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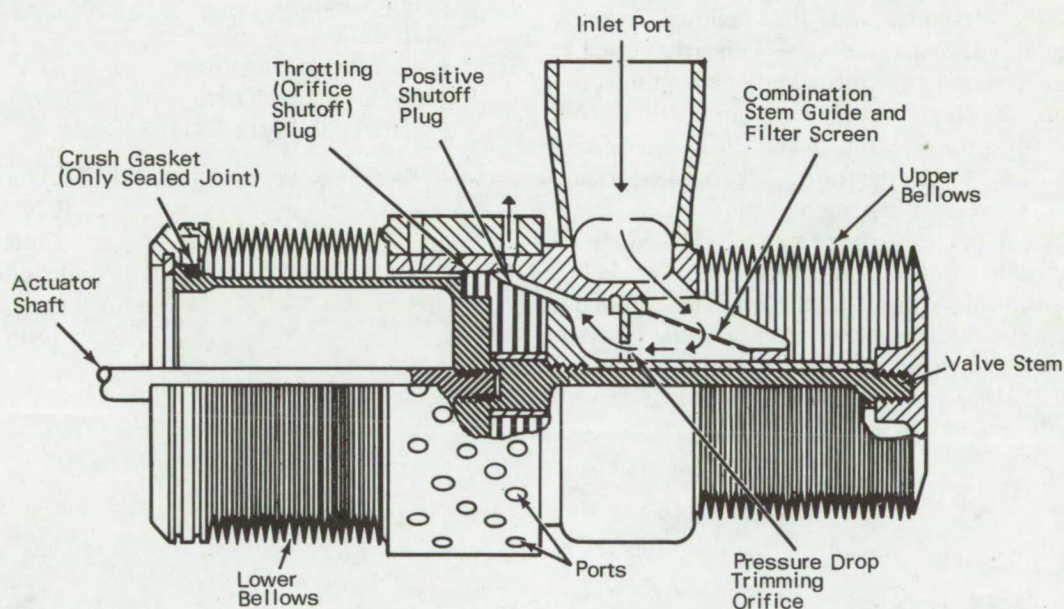
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Liquid-Fuel Valve with Precise Throttling Control

A prototype liquid-fuel valve performs on-off and throttling functions in a vacuum, without component cold-welding or excessive leakage. The valve is designed to enable simple and rapid disassembly and parts replacement, even when the unit is

the fuel mass flux and mixture ratio across the injector at design values.

Fuel enters the valve assembly through the inlet port and is distributed throughout an annular manifold of variable area to maintain full flow at



welded into the fuel lines. Seals or potential leak paths are minimized, and the valve operates with a short working stroke to provide maximum throttling sensitivity commensurate with good control. Individual injection orifices (not part of the valve), fed through tubing connected to the valve ports, provide essentially identical flow rates. Operation of the valve in this manner should ensure positive control of the injector hydraulic system while maintaining

constant velocity. The fuel then passes into and fills the internal cavity, including the upper bellows, upstream of the positive shutoff plug. The flow inside the valve encounters first a conical filter screen and then a trimming orifice which adjusts the overall valve pressure drop. The support for the filter and trimming orifice also serves as a guide for the valve stem. The bellows are designed to make the valve self-closing; an external force to open or "crack"

(continued overleaf)

the valve must be supplied through an actuator shaft attached at a point within the body assembly. The on-off function is performed by a laminated plug (positive shutoff plug) made of alternating layers of a fluorocarbon polymer and an aluminum alloy. Throttling is accomplished by a similar plug (attached to the same stem) which progressively uncovers the individual valve ports as the valve stem moves down. The ports (round holes) are arranged in a series of spirals around the circumference of the bore and are individually connected to the injector orifices by tubing. Internally, the ports are narrow rectangular slots, so that a minimal stem travel can completely open or close each port on the outer surface of the valve body.

The central valve stem, to which the on-off and throttling plugs are attached, is fixed to both the top and bottom bellows, and the entire assembly moves as a unit. The position of the stem (and therefore of the plugs) is determined by the external actuator. When the valve is open, a constant actuator force is sufficient to hold the stem in any position, since the pressure and the bellows spring forces are balanced. When the valve is nearly closed, the ports are covered (or uncovered, depending on the direction of stem travel) one at a time to achieve finer throttling at the lowest flow rates. At intermediate flow rates, the ports are covered two and three at a time; at the highest flow rates, five at a time. When the valve is completely closed, the top bellows is in compression and the bottom bellows is in tension as a result of the preloads applied during assembly. In order to "crack" the valve open, the force applied by the external actuator must exceed the net force tending to hold the valve shut.

Notes:

1. Design of this valve is based on the concept of "discrete-element" throttling. With appropriate design changes, however, the valve could be adapted to a dual-manifold, pressure/area-step throttling technique, such as described in SPS 37-44, Vol. V, p 7, Caltech/JPL, Pasadena, California, 91103.
2. Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP71-10449

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,568,447), and royalty-free license rights will be granted for its commercial development. Inquiries about obtaining a license should be addressed to:

Patent Counsel
Mail Code 1
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103

Source: R. W. Riebling, A.R. McDougal, and
R.N. Porter of
Caltech/JPL
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