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PROCESS OF MAKING ELECTRON DISCHARGE DEVICE

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This invention relates to process of making electron discharge devices and more particularly to filaments used in connection with electron discharge devices for radio and similar apparatus.

The objects of the invention are to provide a filament having a high electron emission; to provide means for utilizing elements in substantially uncombined state which cannot ordinarily be handled because of oxidizing or otherwise combining with gases present in the air; to provide means for overcoming an oxidized or similar coating in the finished electron discharge device; to provide a coating on the filament prior to placing the same in the electron discharge device which may be readily removed from the filament after the filament is sealed within the electron discharge device; to provide a coating which will not only be removable but which will protect the filament against further oxidation and will reduce the oxide of the filament to its element or base; to thus obtain a filament having maximum efficiency with minimum difficulty; to provide a filament and process of treating the same for rendering it effective after sealing in place in a bulb; to avoid the necessity of applying a residual gas reducing agency to the plate; to employ a coating on the filament for also reducing the residual gases in the bulb; to obtain a reduction of the residual gases and removal of the oxidized coating at reduced temperature; to reduce losses from unnecessary volatilization of the electron emissive substance or its oxide; to also reduce losses from electrical defects, inactive filaments and avoid unnecessary bombardment of the filament by positive ions of gases present before reduction thereof; to secure simplicity of construction of electron discharge devices, and to obtain other advantages and results as may be brought out in the following description.

In carrying out my invention, I preferably employ an electron emissive filament, as one instance of which I may mention a thoriated filament, although it is to be understood that there are other filaments which may be also used. Generally speaking, electron emissive substances are, and especially the element thorium is, very easily oxidized, and in fact, so easily oxidized that merely exposing the element to the atmosphere will result in its becoming coated with its oxide. The filament wire is usually in an oxidized state when received or ready for incorporation in an electron discharge device, and my invention contemplates the utilization of such oxidized filament, although it is to be understood that the invention may also be used in connection with filament which has not become oxidized.

The filament wire is first placed in a bulb of suitable size and shape which can be evacuated and sealed in which the filament may be given a coating. The coating which I prefer to apply is protective in its nature so that where the pure or substantially pure electron emissive element is being used, the coating will prevent oxidation when the filament is again exposed to the atmosphere. The coating is also preferably of such a nature that it will be adapted to subsequently reduce the oxide of the electron emissive element to its pure or substantially pure state. Within the said bulb, I preferably include a piece of nickel or similar carrier having some magnesium on it. The magnesium is "exploded" that is, heated to such a point that it vaporizes and deposits on everything within the bulb, thus forming the protective coating above mentioned upon the filament wire.

There are a number of ways in which sufficient heating of this nickel or carrier may be obtained for exploding the magnesium, and amongst these various ways may be mentioned the use of a pulsating current acting upon the tube from the exterior thereof. While various types of pulsating currents may be employed satisfactorily, I have found that a fairly high audio frequency pulsating current gives excellent results. It is to be understood also, that the action of this pulsating current upon the filament wire is obtained without direct electrical contact therewith. As another means for heating the plate for exploding the magnesium, the carrier or piece of nickel may be in the nature of a strip connected at its ends through the bulb to an exterior source of potential by which

sufficient current may be applied for rendering the same incandescent. Other means are known for accomplishing the same result and further description thereof is considered unnecessary at this time. Suffice it to say that suitable means have to be employed for heating the carrier or nickel for exploding the magnesium and it is within the scope of the invention to employ means having direct contact or no contact as may be found most desirable. It may further be stated that because of the greater mass of the carrier or nickel, it will become heated much more readily than the filament which has relatively little mass, and therefore the heating for exploding the magnesium will not have a bad effect upon the filament.

After the filament has become thus coated, the bulb is broken or otherwise removed and the filament is inserted in the tube of an electron discharge device in the usual manner. After the operative parts of the electron discharge device are sealed within the tube, the filament is lighted and the magnesium coating upon the filament reduces the oxide of the electron emissive substances to a pure or substantially pure state and also reduces the residual gases contained within the tube.

In electron discharge devices heretofore manufactured it has been necessary to obtain bombardment of the plate by the tungsten in the filament because of the fact that the exposed part of the thorium would not be in a pure or substantially pure state until after the magnesium was exploded, the magnesium heretofore being upon the plate. It is to be noted in the present process that the magnesium is directly upon the filament and the electron emission is obtained from the thorium or similar substances shortly after the filament is lighted. Furthermore, the temperature to which the filament has to be lighted in order to obtain this emission is very much less, and in fact, may be estimated as one-half of the temperature to which the filament had to be lighted under the old process of exploding the magnesium from the plate. Obviously, I am thus enabled to produce electron discharge devices with less likelihood of burning out the filament in the process of manufacture and reduce losses in a greater number of cases from what heretofore has been known as inactive filament. Under the old process it often occurred that insufficient emission could be obtained from the tungsten to explode the magnesium, although the filament might otherwise be in perfect condition. Under the present process, by utilizing magnesium directly upon the filament, the proportion of electron discharge devices wherein the filament is inactive is reduced very considerably. The present process also obtains a greater amount of the oxidized electron emissive substances reduced than in the prior electron bombardment method, because of the close association of the magnesium and its resultant increased reducing effect upon the oxide of the filament in preference to reduction by residual gases. Thus, in other words, I am enabled to obtain a filament of greater purity and having greater electron emissive qualities than when the magnesium is exploded from the plate.

It is to be understood that it is detrimental to a filament wherein various substances are used, to heat the filament to any temperature which will have a tendency to volatilize the electron emissive substances of the filament. In the use of thorium, as referred to in the prior description, as the electron emissive substance it is to be noted that the thorium oxides are much more volatile than the tungsten and under the old system necessitating raising the tungsten to a higher temperature for bombardment of the plate, there were large percentages of losses of thorium and thorium oxide from the filament. Of course all of the thorium and thorium oxide lost from the filament means just that must less of the active electron emissive material and a less efficient device. Likewise, under the old method of bombardment of the plate by the tungsten, the gases present in the tubes become ionized by the electron emission from the filament, and having a relatively large mass and traveling with considerable speed under the voltage applied and therefore will strike the filament with considerable force chipping off active material with which the surface is coated. In the process of the present invention, the time interval during which the gases are present prior to their reduction is comparatively very short, and therefore the losses due to chipping by these roving positive ions will be reduced to a minimum and the filament will therefore be left with a greater amount of active material upon its surface.

As an additional feature of the present invention, it is observed that aging of the device is obtained while the other operations are in process upon the tube. In other words the filament may be lighted while the tube is on the pump or after the tube is finished. The filament is lighted slowly and brought to the proper temperature gradually. I also wish to point out at this time that the filament may be shaped either before or after it has been treated or coated in the original bulb.

In constructing an electron discharge device in this manner, it will be noted that it is unnecessary to heat the plate therein as heretofore done for exploding magnesium upon it, the magnesium being directly vaporized or exploded by the filament. In this way, I enable a tube to be manufactured and residual gases reduced without any detrimental effect upon the plate such as warping, melt-

ing, etc. However, if so desired magnesium may also be applied to the plate, and exploded subsequent to exploding the magnesium on the filament. By exploding the magnesium on the filament first, the surface of the filament will be coated with electron emissive substance which can then bombard the plate with much less detrimental effect than has heretofore been possible.

Obviously detail changes and modifications may be made in the manufacture and use of my invention, and I do not wish to be understood as limiting myself except as set forth in the following claims when construed in the light of the prior art.

Having thus described my invention, I claim

1. A process of manufacturing filaments comprising incorporation of an electron emissive substance partially oxidized therein, and coating said filament by depositing thereon by vaporization a quantity of magnesium for reducing the oxide of the electron emissive substance.

2. A filament comprising an electron emissive substance and its oxide, and a coating of vaporized magnesium on the filament for reducing the same.

3. The process which comprises coating an electron emissive filament in a vacuum with a protective and reducing coating of magnesium, mounting said filament within a container, evacuating the container and flashing the coating by heating the filament simultaneously to reduce the oxides in said filament, and to clean up residual gases within the container.

4. The process of manufacturing an electron emissive filament containing thorium and its oxide, which comprises vaporizing onto the filament a coating of magnesium while in one evacuated receptacle, removing the magnesium coated filament from the first receptacle and mounting it in a second evacuated receptacle, and gradually heating the coated filament to flash the magnesium while in said second receptacle.

5. The process of manufacturing an electron emissive filament containing an electron emissive substance with its oxide, which comprises mounting said filament in a first evacuated container and vaporizing onto said filament a coating of magnesium while in said container, removing said coated filament from the first container and mounting it in a second evacuated container, and gradually heating the coated filament to cause a chemical reaction between the coating and the filament while in said second container to reduce the filament oxide.

6. The process of manufacturing an electron emissive filament which comprises incorporating in the filament an electron emissive substance and its oxide, mounting the filament in a first evacuated container, vaporizing onto the filament a coating of magnesium while in said container, removing the coated filament from said container, and sealing it into an electron discharge device, and gradually heating the coated filament to flash the magnesium while in the second evacuated container.

7. The process of manufacturing an electron emissive filament which comprises incorporating thorium and its oxide in said filament, mounting the filament in an evacuated container, vaporizing onto the filament a coating of magnesium while in said container, removing the coated filament from said container and mounting it in an electron discharge device, and gradually heating the coated filament while in the electron discharge device to secure a chemical reaction between the magnesium coating and the thorium oxide to render the filament electronically active.

8. The process of manufacturing a metallic electron emissive filament which comprises incorporating an electron emissive substance in said filament, vaporizing onto said filament in an evacuated container a quantity of magnesium to provide said filament with a protective coating of the vaporized magnesium, removing said coated filament and mounting it in another evacuated container.

9. The process of manufacturing an electron emissive filament which comprises incorporating in said filament an electron emissive substance, placing the filament, together with a quantity of magnesium in a bulb, evacuating the bulb, depositing the magnesium by vaporization onto said filament, removing the filament from said bulb and mounting it in another bulb, gradually heating said filament while in said other bulb, and simultaneously evacuating said other bulb to cause said coating to reduce the oxides existing on the filament.

10. An electron emitter comprising a thoriated filament having thereon a coating of vaporized magnesium.

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