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ELECTRODE FOR ELECTRON DISCHARGE TUBES AND METHOD OF FORMING THE SAME

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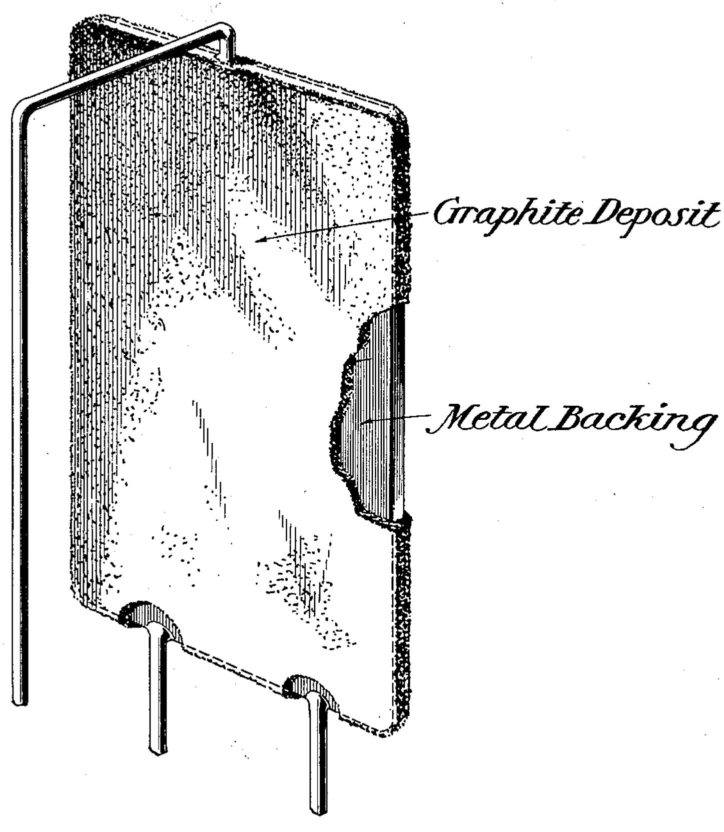

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ELECTRODE FOR ELECTRON DISCHARGE TUBES AND METHOD OF FORMING THE SAME

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This invention relates to improvements in material and methods for forming the cold electrodes of electron discharge tubes.

It has heretofore been proposed to so produce the cold electrodes of such tubes that they freely yield the heat generated in or transmitted to them by conduction, by electron impact and by the thermal radiation present in the tube. In particular, it has been proposed to provide a black coating of nickel oxide upon the surface of the electrodes, or to coat them with other similar materials for the purpose of giving them the equivalent of a "black body" characteristic of thermal radiation. Such materials, however, have usually been found in practice to give rise to difficulties by the absorption or adsorption of gaseous bodies in such coatings, by reason of the different electrical conduction of many such bodies, and by the poor adherence of some such materials to the body of the electrode.

According to the present invention, a cold electrode is produced which is excellently adapted for heat radiation, which does not effect the evacuation of gases from the tube itself, and does not adsorb or absorb gases so that the latter may be given off later during the operation of the tube in commerce.

One of the objects of the present invention, therefore, is to provide an electrode material competent to radiate heat easily.

Another object of the present invention is a method of producing such electrode material by certain definite steps which are simply and cheaply accomplished.

With these and other objects in view as will appear in the course of the following specification and claims, a method employable according to this invention may be described in detail as follows:

A sheet or other body of a metal such as nickel, is formed mechanically into the shape intended for the electrode, for example, the anode of an electron discharge tube of the diode rectifying type.

These formed electrodes may then be scoured by heating in the presence of hydrogen, whereby to remove substantially all oxygen and readily vaporizable and volatilizable substances in the metal. A number of these elements are placed in a sleeve or tube furnace and raised to a temperature in excess of 1850° F., while gas containing hydrocarbons is passed through the tube. Such a gas may contain saturated, unsaturated or cyclic hydrocarbons: and it has been found in practice that "city gas", being the illuminating gas delivered through mains in cities and containing vaporized products of hydrocarbon oils, and usually showing by analysis a considerable percentage of unsaturated hydrocarbons as well as saturated hydrocarbons and some cyclic hydrocarbons, is excellently adapted for the purpose.

With the first quantities of gas passed through, a little water or carbon dioxide may be admitted for the purpose of eliminating any hydrogen present and of apparently producing a very slight oxidation of the surface of the nickel; with the further effect of removing substantially all remaining traces of other volatilizable and vaporizable substances; or a coating of any of the iron oxides may be formed thereon prior to insertion in the sleeve furnace.

It has been found, for example, that in making anodes which are about one square inch in size, with two hundred plates in a batch in the tube, corresponding to four hundred square inches of surface, a couple drops of water are sufficient, or one-tenth of a cubic foot of carbon dioxide gas, or a very thin coating of iron oxide on the plates. These oxygen-containing materials are illustrative of a material in small quantity competent to eliminate hydrogen and produce or represent a slight superficial oxidation of the sheet metal involved. The city gas may, for example, be employed under about six inches of water pressure, corresponding to the usual main pressure in cities.

After the few drops of water, or small quantity of carbon dioxide, respectively used, have passed through the tube or the iron oxide has been produced; the flow of city gas containing the hydrocarbons is continued, with a previous drying of the gas by passage over calcium chloride or other usual water-removing agent so that a practically dry gas passes over the surface of the nickel metal while the latter is heated to a temperature above 1850° F., and usually less than 2000° F. It has been found in practice that an optimum working condition is attained at a closely regulated temperature of 2000° F. Such temperature is maintained for about fifteen minutes to thirty minutes.

At the end of this time, the plates are pushed along in the sleeve furnace to remove them from the heated zone, and the passing of gas is continued. The plates are now allowed to cool in the atmosphere of gas until they attain substantially room temperature. They are then quickly removed and placed in desiccators, being handled with tongs to prevent any contamination. They are then assembled as soon as possible into the discharge tubes of which they are to form a part, and the tubes immediately pumped out so that substantially no moisture can come to the coating after it is formed.

As thus produced, the electrodes appear under the microscope to be coated with a shiny gray, closely adherent, superficial layer of graphite crystals. As noted above, with the employment of nickel sheet electrodes and the hydrocarbons in the city gas, the temperature of 1950 to 2000° F. appears to be an optimum, while a temperature greater than 1850° F. appears essential. At a temperature of 1700° F., for example, the deposit upon the nickel plate is soft and sooty in appearance, with oxidized spots showing through the streaky deposit: while higher temperatures than 2000° F. do not appear to add to the results.

It appears that the deposit comprises a peculiar form of crystalline graphitic deposit in a superficial layer. The crystals of this material do not appear to absorb or adsorb gases, so that there is no difficulty in effecting a complete evacuation of the tubes when assembled. Further, the high temperature of formation of this material permits the tube to be evacuated while the electrode is raised to a high red heat without destruction of this coating material. Actual tests with such plates in comparison to uncoated plates show that the treated electrodes will sustain far greater densities of discharge without being heated visibly and without perforation or other fusing.

It will be understood that while the treatment has been described above as primarily applicable to a sheet of nickel metal, it is likewise applicable to other bodies formed of nickel and similar metals which are adapted for use as cold electrodes in electron discharge tubes, being in the form of a screen, coil, etc.

The treatment especially is found to increase the efficiency of the evacuating means ordinarily employed for such tubes, so that the tubes reach a permanent high vacuum in a less time.

The drawing shows a conventional cold electrode comprising a metal backing having a graphite deposit of the present nature thereon, which is illustrated as being broken away adjacent a vertical edge and at points along the bottom edge to show the composite nature of the electrode. It may be employed as an anode in an electron discharge tube.

While the invention has been described in a specific instance, it will be understood that it is not limited solely thereto, but may be employed in many ways within the scope of the appended claims.

We claim:

1. The method of depositing an adherent graphite film upon metal which comprises superficially oxidizing the metal and thereafter heating the metal in the presence of a vaporized hydrocarbon to a temperature greater than 1850° F.

2. The method of producing a cold nickel-base electrode for an electron discharge tube which comprises scouring the nickel metal in an atmosphere of hydrogen, creating a superficial oxide coating on the metal, and heating the metal in the presence of a vaporized hydrocarbon to a temperature in excess of 1850° F.

3. The method of preparing a graphite coating on the surface of nickel which comprises heating the nickel in the presence of a hydrocarbon and a small quantity of oxygen-containing materials, and thereafter heating the nickel in the presence of substantially dry and oxygen-free hydrocarbons to a temperature greater than 1850° F.

4. The method of producing a cold nickel electrode for an electron discharge tube comprising heating the electrode in the presence of a minute quantity of oxygen-containing material whereby to produce a superficial film of oxide and to remove traces of oxidizable and vaporizable material from the nickel, and thereafter heating the nickel in the presence of hydrocarbons to temperatures of substantially 2000° F.

5. An electrode for an electron discharge device comprising nickel having non-absorbent graphite crystals adhering directly thereto.

In testimony whereof, we affix our signatures.

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