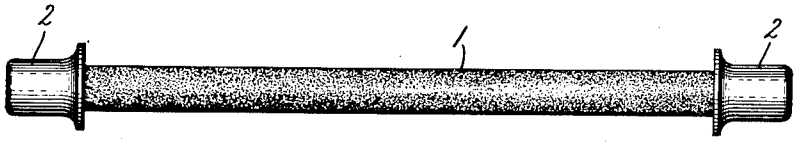
E. WEINTRAUB.

ELECTRICAL RESISTANCE.

APPLICATION FILED OCT. 27, 1909.

1,019,390. Patented Mar. 5, 1912.



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UNITED STATES PATENT OFFICE.

EZECHIEL WEINTRAUB, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRICAL RESISTANCE.

1,019,390. Specification of Letters Patent. Patented Mar. 5, 1912.

Application filed October 27, 1909. Serial No. 524,941.

To all whom it may concern:

Be it known that I, EZECHIEL WEINTRAUB, a citizen of the United States, residing at Lynn, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Electrical Resistances, 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.

My invention also embraces the product so produced.

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, so that there might be no magnesium in the final product. 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 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 coefficient.

Starting with boric anhydrid, I may reduce this with magnesium in well-known manner, and then compress the resultant magnesium borid 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 its magnesium 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 2,000 degrees C. 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 but 18% carbon is as high as could ordinarily be desired. 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. and five or 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. This method is claimed in my divisional application, Serial No. 585,389, filed October 5, 1910.

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 still another method of building up the resistance sticks, I may start with a thin rod or filament of carbon, and deposit thereon a heavy layer of boron. This may be done by heating the rod or filament in a mixture of boron chlorid and hydrogen. Sticks or rods of any desired section may be built up in this manner, and by suitable high heat treatment of the stick the original carbon core will disappear as a core and be taken up by the boron. If it is desired that the stick shall contain more carbon than would be furnished by the initial filament or carbon rod, the treating gas may contain gasolene, carbon tetrachlorid, or other volatile carbon compound decomposable to deposit carbon on a hot body. The proportions depend upon the amount of carbon desired. This method is claimed in my application, Serial No. 585,390, filed October 5, 1910, as a division of my application, Serial No. 524,950, filed Oct. 27, 1909.

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, fused or welded 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 centigrade, 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 cut-outs 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. A resistance element consisting of boron associated with an appreciable quantity of carbon, and having a relatively high negative temperature coefficient of resistance.

2. A self-reducing resistance element consisting mainly of boron and containing at least a small quantity of another element.

3. A resistance stick consisting of boron associated with carbon in appreciable quantity but less than eighteen per cent.

4. A resistance element consisting essentially of boron associated with about five per cent. carbon.

5. A resistance element, consisting of boron associated with an appreciable quantity of carbon and having a terminal of metal fused thereto.

6. A self reducing resistance consisting of boron associated with an appreciable quantity of another element.

In witness whereof, I have hereunto set my hand this 26th day of October 1909.

EZECHIEL WEINTRAUB.

Witnesses:
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