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A Bibliography of Electrothermal Thruster Technology, 1984

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CONTENTS

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SUMMARY

Electrothermal propulsion concepts are briefly discussed as an introduction to a bibliography and author index for resistojets, thermal arcjets, pulsed electrothermal thrusters, microwave heated devices, solar thermal thrusters, and laser thermal thrusters.

INTRODUCTION

Electrothermal propulsion systems have characteristics that are attractive for geosynchronous satellite stationkeeping, altitude maintenance for low Earth orbiting spacecraft, maneuvering, and orbit raising. Electrothermal thrusters comprise resistojets, thermal arcjets, pulsed electrothermal thrusters, microwave heated devices, solar thermal thrusters, and laser thermal thrusters (figs. 1 to 6).

Resistojets (fig. 1) use resistive elements to heat the propellant and, thus, increase exhaust velocity. Potential propellants for resistojets include nitrogen, ammonia, hydrogen, carbon dioxide, steam, and mixtures of carbon dioxide or methane and hydrazine. Resistojet propulsion is the most mature technology of those discussed herein. Approximately 26 flight experiments and operational propulsion systems using resistojets were developed from 1965 to 1984. In 1984, 40 hydrazine resistojets are performing north/south stationkeeping on 8 Intelsat V and 3 RCA spacecraft (refs. 01:225:1981 and 01:234:1983). NASA is now pursuing the development of a permanent facility in low Earth orbit. This facility will comprise a manned space station core, co-orbiting platforms, and free-flying spacecraft which require propulsion systems for orbit maintenance, maneuvering, and possibly attitude control. The resistojet system is a candidate to satisfy these auxiliary propulsion requirements, which are more demanding and variable than those of present space systems.

The thermal arcjet (fig. 2) converts electrical energy to thermal energy by using an arc discharge. The thermal energy is further changed to directed kinetic energy by expanding the propellant through a nozzle. Thermal arcjets for space propulsion were the object of significant technology efforts from about 1959 to 1965. Today, a renewed interest in the arcjet rests on its potential for high-performance stationkeeping systems, for satellite propulsion, and for high-power orbit raising applications.

Exploratory studies and some experimental evaluations have been made for pulsed electrothermal (ref. 06:003:1984), microwave (ref. 07:012:1984), solar thermal (ref. 08:003:1983), and laser thermal (ref. 09:019:1982) devices. Technology work deals primarily with concept feasibility and performance potential.

This report is a bibliography of the work related to the six types of electrothermal thrusters as well as to power processing and propellent management. An author index of all citations is also included.

DESCRIPTION OF THE BIBLIOGRAPHY

This bibliography is designed to give the technologist and systems engineer an extensive list of reports relating primarily to resistojet and thermal arcjet technology. A significant number of citations deal with propellent management, power systems, and other electrothermal propulsion concepts.

There are nine separate categories under which the reports are listed: resistojets, thermal arcjets, related topics, propellent management, power and control, pulsed electrothermal thrusters, RF and microwave devices, solar thermal thrusters, and laser thermal thrusters. The entries are listed in an order such that the chronological order of the year of publication supersedes the alphabetical order of the author's last name. Each entry has a three-number code. The first number of the code is the category number. For example, resistojets are category one, and laser thermal thrusters are category nine. The category number is followed by the number of that particular entry within the category. The third number of the code is the year in which the report was published. This code permits easy location of each author's publication through the author index found at the end of the bibliography.

CONCLUDING REMARKS

The bibliography contains nearly 700 citations relating primarily to low-thrust (<1 N), electrothermal propulsion system technology. Included in the bibliography are three survey papers on electric propulsion (01:230:1982), 01:235:1983, 01:239:1984), three survey papers relating primarily to resistojets and arcjets (02:106:1965, 01:181:1973, 01:231:1982), and one survey paper on laser research and applications (09:022:1983). Other papers summarize the performance, design criteria, and technology status for electrothermal thrusters, power processors, and propellent system components. Many papers deal with mission analysis, system studies, propulsion system design, thruster materials, propellent properties, diagnostic methods, flow field effects, and nozzle performance. The bibliography has been designed to facilitate updating.

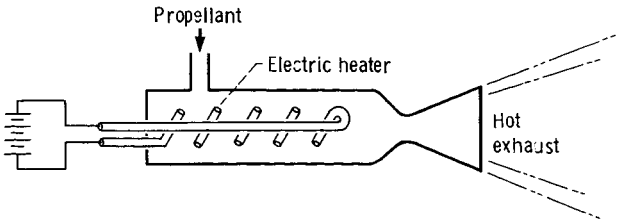

Figure 1. - Resistojet.

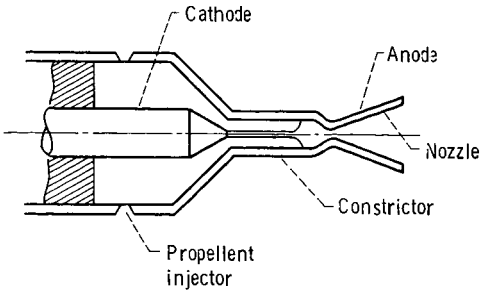

Figure 2. - Thermal arcjet.

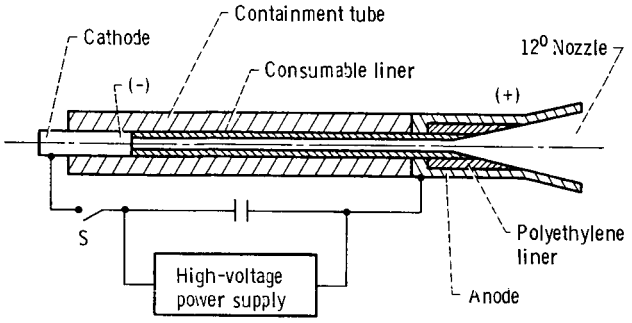

Figure 3. - Pulsed electrothermal thruster.

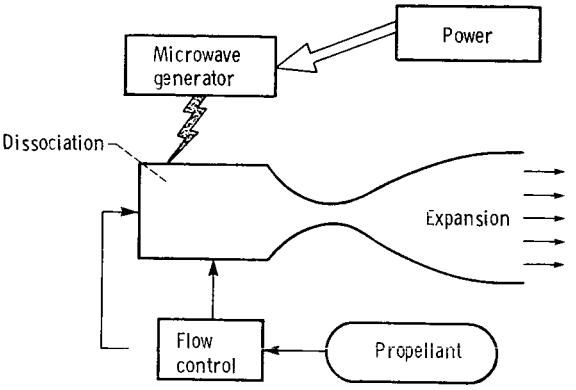

Figure 4. - Microwave heated device.

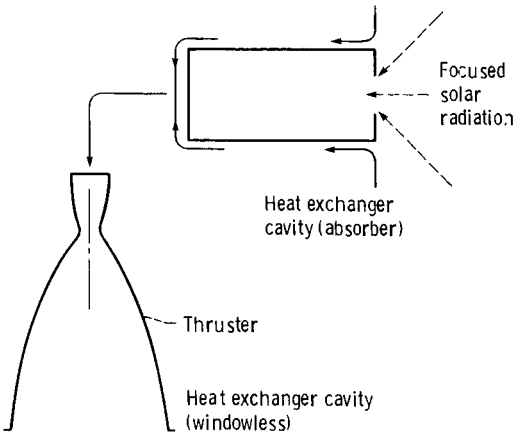

Figure 5. - Solar thermal thruster.

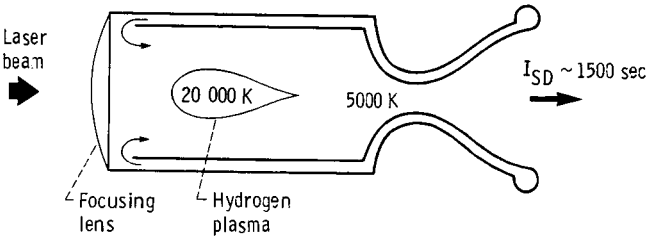

Figure 6. - Laser thermal thruster.

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16. Abstract

Electrothermal propulsion concepts are briefly discussed as an introduction to a bibliography and author index for resistojets, thermal arcjets, pulsed electrothermal thrusters, microwave heated devices, solar thermal thrusters, and laser thermal thrusters.

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