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THERMIONIC TUBE ELECTRODE

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My invention relates to the manufacture of thermionic tubes and has particular reference to making cathodes or other electrodes therefor.

In the manufacture of electrodes for use in thermionic tubes, it has been found desirable in many instances to employ an insulating carrier, which may be heated by a filament passing therethrough if the electrode is to be used as a cathode, and to coat this carrier with a metallic conducting surface. Such electrodes are particularly desirable for use in the so-called A. C. tubes in which the thermal lag of the insulating carrier prevents to a large extent the fluctuations in its surface temperature.

These cathodes have in general been made of a special grade of highly vitrified porcelain, and it has been the custom to form the metallic coating either by the Schoop process of spraying the nickel thereon or by bending a thin nickel sheet around a porcelain tube. Neither of these methods have proved satisfactory, mainly on account of the difficulty of obtaining good thermal conductivity between the insulating support and the metallic coating. When this coating is applied by Schoop's process of spraying, it is difficult to apply it uniformly and it is also noted that it does not adhere as firmly to the porcelain as is desirable. Obviously, when the cathodes are formed by bending a sheet around a porcelain tube contact between the sheet and tube is far from perfect.

It is accordingly, an object of my invention to provide a thermionic cathode or other electrode having a metallic coating in intimate and permanent contact with an insulating support.

Another object of my invention is to provide a method whereby electrodes designed primarily for use in thermionic tubes may be easily and economically manufactured.

A further object of my invention is to provide a more efficient cathode for use in thermionic tubes.

Still another object of my invention is to provide a method whereby an insulating support may be coated with a firm, adherent coating of metal which will not flake off in use.

The porcelain tubing, or other object of which it is desired to form an electrode, is first painted with a mixture of finely divided metallic particles suspended in a volatilizable vehicle. The coated electrode is then given such further treatment as will drive off the vehicle and cause the adhering particles to change their characteristics. My preferred method comprises the following steps:

The porcelain tubing or other object, metallic or insulating, of which it is desired to make an electrode, is first painted with a mixture comprising finely divided particles of metal such as nickel or a metallic oxide such as nickel oxide in water or in some other liquid such as glycerine, alcohol or turpentine which may be later driven off by heat without any deleterious residue. I contemplate using, in this mixture if desirable, a temporary binding material such as agar-agar, it being obvious that this binding material should be such that subsequent heat or other treatment will entirely remove it from the cathode. I may also use as a binder or soluble compound of nickel, such as the formate or nitrate, which when heated shall decompose to liberate metallic nickel.

As an alternative method of obtaining the coating, the porcelain tubing may be coated with the binder and slightly moistened, and the finely divided particles of metal or metallic oxide may be placed thereon either by means of an air blast or by being lightly dusted from a camel's hair brush.

If a liquid vehicle or binder is used in the process of applying the particles to the porcelain support, the coated cathode is then thoroughly dried. After drying, if metallic particles have been used, the coated electrode is then fired in a vacuum or in a neutral or a reducing atmosphere at a temperature below the melting point of the metal but high enough to cause the metallic particles to sinter together into an adherent conducting layer over the porcelain. During this heating, any residue of the binder is driven off.

If particles of metallic oxide such as nickel oxide have been used in the coating material, the heat treatment above referred to is given, not in a vacuum, but in a reducing atmosphere, in order to reduce the oxide particles to the metallic state. The temperature is then raised to a point below the melting point of the particles, which are accordingly caused to sinter together into a coherent conducting layer as is the case when the metallic particles are employed directly. In the case of nickel, this temperature would approximate 1200° C.

The porcelain used, although it may be highly vitrified, has microscopic openings in its surface and the liquid will to a certain extent penetrate into these openings and carry along the finely divided particles. It will thus be seen that upon drying, the coated electrode the surface coating is "keyed" to the porcelain by innumerable small extensions, very much in the same way that plaster is keyed to a wire-netting or lath-covered

wall. When the metallic particles are later sintered together, these microscopic extensions of the coating obviously coalesce with the major portion of the coating, anchoring it firmly to the porcelain.

Among the principal advantages secured by my new and improved process may be mentioned the fact that the coating thus obtained shows no tendency to flake off even though the support be raised to a temperature of 1000° C. The coating is firm and coherent and in excellent thermal contact with the porcelain so that the heat from the porcelain is very readily conveyed thereto.

My process is also capable of being carried out by the most unskilled laborer, it being only necessary to carefully superintend the last step of the firing process in order to make sure that all of the vehicle or binder is eliminated and that the particles are entirely sintered together.

Although I have described herein certain specific forms of my invention, I am fully aware that many other modifications are possible and my invention is not to be limited except insofar as is necessitated by the prior art and as indicated by the following claims.

I claim as my invention:

1. The process for manufacturing thermionic tube cathodes which includes applying to a surface a coating comprising finely divided nickel suspended in a volatilizable vehicle, eliminating the major portion of the vehicle, placing the coated surface in a non-oxidizing environment, eliminating the residuum of the vehicle, and then heating the nickel to a sintering temperature.

2. The process of manufacturing a cathode which comprises applying to the surface of an insulating refractory material a coating of finely divided metal suspended in a volatilizable vehicle, eliminating the vehicle, and then sintering the metal particles.

3. The method of making metal films upon porous, electrically non-conducting bodies, which comprises mixing a highly comminuted metal with a sufficiently viscous liquid which does not react with the body at ordinary temperatures, to form a paste, spreading the paste upon the body, and then heating the coated body to a sintering temperature.

4. The method of making metal films upon porous electrically non-conducting oxide bodies, which comprises forming a paste by mixing a highly comminuted metal with a sufficiently viscous liquid which reacts with the metal at high temperatures to form a conducting compound, spreading the paste upon the oxide body, and then heating the coated oxide body to a sintering temperature.

5. The method of making metal films upon porous electrically non-conducting oxide bodies, which comprises forming a paste by mixing a highly comminuted metal with a sufficiently viscous liquid which reacts with the oxide at high temperatures to form a conducting compound, spreading the paste upon the oxide body, and then heating the coated oxide body to a sintering temperature.

6. The method of making metal films upon porous electrically non-conducting oxide bodies, which comprises forming a paste by mixing a highly comminuted metal with a sufficiently viscous liquid which reacts with both the metal and the oxide body at high temperatures to form a conducting compound, spreading the paste upon the oxide body, and then heating the coated oxide body to a sintering temperature.

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