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METHOD OF IONIC PROPULSION UTILIZING A LASER-STIMULATED IONIC EMISSION

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Fig. 1.

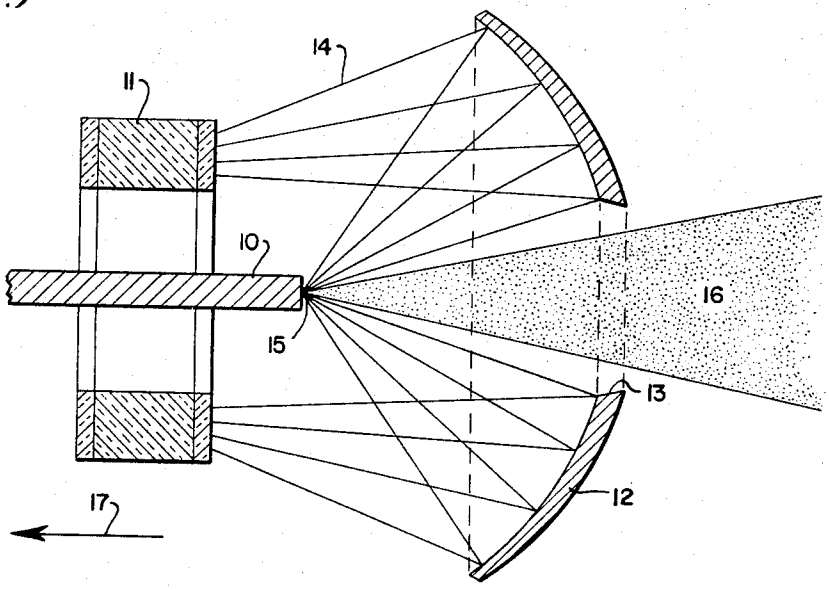
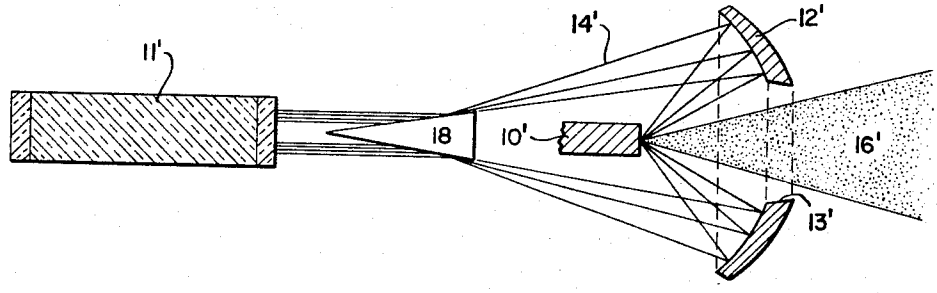


Fig. 2.



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METHOD OF IONIC PROPULSION UTILIZING A LASER-STIMULATED IONIC EMISSION

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ABSTRACT OF THE DISCLOSURE

A laser beam is focused to a small spot area of a metallic thrustor causing the emission of a plasma, consisting of ions and electrons, in which the initial velocity of the ions is sufficiently high to develop a propulsion thrust.

This invention relates to an improved ion engine propulsion system.

Ion engines presently in use require elaborate ion accelerators to produce exhaust velocities high enough to develop a usable thrust. Accelerators are necessary because ions produced by present methods do not acquire any appreciable velocity upon emission from the ion source and hence are not capable of developing any appreciable thrust. Because of the opposite polarity between positively charged ions and negatively charged electrons, the ion accelerating structure will eject only ions. This results in a net unbalanced charge of negative value on the spacecraft. This negative charge tends to draw back the positive ions, thereby decreasing the velocity thereof. Without correction ion flow ceases altogether. Thus, accelerators introduce the problem of beam neutralization. Various types of neutralization structures have been developed whereby, in use, the net charge of the exhausting beam is substantially zero. As with the case of accelerating structure, these beam neutralizers increase the weight and complexity of the system, as by tubing and electrical connections.

It is accordingly a principal object of the present invention to provide an ion engine propulsion system wherein accelerating structure and therefore beam neutralizing structure are no longer required.

Another object of the present invention is to provide an ion engine propulsion system wherein the ions emitting from the ion source do so with sufficient velocity to develop a usable thrust.

Basically, the principles of the present invention are carried out by focusing a beam of high energy coherent light on an area of the spacecraft thrustor. It has been found that a high density ion emission having very high velocities is produced when a beam of laser light is focused on the surface of a suitable material, as for example, tungsten. This high velocity ion particle flow produces in and of itself a thrust sufficient to propel a spacecraft in a desired direction.

For a fuller understanding of the present invention, reference may be had to the following description thereof taken in conjunction with the accompanying drawing wherein:

FIGURE 1 is a diagrammatic longitudinal sectional view of one method of directing a laser beam on the surface of a spacecraft thrustor; and

FIGURE 2 is a variation of the arrangement shown in FIGURE 1.

Referring now to FIGURE 1, an ion emitting thrustor

10 is attached to or otherwise made an integral part of a spacecraft (not shown). The thrustor is shown, for example, as a solid cylindrically shaped rod made of any suitable ion producing material as, for example, tungsten. Surrounding the thrustor **10** and in spaced relation thereto is an annular laser device **11** which can be made of well-known types as, for example, ruby crystals. Spaced a predetermined distance from laser **11** and thrustor **10** is a concave focusing mirror **12**. The mirror is of spherical or dish shape with the central or hub portion thereof removed as at **13**, and may be fabricated of a highly reflective conducting material.

In operation, a beam of laser light indicated at **14** is focused on a small spot area **15** of thrustor **10** by means of reflecting mirror **12**. Since the spot is very small, say a few mils in diameter, the localized radiation energy per unit area is going to be very high regardless of the particular energy level of the laser. Therefore, the exact energy output of the laser is not critical and conventional ruby lasers of from one to ten joule strengths would operate satisfactorily. The high energy laser light beam on spot **15** causes the emission of a plasma **16** consisting of electrons and ions, which plasma passes through the opening **13** in mirror **12**. The velocity of the ions in this plasma is sufficiently high to create a thrust in a direction of arrow **17**. The thrustor **10**, therefore, is propelled in the direction of arrow **17**, causing a corresponding movement of the spacecraft to which the thrustor is attached.

FIGURE 2 is a variation of the arrangement shown in FIGURE 1; wherein the numerals refer to like parts except as distinguished by a prime. Instead of using an annular laser ring as in FIGURE 1, a solid cylindrical laser **11'** is utilized. This makes necessary the insertion of an additional reflecting mirror **18** between the laser and the thrustor **10**. Except for this, however, the structure shown in FIGURE 2 operates in the same manner as that shown in FIGURE 1.

The reasons why the laser beam is capable of producing such high ionic emission are not precisely known; however, several theories have been advanced any one or all of which may be explanatory:

(1) Thermionic emission by high heat content of laser beam.

(2) Thermionic emission enhancement by the absorption of photons from laser beam.

(3) Thermal ionization in gas, i.e., collision of atoms.

(4) Thermionic emission enhancement of absorption of energy from thermionically emitted electrons.

Propelling a spacecraft in the manner described hereinabove will reduce the overall weight and complexity of the propulsion system, as by elimination of all the electrical connections and hardware associated with the heretofore used accelerators and beam neutralizers. In addition to this, the craft will no longer have to carry boiler structure to vaporize the ion metal source because with the present procedure the ionization occurs directly from the metal ion source without first converting a bulk thereof into gaseous form. This means that great torque arms can be taken advantage of to produce greater turning movement on the craft for attitude control. In which case, a plurality of thrustors would be suitably arranged about the spacecraft.

While one of the main advantages of the present invention resides in the elimination of the necessity for beam accelerators and neutralizers, it is clear that such structure may be advantageously used if desired to pro-

duce even greater exhaust velocities and therefore greater thrusts.

It is intended that the invention be limited only by the scope of the appended claim.

What is claimed is:

1. The method of developing a propelling thrust in an ion propulsion engine comprising the steps of:

(a) placing a metallic thrustor on said engine and oriented such that movement of said engine in a desired direction will occur when said thrustor is actuated,

(b) forming a beam of laser light, and,

(c) directing said beam on a portion of an end surface of the thrustor to ionize the metallic material of said thrustor end surface portion, thereby producing a flow of ion particles having high initial velocity, producing a reaction thrust against said end surface of said thrustor.

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CARLTON R. CROYLE, *Primary Examiner.*