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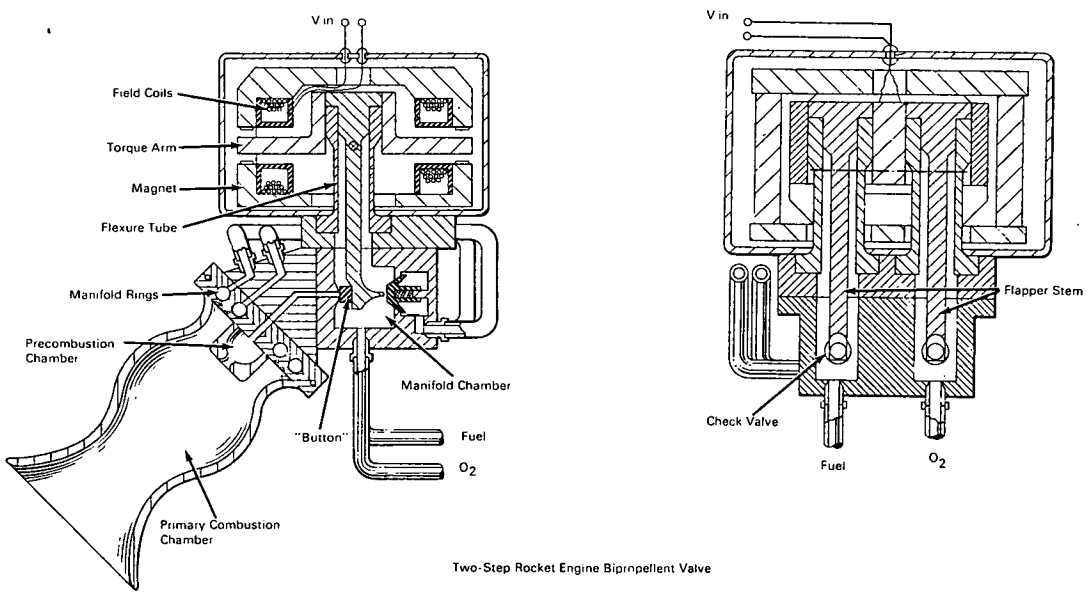
NASA TECH BRIEF

Two-Step Rocket Engine Bipropellant Valve Concept



Two-Step Rocket Engine Bipropellent Valve

The problem:

Attitude control rocket engines which utilize hypergolic propellants tend to generate high pressure surges or spikes in the combustion chamber at the instant combustion is initiated. These surges are detrimental to chamber structural integrity where non-ductile refractory materials are used.

The solution:

It has been found that the high pressure spikes in the primary chamber can be reduced by initiating combustion in a precombustion chamber that is isolated from the primary combustion chamber and is constructed of a ductile material. Various two-step bipropellant valve concepts exist which could control the initial propellant flow into the precombustion chamber and the subsequent full propellant flow into the main chamber for full thrust. The example below describes a torque motor valve concept.

How it's done:

Fuel and oxidizer enter their manifold chambers at a predetermined pressure; for initial combustion conditions, a low propellant mode is maintained by displacing the flapper buttons from the orifice leading to the precombustion chamber. This action is achieved by energizing the field coils which produces an electromagnetic flux across the air gap. A bending moment is thus created on the torque arms causing rotation of the flapper stems which in turn, controls the flapper buttons. The amount of current through the field coils determines the angular position of the flapper stem. At a predetermined high current level, the check

(continued overleaf)

valves are opened by the stems and maximum combustion conditions are achieved by the propellant flow being conducted to the manifold rings in addition to the continued flow to the precombustion chamber. The two distinct thrust levels allow the momentary establishment of stable combustion conditions within the main combustion chamber prior to the introduction of maximum propellant flow, and in this way eliminates the primary chamber pressure spike condition. This technique also may be used where two discrete thrust levels are desired and the high thrust level is approximately one order of magnitude greater than the low thrust level.

Notes:

1. A solenoid-controlled valve system applicable to rocket and internal combustion engines has been designed to prevent high pressure surges on start-up. This control system is in the conceptual stage only; no model or prototype has been built. It may be of interest to the aircraft, hydraulics, and pneumatics industries.
2. No further documentation is available. Inquiries may be directed to:
   Technology Utilization Officer
   Manned Spacecraft Center
   Houston, Texas 77058
   Reference: B69-10280

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, non-exclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

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