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Lockheed Martin Joule-Thomson Compressor Development

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This paper describes the development and testing of a space-quality compressor capable of delivering closed-loop gas flow with a high pressure ratio, suitable for driving a Joule-Thomson cryocooler. The compressor is based on a traditional "Oxford style" dual-opposed piston compressor with linear drive motors and flexure-bearing clearance-seal technology for high reliability and long life. This J-T compressor retains the approximate size, weight, and cost of the ultra-compact, 200 gram Lockheed Martin Pulse Tube Micro Compressor, despite the addition of a flow-rectifying system to convert the pressure wave into a steady flow.

Key to this program was the development of a custom miniature check valve, small enough to be incorporated into the compressor without affecting overall size and with fast enough response time to capture the pressure pulses. One of the major challenges of working at this small scale is that components must be conceived within the confines of a plausible manufacturing process to be viable and cost effective.

Incorporating the micro check valves into the compressor body was done with a goal of minimizing dead volumes in order to maximize pressure ratio output. The result is a system of bores and passages that comprise an efficient two-stage, four-valve circuit integrated into a single-piece compressor hub.

The size, weight, and manufacturing costs of this J-T compressor are nearly the same as our Pulse Tube Micro compressor. And since it uses many of the same parts and processes, it can be readily adapted to the same high-volume, low cost manufacturing. Other uses for this compressor include long-life low power pumping of circulating systems, such as ambient or cryogenic remote cooling loops.

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