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ACTIVATION OF FILAMENTARY MATERIAL

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Fig. 1.

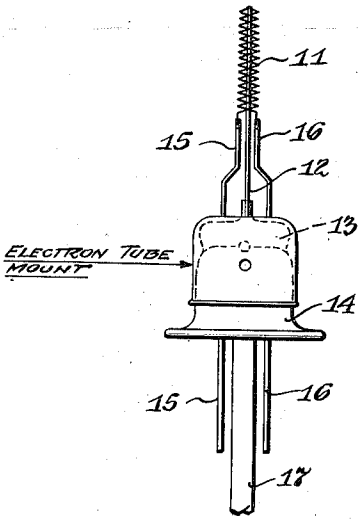


Fig. 2.

INVENTOR
D. S. GUSTIN
N. H. BRYANT
BY
ATTORNEY

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ACTIVATION OF FILAMENTARY MATERIAL

Daniel S. Gustin, Bloomfield, and Nelson H. Bryant, East Orange, N. J., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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12 Claims. (Cl. 148—13.1)

This invention relates to electron-emitting devices such as radio tubes, X-ray tubes and the like, and more particularly to the activation of filamentary material which forms the cathodes thereof.

The primary object of our invention, generally considered, is to accurately activate filamentary material for the cathode of electron-emitting devices by an improved method avoiding the use of such material as benzol vapor which is uncertain and dangerous.

Another object of the invention is to activate thoriated filamentary material in an atmosphere produced by passing a non-explosive protective fluid, such as "forming gas," through a mixture of xylene and dehydrated mineral oil.

A further object of our invention is to activate filamentary material, when mounted as a cathode for an electron-emitting device, by performing such operation when the filament lies horizontal rather than vertical, thereby making it possible to hold such material at a more uniform temperature, and consequently produce more uniform activation.

A still further object of our invention is an accurately carbonized thoriated filament, adapted for electron-emission purposes.

Other objects and advantages of the invention, relating to the particular arrangement and construction of the various parts, will become apparent as the description proceeds.

Referring to the drawing:

Fig. 1 is an elevational view of a mount for an electron discharge device.

Fig. 2 is an elevational view, partly diagrammatic, of apparatus for activating the filament of such a mount.

Various methods have been devised for the purpose of converting the thorium oxide content of drawn thoriated tungsten filaments to metallic thorium, so that the filaments are more efficient electron emitters when used as cathodes in electrical discharge devices.

A common method heretofore employed uses benzol vapor for applying carbon to the filament to effect a reduction of the thorium oxide or suboxide content to metallic thorium during a subsequent seasoning schedule. Such seasoning is for the purpose of causing the added carbon to effect a reduction of the thorium oxide content of the filament. When the temperature is raised, the liberated thorium is directed to the surface of the filament.

It has been found that using an atmosphere of hydrogen which contains benzol vapor for the purpose of carbonizing thoriated tungsten filaments, is uncertain and dangerous. The hydrogen may explode and frequently does, and the amount of benzol vapor in the hydrogen depends upon the rate of flow of the latter and the physical construction of the container. Actual results obtained may vary from almost no carbide to too much on the filament.

In accordance with our invention, we bubble "forming gas," which is a non-explosive mixture of hydrogen and nitrogen, protective against oxidation, preferably containing from 8% to 12% of hydrogen, through xylene [$C_6H_4(CH_3)_2$] which has been diluted with preferably an equal quantity of vacuum pump oil. The latter is a high grade dehydrated mineral oil.

The oil used was grade 2970–1 in accordance with the Westinghouse Electric & Manufacturing Company Purchasing Department Specification No. 2970–F, approved June 2, 1921, revised September 5, 1938. In accordance with this, the oil shows not more than .005% ash, the volatile oil and moisture present does not exceed .02%, the specific gravity at 15.6° C. is between .90 and .91, the viscosity (Saybolt) at 38° C. is between 275 and 325 sec., and at 99° C. is between 50 and 55 sec., the minimum flash point is at 199° C., the minimum fire point is at 230° C., and the steam emulsion number is a maximum of 90 seconds. It will, however, be understood that other oils are undoubtedly suitable for the purpose, so that we do not wish to be limited to the exact oil or one having the exact properties of that used.

We thereby obtain an atmosphere which is particularly desirable for filament carbonization or activation purposes. Cracked or combusted gas, produced as by incompletely burning illuminating gas, and having a typical composition of about 69% N., 13% H., 5% Co_2, 12% CO and .7% CH_4, may be used instead of forming gas, although the latter is preferred because it is less toxic.

The xylene, which is the source of the carbon for the process, has been used undiluted, the "forming gas" being bubbled therethrough. Such a procedure gave a black deposit of carbon on the filament at the filament temperature used, that is, when the filament was raised to a white heat, or to between 1900° C. and 2200° C. Raising the treating temperature of the filament helped to get away from the trouble, but also speeded up the reaction, giving less uniformity, and making the filament softer so that it sagged to an undesirable extent due to its own weight. Therefore, we diluted the xylene with pump oil, thus lowering the vapor pressure of the former, naturally lower than benzol, to slow down the reaction. Such dilution permits us to saturate the "forming gas" from the xylene mixture, and thus obtain a uniform carbonizing constituent in the gas. A dilution of one part of xylene to one part of pump oil was found desirable, but the process worked equally as well up to five parts of pump oil to one part of xylene. Preferred operating temperatures range from 60° to 80° F.

Referring now to the drawing in detail, the

thoriated tungsten filament 11 to be activated is shown with its intermediate portion supported by the central wire 12, one end of which is embedded in the press 13 of the stem 14 and the other, or free end, of which is secured to the filament in any convenient manner, as by spot welding. The ends of the filament connect with lead-in conductors 15 and 16, which pass through the press and out of the flare tube 14. As is usual, the flare tube is provided with an exhaust tube 17.

The apparatus for activating the filament 11, and others of like construction, is shown in Fig. 2, wherein 18 represents a flask, or other receptacle, containing a mixture of xylene and pump oil 19, preferably within the limits of one part xylene to one to five parts of pump oil. The oil is preferably a high-grade dehydrated mineral oil, such as commonly used for lubricating vacuum pumps. The activating atmosphere is produced by passing "forming gas" or its equivalent from a supply into the flask 18 and bubbling it from tube 21 through the diluted xylene 19, from whence it passes through pipe 22 containing glass wool 23 or other material which will remove droplets, and then on to the chamber 24 in which the filament 11 of the mount, as illustrated in Fig. 1, is activated.

The filament mount is desirably held in place, as by a washer 25, which may be formed of asbestos or other suitable material, around the flare tube 14 to seal the space between said tube and the horizontally extending neck 26 of the envelope 24, against the entrance of air into said envelope. While the carbonized gas is passed through the envelope 24, the filament 11 is desirably raised to a white heat, that is, to a temperature between 1900° C. and 2200° C., for a set interval, as controlled by timer 27 in circuit with source of power 28. The lower the treating temperature of the filament, the longer the treating time required for the same degree of carbonization or activation. The temperature of the filament, which is connected to said source of power through ammeter 29 and timer 27, is controlled by rheostat 31, so that the filament is subjected to just the right amount of activation prior to the current being cut-off by the timer. The flow of activating atmosphere through the envelope 24 is controlled by valve (not shown) in the pipe or tube leading from the source of gas supply so that a sufficient, but not excessive, stream of such activating gas is supplied to the filament during the activating process.

From the foregoing it will be seen that we have improved on the method of activating filaments for discharge devices by substituting a non-explosive atmosphere, accurately controllable because the vapor pressure is such that saturation of the gas is effected, for an explosive and uncertain atmosphere, at the same time providing for horizontal rather than a vertical position during activation, as well as for the accurate control, not only of the activating temperature of the filament, but also the duration of such activation. By activating the filament after mounting, breakage due to handling after embrittlement by the activating or carbonization process is avoided.

Although a preferred embodiment of our invention has been disclosed, it will be understood that modifications may be made within the spirit and scope of the appended claims.

We claim:

1. The method of carbonizing thoriated filamentary material comprising bubbling gas through xylene diluted with oil to desirably reduce its vapor pressure, and heating said material in the atmosphere so produced.

2. The method of carbonizing thoriated filamentary material comprising bubbling a non-explosive gas, protective against oxidation, through xylene sufficiently diluted with oil to give it a desired vapor pressure, and heating said material in the atmosphere so produced.

3. The method of carbonizing thoriated filamentary material comprising bubbling gas through a mixture of xylene and mineral oil, and heating said material in the atmosphere so produced.

4. The method of carbonizing thoriated filamentary material comprising heating in "forming gas" saturated by contact with a mixture of one part of xylene and from one to five parts of dehydrated mineral oil.

5. The method of carbonizing a thoriated filament comprising introducing said filament while mounted on a stem into a vessel, passing gas through xylene diluted with oil to desirably reduce its vapor pressure, and then through said vessel, and simultaneously heating said filament.

6. The method of carbonizing a thoriated filament comprising introducing said filament while mounted on a stem into a vessel, bubbling a non-explosive protective gas through xylene sufficiently diluted with oil to give it a desired vapor pressure, then passing said gas through said vessel, and simultaneously heating said filament therein.

7. The method of carbonizing a thoriated filament comprising enclosing said filament while mounted on a stem in a vessel, bubbling gas through a mixture of xylene and mineral oil, then passing said gas through said vessel, and simultaneously heating said filament therein.

8. The method of carbonizing a thoriated filament comprising enclosing said filament while mounted on a stem in a vessel, saturating forming gas by bubbling it through a mixture of xylene and dehydrated mineral oil, passing said saturated gas through said vessel, and simultaneously raising said filament therein to a white heat.

9. The method of carbonizing a thoriated filament comprising enclosing said filament while mounted on a stem in a vessel while held in a horizontal position, passing a non-explosive protective gas through xylene diluted with dehydrated mineral oil, then passing said gas through said vessel, and simultaneously heating said filament therein to between 1900° C. and 2200° C.

10. The method of carbonizing a thoriated filament comprising enclosing said filament while mounted on a stem in a vessel, passing a non-explosive protective gas through xylene diluted with dehydrated mineral oil, then passing said gas through said vessel, and simultaneously heating said filament therein to between 1900° C. and 2200° C. for a predetermined accurately-controlled period of time.

11. The method of preparing an atmosphere for carbonizing purposes comprising bubbling a gas through xylene diluted with oil to give the formed mixture a desired vapor pressure.

12. The method of preparing a mixture for carbonizing purposes comprising passing "forming gas" in contact with a mixture of one part of xylene and from one to five parts of dehydrated mineral oil to effect saturation thereof.

DANIEL S. GUSTIN.
NELSON H. BRYANT.