

UNITED STATES PATENT OFFICE

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METHOD OF COATING SUBSTANCES

No Drawing.

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This invention relates to a method of coating substances with metal or metals of the alkali or alkaline-earth groups, and with the oxids of such metals. The invention is more particularly applicable to the formation of electron-emitting elements or cathodes (whether of the filamentary or indirectly-heated type) suitable for use in vacuum tubes such as audion tubes, X-ray tubes, and the like. Although the invention is not limited to a method of making such elements, it will hereafter be described in that connection, by way of suitable example.

Cathodes of the "dull-emitter" or Wehnelt type ordinarily consist of a platinum or other metallic core, usually in the form of a wire or ribbon, which has been coated with oxid of some metal or metals, such as barium, strontium, or the like. Several methods have heretofore been employed in the production of such cathodes. One of the older processes is to dip the wire to be coated into a solution of the nitrate of the desired metal or metals, and then decompose the nitrate by heating in an inert atmosphere in order to obtain the oxid. It is ordinarily necessary to apply a considerable number of successive coats of oxid in this manner if a uniform electron emission is to be obtained from the finished element. In another method of producing an oxid coating the heated wire is brought into contact with solid paraffine in which is suspended a considerable amount of barium or strontium carbonate, or the like. The carbonates being decomposed, an oxid coating remains. In this case, also, a large number of successive coatings are required. Still a third method is to paint or coat the wire with a solution of barium azide, and then apply heat in order to decompose the compound to metallic barium, which readily oxidizes.

Each of these methods is open to a number of objectives, and presents certain definite disadvantages. In the first two methods there is not only the already mentioned necessity for applying a large number of successive coatings of oxid if a stable or uniform electron emission is desired, which is troublesome and expensive in itself, but there is the further difficulty that considerable quantities of

gas are apt to be occluded during the coating process. It is extremely difficult, or impossible, completely to remove this occluded gas during the subsequent evacuation of the tube, and this may account, to some extent, for the frequent erratic behavior of cathodes made in this way. Moreover, it is difficult to make the coatings of uniform thickness; and "hot-spots" and consequent burning out of the filament frequently occur. With regard to the third process, barium azide is a highly explosive compound; its preparation is correspondingly difficult, and the process is so dangerous as to be highly unsatisfactory.

Our invention provides a means for applying metallic or oxid coatings to substances of any desired character. The method is substantially free from the foregoing difficulties and objections, and results in a more uniform and adherent coating than has been (so far as we are aware) hitherto obtainable.

According to our invention we dissolve an alkali or alkaline-earth metal, or a salt or oxid of such a metal, in an organic solvent, either by direct solution in the case of a metal compound; or by converting the metal to an organic compound by means of the solvent, and solution of the resulting compound, in the case of a metal. We then apply the resulting solution to the substance, for example a cathode element or filament, which is to be coated. The solvent is then evaporated, by exposure to the air or otherwise, when a uniform and adherent coating of the dissolved compound remains. In the event that a metal, or a salt not an oxid, was employed, the coating may be readily converted to oxid by further exposure to the air, or by heating in air or other oxidizing atmosphere if necessary.

Particular examples of methods of carrying out our invention are as follows:

1. Barium iodide is dissolved in ethyl alcohol to form a saturated solution. This solution is applied to a filament element by dipping, brushing, or otherwise. The element is then exposed to the air until the alcohol evaporates. The element is then heated, preferably by means of its own resistance to an electric current, in an oxidizing atmos-

phere in order to convert the barium iodide into emissive barium oxid. The resulting coating is firm, uniform, and adherent.

2. Barium oxid is dissolved in ethyl alcohol and applied to a filament element in the same manner. Heating in an oxidizing atmosphere is generally unnecessary in this case.

3. Barium metal is treated with an excess of ethyl alcohol to form barium ethylate, which is dissolved in the excess alcohol to form a solution of barium ethylate. This solution is applied as before, and the coating of barium ethylate which remains after evaporation of the solvent is decomposed by heating to form the desired oxid coating.

4. Barium metal is dissolved in an excess of acetone to form a solution in acetone of barium enol-acetonate, which is employed as in Example 3 above.

It must be understood that the foregoing examples are merely illustrative of our invention, which is, of course, not limited thereto.

Throughout the foregoing examples we have referred to the metal barium, or its salts or oxids, for the sake of uniformity. Calcium, strontium, or other metals of the alkaline-earth group, their salts or oxids, may replace, or be used in conjunction with, barium; or alternate coatings of different compositions may be employed. The same applies, also, to alkali metals such as sodium, potassium, etc., or their compounds. We frequently employ solutions containing several of these metals, or apply alternate coatings derived from different solutions.

According to our invention, also, when two or more separate organic solvents are miscible, we may employ a suitable mixture of solvents to replace a single one, and such a mixture is included by the term "organic solvent" or the like as herein employed.

With regard to the substance which is to receive a metallic or oxid coating, we may employ a metal in the form of a wire, filament, ribbon, small tube or rod, plate, or the like. We have found that nickel, or nickel-chromium alloys, are good examples of metals which act satisfactorily in receiving and retaining the coating. Even more refractory metals, such as tungsten, molybdenum, tantalum, platinum, etc., are also suitable. Our invention, however is not confined to coating metallic substances. In some cases we wish to apply a metal or oxid coating to a non-metallic substance such as porcelain, silica, and so forth. There are certain types of cathodes (used in the so-called "heater" tubes) in which the emitting surface is not identical with the heating element, but comprise a tube or small cylinder, etc., which is heated by means of a separate filament or heater arranged within it. Our invention is equally applicable to coating such emitting elements

intended to be separately heated, and may be applied to them whether they are of metallic or non-metallic composition.

It will be clear from the foregoing description that our process is susceptible of many variations and modifications, all of which come within the spirit of the invention.

We claim:

1. Process of coating substances with alkaline-earth oxid material to form an electron-emitting cathode element, which comprises treating alkaline-earth metal with an organic solvent to form an organic compound, dissolving said compound in excess of said solvent, applying the resulting solution to the substance to be coated, and converting the resulting coating to oxid.

2. Process of coating a non-metallic refractory element with alkaline-earth oxid material to form an electron-emitting cathode element, which comprises treating alkaline-earth metal with an excess of organic solvent to form a solution, applying the solution to the non-metallic refractory element to be coated and converting the applied solution to an oxid coating.

3. Process of coating a metallic element with barium oxid material to form an electron-emitting cathode element, which comprises treating barium metal with an excess of ethyl alcohol to form a solution, applying the solution to the metal to be coated and converting the applied solution to an oxid coating.

4. Process of coating a metallic element with barium oxid material to form an electron-emitting cathode element, which comprises treating barium metal with an excess of acetone to form a solution, applying the solution to the metal to be coated and converting the applied solution to an oxid coating.

5. Process of coating a metallic element with barium oxid material to form an electron-emitting cathode element, which comprises treating barium metal with an excess of a saturated aliphatic oxygen-containing organic solvent to form a solution, applying the solution to the metal to be coated and converting the applied solution to an oxid coating.

In testimony whereof, we affix our signature.

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