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SECONDARY ELECTRON EMITTER AND METHOD OF MAKING IT

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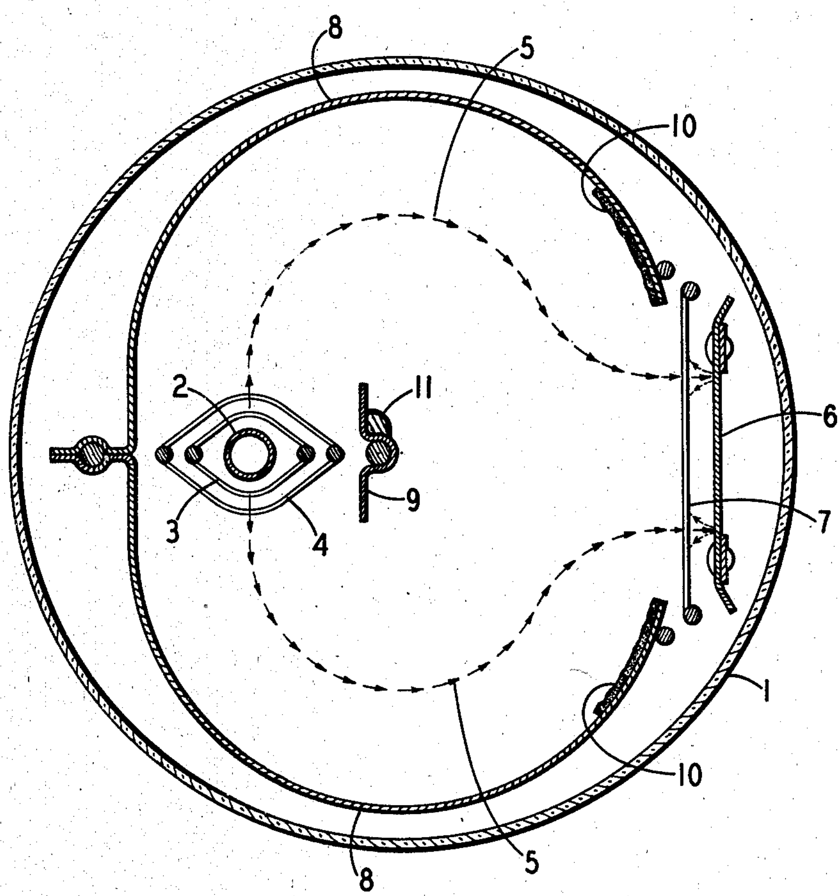

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SECONDARY ELECTRON EMITTER AND METHOD OF MAKING IT

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This invention relates to an electric discharge tube comprising a secondary electron emitting electrode or emitter with at least a part of its surface consisting of a substance readily emitting secondary electrons when struck by a stream of primary electrons.

Various materials have been used for secondary electron emission electrodes, such as the alkali metals and their oxides, for example, caesium, and the alkaline earth metals such as barium and strontium and their oxides, and in addition magnesium and aluminum and their oxides have been suggested. Generally these electrodes or emitters can be made by methods of manufacture known for primary thermionic cathodes, for instance, by applying the material containing the active metal to the secondary electron emission electrode by vaporization from a primary cathode.

We have found that excellent secondary electron emittters may be made in accordance with our invention. According to the invention, in an electric discharge tube comprising a secondary emission electrode or emitter the active substance consisting of a compound of a metal selected from the group consisting of the alkali metals, the alkaline earth metals, and magnesium, is obtained on the emitter by evaporating one or more of these metals, or compounds of the metals through a gas atmosphere having a sufficient pressure. When the metal itself is evaporated, we prefer to evaporate it through an atmosphere of a gas reacting with the metal and combining with the secondary emission electrode. For this purpose the gas pressure must have a value such that the compound, and not merely a metal surface is produced. In vaporizing a metal compound either a reacting or inert gas atmosphere may be used. In vaporizing the compounds in a gas atmosphere, whether reactive or not, the pressure of the gas need not be as high as for the vaporization of the metals themselves. We have found that in this manner a much better secondary emission is obtained than when the metals, whether mixed with compounds or not, are evaporated in a high vacuum, an advantage which may perhaps be due to the influence of the structure of the coatings on the secondary electron emission properties of the secondary emission electrodes.

The method, according to the present invention, may be carried out in different ways. According to one way, a source of alkali metal, alkaline earth metal, or magnesium, either the metal or a readily decomposable compound of the metal, is secured on another electrode in a discharge tube having a secondary emission electrode, the metal being evaporated after a gas such as carbon dioxide, oxygen, and the like, for example, has been introduced at a suitable pressure into the tube. In this case there is formed on the surface of the secondary emission electrode an oxide whose secondary emission is appreciably higher than that of the pure metal. According to another way, a carbon dioxide atmosphere is obtained by providing barium-strontium carbonate on a separate heatable electrode, and magnesium at another point of the tube, and by heating the carbonate shortly before vaporization of the magnesium to such a degree that carbon dioxide is set free and part of the resulting barium and strontium oxide also evaporates to the secondary electron emitter, so that the secondary electron emission electrode is finally coated with a mixture of barium oxide, strontium oxide, and magnesium oxide having a very good secondary electron emission and a ratio of secondary to primary electrons much greater than unity at practicable voltages.

The invention will be more clearly understood by reference to the accompanying drawing representing, by way of example, a discharge tube in which the method of the invention may be used. This tube comprises a cathode 2, coated with barium and strontium oxides, a control grid 3, and a screen grid 4. The electrons issuing from the cathode are led along curved paths, schematically represented by the arrows 5, to a secondary emission electrode 6 and an anode 7. The secondary electron emitting electrode 6 is preferably a sheet of nickel having on its active surface a thin layer or film of barium oxide, strontium oxide, and magnesium oxide applied in accordance with our invention. In addition, the tube comprises a curved accelerating electrode 8 and a shield 9 which serve to direct the electron discharge along curved paths and at the same time prevent material evaporating from the primary cathode from reaching the secondary emission electrode. The accelerating electrode 8 is sprayed with a thin layer 10 of barium-strontium carbonate having a thickness of about 30 microns. By high frequency heating of the electrodes after exhausting and sealing off the tube, the temperature of this electrode is raised to such a degree that barium and strontium carbonates on the electrode break down and produce oxides, some of which evaporate over to and deposit on the secondary emission electrode as a very thin film or coating, and, at the same time, a carbon dioxide atmosphere evolves. Then a quantity of magnesium 11 on the shield 9 is evaporated in the atmosphere of carbon dioxide and forms magnesium oxide on the electrode 6. In this case care has to be taken that the carbon dioxide is at such a pressure that no surface of metallic magnesium is formed. Usually the easily detectable pressure developed in the tube by the decomposition of the carbonates is sufficient. As a result, the surface of the nickel electrode is coated with a layer of active material in the form of an intimate admixture consisting predominantly of oxides from the barium strontium carbonate coating, and of the oxide or compound of the vaporized metal, such as magnesium. Usually metallic magnesium is not observable on the coating, although it is possible that minute amounts of metal are present in it.

We claim:

1. The method of forming in a tube a metal electrode having a surface of high secondary electron emissivity which comprises evacuating the tube, heating an alkaline earth metal carbonate in the tube to a temperature at which the carbonate decomposes with evolution of carbon dioxide gas and some alkaline earth metal oxide, and evaporating a metal selected from the group consisting of the alkaline earth metals and magnesium through the carbon dioxide atmosphere to the surface of the metal electrode.

2. A secondary electron emitter comprising a sheet of nickel having a surface coated with a mixture consisting predominantly of an alkaline earth metal oxide and of magnesium oxide.

3. A secondary electron emitter comprising a sheet of nickel having a surface coated with a mixture consisting predominantly of an alkaline earth metal oxide and of an oxide of a different metal selected from the group comprising the alkali metals, the alkaline earth metals, and magnesium.

4. The method of making a secondary electron emitting electrode which comprises enclosing a metal electrode in an evacuated vessel, producing in said vessel an atmosphere of carbon dioxide, depositing on said metal electrode in said atmosphere a thin film of alkaline earth metal oxide, and vaporizing in said atmosphere a different metal selected from the group of alkali metals, alkaline earth metals, and magnesium to form a layer of oxide of said different metal on said film of alkaline earth metal oxides.

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