Lewis

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO ATTN OF: GP

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No. : 3,552,124

Government or Corporate Employee : U.S. Government

Supplementary Corporate Source (if applicable) : n/a

NASA Patent Case No. : LEW-10106-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes ☐ No ☒

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of. . . "

Elizabeth A. Carter

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Enclosure
Copy of Patent cited above

FACILITY FORM 602

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ION THRUSTOR ACCELERATOR SYSTEM

Filed Sept. 9, 1968

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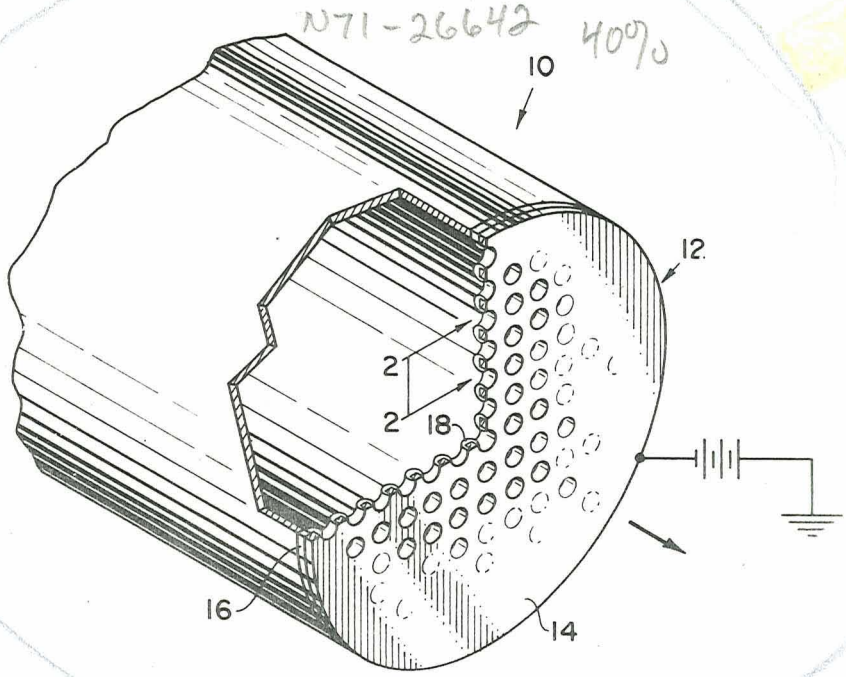

FIG. 1

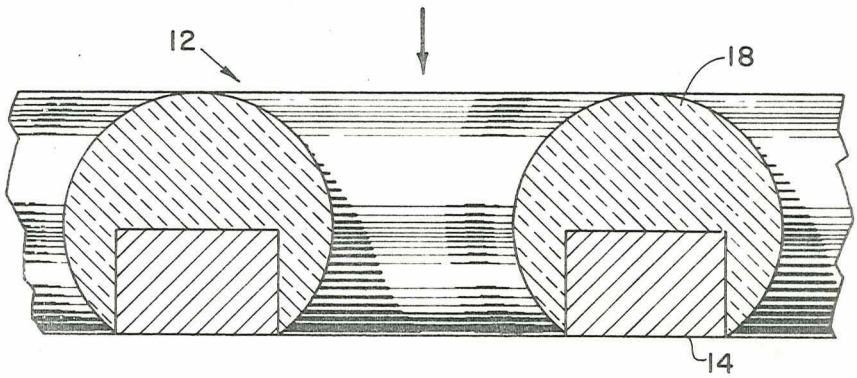

FIG. 2

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1642

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3,552,124

ION THRUSTOR ACCELERATOR SYSTEM

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Filed Sept. 9, 1968, Ser. No. 758,390

Int. Cl. F03h 5/00

U.S. Cl. 60—202 1 Claim

ABSTRACT OF THE DISCLOSURE

A single coated grid accelerator system for an ion thrustor. The grid is coated with an insulating material that is bonded to its surface.

STATEMENT OF GOVERNMENT OWNERSHIP

The invention described herein was made by employees of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

This invention is concerned with a single grid accelerator system for an ion thrustor. The invention is particularly directed to a glass coated grid for use in such a system.

Double grid accelerator systems have been used on ion thrustors. Such systems combine a screen grid with an accelerator grid. A screen grid increases the thrustor weight and complexity. Also problems of thermal buckling and warping have been encountered, and prevention of electrical shorting of the grids presents an insulating problem.

A single grid accelerator system was suggested in an attempt to solve these problems. Such a system may have boron nitride clamped to the accelerator grid. It was also proposed to spray aluminum oxide onto the accelerator grid. It was further suggested that a ceramic material be cemented on the accelerator grid.

Various difficulties were encountered in using these grids. Because the boron nitride had to be clamped onto the grid it was in the form of thick sheet to prevent cracking. The use of a thick insulating coating reduces thrust because of the increased acceleration distance of the ions. The use of thick coatings also limited the size of the ion thrustor because as the diameter of the grid increased the insulator thickness had to be increased to prevent cracking. The flame sprayed aluminum oxide coatings degraded because it is extremely porous to mercury. The ceramic cements are also porous and failed in a manner similar to that of the aluminum oxide coatings.

SUMMARY OF THE INVENTION

These problems have been solved in the accelerator system constructed in accordance with the present invention which utilizes a single glass coated grid. The glass forms a strong mechnical bond to a metal grid. When the coating is of the required thickness it is electrically reliable.

It is, therefore, an object of the present invention to provide an ion thrustor having an accelerator system which utilizes a single grid thereby eliminating the problems encountered in a double grid system.

Another object of the invention is to provide an improved accelerator grid which enhances the ion extraction capability of an ion thrustor.

A still further object of the invention is to provide an improved grid structure for an ion thrustor which enables

larger diameter accelerator systems to be used for low voltage operation.

These and other objects of the invention will be apparent from the specification which follows and from the drawing wherein like numerals are used throughout to identify like parts.

DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 is an isometric view with parts broken away of an ion thrustor having an accelerator system constructed in accordance with the present invention, and

FIG. 2 is an enlarged sectional view taken along the line 2–2 in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In a typical electron bombardment ion thrustor of the type described in U.S. Pat. No. 3,156,090, mercury vapor is fed into an ionization chamber through a distributor plate. Atoms of the vaporized propellant are then bombarded by electrons emitted from a cathode. The path length traveled by electrons going from this cathode to an anode is greatly increased by an axial magnetic field thus causing more ionization by electron bombardment.

Such a conventional ion thrustor utilizes a double grid accelerator system having both a screen grid and an accelerator grid. The screen grid serves to contain the discharge plasma while forming the necessary ion optics to prevent direct impingement of accelerated ions onto the accelerator grid. Ions in the near vicinity of the screen grid have a high probability of being accelerated through openings in the screen and the accelerator grids because of the high electric fields present at the grids. Thrust is produced as these ions accelerate through the grid system.

Referring now to the drawing an ion thrustor shown in FIG. 1 has an ionization chamber **10** for containing a propellant that has been ionized in any conventional manner. By way of example, this propellant may be mercury that is ionized by electron bombardment as described in the aforementioned U.S. Pat. No. 3,156,090.

The ion thrustor further includes an accelerator system **12** constructed in accordance with the present invention for accelerating propellant ions in the direction of the arrows in FIGS. 1 and 2. The accelerator system **12** utilizes a single grid **14** of an electrically conducting material that is connected to a source of electric power, such as a battery, as shown in FIG. 1. This electrical power source impresses a potential on the grid **14** that is highly negative relative to the ionization chamber **10**.

An insulator **16** having an annular configuration extends about the periphery of the ionization chamber **10**. The insulator **16** serves to electrically isolate the single grid **14** from the metal housing forming the ionization chamber **10**.

An important feature of the invention is that the electrically conducting grid **14** is coated with an insulating material **18**. This insulating coating **18** is bonded to the grid **14** as best shown in FIG. 2.

In a conventional double grid system of the type previously described, a plasma sheath is formed near the upstream surface of the screen grid. In the single grid system of the present invention, the sheath is believed formed near the upstream surface of the insulating coating **18**. Because of the high electrical resistance of the insulating coating **18**, charges can build up on its surface to form a virtual screen grid.

In this manner the plasma sheath is moved closer to the negative accelerator **14**. This increases the field strength for a given voltage which, in turn, increases the ion beam current density.

The grid 14 is electrically conductive to establish the proper electrostatic field for accelerating the ions in the chamber 10. Because a portion of the electrically conducting grid 14 is not covered by the insulating material 18, sputtering erosion of the exposed surface of the grid 14 may be encountered. Where long life is of importance the electrically conducting grid 14 is a metal which is resistant to sputtering erosion. Molybdenum is a grid metal that has been found to be resistant to such erosion.

The grid 14 is preferably of a metal which has a thermal expansion coefficient that matches the thermal expansion coefficient of the insulating material 18, which is preferably glass. Molybdenum has been satisfactory for grids 14 that are coated with glass. It is also contemplated that stainless steel, tungsten, and tantalum can be used for the grid 14.

A slurry is prepared by suspending finely milled particles of the insulating material 18 in a solution of water or some other organic or inorganic solvent. This slurry is sprayed onto one face and walls of the holes in a perforated plate forming the grid 14. The grid surfaces to be coated are initially oxidized prior to being covered with the sprayed slurry.

The insulating coating 18 is preferably a type of glass that forms a good seal with the material of the grid 14. Corning glass 7052 has been found to be satisfactory for the slurry used in coating a molybdenum grid.

When the sprayed on slurry dries, the grid 14 is placed in an oven which is at a temperature hot enough to fuse the fine glass particles together and to seal the glass to the metal. Great care must be taken to insure the proper firing temperature to prevent the glass from flowing over and covering the accelerator grid holes or openings. If the temperature is too low the glass will not fuse or form a good bond. The glass preferably has a working temperature greater than about 1400° F so that the glass remains a good insulator at the ion thrustor operating temperature. Corning glass 7052 has a working temperature of of about 2000° F.

After removing the grid from the firing oven it is permitted to cool slowly. FIG. 2 shows the glass coating 18 after firing. By using a fused glass type seal, optimum results are obtained between the insulator and the grid. The glass coating is permanently impervious to mercury diffusion which causes other types of oxides or ceramic coatings to fail.

While a preferred embodiment of the invention has been described it will be appreciated that various modifications may be made to the disclosed structure and materials without departing from the spirit of the invention or the scope of the subjoined claims. For example, the size of the coated grid as well as the geometry of the perforations may be varied. It is further contemplated that the geometry of the coating may be changed to meet special requirements. A single grid accelerator system constructed in accordance with the invention can be used with various types of thrustors using other propellant materials. By way of example, such an accelerator system can be used with a contact ionization thrustor utilizing cesium as a propellant.

What is claimed is:

1. In an accelerator system for an ion thrustor having a chamber for containing an ionized propellant, the improvement comprising

a single electrically conducted metal plate having a plurality of apertures therein mounted at one end of said chamber, said plate having a first surface facing toward said chamber and a second surface facing away from said chamber, each of said apertures having a wall extending between said first surface and said second surface,

a fused glass coating covering said first surface and said wall of each of said apertures for protecting the same from sputtering erosion, and

means for applying a potential to said metal plate that is highly negative to said chamber whereby the ionized propellant is accelerated through each of said apertures without contacting said wall thereof.

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U.S. Cl. X.R.

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