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ELECTRODE AND METHOD OF MANUFACTURE

Charles P. Marsden, Bloomfield, and Carson M. Wheeler, Montclair, N. J., assignors to Hygrade Sylvania Corporation, Salem, Mass., a corporation of Massachusetts

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5 Claims. (Cl. 250—27.5)

This invention relates to electrodes and with particularity to an improved electrode suitable for use in electron discharge devices or the like.

An object of the invention relates to an improved method of manufacturing an electrode for electron discharge tubes or the like.

Another object of the invention relates to an improved form of carbon electrode for electron discharge tubes.

Another object relates to an improved form of electrode prepared from synthetic graphite.

A still further object resides in the method of treating a synthetic graphite electrode whereby its usefulness and reliability in an electron discharge tube are materially increased.

A further feature relates to the method of degasifying a synthetic graphite member.

A further feature relates to a method of treating a graphite member whereby loose particles of graphite such as result from machining or handling are substantially completely removed. As a result of this feature the member may be used as an electrode in a vacuum or like tube without danger of any loose particles being dislodged onto the cathode, press or other parts where such particles would interfere with the tube operation.

A still further feature relates to a process of treating a carbon body so that it consists substantially entirely of graphitized material both interiorly and exteriorly.

Other features and advantages not specifically enumerated will be apparent after a consideration of the following detailed description and the appended claims.

In certain types of devices such as electron discharge tubes or the like, it is necessary to employ an electrode which is substantially gas free and is capable of withstanding heat. For example, in certain types of tubes the anode or plate element is subjected, both during manufacture as well as during normal use, to comparatively high temperatures. Ordinary metals are therefore unsuitable for such use, and it has been proposed to employ for this purpose electrodes consisting of refractory metals such as tungsten, molybdenum, and the like. Entirely apart from their initial cost, such refractory metal electrodes have numerous disadvantages which materially increase the cost of manufacturing tubes in which they are embodied. For example, while refractory metal electrodes are capable of standing high temperatures without decomposition, they tend to become distorted and change their shape. This defect is of pronounced importance in radio tubes or the like, since the spacings between the various electrodes must be maintained with extreme accuracy. The distortions in metal electrodes militate against this accuracy in alignment and spacing. In addition to the mechanical disadvantages which are peculiar to refractory metal electrodes is the difficulty of rendering them completely gas free, and of protecting them from contamination. Furthermore, in degasifying such metal electrodes, it is necessary to subject them to a heat treatment in vacuo, or at least in a non-oxidizing atmosphere.

In an attempt to overcome the above defects and other disadvantages of metal electrodes, it has been proposed to employ carbon electrodes. However, even with carbon electrodes it has been found that they do not respond readily to the ordinary heat treatment processes. Heretofore, the customary treatments of such carbon electrodes as have been employed required that they be subjected to a degasifying treatment in vacuo or at least in a non-oxidizing atmosphere. It was soon found that this ordinary method of heat treatment was insufficient, particularly where such electrodes are employed in high power devices such as transmitting tubes or the like. Accordingly, tubes embodying such carbon electrodes must be evacuated and heat treated in successive steps. Thus, in the case of radio tubes having the anode or anodes of carbon, it is necessary first to heat the anode to a predetermined temperature and then exhaust the gases thus freed, this procedure being repeated in successive stages until the maximum degasification is achieved. However, even when the degasification is carried to the furthest degree possible, the carbon anode is not completely degasified, and in the case of transmitting tubes where the anode, during use, may be at a dull red heat, enough gas may be liberated to destroy, in many cases, the operability of the tube.

In accordance with the present invention, it has been found that electrodes for electron tube devices may be made from synthetic graphite and subjected to a treatment which overcomes all the above noted disadvantages. One of the most important advantages of the electrode and process of treatment to be described, is the remarkable shortening of the required exhaust schedule, particularly in the case of high power tubes, such as radio transmitting tubes, or the like.

In carrying out the above objects the invention contemplates the utilization of ordinary

lamp black or amorphous carbon which is mixed with any suitable carbonaceous binder, and the mixture graphitized by any suitable graphitizing process such, for example, as the well-known Acheson process.

The graphitized product may then be formed to any desired shape determined by the use to which the product is to be put. If it is to be used in a vapor rectifier tube, it may be suitably formed to the shape of a plug or button, whereas if it is to be used as an anode in a grid-control tube, it may take the form of a flat plate, or plates, suitably joined together, or preferably, it may be in the form of a unitary circular or flattened cylinder as disclosed in copending application Serial No. 671,306, filed May 16, 1933.

It has been found that such a synthetic graphite electrode, even if subjected to ordinary heat treatment in vacuo, or in a non-oxidizing atmosphere, while it can be gas-freed to a certain extent, nevertheless liberates enough gas during the use of the tube to materially curtail its reliability.

Probably one reason for this may reside in the fact that the graphitizing process results in incomplete and non-uniform crystallization, as a result of which occluded carbonaceous products are effectively bound up or entrapped on the interior of the electrode. The most rigorous heat treatment, which must be continuous and in vacuo, does not completely release all these occluded or entrapped carbonaceous products.

However, in accordance with the present invention it has been found that if such a synthetic graphite electrode is subjected to heat in the open air, or even in an oxidizing atmosphere so as to bring the body to almost white heat, not only is the electrode completely degasified, but its structure is such as to reduce contamination to a negligible quantity.

The invention is not limited to any particular temperature, although it is preferred to heat the electrode to a white heat or approximately 1200° C., preferably in the open air by means of a high frequency current. Any well known manner of subjecting the synthetic graphite electrode to the action of a high frequency current may be employed, and while the invention is not limited to any particular range of frequencies for this purpose, it is preferred to employ currents in what are known as the radio frequency ranges.

While it is preferred to heat the carbon body by induction or conduction through the intermediary of a high or radio frequency current, other methods of heating may be employed. For example the carbon body may be heated in an electric resistance furnace in an oxidizing atmosphere or by using the body itself as the resistor or, if desired, the carbon body may be heated in a gas-fired muffle furnace in which there is an excess of oxygen or other oxidizing material or gas adjacent the carbon body, or in any other heater so long as the carbon body is heated to a sufficiently high temperature in the presence of an oxidizing agent to remove substantially all the non-graphitized material both from the surface and from the interior of the body.

Since the electrode may be treated in the open air, the cost of treatment of the electrode itself is small in comparison with the usual treatment of metal electrodes in vacuo. Furthermore, when the synthetic graphite member or electrode is subjected to the action of radio frequency currents so as to raise its temperature to a white heat as above described, the finished product can be handled with much less care, so far as contamination is concerned, than is possible with ordinary graphite or carbon members.

When such an electrode is mounted within the tube, it needs very little further heat treatment, if any, prior to the sealing-off of the tube, thus further reducing the cost of tube manufacture. However, the most important aspect of the invention resides in the fact that, after the above described treatment, a tube embodying such an electrode can be used for high power uses such as transmitting tubes or the like, without any danger of gas being released from the electrode, even though subjected to high temperature.

It is to be understood, of course, that the invention is not to be limited to any particular manner of heating the synthetic graphite electrode while in the open air. For example, the electrode may be positioned within the field of a radio frequency current or coil until sufficient heat is induced. Furthermore, the invention is not limited to any particular duration of this heat treatment so long as all, or substantially all, the carbonaceous products are removed not only from the outer surface of the electrode, but also from the interior thereof. It has been found that the synthetic graphite electrode, when subjected to the above heat treatment, produces in its neighborhood a visible glow usually bluish in color, and upon completion of the treatment, even the physical appearance of the synthetic graphite electrode changes. Even to the naked eye the finished electrode appears as a uniform crystalline structure. While the process is being carried on the glow about the electrode is comparatively steady, but when incandescent particles of the electrode fly off it is an indication that the treatment is complete and that substantially all the non-graphitized material has been removed.

Various changes and modifications may be made herein without departing from the spirit and scope of the invention.

It will also be understood that while the invention has been described in connection with an electrode for electron discharge devices, a graphitized carbon body treated as described is useful in any situation where a substantially gas free carbon member is required.

What we claim is:

1. The method which comprises subjecting a graphitized amorphous carbon body to the action of a high frequency field in an oxidizing gaseous atmosphere, and maintaining said action until substantially all amorphous carbon is removed.

2. The method which comprises mixing comminuted amorphous carbon with a carbonaceous binder, graphitizing the mixture, and heating the graphitized mixture in the open air to remove occluded gases, and maintaining the application of heat until substantially all ungraphitized carbon is removed.

3. The method which comprises subjecting synthetic graphite while in an oxidizing atmosphere to the action of a high frequency current bringing the graphite to the neighborhood of 1200° C., and continuing said action until substantially all ungraphitized carbon is removed.

4. The method which includes the steps of subjecting synthetic graphite while in an oxidiz-

ing atmosphere to the action of a radio frequency electric field to raise the graphite to substantially white heat, and maintaining said action only while a steady glow emanates from the graphite.

5. A new article of manufacture consisting of solid synthetic graphitized amorphous carbon rendered substantially entirely free from entrapped carbonaceous materials, and substantially entirely free from ungraphitized carbon.

CHARLES P. MARSDEN.
CARSON M. WHEELER.