E. WEINTRAUB.

METHOD OF MAKING RESISTANCE MATERIAL.

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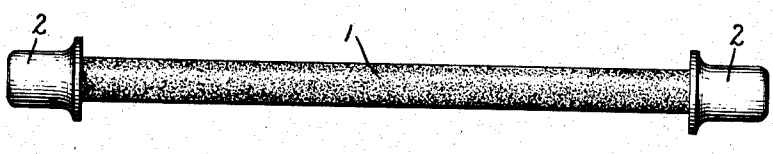
1,019,568.

Patented Mar. 5, 1912.



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UNITED STATES PATENT OFFICE.

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METHOD OF MAKING RESISTANCE MATERIAL.

1,019,568. Specification of Letters Patent. Patented Mar. 5, 1912.

Original application filed October 27, 1909, Serial No. 524,941. Divided and this application filed October 5, 1910. Serial No. 585,389.

To all whom it may concern:

Be it known that I, EZECHIEL WEINTRAUB, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Methods of Making Resistance Material, (division of my application filed October 27, 1909, Serial No. 524,941,) of which the following is a specification.

My present invention relates to resistances suitable for use in electrical systems, and comprises a process for making resistances consisting in large part of boron or a boron compound.

The accompanying drawing illustrates one form of resistance stick made according to my present invention.

For many years it has been known that boric anhydrid could be reduced with magnesium to yield a compound rich in boron, but containing magnesium as an essential component. Moissan attempted to improve on this process and obtain boron free from magnesium, and to this end, decreased the proportion of magnesium in the reaction mixture. Former experimenters had used two parts boric anhydrid by weight to one of magnesium, and obtained magnesium borid. Moissan used three parts boric anhydrid to one part magnesium, and obtained after purifying his product what he called "pure boron." He describes it as being a brownish powder, practically non-conductive for electricity, and vaporizable without fusion. I am convinced that this material is not pure boron, but is in fact a boron suboxid associated with more or less magnesium borid. This I have established by analyses and tests, which need not here be recited in detail. I have found that pure boron is quite a different material, and I have discovered how to produce it in large quantities, and I have investigated its characteristics, and have conceived for it several industrial applications.

I have discovered that pure boron can be fused, and that it has a negative temperature coefficient of a magnitude without precedent. I find that boron, when changing in temperature from room temperature to 400 degrees C., drops in resistance according to the ratio of approximately two millions to one. I know of no element or compound even approaching in magnitude this enormous change in resistance in the interval of temperature mentioned. In the present application I have shown how this discovery may be made useful in the arts by the construction of resistance sticks or elements in which the temperature coefficient is negative, and of great magnitude, because of the preponderating influence of the boron present in the stick either in its elemental state or combined with carbon, silicon, or another chemical element.

Pure boron has a relatively high ohmic resistance, and although useful as a resistance material, can be greatly improved for many purposes by the addition of carbon. The percentage of carbon may vary through wide limits, its function being to decrease an otherwise high initial resistance while simultaneously controlling the negative temperature coefficent.

Starting with boric anhydrid, I reduce this with magnesium in well-known manner, and then compress the resultant powder into a stick. I next heat the stick in an Arsem vacuum furnace of the type shown in United States Patent No. 785,535, of March 21, 1905, where the stick not only gives up the impurities with which it is composed, but also takes up some carbon from the vapors normally given off by the graphite heater of the furnace when operating at a temperature in the neighborhood of 2000 degrees C. The furnace should be heated up gradually and kept at the high temperature a long time. If the carbon taken up in this manner is not sufficient for the purpose in hand, enough carbon can be added to the magnesium borid powder before the powder is pressed into stick form. The amount of carbon to be introduced varies with the use to which the sticks are to be applied. In case of motor starting resistances, a large negative temperature coefficient is desirable, and the percentage of carbon will be small, say between a few tenths of a per cent. or five and six per cent. If the resistance sticks are to be used for lightning arrester resistances, the percentage of carbon may with advantage be as high as ten per cent. With these

proportions the temperature coefficient is small while the specific resistance is still considerable.

As a modified method of building up the resistance sticks, I find that I can start with boric anhydrid and reduce with carbon, being careful that the anhydrid is in excess of the carbon. The reduction product is then ground, pressed into sticks and finally sintered in an Arsem or other furnace.

As shown in the drawing, sticks 1 of boron, or boron associated with carbon, can with advantage be provided with iron terminals 2, made in the shape of caps and shrunk or fused to the ends of the stick. The sticks can be used as automatic motor starters, according to methods now well known, and the self-reducing characteristics of the stick will control automatically the supply of current to the motor. Thus, with a stick containing five per cent. carbon, one inch long and one quarter inch square, the resistance at room temperature is about 80 ohms, but on heating up to 800 degrees, the resistance progressively drops to about .08 ohms.

These self-reducing resistance sticks may be used not only as motor starters, but also as thermal cutouts for transformers, lamps and the like, according to methods made known in connection with other materials having negative temperature coefficients.

It will be understood that the resistance material above described need not be in the form of a coherent stick, and can be used in other relations where its enormous negative temperature coefficient is of use in controlling the current, or in magnifying the effects of current variations, and the like.

What I claim as new and desire to secure by Letters Patent of the United States, is—

1. The method which consists in reducing boric anhydrid with magnesium, adding carbon to the material thus produced, and heating to free the material from substantially all components except boron and carbon.

2. The method which consists in mixing carbon with impure boron, pressing into sticks, and heating to eliminate all components except the boron and carbon.

3. The method of making resistances of boron associated with carbon which consists in sintering impure boron in the presence of carbon until only boron and carbon remain.

4. The method which consists in associating carbon with impure boron and heating to eliminate impurities and to sinter the residue.

5. The method of making resistance bodies which consists in sintering impure boron in the presence of carbon.

6. The method of making resistance bodies which consists in mixing carbon with impure boron, pressing into shape, and heating to eliminate impurities and to sinter the residue.

In witness whereof, I have hereunto set my hand this third day of October, 1910.

EZECHIEL WEINTRAUB.

Witnesses:

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