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THE TURBOROCKET ENGINE: AN INTEGRATED PUMP-FED ROCKET ENGINE FOR PROPULSION APPLICATIONS

Abstract

The Turborocket Engine is an integrated pump-fed rocket engine, which takes its basic form factor from Heron's Aeolipile, the rotating steam-powered marvel from antiquity. Also known as a "rotary rocket engine", the Turborocket Engine operates as a high-performance pump-fed rocket engine in a simple, compact configuration. However, fundamental misunderstandings as to its basic operation and performance have hindered its development, and it has remained an obscure and largely ignored engine concept.

In this paper, we evaluate the Turborocket Engine using the conservation of angular momentum and Euler's Turbomachinery equations to develop a quantitative description of the engine's operation. Using this theoretical model in conjunction with standard rocket engine performance equations, a computational methodology is presented by which the performance of the Turborocket Engine can be ascertained. Computed results using this methodology show that the Turborocket Engine configuration can deliver performance comparable to conventional pump-fed rocket engines in a simple, integrated engine configuration. The engine configuration is scalable from very small sizes with thrusts under 250 Newtons, to fairly large sizes, perhaps as large as several hundred kilo-Newtons.

A discussion is provided on the design principles of Turborocket Engine systems, including bearings selection, seal configurations, and other design considerations. Prototype Turborocket Engine hardware is shown, along with their design details. Hot-fire test results obtained with a prototype Turborocket Engine are compared with the theoretical models. Differences between computed and experimental results are presented. A discussion of these differences provides insight into the strengths and weaknesses of the basic theoretical performance treatment and suggests approaches to improve model fidelity and engine design.

In addition to its utility as a pump-fed rocket engine, the Turborocket Engine's simple geometry allows its integration into other engine systems, such as turbojets, ramjets, and scramjets, to enable novel combined-cycle engine configurations with high performance over a wide ranges of speeds and altitudes. Notional concepts of example combined-cycle configurations are presented and discussed. Lastly, the use of the Turborocket Engine as a source of direct shaft power with little to no changes in the basic configuration is considered as a further utility of the Turborocket Engine configuration.