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THERMIONIC DEVICE AND GETTER ELEMENTS THEREFOR

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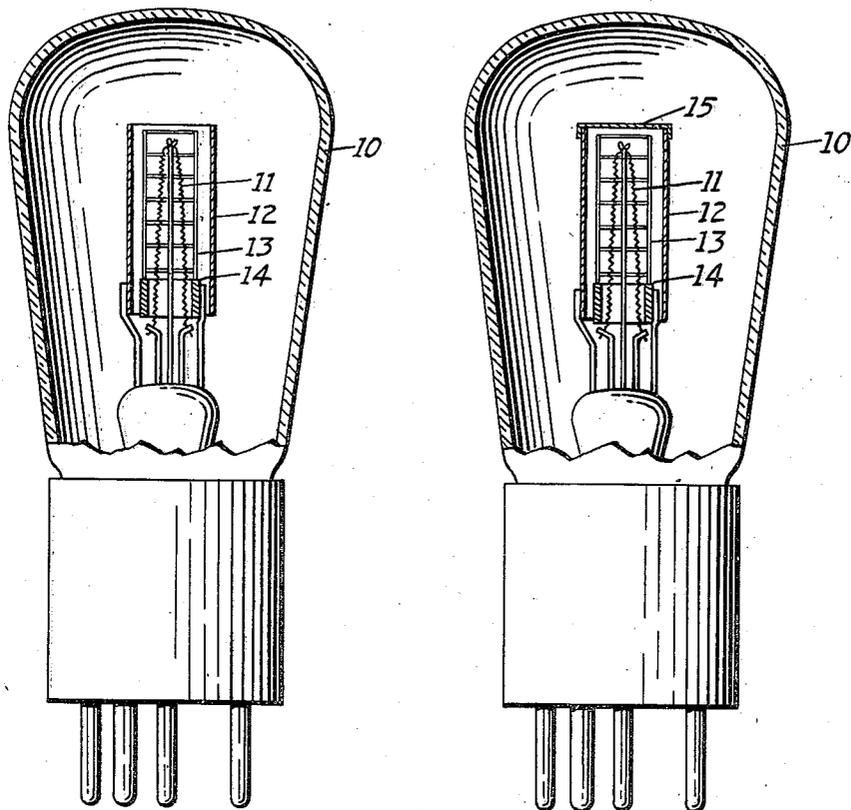


Fig. 1

Fig 2

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THERMIONIC DEVICE AND GETTER
ELEMENTS THEREFORFrank H. Driggs, Highland Park, Ill., assignor to
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1

This invention relates to thermionic devices such as electron discharge devices, vacuum tubes, and the like, and to means for removing the residual gas in such devices.

Although the invention is applicable to various types of thermionic devices, it is described herein as related to the manufacture of thermionic vacuum tubes. In the manufacture of these types of devices, the electrodes or elements are supported in a suitable envelope such as, for example, a glass bulb which is evacuated. During evacuation, the electrodes and envelope are heated to a temperature sufficiently high to drive from the electrodes and envelope water vapor and gases. After evacuation the envelope is sealed.

A higher degree of vacuum is obtained by the use of getter materials sealed within the envelope and activated after evacuation so as to remove residual gases. A large number of getter materials have been used, but the great majority of these materials possess inherent disadvantages in their tendency to migrate from place to place within the vacuum device. Many of these materials also possess a poor gettering action in the presence of mercury vapor, have excessively high vapor pressures at the temperatures of operation of the thermionic device. Some of these getter materials function by volatilization and subsequent condensation of the material during which the residual gases within the device are absorbed or adsorbed. In some instances, the getter materials function by chemically reacting with the residual gases.

More recently, it has been found that certain of the refractory metals such as columbium and tantalum possess this ability to adsorb or absorb residual gases. The use of these refractory metals has not been realized on a large commercial scale chiefly because of the expense of these materials. Certain other metals have been found to possess an ability to absorb or adsorb gases, however, their poor gettering properties have prevented their use in thermionic devices.

One of the objects of this invention is to provide means for removing the residual gas in vacuum devices.

A further object of this invention is to provide means for increasing the effectiveness of certain metals as getter materials to permit their use as getter bodies in thermionic devices.

Another object of this invention is to provide a continuous getter action during normal use of the devices.

Other objects and advantages of this invention will become apparent from the description and claims which follow.

The present invention is based upon my discovery that highly porous, self-supporting bodies such as slugs, buttons, disks or pellets of alumi-

2

num, beryllium, chromium, uranium or mixtures of two or more of these metals produce satisfactory gettering action and have the required low vapor pressure at the normal operating temperature of various thermionic devices.

The highly porous, self-supporting body is relatively inexpensive, easily handled during all stages of the manufacture of thermionic devices and may be positioned within the thermionic device so as to produce a permanent or continuous getter action during the use of the device.

In preparing the porous bodies for getter purposes, powder metallurgy processes are preferably employed. The desired metal powder is subjected to the required pressure. The pressed body is then sintered, preferably in a vacuum and cooled in a vacuum so that the finished product is relatively free from gas. The porous body may be readily welded to a suitable supporting member such as a wire for mounting in the thermionic device, or the supporting member may be positioned in the die so that the powder is pressed about the wire. During sintering the porous body becomes welded to the supporting member.

The porous body is disposed within the thermionic device so that it may be heated to a fairly high temperature during the out-gassing cycle to remove occluded gas. The porous body may be included as a part of one of the active electrodes of the device and heated by internal bombardment or may be heated by high frequency excitation. The getter body may also be heated by the passage of a current through the getter body by means of suitable supporting leads passing through the envelope of the thermionic device and connected to an external source of energy.

In some instances it is desirable to include the porous getter body as a part of one or more of the electrodes of the thermionic device, for example, as a stray electron shield, as an anode end plate, as a grid collar or in various other positions where the necessary out-gassing temperatures will be reached and where the pellet will pass through cycles of varying temperatures during operation of the device. Such arrangement is desired so that the body will be heated sufficiently, but to relatively low temperatures, during normal operation of the thermionic device to remove gases released by the envelope and the electrodes.

The application of the porous getters of my invention in the production of thermionic vacuum tubes is illustrated in the accompanying drawings wherein:

Fig. 1 is an elevational view, partly in section, of a thermionic tube embodying my invention.

Fig. 2 is a similar view illustrating a further embodiment of my invention.

In the thermionic tube illustrated, the numeral 10 designates the envelope of the tube. Mounted within the envelope is a cathode 11 in the form

of a filament, a cylindrical anode or plate 12 and wire grid 13. These electrodes or elements are supported upon suitable lead wires which are connected electrically to the prongs in the base of the tube in the usual manner. The grid 13, as illustrated in Fig. 1, is mounted upon a grid collar 14 formed of a self-supporting, porous body as described herein.

In the thermionic tube illustrated in Fig. 2, the grid is also shown mounted upon a grid collar 14 of self-supporting, porous getter material. The anode 12 of the tube is provided with an end plate 15 of the porous getter body of my invention.

The location of the porous getter body as shown in the drawings is such that during operation of the tubes the getter body will be heated to temperatures at which the porous body readily absorbs or adsorbs gases which may be released by the electrodes or the envelope. During the out-gassing step in the manufacture of the tubes, the grid collar 14 and end plate 15 are heated, for example, by high frequency excitation, to the required out-gassing temperatures.

The specific mechanism of the gettering action is not known but the porous, sponge-like body of the present invention possesses a large active surface of a nature which is most active in gettering action. The generally recognized theory of gettering is that the large proportion of this action is an adsorption effect wherein a monoatomic layer of gas is attracted to and held by the surface of the metal. This adsorption effect is substantially increased in the getter bodies of the present invention because of the large area of metal exposed to the gases. It is also believed that the adsorbed gas is more readily held in pocket-like conformations which are characteristic of the porous getter bodies of my invention. It is also believed that there is an actual solution or absorption of the occluded gas by a slow infiltration of the gas within the crystal lattice structure of the metal. In the getter bodies of the present invention, the external gas film is much more subject to rupture than is a uniform unbroken film such as is present on a smooth sheet, plate or wire surface which probably permits a more rapid infiltration of the gas into the interior of the metal.

In the manufacture of thermionic devices, such as thermionic tubes, in accordance with this invention, the out-gassing cycle is applied in the usual order of filament, grid and anode and is then followed by a substantially complete out-gassing of the porous body by heating to a relatively high temperature, the specific temperature being dependent upon the particular metal constituting the getter material. An additional out-gassing of the tube elements while the getter body is maintained at the relatively high temperatures improves the final gas absorption of the finished device. After the out-gassing cycle and after the device has been sealed from the vacuum system or pump, the porous getter body is raised in temperature to that required for the specific getter material, maintained at such temperature for five to fifteen minutes and then slowly cooled. Several such cycles are preferable to effect the desired removal of the residual gases.

Thermionic devices made in accordance with the present invention have an exceedingly high degree of vacuum which is maintained throughout the life of the device. Where the getter body is mounted within the device so as to be heated

to an active or gettering temperature during the use cycles of the device, the gettering action is continuous throughout the life and use of the device. In devices wherein the porous getter body is not arranged to be heated to gettering temperatures during normal use of the device, it is possible to remove the tube from service periodically or when the operation indicates an abnormal loss of vacuum due to released gases, and restore the original degree of vacuum by heating the getter body by high frequency excitation. In many instances, restoration of the original degree of vacuum greatly extends the useful life of the thermionic device.

I claim:

1. In a high vacuum thermionic tube having a cathode and an anode, a getter element consisting of a self-supporting, sintered, porous body of a metal selected from the group consisting of aluminum, beryllium, chromium, uranium and mixtures of at least two of the metals.

2. In a high vacuum thermionic tube comprising an envelope, a cathode and an anode within said envelope, a self-supporting, sintered, porous body of a metal selected from the group consisting of aluminum, beryllium, chromium, uranium and mixtures of at least two of the metals; said body being arranged for heating to high de-gassing temperatures within said envelope.

3. In a high vacuum thermionic tube comprising an envelope, a heated cathode and an anode within said envelope, a self-supporting, sintered, porous body of a metal selected from the group consisting of aluminum, beryllium, chromium, uranium and mixtures of at least two of the metals; said body being arranged for heating to high de-gassing temperatures within said envelope and arranged to be heated to a relatively low temperature during use of the tube.

4. In a high vacuum thermionic tube having a cathode and an anode, a getter element consisting of a self-supporting, sintered, porous body of aluminum.

5. In a high vacuum thermionic tube having a cathode and an anode, a getter element consisting of a self-supporting, sintered, porous body of beryllium.

6. In a high vacuum thermionic tube having a cathode and an anode, a getter element consisting of a self-supporting, sintered, porous body of uranium.

7. In a high vacuum thermionic tube having an envelope and electrical elements therein including a cathode and an anode, a gettering element consisting of a self-supporting, sintered, porous body of a metal selected from the group consisting of aluminum, beryllium, chromium, uranium and mixtures of at least two of the metals, said body constituting at least a part of one of said electrical elements.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,689,297	Rentschler	Oct. 30, 1928
2,029,144	Wiegand	Jan. 23, 1936
2,100,746	Miller et al.	Nov. 30, 1937
2,295,694	Slack et al.	Sept. 5, 1942
2,362,468	Clark	Nov. 14, 1944