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BORON- AND BORON AND CARBON STARTER
FOR MERCURY ARC

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My invention relates to a make-alive electrode and particularly to a resistance type electrode and method of making the same.

It has recently been discovered that the operating and control characteristics of vapor electric converters, such as mercury arc rectifiers, could be materially improved by extinguishing the cathode spot at the end of each conducting cycle and restarting the arc at the beginning of the next successive conducting period. It has heretofore been customary to constantly excite such converters by initiating a cathode spot and maintaining it by a suitable keep-alive means throughout the entire active period of the converter. The type of excitation in which a cathode spot is initiated at the beginning of each conducting cycle is known as make-alive excitation, as distinguished from the previous well known keep-alive types of excitation.

In the application of make-alive excitation, it was found that the cathode spot was best initiated by means of a make-alive electrode of suitable resistance material in contact with the cathode of the converter.

Prior to my invention, the most advantageous make-alive material was carborundum, preferably in crystal form. However, carborundum and all of the previously known materials have several marked disadvantages among which the most important was the high current necessary to initiate the cathode spot and the tendency of the make-alive material to amalgamate with the cathode material. This tendency to amalgamate was particularly noticeable when for some reason, such as the failure of the control apparatus, an inverse current flowed from the cathode to the make-alive electrode.

Another particularly undesirable result in sealed off converters was the tendency of the make-alive materials to combine with any impurities in the converter and give off gases which affected the vacuum of the apparatus.

I have found that a make-alive electrode composed of boron carbide or a mixture of boron carbide with carbon, or boron, or both, possesses many desirable electrical and mechanical characteristics for use as make-alive material. However, boron carbide, made according to previously known methods, was found to have a very erratic behavior so that only a small percentage of such material was suitable for make-alive electrodes.

I have found that when substantially pure carbon rods are converted into boron carbide by heating in the presence of an atmosphere of bo-

ron, the resulting electrodes have substantially identical characteristics. Also I have found that a small proportion of unconverted boron has a beneficial effect on the electrical characteristics of the starting material.

Accordingly, it is an object of my invention to provide a make-alive electrode of boron carbide or a mixture of boron carbide with boron or carbon.

With previously known starters each starter has been a definite compound and consequently had a definite starting current; however, with a mixture according to my invention, a wide range of starting currents can be obtained by varying the proportions of the mixture. If a large excess of unconverted boron is present the starting current may be of the order of milliamperes ranging from this low figure to a current of the order of several hundred amperes when an excess of unconverted carbon is present.

Accordingly it is a further object of my invention to provide a starting material which may have any desired starting characteristics.

It is a further object of my invention to provide a make-alive electrode requiring a low current density to initiate the cathode spot.

It is a further object of my invention to provide a make-alive material which if it combines with the impurities in the rectifier produces a solid residue which does not affect the vacuum in the converter.

It is a further object of my invention to provide a method of producing make-alive electrodes having substantially identical characteristics.

Other objects and advantages of my invention will be apparent from the following detailed description, in which the several advantages of my invention are particularly pointed out.

In constructing a make-alive electrode according to my invention, I provide substantially pure carbon in the form of rods. These rods are placed in a suitable crucible and heated to approximately 1850° C. for a period of approximately three hours in an atmosphere produced by adding boron oxide to the crucible. I prefer to use a crucible having an opening in the top and to constantly supply boron oxide throughout the heating period so that the rods are constantly surrounded by an atmosphere of boron or boron oxide.

After heating for substantially three hours, the rods are found to have a white layer or coating on the exterior thereof. This exterior surface is removed by grinding, scraping, or any other suitable means to provide a clean surface. This sur-

face is then painted with a boron bearing paint preferably composed of a mixture of ethyl acetate and boron. The painted rods are then packed on end in a suitable crucible and the interstices between the rods and the crucible is filled with a packing of boron nitride, after which the rods are heated to approximately 1800° C. for a period of approximately one hour.

Rods made according to my method can be made to have a starting current ranging from the order of amperes to the order of hundreds of amperes by varying the time of treatment and consequently the amount of unconverted boron or carbon present in the mixture.

While the rods produced according to the above-noted description have given satisfactory service, I have found that the characteristics may be further improved by vacuum treating the electrodes at approximately 950° C. after removing the outer surface and before applying the boron paint.

Also I have found that vacuum treating the finished electrodes materially assists in removing any gases that may be present in the material.

While I have described the specific embodiment of my invention, it will be apparent to those skilled in the art that many changes may be made therein without departing from the true spirit of my invention or the scope of the appended claims.

I claim as my invention:

1. The method of producing make-alive electrodes operable at low current densities comprising heating carbon rods in the presence of an excess of boron oxide to convert a portion of the carbon to boron carbide, vacuum treating the converted rods at an elevated temperature and then highly heating the converted rods in the presence of an excess of boron.

2. A low current make-alive electrode for a mercury arc converter comprising a rod-like electrode of resistance material which will not amalgamate with mercury in the presence of an electrode arc, said material consisting essentially of a mixture of boron, carbon and boron carbide.

3. A make-alive electrode for a vapor electric device comprising a rod of resistance material composed essentially of boron, carbon and chemical combinations of boron and carbon, the combined boron and carbon being in excess of the uncombined boron and carbon.

4. The method of producing a make-alive electrode which comprises heating a substantially pure carbon rod in the presence of boron.

5. The method of producing a make-alive electrode which comprises providing carbon rods, heating said rods in an atmosphere of boron and boron oxide for three hours, removing the outer surface of said rods, painting the rods with boron paint and heating for one hour in the presence of boron nitride.

6. The process of forming make-alive electrodes which comprises heating a carbon rod in an atmosphere of boron and boron oxide of substantially 1800° C. for three hours, removing the outer surface of said rod, applying a coating of ethyl acetate and boron, packing said rod in boron nitride and heating for one hour at approximately 1800° C.

7. A make-alive electrode consisting of a rod of resistance material comprising essentially boron, carbon and boron carbide, the boron carbide being in excess of the uncombined boron and carbon.

8. The method of constructing a make-alive

electrode which comprises heating substantially pure carbon rods at approximately 1800° C. in an electric furnace to drive off impurities, introducing an arc of boron carbon into said furnace to convert a substantial portion of the carbon to boron carbide, vacuum treating the boron carbide rods so produced at approximately 950° C. coating the rods with boron and heat treating the rods at substantially 1900° C.

9. The method of producing reproducible make-alive material which comprises heating carbon rods in a crucible at approximately 1850° C. in an atmosphere produced by introducing boron oxide into said crucible, removing the surface of said rods, applying a coating of boron to the surface of said rods, and heating said rods in the presence of boron nitride.

10. The method of producing make-alive electrodes which comprises heating a carbon rod in an atmosphere containing boron and boron oxide, coating the heated rod with boron and heating the coated rod in the presence of boron nitride.

11. A make-alive electrode for a vapor-electric device comprising a mixture produced by heat treating substantially pure carbon in an atmosphere of boron for three hours at 1800° C. and in the presence of boron nitride for one hour at 1800° C. said mixture being primarily boron carbide with admixtures of boron and carbon in such proportions that the final product has the chemical analysis of the order of boron 73% and carbon 16%.

12. A make-alive electrode for an arc type device comprising a resistance material consisting of boron, carbon and compounds of boron and carbon in such quantities that the mixture has a chemical analysis of approximately boron 73% and carbon 16%.

13. A make-alive electrode for a mercury-arc converter comprising a rod-like electrode of resistance material which will not amalgamate with mercury in the presence of an electric arc, said material being essentially boron carbide with small quantities of substantially free boron and carbon distributed through the material.

14. In combination with a vapor-electric device, a make-alive electrode comprising a body of resistance material consisting principally of boron, carbon and compounds of boron and carbon in such proportions that a chemical analysis shows approximately 16% carbon and 73% boron.

15. In combination with a vapor-electric device, a make-alive electrode comprising a body of resistance material consisting principally of boron, carbon and compounds of boron and carbon in such proportions that a chemical analysis shows approximately 16% carbon and 73% boron, the combined boron and carbon being in excess of the uncombined boron and carbon.

16. In combination with a mercury-arc converter, a make-alive electrode comprising a rod-like body of resistance material which will not amalgamate with mercury in the presence of an electric arc, said material being essentially boron carbide with small quantities of uncombined boron and carbon.

17. The combination with an electric discharge device of a make-alive electrode in contact with one of the electrodes of said device for creating a cathode spot thereon comprising a rod composed of approximately 73% boron and 16% carbon, said boron and carbon being substantially combined as carbides of boron.

18. In combination with an electric discharge

device, a make-alive electrode comprising a rod of resistance material composed of carbon in the proportion of approximately 16%, boron in the proportion of approximately 73%, said boron and carbon being substantially combined as boron carbide.

19. In combination with a vapor-electric device, a make-alive electrode composed substantially of boron carbides.

20. In combination with an arc-type converter having an anode and a mercury cathode, a low current make-alive electrode dipping into said cathode during normal operation thereof, said make-alive electrode consisting essentially of

boron carbide with a small percentage of uncombined carbon and boron.

21. In combination with an arc-type converter having an anode and a pool-type cathode, a make-alive electrode comprising a body of resistance material dipping into the pool-type cathode during normal operation of the converter, said resistance material being composed of a mixture of boron carbide, boron and carbon in the proportions produced by heat treating a substantially pure carbon rod in an atmosphere of boron oxide for approximately three hours at a temperature of the order of 1800° C.

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