controlling the resistivities of composite resistor bodies which consists in mixing together, without any substantial amount of liquid, a powdered material and a second, more finely powdered, material having a higher order of conductivity than said first-mentioned material, adding to the resulting mix some additional powdered material having a lower order of conductivity than said second-mentioned material, mixing the materials a second time, and causing the particles resulting from said second mix to be bonded together into a solid. 100

8. The method of controlling the resistivities of composite resistor bodies which consists in mixing together, without any substantial amount of liquid, a powdered material and a second, more finely powdered, material having a higher order of conductivity than said first-mentioned material, adding to the resulting mix some additional pow- 105

dered material having a lower order of conductivity than said second-mentioned material and having smaller particles than the particles resulting from the first mix, again mixing the materials together, without any
5 substantial amount of liquid, and causing the particles resulting from said second mix to be bonded together into a solid.

In testimony whereof, I have hereunto subscribed my name this 24th day of June, 1926.
10 EARL J. HAVERSTICK.

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