Mechanics/Machinery

Propellant-Flow-Actuated Rocket Engine Igniter

A pneumatically driven hammer initiates ignition.

Lyndon B. Johnson Space Center, Houston, Texas

A rocket engine igniter has been created that uses a pneumatically driven hammer that, by specialized geometry, is induced into an oscillatory state that can be used to either repeatedly impact a piezoelectric crystal with sufficient force to generate a spark capable of initiating combustion, or can be used with any other system capable of generating a spark from direct oscillatory motion.

This innovation uses the energy of flowing gaseous propellant, which by means of pressure differentials and kinetic motion, causes a hammer object to oscillate. The concept works by mass flows being induced through orifices on both sides of a cylindrical tube with one or more vent paths. As the mass flow enters the chamber, the pressure differential is caused because the hammer object is supplied with flow on one side and the other side is opened with access to the vent path. The object then crosses the vent opening and begins to slow because the pressure differential across the ball reverses due to the geometry in the tube.

Eventually, the object stops because of the increasing pressure differential on the object until all of the kinetic energy has been transferred to the gas via compression. This is the point where the object reverses direction because of the pressure differential. This behavior excites a piezoelectric crystal via direct impact from the hammer object. The hammer strikes a piezoelectric crystal, then reverses direction, and the resultant high voltage created from the crystal is transferred via an electrode to a spark gap in the ignition zone, thereby providing a spark to ignite the engine. Magnets, or other retention methods, might be employed to favorably position the hammer object prior to start, but are not necessary to maintain the oscillatory behavior. Various manifestations of the igniter have been developed and tested to improve device efficiency, and some improved designs are capable of operation at gas flow rates of a fraction of a gram per second (0.001 lb/s) and pressure drops on the order of 30 to 50 kilopascal (a few psi).

An analytical model has been created and tested in conjunction with a precisely calibrated reference model. The analytical model accurately captures the overall behavior of this innovation. The model is a simple "volume-orifice" concept, with each chamber considered a single temperature and pressure "node" connected to adjacent nodes, or to vent paths through flow control orifices. Mass and energy balances are applied to each node, with gas flow predicted using simple compressible flow equations.

This work was done by Mark Wollen of Innovative Engineering Solutions, Inc. for Johnson Space Center. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to MSC-25078-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Lightweight Liquid Helium Dewar for High-Altitude Balloon Payloads

A factor-of-five or better reduction in mass is achieved.

Goddard Space Flight Center, Greenbelt, Maryland

Astrophysical observations at millimeter wavelengths require large (2-to-5-meter diameter) telescopes carried to altitudes above 35 km by scientific research balloons. The scientific performance is greatly enhanced if the telescope is cooled to temperatures below 10 K with no emissive windows between the telescope and the sky. Standard liquid helium bucket dewars can contain a suitable telescope for telescope diameter less than two meters. However, the mass of a dewar large enough to hold a 3-to-5-meter diameter telescope would exceed the balloon lift capacity.

The solution is to separate the functions of cryogen storage and in-flight thermal isolation, utilizing the unique physical conditions at balloon altitudes. Conventional dewars are launched cold: the vacuum walls necessary for thermal isolation must also withstand the pressure gradient at sea level and are correspondingly thick and heavy. The pressure at 40 km is less than 0.3% of sea level: a dewar designed for use only at 40 km can use ultra thin walls to achieve significant reductions in mass.

This innovation concerns new construction and operational techniques to produce a lightweight liquid helium bucket dewar. The dewar is intended for use on high-altitude balloon payloads. The mass is low enough to allow a large (3-to-5-meter) diameter dewar to fly at altitudes above 35 km on conventional scientific research balloons without exceeding the lift capability of the balloon.

The lightweight dewar has thin (250-micron) stainless steel walls. The walls are too thin to support the pressure gradient at sea level: the dewar launches warm with the vacuum space vented continuously during ascent to eliminate any