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NASA TECH BRIEF

Continuous Detonation Reaction Engine

A reaction engine operating on the principles of a controlled condensed detonation rather than on the principles of gas expansion has been conceived. The controlled condensed detonation results in reaction products that are expelled at a much higher velocity than are the gaseous products resulting from a controlled burning as in a conventional reaction engine. In any detonation reaction, a shock wave is produced as well as gaseous products of combustion and the shock wave and gaseous products resulting from the detonation are vectored in a symmetrical pattern and are codirectional. Thus, the exit velocity of the reaction products approaches the velocity of the shock wave.

The engine includes an outer housing, enclosing a pair of inner walls, that defines an oval or elliptical continuous channel. This channel has one open side and forms a detonation reaction chamber in which a continuous detonation reaction is generated. Each inner wall has a series of orifices or injector ports through which fuel and oxidizer are injected into the chamber. The engine also includes an oxidizer manifold and a fuel manifold connected to the injector orifices formed in the inner walls. The injector orifices are canted at an angle and arranged in pairs so that fuel and oxidizer pass through the orifices and form impingement points of propellant mixture at spaced intervals around the channel shaped detonation reaction chamber.

A detonation wave generating device is included in the housing and positioned so that when actuated it will initiate operation of the engine. The detonation wave generator is an explosive device capable of generating a detonation wave that will detonate the fuel and oxidizer mixture at the first of the impingement points in the detonation reaction chamber.

The shock wave and detonation products resulting from the reaction at the first impingement point will follow a direction toward the rear or discharge end of the engine that is oriented at an angle to the longitudinal axis of the engine. The angular direction of the reaction is controlled by the injection angle of the propellant mixture. Thus, the reaction at each impingement point provides a pulse of power that can be broken into two vectorial components, one of which is directed to the rear of the engine to generate a thrust and the other directed towards the next successive impingement point to reinforce the detonation wave generated by the detonation wave generating apparatus and thus detonate the fuel and oxidizer at the next point. The reaction is then repeated and the next impingement point of fuel and oxidizer is detonated and so on. Thus, after the initial detonation by the detonation wave generating device, the reactions within the detonation reaction chamber are continuous and self sustaining since the original detonation wave generated by the detonation wave generator is reinforced at each impingement point.

Since the detonation reaction at each impingement point has a resultant direction having one component perpendicular to the longitudinal axis of the engine, a torque moment will be generated which tends to rotate the engine about its longitudinal axis. This moment is very undesirable if the engine is to be used in a free bodied vehicle like a rocket and the torque moment must be countered to prevent rotational motion of the rocket. A proper geometrical arrangement of a group of engines with opposite direction of detonation wave travel is one solution. However, in an application wherein it is desirable to use a single engine, the unbalanced force can be balanced by using an engine employing a multiplicity of coaxial

(continued overleaf)

and coplanar detonation reaction channels in one engine. The number of channels used would be an even number with the traveling detonation wave going in opposite directions in alternate channels.

Note:

Inquiries concerning this invention may be directed to:

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Patent status:

This is the invention of NASA employees, and U.S. Patent No. 3336754 has been issued to them. Inquiries about obtaining license rights for its commercial development should be addressed to the inventors, O. H. Lange, R. J. Stein, and H. E. Tubbs, at Marshall Space Flight Center.

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