Sept. 22, 1964 J. ULAM 3,149,459

ELECTRIC ARC TYPE PROPULSION MOTOR

Filed July 30, 1959

Fig. 1.

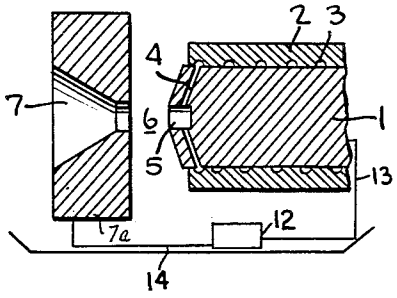


Fig. 3.

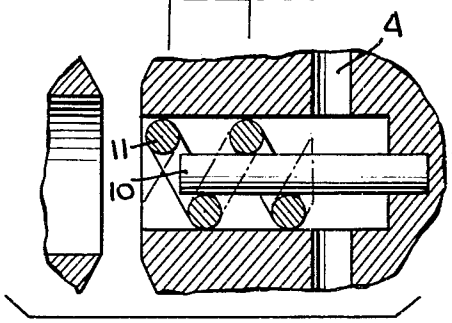


Fig. 2.

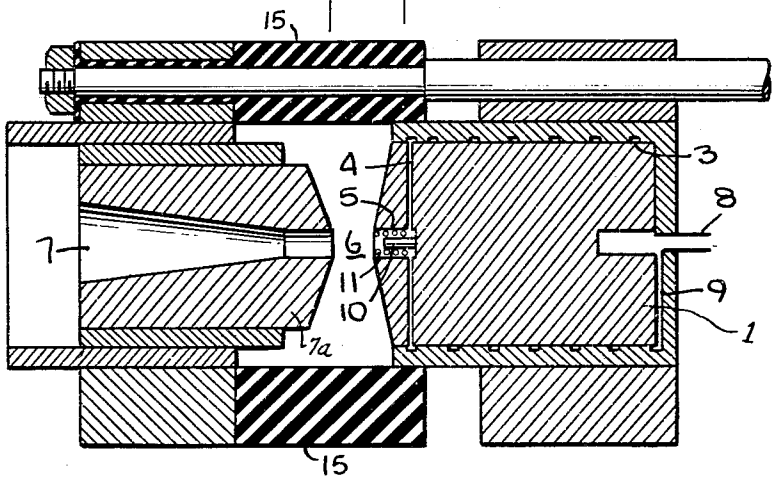


Fig. 4.

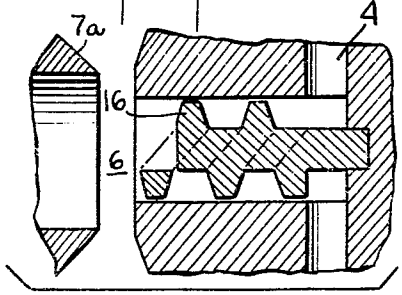
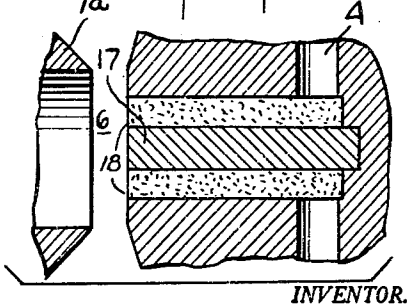


Fig. 5.



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ELECTRIC ARC TYPE PROPULSION MOTOR

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Electric arc type propulsion is based on the transformation of electric energy into kinetic energy and the type of motor depends on the process employed to bring about this transformation.

In electrothermic jet motors the ejected body, said working fluid, is heated electrically. The conversion of the thermal energy transmitted to the working fluid into kinetic energy is then obtained by expansion, according to the usual process. In this case, the electric energy simply replaces the chemical energy usually employed in the jet engines to bring the working fluid to a high temperature. Based on this principle it is possible to design the electric ram-jet engines, in which air is used as the working fluid, as well as electric rocket motors utilizing a working fluid contained in tanks. The most effective means of heating the working fluid is to employ an electric arc, which permits attainment of very high temperatures, impossible to obtain by any other way.

The problems arising in such case are the method of supplying working fluid as well as the form of arc discharge.

The object of the present invention is to provide a device in which the working fluid is supplied through the inside of the electrode or over its surface to the surface on which it is abruptly transformed in vapor, the latter being superheated and ejected at a high velocity.

The liquid arrives, preferably parallel to the surface of the foremost part of the electrode, which presents a footing of the arc; the attachment of the arc to the surface of the foremost part of the electrode is due to the locally reduced heat of evaporation and to the lower value of the work of entry of electrons into the liquid.

Any liquid can be utilized as the working fluid, preferably however a conducting liquid, such as the mercury or an amalgam, a liquid alloy or water acidified or containing some salts.

By a convenient choice of the form of the flow passages conducting the liquid to the surface of the foremost part of the electrode it is possible to employ this liquid for the cooling of the electrode and also obtain also an initial pre-heating of the liquid.

According to the invention the liquid can arrive on the surface of the foremost part of the electrode through a porous zone or along several flow passages which provide for its arrival parallel to this surface.

The attachment of the arc on the surface of the electrode spot can be facilitated by a rod of a refractory material placed in the mass of the liquid and having the form e.g. of a point or ring.

The cavity by which the liquid arrives can possess the form of a small canal disposed in the axis of the electrode and containing a central rod surrounded by a helical spiral forming the flow passage or a similar arrangement; it can be also constituted by a piece of porous carbon or carbon containing a great number of small canals.

The enclosed drawing shows—as non-limitating examples—several ways of realization of the invention.

The FIG. 1 represents a section of a simple form of the essential part of the device.

The FIG. 2 represents a section of a form of the whole device.

The FIGS. 3, 4 and 5 represent three embodiments of the cavity conducting the product to the surface of the foremost part of the electrode.

In the FIG. 1 the electrode **1** and the socket **2**, provided

with a helical canal **3**, form a helical flow passage for the liquid which arrives, through the canal **4**, to the cavity **5**. In arc chamber **6** the liquid is abruptly transformed into vapor by the action of the electric arc, this vapor then being superheated and ejected at a high velocity through the nozzle **7** in the other electrode *7a*.

Electrical energy to form the electric arc is provided by energy source **12**. As shown in FIG. 1, conducting leads **13** and **14** connect electric energy source **12** to electrodes **1** and *7a*, respectively.

In the FIG. 2 the liquid—contained in a tank not shown in the drawing—passes through the flow passage **8**, then through passage **9** constituted by the helical canal **3** formed either in the internal surface of the socket **2** or in the external surface of the electrode **1**. From the helical flow canal **3** the liquid, passing through the canal **4**, attains the cavity **5** inside of which there is a central rod **10** surrounded by a helical spiral **11**; the arrangement composed of the last two parts forms a second helical flow passage which conducts the liquid in such a way as to make it emerge on the surface of the foremost part of the electrode **1** almost parallel to this surface. In arc chamber **6**, under the action of the arc, the liquid is abruptly evaporated, the vapor superheated and ejected at a high velocity in the nozzle **7** made in the other electrode *7a*. Electrodes **1** and *7a* are insulated from each other by a suitable insulating material **15**.

FIGURE 3 represents an enlarged sectional view of the second helical flow passage according to FIGURE 2.

The FIG. 4 represents a section of a drawn rod **16**, which can be employed instead of the arrangement described above, to form the second helical flow passage.

The FIG. 5 represents a section of an arrangement in which the liquid arrives on the surface of the electrode passing through porous walls **18** surrounding the central rod **17**.

Summary

The invention concerns:

(1) A device for electric jet propulsion characteristic in that the working fluid is supplied to the surface of the electrode through the interior or along the surface of the latter, and transformed abruptly in vapor which is superheated and ejected at a high velocity.

(2) The embodiments of the device conform to 1, characterized by the following points which can be employed separately or in various combinations:

(*a*) The liquid arrives at a given place at the foremost part of the electrode which forms the footing of the arc.

(*b*) The flow passages which conduct the liquid to the surface of the foremost part of the electrode are arranged in the manner which uses the liquid for the cooling of the electrode and causes an initial pre-heating of the liquid.

(*c*) The liquid is supplied to the surface of the foremost part of the electrode through several flow passages which cause the liquid to arrive so that it emerges on the surface almost parallel to the surface.

(*d*) The flow passage conducting the liquid to the surface of the foremost part of the electrode is formed by a cylindrical rod surrounded by a helical spiral.

(*e*) The flow passage is formed by a drawn rod.

(*f*) The liquid arrives at the surface of the foremost part of the electrode passing through a porous zone.

(*g*) In the cavity containing the liquid a piece of a refractory material is placed, having, e.g., a form of a point or of a ring.

What is claimed is:

1. An electrothermic jet motor comprising, in combination, an arc chamber, a first and second electrode disposed in said arc chamber, said electrodes being in line

with each other and separated by a gap to provide an arc discharge therebetween, an inlet for a working fluid, a cavity in said first electrode located in the foremost part of said first electrode adjacent said gap, passageway means for transporting said working fluid from said inlet into said cavity and adapted to promote heat exchange between said first electrode and said working fluid, a concentrically disposed refractory rod in said cavity, fluid distribution means surrounding said rod and adapted to emit said working fluid into said gap substantially parallel to the surface of said first electrode, said second electrode having a jet nozzle therein whose axis of symmetry substantially coincides with the direction of propagation of said arc discharge, said nozzle being adapted to convert thermal energy into kinetic energy.

2. The device of claim 1 wherein said fluid distribution means comprises a helical spiral body.

3. The device of claim 1 wherein said fluid distribution means comprises a porous refractory material.

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