Manufacturing & Prototyping

Coaxial Propellant Injectors With Faceplate Annulus Control

These injectors are simpler and less expensive, relative to prior coaxial injectors.

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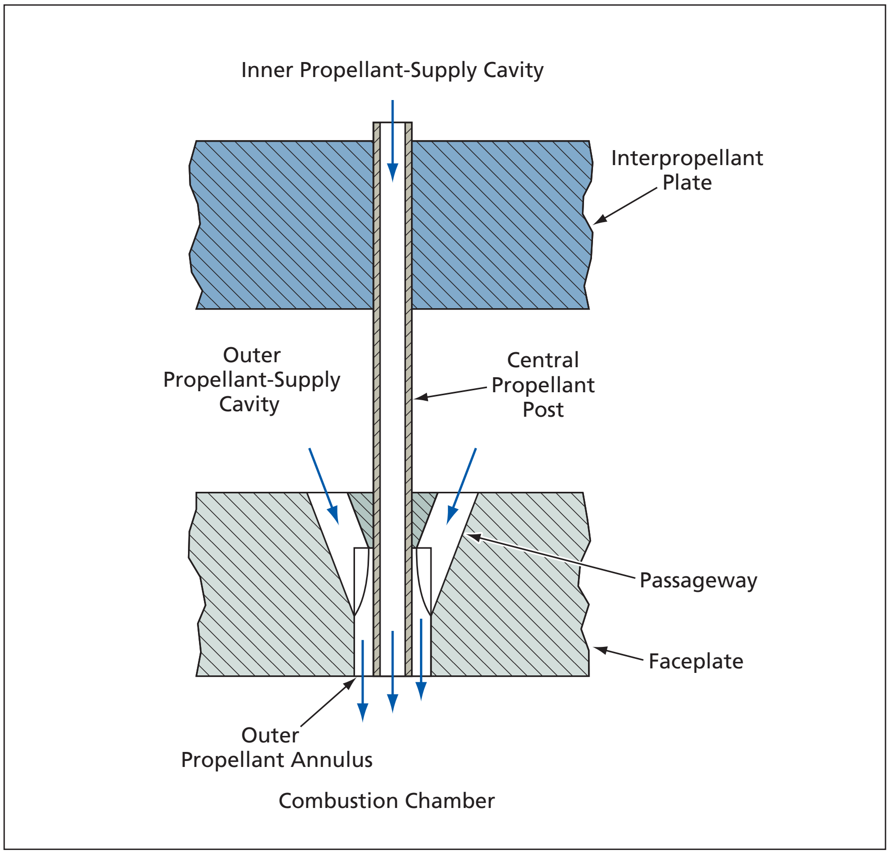
An improved design concept for coaxial propellant injectors for a rocket engine (or perhaps for a non-rocket combustion chamber) offers advantages of greater robustness, less complexity, fewer parts, lower cost, and less bulk, relative to prior injectors of equivalent functionality. This design concept is particularly well suited to small, tight-tolerance injectors, for which prior designs are not suitable because the practical implementation of those designs entails very high costs and difficulty in adhering to the tolerances.

The concept applies to a system for simultaneous injection of two propellant fluids — one (typically, an oxidizer) stored in an inner propellant-supply cavity and the other (typically, a fuel) stored in an outer propellant-supply cavity. The two propellant supply cavities are separated by an interpropellant plate, and the outer propellant-supply cavity is separated from the combustion chamber by a faceplate.

The figure presents a simplified cross-sectional view of a coaxial injector according to this concept. The injector includes a central propellant post, which is a tube that extends from the inner propellant-supply cavity, through the faceplate, ending at a location flush with the combustion-chamber surface of the faceplate. An annulus for forming an annular flow outer propellant surrounding the central flow of inner propellant and features for maintaining the lateral alignment of the central propellant post relative to this annular flow are integral parts of the faceplate, machined from the faceplate, as described below. First, a through hole that defines the minor diameter of the annulus and that holds the central propellant post in lateral alignment relative to the annulus is drilled into the faceplate. Next, the outer diameter of the annulus is formed as a precise counterbore to the through hole.

By means of electrical-discharge machining or another method suited to the specific design, slanted passageways are formed to allow flow from the outer propellant cavity to the annulus. The number and dimensions of these passages depend on the specific design and are chosen to ensure uniform annular exit flow.



The **Outer Propellant Annulus**, passageways for the outer propellant, and associated features for maintaining the coaxial alignment of the central propellant tube are machined into the faceplate.

The central propellant post can be fabricated from drawn, centerless-ground tubing. One end of the central propellant post is bonded to the interpropellant plate, completing a seal that maintains separation between the two propellants prior to injection. The other end of the central propellant post can float freely in the through hole, or, for additional support, it can be bonded to the faceplate at either or both end(s) of the through hole.

In the combustion chamber, the jet of inner propellant flowing from the outer end of the central propellant post mixes with the annular flow of outer propellant, and the resulting mixture burns. The physical and chemical properties of the propellants and the injection geometry are major determinants of the efficiency of the combustion process.

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Title to this invention has been waived under the provisions of the National Aeronautics and Space Act {42 U.S.C. 2457(f)} to The Boeing Company. Inquiries concerning licenses for its commercial development should be addressed to:

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