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CATHODE FOR ELECTRON DISCHARGE DEVICES

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FIG. 1

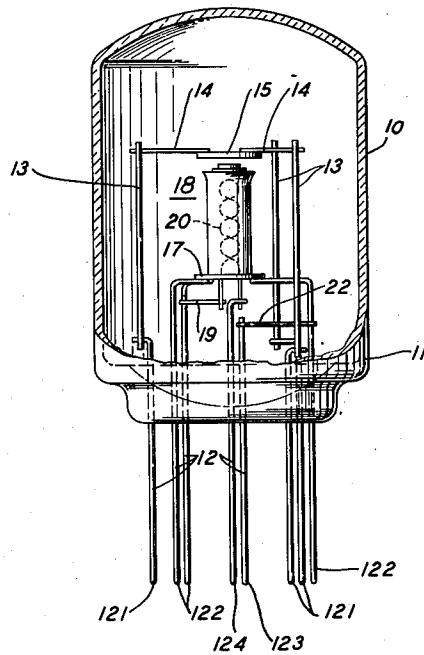


FIG. 2

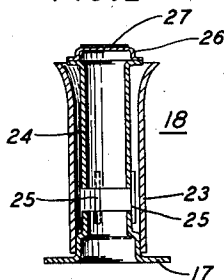
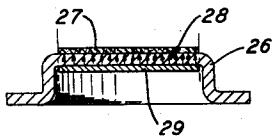


FIG. 3



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CATHODE FOR ELECTRON DISCHARGE DEVICES

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3 Claims. (Cl. 117-201)

This invention relates to electron discharge devices and more particularly to cathodes for such devices.

This application is a continuation-in-part of my application Serial No. 207,004, filed January 20, 1951, now abandoned.

It has become general practice in electron discharge devices utilizing heated and particularly indirectly heated cathodes to employ an electron emissive coating on the cathode surface as the source of the electrons for the device. Such a coating may contain individually or together barium, strontium and calcium oxides. These alkaline earth metal oxide coated cathodes are generally prepared by coating onto the cathode blank the alkaline earth metal carbonates and breaking down the carbonates in situ to the oxides to remove the carbon oxide content of the coating.

It has been known that the emission characteristics of the cathodic coating are dependent to a large degree upon the reducing agents within the cathode base material. Such reducing agents might include magnesium, silicon, iron, carbon, titanium, tantalum, aluminum, lanthanum, thorium, cerium, zirconium, manganese, tungsten and others which react with the alkaline earth metal oxides to reduce the oxides to the pure metal. While it has been known that these reducing agents have a part in determining the emission characteristics of the oxide coating the exact quantitative interrelationship of these characteristics is not known. An emission characteristic which is of prime importance is the life of the coating, that is, the number of hours of continuous emission a coating will sustain before failing.

The material most commonly employed for the cathode base on which is coated the emissive coating is nickel. Presently available commercial nickel usually contains reducing agents as impurities therein, particularly carbon, magnesium, silicon, titanium, and to a lesser extent, aluminum. It is therefore desirable to control the amounts of these reducing agents in the nickel base in order to obtain the maximum coating life and therefore tube life.

One object of this invention is to increase the life of electron discharge devices and more particularly to increase their life by increasing the life of the emissive cathodic coating therein.

A further object of this invention is to control the emission characteristics of alkaline earth metal oxide coatings.

A still further object of this invention is to improve cathodes for utilization in electron discharge devices.

I have found that the life and optimum operation of an alkaline earth cathode coating is dependent in a large measure on the reducing agent content of the metallic base on which the coating is placed and specifically on the amount of the reducing agents, the specific reducing agents, and the rate at which these reducing agents diffuse through the metal base to the cathode coating. In the subsequent discussion reference will be made to nickel

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as the base metal and barium alone of the alkaline earth metals, but it is to be understood that my invention is, of course, not so limited but is as equally valid for the other alkaline earth metals, such as strontium and calcium, and for other metals for the cathode base as for those specifically referred to herein. I have found that the amount of reducing agent content, the specific reducing agents, and their rate of diffusion may readily be controlled in cathodes in accordance with my invention by coating a reducing agent or combination of agents onto the reverse face of the nickel directly beneath the oxide coating.

The nickel base having the oxide coating on one surface and a reducing agent coating on another surface directly opposite the emissive coating may be a commercially pure nickel or may actually be an especially purified nickel having only negligible amounts of reducing agents in it so that substantially the entire reducing agent content of the base is provided by the coating itself. By positioning all or a major portion of the reducing agent in a coating on the under side of the nickel base from the oxide coating I am able to obtain a degree of control over the rate of formation of free barium or other free emissive metal considerably greater than may be obtained by relying solely on the reducing agent content of the nickel or metallic base of the cathode.

It is therefore a feature of this invention that a reducing agent or agents be coated onto the under side of a cathode base metal directly beneath the electron emissive coating.

It is a further feature of this invention that the reducing agent thus coated on the under side of the metal base be non-electron emissive and not vaporize during operation of the device. Further in accordance with this feature, the reducing agent coating may be selected from the group consisting of carbon, titanium, silicon, and magnesium, or alloys thereof.

A complete understanding of this invention and the various features thereof may be gained from the following detailed description and the accompanying drawing in which:

Fig. 1 is a side view of an electron discharge device in which may be incorporated this invention, the bulb envelope being shown partly in section;

Fig. 2 is a sectional view of the cathode assembly of the device of Fig. 1 showing a cathode wherein the emissive coating is positioned on one surface of a metal base and the reducing agents are solely within the metal base; and

Fig. 3 is a sectional view of a cathode in accordance with this invention wherein a reducing agent coating is coated onto the surface of the cathode base opposite the surface on which the cathode coating itself is positioned.

Referring now to the drawing, Fig. 1 shows a diode structure comprising an electron discharge device such as may be employed for detection or rectification purposes. The subsequent data and graphs relate to materials employed and tested in this structure. The diode comprises a glass envelope 10 having a stem 11 through which eight leads 12 extend. Three leads 121 are attached to upright strut members 13 and cross strut members 14 to support a flat circular anode 15. Three other leads 122 are bent over and secured to a platform 17 of the cathode to support the assembly 18, best seen in Fig. 2. One of the leads has secured thereto a short piece of nickel wire 19 attached to one end of the cathode heater 20. The other end of the heater 20 is attached to and supported by another lead 123. The eighth lead 124 has attached thereto one end of a "batalum" getter 22 which extends over to another of the cathode support leads 122.

The cathode assembly 18, as seen in Fig. 2, comprises an outer cylindrical radiation shield 23 attached to the

platform 17, an inner heater cup 24 supported from the platform 17 by three nilvar wires 25, a cathode base 26 welded to the uppermost end of the heater cup 24, and a cathode coating 27 on the upper surface of the cathode base 26 and spaced directly beneath the anode 15. In the cathode of Fig. 2 the cathode coating 27 is on the upper surface of the cathode base 26 and the reducing agents within the base itself are relied upon to provide the free barium or free emissive metal in the cathode coating 27 requisite for the desired electron emission. In accordance with my invention and as shown in Fig. 3, the base 26 may be utilized, as in the cathode structure illustrated in Fig. 2, but the reducing agents within the base 26 have added thereto a coating of one or more reducing agents 29 placed on the underside of the base 26 directly beneath the oxide coating 27. Alternatively, in accordance with my invention, the nickel base 26 of the cathode of Fig. 3 may be of pure nickel having negligible amounts of reducing agents in it and the entire reducing agent content of the base provided by the coating 29 of one or more reducing agents. In such a case the thickness of the base may be utilized to control the time and rate of diffusion of the reducing agents through the base to the cathode coating. It may be desired to have some reducing agents in the base itself but a larger quantity or an excess of a particular reducing agent, such as carbon which diffuses rapidly through the base, as the coating 29 on the underside of the base. While a reducing agent coating has been described, it is to be understood that certain reducing agents, because of their nature, may best be applied as a nickel alloy or in some other combination, rather than as a coating of the pure reducing agent. Thus magnesium, which is very volatile, is best applied to the undersurface of the nickel base 26 as a nickel alloy.

I have found that considerable care should be taken in the preparation and fabrication of electron discharge devices in which greatly improved cathode life and emissive results are to be obtained by positioning of the reducing agent coating on the under side of the cathode base in accordance with my invention. Serious contamination or poisoning of the cathode either during the processing of the device or during its operation should be avoided. Similarly, the migration of the reducing agents into the base metal directly beneath the cathode coating from other portions of the cathode support structure or the fabrication of some agents from other elements of the device onto the cathode support structure or onto the cathode coating itself should be avoided. Thus, I have found it advantageous that the heater cup 24 be of substantially pure nickel, as should even the outer cylindrical shield 23 and the anode 15. Most reducing agents, with the notable exception of carbon, are

volatile and if heated will vaporize over to the cathode base or even onto the cathode coating itself. In the specific diode of Fig. 1 I have found that this structure, and particularly due to the employment of the nilvar wires 25, is such that the shield 23 remains sufficiently cool to prevent vaporization of significant quantities of any materials. Further, because particularly of the effect of carbon as a reducing agent, it is desirable that the parts employed in the cathode structure be exceptionally clean and, specifically, clean of any grease.

It is thus to be understood that the above descriptions are only illustrative of the application of the principles of discovery and of this invention. Numerous other arrangements may be devised by those skilled in the art incorporating the principles of the invention without departing from the spirit and scope of the invention.

What is claimed is:

1. A cathode for an electron discharge device comprising a metal base, an electron emissive alkaline earth metal oxide coating on one side of said base, and a non-emissive reducing agent coating capable of reacting with said alkaline earth metal oxide coating to reduce said oxide coating to the pure metal after diffusion through said base positioned on the other side of said base directly opposite said oxide coating, said reducing agent coating not vaporizing during operation of the device.

2. A cathode for an electron discharge device comprising a nickel base, a coating of electron emissive oxides on one side of said base, said oxides being selected from the group consisting of barium, strontium, and calcium oxides, reducing agents dispersed in said base beneath said coating and diffusible towards said coating, and a coating of reducing agents positioned on the other side of said base directly opposite said oxide coating, said reducing agents and said reducing agent coating each comprising at least one material which reacts with said oxides to reduce said oxides to pure metal and said reducing agent coating being non-electron emissive and not vaporizing during operation of the device.

3. A cathode in accordance with claim 2 wherein said reducing agent coating is selected from the group consisting of carbon, titanium, silicon, and magnesium.

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