UNITED STATES PATENT OFFICE.

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

BORONIZED CONDUCTOR AND METHOD OF MANUFACTURE.

1,019,391. Specification of Letters Patent. Patented Mar. 5, 1912.

No Drawing. Application filed October 27, 1909. Serial No. 524,943.

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 Boronized Conductors and Methods of Manufacture, of which the following is a specification.

It is the object of my present invention to utilize the element boron as a means for producing a change or changes in various forms of carbon whereby that material acquires new characteristics and becomes better suited for use as the incandescing medium of a lamp, a furnace, or the like, and likewise for other purposes in the electrical art, for example, as a material for making brushes.

My present application is directed to the action of boron on carbon, and to the product resulting from that action which I have hereinafter designated boronized carbon. As a specific embodiment of the basic idea of my present invention, I will describe the treatment with boron of what is known among lamp makers as a base filament.

If a base filament of small cross section is heated with current to bright red heat in a mixture of boron chlorid and hydrogen, a deposit of boron is obtained on the filament as disclosed and claimed in my application, Serial No. 585,390, filed October 5, 1910. The deposition of a very little boron is sufficient for my present purpose. If now the coated filament be embedded in carbon or graphite, packed in a crucible, and then heated to about 2,000 degrees centigrade for some time, either in a vacuum furnace of the type shown in the United States Patent to Arsem, No. 785,535 of March 21, 1905, or in an ordinary electric furnace, the filament will be found, on removal from the furnace, to have changed in resistance, and furthermore to have acquired a marked positive temperature coefficient. Neither the original base filaments nor pure boron has a positive temperature coefficient. The filament can also be heated by the direct passage of current through the same. During the firing most of the boron vaporizes, though it is possible that mere traces may remain, and by some peculiar action on the carbon of the base filament, convert it into that form of carbon possessed of a low ohmic resistance and a positive temperature coefficient and designated in the claims as boronized carbon. The filament resulting from this operation may be mounted in a lamp and used under commercial conditions as a light giving source, or it may be used as a fillet or core on which to deposit additional material for building up a conductor of large cross section.

As another embodiment of the basic invention herein set forth, I will describe an operation in which the boron is used to produce changes in carbon deposited on a fillet from a volatile carbonaceous compound.

Starting with a base filament either of ordinary type, or after boronization, as above described, I deposit on it a very thin coating of boron. This may be done by heating the filament with current in the above-mentioned mixture of hydrogen and boron chlorid. I next remove the filament to a chamber containing gasolene or other suitable carbonaceous vapor and there deposit a layer of carbon in well-known manner. The filament then consists of a core enveloped in a boron layer, and with an outer coating of carbon. The amount of boron is small and only a part of one per cent of the amount of carbon. The next operation consists in heating this composite filament either with current, or in a suitable furnace to cause action of the boron on the carbon coating. This action may be called boronization and the carbon so acted on may be called boronized carbon. As a result of the heat treatment, the temperature coefficient changes from negative to positive, the surface of the filament becomes gray and metallic and is so constituted that its vapor tension is far below that of either carbon or boron. A filament so treated or boronized can be operated in an incandescent lamp at high temperature without detrimental blackening of the bulb.

As a third and preferred embodiment of the basic idea of my present invention, I will describe the production of a stable lamp filament by deposition of carbon in the presence of boron, and under such conditions that the boron exerts its converting power and changes the carbon deposit from ordinary carbon to what may be designated as boronized carbon characterized by low vapor tension, low specific resistance, and a positive temperature coefficient of resistance. This result may be attained by heating a base filament, either of the boronized type or otherwise, in a mixture of boron chlorid

and gasolene, or carbon tetrachlorid, or other carbon-containing vapor. For if the filament be heated with current, as in the ordinary treating operation, carbon will be deposited from the gasolene, and the presence of boron chlorid in the treating chamber will insure conversion of the deposited carbon into carbon of the desired type. Careful tests for boron show that only traces exist in the final product.

I have investigated the relative proportions of gasolene and boron chlorid best suited for this work, and have obtained best results with a mixture consisting of gasolene at a pressure of three millimeters of mercury to boron chlorid at a pressure of 24 millimeters of mercury. As an alternative treating mixture for the carbon deposition above described, I may use 100 millimeters of hydrogen, 24 millimeters boron chlorid, and 24 carbon tetrachlorid. The conditions are always so chosen as to give but a small percentage of boron in the deposited carbon.

In the specific embodiment above set forth, boron chlorid has been relied on as the halid which undergoes decomposition, but other halids may be used since they too will yield a suitable deposit when handled according to the steps of the process here disclosed.

As one special advantage of the use of boron, mention may be made of the low temperature at which the boron brings about the remarkable changes in the carbon. Although this temperature varies somewhat in accordance with the particular variety of carbon under treatment, nevertheless, with gasolene carbon produced, when boron chlorid and gasolene are used as the treating mixture, the temperature of boronization may be well below 2,000 degrees C., and even in some cases as low as 1,000 degrees C.

I have described my invention as applied to the production of incandescent lamp filaments, but I recognize that it is applicable to the treatment of conductors of larger size, such, for instance, as electrodes and especially brushes.

As to the theory of the action of the boron, I am inclined to consider the resulting product as a solid solution of a very small quantity of boron in carbon. It is remarkable that a substance like boron with an enormous negative temperature coefficient, when dissolved in very small amounts in carbon, which also possesses a negative temperature coefficient, imparts to the latter a positive temperature coefficient.

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

1. The method of changing the characteristics of carbon and giving to it a positive temperature coefficient, which consists in subjecting the carbon at a high temperature to the action of boron.

2. The method which consists in changing the specific resistance and the temperature coefficient of a carbonaceous conductor by subjecting the conductor while hot to the action of boron.

3. The method of constructing a conductor, which consists in depositing carbon on a conductive body and simultaneously modifying the character of said deposited carbon through the action thereon of boron.

4. The method of constructing a conductor having a positive temperature coefficient, which consists in depositing carbon on a heated conductive body and governing the character of the deposit by the action of a boron halid.

5. The method of constructing a conductor which consists in depositing carbon of low vapor tension, low specific resistance and positive temperature coefficient, by heating a conductive body in a mixture of boron halid and a volatile hydrocarbon.

6. The method of treating a lamp filament, which consists in heating the filament with electric current in a mixture of boron chlorid and gasolene.

7. A conductor of carbon associated with a very small quantity of boron and characterized by a positive temperature coefficient and a specific resistance lower than that of carbon as deposited from gasolene.

8. A lamp filament consisting of a conductive core enveloped in carbon associated with a very little boron and having a positive temperature coefficient.

9. A lamp filament consisting of a core enveloped in a solid solution of boron in carbon and characterized by a positive temperature coefficient and a specific resistance lower than that of carbon deposited from gasolene.

10. The method of treating a filament, which consists in heating it with electric current in a gaseous mixture containing boron chlorid and gasolene, these materials being mixed in such proportions that the material deposited on the filament shall consist in large part of carbon with a positive temperature coefficient.

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

EZECHIEL WEINTRAUB.

Witnesses:
JOHN A. McMANUS, Jr.,
CHARLES A. BARNARD.