

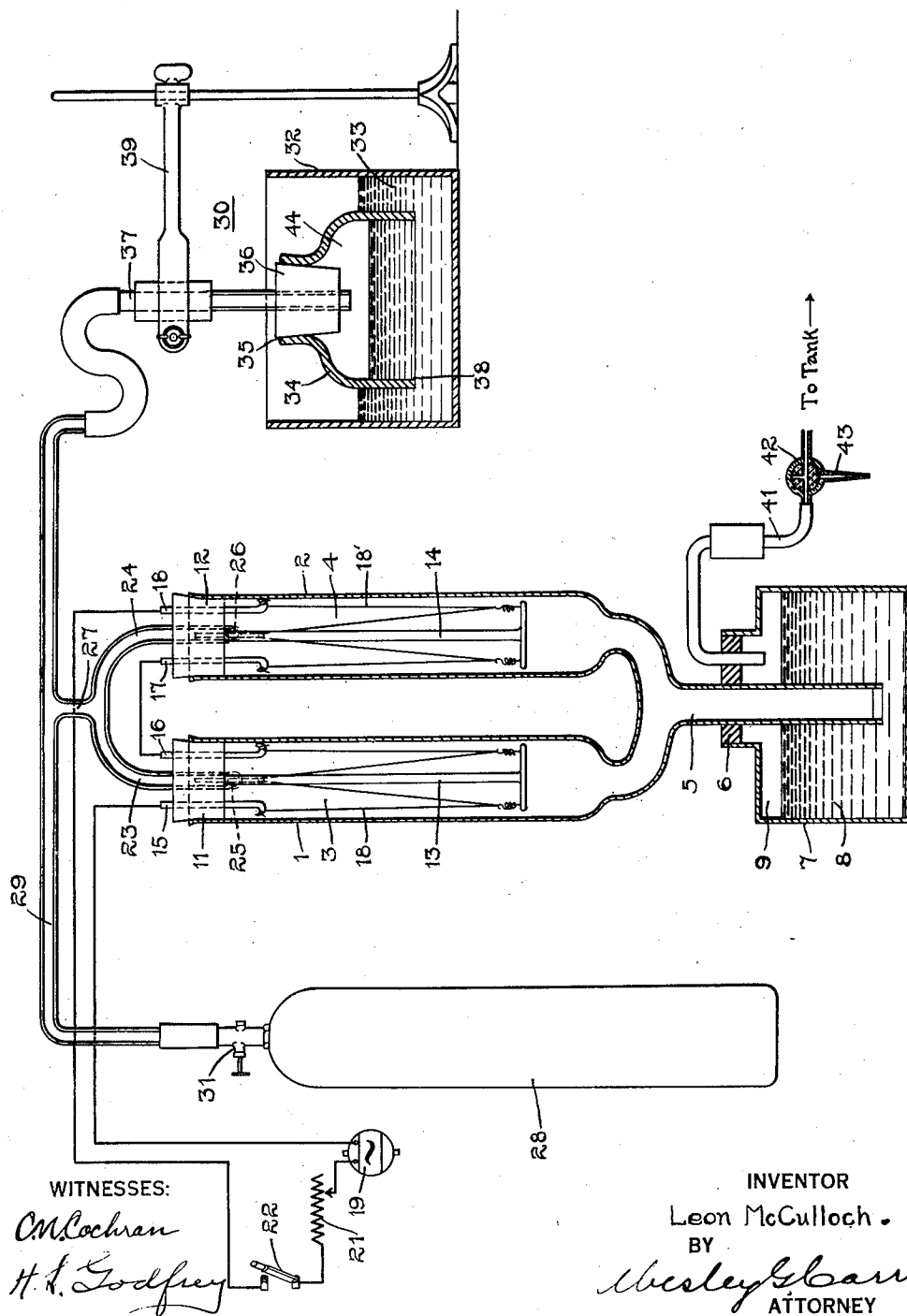
Dec. 18, 1928.

1,695,899

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ELECTRON EMITTING ELEMENT

Filed Sept. 27, 1922



Patented Dec. 18, 1928.

1,695,899

UNITED STATES PATENT OFFICE.

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ELECTRON-EMITTING ELEMENT.

Application filed September 27, 1922. Serial No. 590,777.

My invention relates to thermionic devices and particularly to electron-emitting elements and processes of manufacture thereof.

5 The principal object of my invention is to provide an improved method of coating electron-emitting elements, whereby coated Wehnelt elements may be obtained having highly desirable characteristics and where-
10 by material economies may be effected in the time required for the coating process.

In the ordinary methods of manufacturing filaments of the class described, coated filaments have been produced, the coatings of
15 which were of variable thickness, rough and poorly adherent. Another disadvantage of the coated filaments of the prior art resides in the fact that most or all of them must be stored in sealed containers, inasmuch as the
20 chemical composition of the same is subject to change in the presence of water vapor and of carbon dioxide.

According to my invention, I provide a
25 method of coating filaments which produces a filament coating having the desired characteristics. Briefly, the process consists in applying to a conducting element successive coatings of an aqueous solution of barium and strontium nitrates. Each successive
30 coating is heated to ignition temperatures in an atmosphere of carbon dioxide to cause the nitrates of barium and strontium to be converted into carbonates.

The necessary heating to form the carbonate coating from the nitrate coating may
35 be done either by passing the filament through a furnace filled with carbon dioxide or by heating the filament with electrical energy in a carbon-dioxide atmosphere. Both methods have been used with success.
40 The resulting coated filament is of such definite and unchanging composition as to withstand all necessary handlings and may be kept indefinitely in an atmosphere of air
45 or carbon dioxide.

The final step in the treatment of the filament occurs when the filament has been mounted in a vacuum tube as the cathode
50 element thereof, the carbonates being in whole or in part reduced to oxides when the tube is subjected to the usual hardening process.

With these and other objects in view, my

invention further consists in the operations and products hereinafter described and
55 claimed and illustrated in the accompanying drawings, wherein

The single figure is a view partially diagrammatic and partially structural, showing
60 one form of apparatus for carrying my process into effect, together with the necessary electrical circuits.

In order to illustrate the method embodying my invention, I have shown an arrangement of apparatus which has been found,
65 in practice, well adapted for carrying my invention into effect. Briefly, the apparatus includes one or more vertically positioned tubes, as 1 and 2, forming chambers 3 and 4,
70 respectively, the lower portions thereof terminating in a common tubular member 5. The tube 5 is carried by a removable stopper member 6 of a receptacle 7 and extends below the surface of a coating solution
75 8 contained therein, thus forming an air-tight space 9 above the surface of the coating solution 8.

The solution just mentioned may consist of an aqueous solution of barium and strontium nitrates. In practice, I have
80 found that such solution is preferably obtained by dissolving a mixture containing three parts of barium nitrate and two parts of strontium nitrate in water in the ratio of five parts of the mixture to one hundred
85 parts of water. While I have specifically mentioned nitrates of barium and strontium, other salts may be successfully employed, such, for example, as bromides and iodides of metals producing electronically-active ox-
90 ides, and also salts formed by the union of such metals with organic acids.

The upper ends of the tubes 1 and 2 are fitted with removable stopper members 11 and 12, carrying supporting structures 13
95 and 14, which extend down into the tubular members 1 and 2, respectively. The structures 13 and 14 may carry filaments 18 and 18', respectively, which are to be coated. The supporting structures 13 and 14 may
100 be provided with external circuit terminals 15, 16 and 17, 18, respectively, which serve to connect the several filaments in series-circuit relation to an external energy source 19 through an adjustable resistor 21 and a
105 switch 22. In practice, a 220-volt alternat-

ing-current generator was found to sufficiently excite the several filaments, as hereinafter more fully explained.

A pair of tubular members 23 and 24, which extend from openings 25 and 26 near the upper ends of the tubes 1 and 2, respectively, terminate in a common tubular member 27 which is connected, through a tube 29 and a valve 31, to a common receptacle 28 containing carbon dioxide under pressure. The common tubular member 27 is also connected to an air-valve apparatus 30 designed to receive the gas contained in the tubes 1 and 2, when the latter is forced out of the same during the coating process, all as hereinafter explained.

The air-valve apparatus 30 comprises a receptacle 32 containing a liquid 33, as water. A second receptacle 34, having a constricted opening 35 at one end provided with a perforated stopper 36 carrying a tubular member 37 and having an enlarged opening 38 at the opposite end, is vertically positioned in the liquid 33 with the tube 37 extending vertically upwards. The tube 37 may be maintained in such position by means of a support 39, which is in sliding contact with the tube, to provide for the vertical motion of the receptacle 34 occasioned by variations in the pressure of the gas contained in the tubes 1 and 2, as hereinafter explained.

The level of the solution in the tubes 1 and 2 during the coating process may be controlled by varying the relative pressures in the tubes 1 and 2 and in the air space 9 formed above the surface of the coating solution 8 contained in the receptacle 7. Means for accomplishing this result is shown in the drawing, where a source of air under pressure (not shown) is connected, through a tubular member 41, having a two-way valve 42, to the upper portion 9 of the receptacle 7 above the surface of the coating solution 8. In one position of the valve 42, the space 9 is connected to the high-pressure source, as just stated, thereby forcing the solution 8 partially out of the receptacle 7 and up into the tubular members 1 and 2 and hence completely covering the filaments 18 and 18', which are to be coated. In another position of the valve 42, the space 9 is connected to atmosphere through a tubular member 43 constricted at its open end sufficiently to cause the coating solution to return, by gravity, to its initial position in the chamber 7 at a predetermined slow rate, say two inches per second, whereby proper drainage from the filaments is provided.

Attention is directed to the fact that, as the solution rises in the tubular members 1 and 2, the gas or air contained therein is forced out of the same and into a space 44 formed above the surface of the liquid 33. The variations in the size of this space, re-

sulting from the vertical motion of the receptacle, are such as to compensate for the variations in the pressure of the gas contained in the tubular members 1 and 2, as can readily be seen.

In order to more fully complete the disclosure of my invention, I will state the method of coating the filament embodying my invention, using values which have been found in practice to produce a filament having the hereinbefore mentioned characteristics.

The filaments which are to be coated are first thoroughly cleansed in any known manner, as by heating the same to incandescence to remove accumulated dirt and dust, and are then mounted upon the supporting structures 13 and 14.

The two-way valve 42 is then operated to cause the coating solution 8 to completely cover and uncover the filaments 18 and 18', as previously stated, the rate of the fall of the coating solution 8 in the several tubes 1 and 2 being such that proper drainage from the filaments 18 and 18' is provided, otherwise, an imperfect coating is obtained. While the coating solution is flowing out of the tubes 1 and 2, the valve 31 is opened to fill the tubular members 1 and 2 and the air space 44 of the air-valve apparatus 30 with carbon dioxide. The switch 22 is then closed to heat the filaments 18 and 18' to ignition temperatures, say 800° C. The effect of heating the filaments in the atmosphere of carbon dioxide is to change the nitrates of barium and strontium into carbonates. Thus, a coating of barium and strontium carbonates is formed on the filaments.

The dipping and heating of the filaments are repeated until a coating of sufficient thickness is built up. While it has been found that a filament having a very long life is obtained with only six coats, the process may be continued until, say, forty coats are formed in order to provide a filament having a large factor of safety. The coated filaments may now be removed from the supporting structure and stored in suitable containers.

The final step in the process occurs when the coated filament has been embodied in a thermionic device (not shown) as the cathode element thereof and the usual treating process started.

As is customary, during the treatment of thermionic tubes, the several elements contained therein are heated to high temperatures in order to drive out the occluded gases and it is during such heat treatment that the carbonates of barium and strontium constituting the coating are converted into oxides.

Thus, in my system, the final step of converting the filament coatings into oxides is

combined with the usual evacuating process, thereby decreasing the time and expense involved in the manufacture of thermionic vacuum tubes. Other advantages of my invention will be apparent from the foregoing disclosure.

While I have shown and described a particular embodiment of my invention for the purpose of more fully disclosing the principles thereof, it is capable of various changes and modifications without departing from the spirit of my invention and I desire, therefore, that only such limitations shall be applied thereto as are specifically set forth in the appended claims or demanded by the prior art.

I claim as my invention:

1. The steps in a method of treating a conducting element which consist in coating said element with an aqueous solution of at least one compound of at least one metal of the alkaline-earth group and subsequently heating said element to ignition temperature in an atmosphere of carbon dioxide.

2. The steps in a method of treating a conducting element which consist in coating said element with an aqueous solution of nitrates of a plurality of metals of the alkaline-earth group and subsequently heating said element in an atmosphere of carbon dioxide to ignition temperatures.

3. The steps in a method of treating a conducting element which consist in coating said element with an aqueous solution of barium and strontium nitrates and subsequently heating said coated element in an atmosphere of carbon dioxide to temperatures high enough to cause said nitrates to change into carbonates.

4. The method of manufacturing a coated filament which consists in depositing thereon successive coatings of an aqueous solution of a compound of a metal of the alkaline-earth group, subjecting each coating to ignition temperatures in an atmosphere of carbon dioxide and finally heating the coated filament in an atmosphere containing little or no carbon dioxide.

5. The method of treating a conducting element which consists in depositing upon said element a coating of an aqueous solution of nitrates of a plurality of metals of the alkaline-earth group, subjecting said coating to ignition temperatures in an atmosphere of carbon dioxide and finally heating the coated filament in an oxidizing atmosphere.

6. The process of manufacturing a Wehnelt-cathode which consists in depositing upon said cathode successive coatings of an aqueous solution of barium and strontium nitrates, subjecting successive coatings in an atmosphere of carbon dioxide to temperatures high enough to cause the coatings of barium and strontium nitrate to be converted into barium and strontium carbonates

and finally heating the cathode in an oxidizing atmosphere.

7. The method of manufacturing an electron-emitting element which consists in depositing upon said element successive coatings of an aqueous solution of barium and strontium compounds, heating the same in an atmosphere of carbon dioxide subsequent to each coating to a temperature sufficient to convert the said compounds of barium and strontium into carbonates and finally heating said element in an atmosphere containing little or no carbon dioxide to convert the carbonates of barium and strontium into oxides.

8. The process of manufacturing a Wehnelt-cathode which consists in depositing upon said cathode successive coatings of an aqueous solution of a compound of a metal of the alkaline-earth group, heating said cathode after each coating to ignition temperatures in an atmosphere of carbon dioxide and subsequently embodying said cathode in an electron tube and subjecting said cathode to ignition temperatures during the hardening process of the tube.

9. The method of manufacturing an electron-emitting element which consists in depositing upon said element successive coatings of an aqueous solution of at least one compound containing a metal or metals of the alkaline-earth group, heating said element after each coating in an atmosphere, of carbon dioxide to such temperatures as to cause the coating to be converted into carbonates and subsequently mounting said element in an electron tube and converting said carbonates into oxides during the treating process of the tube.

10. The method of manufacturing and assembling the parts of an electron-tube comprising an oxide-coated filament which consists in preparing and keeping the filament material outside of the tube in the form of an element coated with at least one carbonate of at least one metal the oxide of which is to be present in the finished coating and subsequently mounting said material in the tube and converting the carbonate coating in whole or in part, into an oxide or oxides.

11. The method of preparing a filament material which consists in initially coating an element with a liquid containing a compound or compounds of a metal or metals of the alkaline-earth group, said liquid being of such nature as to be convertible into a vapor or vapors and a carbonate or carbonates of said metal or metals when heated in an atmosphere of carbon dioxide, and subsequently subjecting said coating to such heating in said atmosphere of carbon dioxide.

12. The method of preparing a filament

material which consists in initially coating an element with a liquid containing a compound of a metal, said liquid being of such nature as to be convertible into a vapor or
5 vapors and a coating containing a carbonate of said metal when heated in an atmosphere of carbon dioxide, and subsequently subjecting said coating to such heating in said atmosphere of carbon dioxide.

10 13. The method of preparing a filament material which consists in initially coating an element with a liquid containing compounds of a plurality of metals, said liquid being of such nature as to be convertible into
15 a vapor or vapors and coating containing carbonates of said metals when heated in an atmosphere of carbon dioxide, and subsequently subjecting said coating to such heating in said atmosphere of carbon dioxide.

20 14. The method of making thermionically active electrodes which comprises coating an electrically conductive body with the carbonate of an alkaline earth metal and

heating said body under conditions unfavorable to the decomposition of the carbonate 25 to cause the alkaline earth carbonate to adhere thereto.

15. An electrode adapted to be rendered thermionically active comprising an electrically conductive body having a coating of 30 alkaline earth carbonates baked thereon in a firmly adherent manner, said carbonates being capable of conversion to the oxides upon application of heat to the body.

16. A filamentary electrode adapted to be 35 rendered thermionically active comprising a metallic core having a coating of alkaline earth carbonates, free from organic material, baked thereon in a firmly adherent manner, said carbonates being capable of 40 conversion to the oxides upon the application of heat to the filament.

In testimony whereof, I have hereunto subscribed my name this 21st day of September, 1922.

LEON McCULLOCH.