B. A. BANKS
ION THRUSTER MAGNETIC FIELD CONTROL
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FIG. 1

FIG. 2

FIG. 3

INVENTORS
BRUCE A. BANKS

BY
Norman C. Musick
Gene E. Troost
ATTORNEY
ION THRUSTER MAGNETIC FIELD CONTROL

Bruce A. Banks, Olmsted Township, Cuyahoga County, Ohio, assignor to the United States of America as represented by the Administrator of the National Aeronautics and Space Administration

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ABSTRACT OF THE DISCLOSURE

The magnetic field of an ion thruster is automatically shunted when the thruster is not operating.

ORIGIN OF THE INVENTION

The invention described herein was made by an employee 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 controlling the magnetic field of an ion thruster for improved starting and to enable adjacent magnetic field sensing devices to properly sense the natural magnetic field. The invention is particularly directed to a temperature controlled magnetic shunting system that is self-control and operates without power.

An electron bombardment ion engine of the type shown in U.S. Pat. No. 3,156,090 has a chamber in which a vaporized propellant is ionized by high velocity electrons emitted by a cathode. A magnetic field is used to increase the path traveled by the high velocity electrons so that more electrons will collide with propellant particles in the chamber.

Transverse difficulties have been encountered with starting a thruster having a high magnetic field. Also satellites and planetary probes using electron bombardment ion thrusters may carry magnetic field sensing devices. The natural magnetic field will not be properly sensed if the sensing device is influenced by the ion thruster.

An electromagnet has been used to produce the required magnetic field. While an electromagnet provides accurate control of the magnitude of the magnetic field it consumes power and requires power conditioning equipment. This equipment adds weight and complexity to the thruster.

Electrostatic ion thrusters of the type shown in U.S. Pat. No. 3,238,715 utilize permanent magnets to produce the required magnetic field. While these permanent magnets require no power there is no control of the magnetic field.

SUMMARY OF THE INVENTION

These problems have been solved by the present invention wherein a thruster is provided with a permanent magnet shunting structure that functions automatically. During operation of the thruster the required magnetic field is provided by a permanent magnet. When the thruster is not operating the magnetic field is confined to a very small region to eliminate stray field lines which might interfere with the natural magnetic field found by adjacent magnetic field sensors.

OBJECTS OF THE INVENTION

It is, therefore, an object of the present invention to provide an automatic control for the magnetic field of an ion thruster.
temperature of the surrounding shunt alloy 34 when the thruster is not operating.

When a weak discharge is obtained between the cathode 20 and the anode 26 the housing 34, the anode, the permanent magnets 32, and a housing of the thruster. In this embodiment no other housing structure is utilized. The anode 26 is adjacent the shunting material 36.

While the preferred embodiment of the invention has been shown and described it will be appreciated that various structural modifications may be made without departing from the spirit of the invention or the scope of the subjoined claims. By way of example, the anode 26 may also be made of the shunting alloy. Also the body of the thruster may be fabricated in the form of concentric cylinders of permanent magnet and shunting alloys. It is further contemplated that the cathode pole piece may be fabricated in the form of concentric cylinders of permanent magnet and shunting alloys.

What is claimed is:

1. An electron bombardment ion thruster comprising: a housing forming the peripheral wall of the chamber for containing an ionizable propellant, a source of said propellant in communication with said chamber, an anode within said chamber, a cathode for emitting high velocity electrons to said anode for bombarding said propellant to form ions, an apertured grid positioned at one end of said chamber to accelerate said ions away from said thruster, a plurality of permanent magnets adjacent said housing to form a magnetic field about said anode and cathode whereby the paths of said high velocity electrons are lengthened to increase the rate of collision of said electrons with particles of said propellant, and means in close proximity with said permanent magnets for shunting said magnetic field only when the temperature in said chamber is below a predetermined minimum value.

2. An electron bombardment ion thruster as claimed in claim 1 wherein the magnetic field is established by high ferromagnetic Curie temperature permanent magnets spaced about the chamber.

3. An electron bombardment ion thruster as claimed in claim 2 wherein the permanent magnets are of an aluminum-nickel alloy.

4. An electron bombardment ion thruster as claimed in claim 2 wherein the means for shunting the magnetic field comprises a low ferromagnetic Curie temperature material adjacent the permanent magnets.

5. An electron bombardment ion thruster as claimed in claim 4 wherein the shunting material is a nickel-iron alloy.

6. An electron bombardment ion thruster as claimed in claim 5 wherein the nickel-iron alloy contains about 30% nickel and 70% iron by weight.

7. An electron bombardment ion thruster as claimed in claim 4 wherein the shunting material surrounds the permanent magnets.

8. An electron bombardment ion thruster as claimed in claim 7 wherein the low ferromagnetic Curie temperature material forms the housing of the thruster.

9. An electron bombardment ion thruster as claimed in claim 1 wherein the anode is of a low ferromagnetic Curie temperature shunting material.

10. An electron bombardment ion thruster as claimed in claim 1 wherein the housing is in the form of concentric cylinders of permanent magnetic and shunting alloy materials.

References Cited

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DOUGLAS HART, Primary Examiner
R. B. ROTHMAN, Assistant Examiner

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313—161