United States Patent

Gardner et al.

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[54] **BRAZING ALLOY FOR BONDING THERMIONIC CATHODE TO SUPPORT**

[72] Inventors: **Fred M. Gardner**, South Glastonbury; **Joseph R. Gervais**, Marlborough; **Frank S. Nettleton**, Meriden, all of Conn.

[73] Assignee: **United Aircraft Corporation**, East Hartford, Conn.

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[51] **Int. Cl.** **H01j 1/14,** H01j 19/06

[58] **Field of Search** 313/337, 346

[56] **References Cited**

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Primary Examiner—David Schonberg

Assistant Examiner—Toby H. Kusmer

Attorney—John D. Del Ponti

[57] **ABSTRACT**

A thermionic cathode comprising a thermionic emissive material consisting essentially of a metal boride, a support consisting essentially of a refractory metal which is reactive with the metal boride and a brazing material bonding the metal boride to the support and acting as a barrier to prevent reaction therebetween.

5 Claims, 2 Drawing Figures

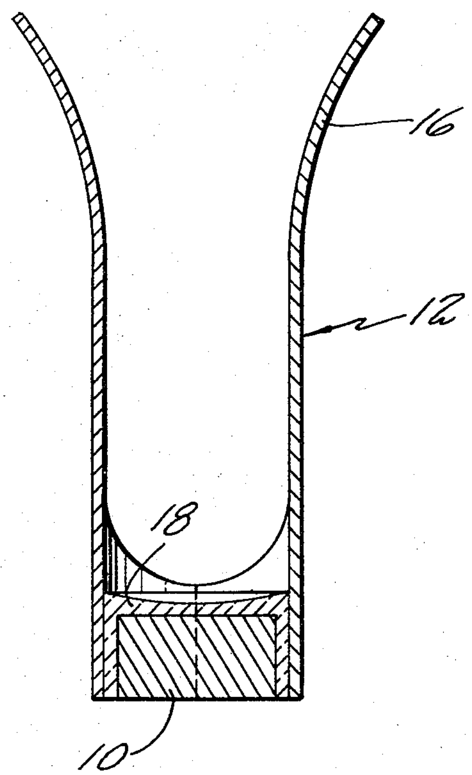


FIG. 1

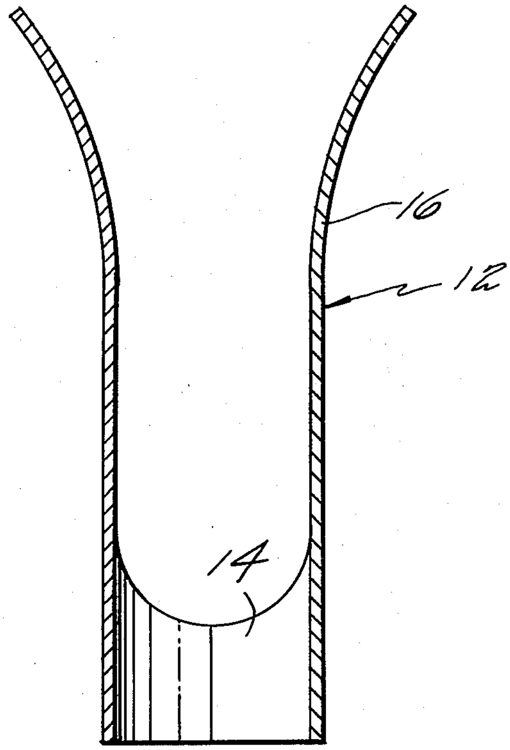
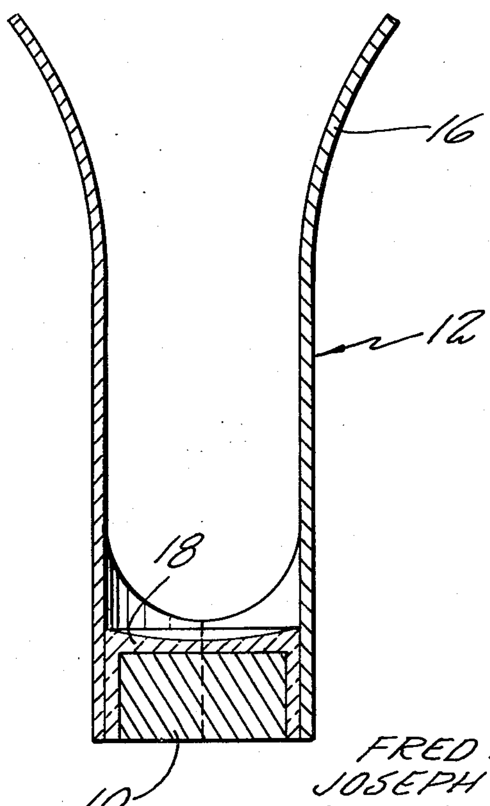


FIG. 2



INVENTORS
FRED M. GARDNER
JOSEPH R. GERVAIS
FRANK S. NETTLETON
BY
ATTORNEY

BRAZING ALLOY FOR BONDING THERMIONIC CATHODE TO SUPPORT

BACKGROUND OF THE INVENTION

It is known that metal borides possess attractive features for use as thermionic electron emitters in cathodes which are repeatedly exposed to air. The metal borides are generally characterized by a relatively low work function (e.g., 2.66 electron volts for lanthanum hexaboride) and a relatively high stability against ionic bombardment when compared to most conventional cathode materials. In order to exploit the potential of the metal borides however, it is necessary to incorporate the material as a compatible part of the cathode structure.

One of the paramount problems in obtaining cathodes of a high current density yield resides in the fabrication difficulties associated with the metal borides. Lanthanum hexaboride, for example, is characterized by a brittleness and hardness which prevent its usage as a self-supporting structure. Furthermore, lanthanum hexaboride not only fails to adhere well to refractory metals commonly used as supports, such as tantalum, molybdenum and tungsten, but also reacts with the same at elevated temperatures such as those encountered at or near normal operating conditions.

SUMMARY OF THE INVENTION

The present invention relates to cathode means utilizing a metal boride as a thermionic emissive material and more particularly relates to cathode means wherein a metal boride is adhered, without subsequent reaction, to a refractory metal support with which it is normally reactive at elevated temperatures. The invention contemplates the use of borides of elements having atomic numbers 57 through 70 such as for example lanthanum hexaboride, and the borides of the rare earths. It also contemplates the use of refractory metal supports such as for example those comprised of tantalum, molybdenum, tungsten or rhenium.

According to one aspect of the invention, a directly heated planar lanthanum hexaboride cathode, capable of yielding an emission density of 10 amperes per cm^2 and higher, is produced by interposing a brazing alloy between a lanthanum hexaboride pellet and a tantalum supporting structure and, in a vacuum, heating to the melting point of the brazing alloy.

BRIEF DESCRIPTION OF THE DRAWING

An understanding of the invention will become more apparent to those skilled in the art by reference to the following detailed description when viewed in light of the accompanying drawing, wherein

FIG. 1 is a side elevational view of the refractory metal support and

FIG. 2 is a side elevational view, in section, of a thermionic cathode after bonding of the emitter to the refractory metal support.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, wherein like numerals indicate like parts, the numeral **10** indicates a thermionic electron emitter, in pellet form, consisting essentially of a boride of an element having an atomic number of from 57 through 70, and preferably of LaB_6. The emitter **10** is preferably made by hot pressing together particles of the boride. In the case of LaB_6, satisfactory emitters were made after being subjected to a temperature of 2,000° C and a pressure of 7,000 psi for 10 minutes. The formed emitter is then positioned concentrically within a support **12** made of a refractory metal such as tantalum. The support **12** comprises a pair of hollow half-circular portions **14** spaced opposite each other to form, in effect, a hollow cylinder which is diametrically split along its axis. Each portion **14** has a leg **16** preferably integrally formed therewith.

With the emitter concentrically disposed within the support **12** and both the support and the emitter supported on a flat surface within a vacuum chamber, the legs **16** are spot welded to heating leads and the area between the emitter **10** and the portions **14** as well as the area behind the emitter are filled with a suitable braze material **18**, preferably in powder form. Braze materials such as $TaSi_2$ and $MoSi_2$ have been found suitable. The chamber is then evacuated to low pressure and the assembly is ohmically heated to the melting point of the braze material. As soon as the braze material is melted, the heating current is quickly reduced and the structure is cooled. The above procedure allows sufficient time for the liquid braze material to fill the entire volume between the emitter **10** and the support **12** yet retains enough material behind the emitter to produce a mechanically sound braze. In this way, the braze material encases all but the emitter face of the boride material. After cooling, the cathode assembly is removed from the vacuum and is faced off by sanding or grinding.

In the practice of the invention, a tantalum support having a wall thickness of 0.005 inches was used along with a hot-pressed LaB_6 pellet and, for a braze material, high purity powdered $MoSi_2$ or $TaSi_2$. The components, assembled as hereinbefore described, were subjected to a vacuum of from 10^{-5} to 10^{-6} torr at a temperature of from approximately 2,000° to 2,500° C. A low powered microscope was used to directly view the $MoSi_2$ or $TaSi_2$ in order to determine when it melted.

Cathodes constructed in the above manner were subjected to vacuum tests. At 10^{-6} torr or better, with the temperature at 1,600° C, the cathodes demonstrated lifetime capabilities of 400 hours or more at a current density of 5 to 10 amperes per cm^2.

What has been set forth above is intended primarily as exemplary to enable those skilled in the art in the practice of the invention and it should therefore be understood that, within the scope of the appended claims, the invention may be practiced in other ways than as specifically described.

What is claimed is:

1. A thermionic cathode comprising a thermionic emissive material consisting essentially of a boride of an element selected from the group consisting of elements having an atomic number of from 57 through 70, a support consisting of a refractory metal which is reactive with said boride at the normal operating temperature of the cathode, and a brazing alloy encasing all but the emitter face of the boride material, said brazing alloy bonding said boride to said support and being of sufficient thickness to prevent reaction therebetween.

2. The invention of claim **1** wherein said metal boride is lanthanum hexaboride.

3. The invention of claim **2** wherein said refractory metal is tantalum.

4. The invention of claim **3** wherein said brazing alloy is tantalum disilicide.

5. The invention of claim **3** wherein said brazing alloy is molybdenum disilicide.

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