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NASA TECH BRIEF

Ames Research Center

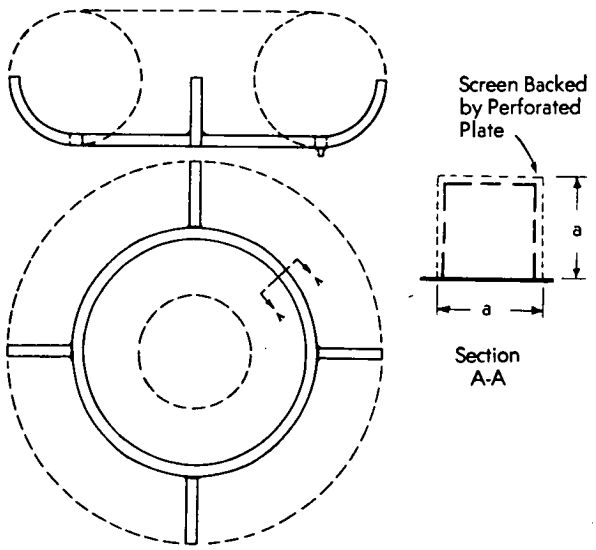
Propellant Acquisition Device for Use with A Spinning Toroidal Tank

Toroidal tanks in spin-stabilized spacecrafts provide significant advantages in regard to control of spacecraft spin and center of mass, packaging, and propellant distribution. However, centrifugal forces resulting from spacecraft spin tend to displace propellant masses from tank outlet regions, and thus it is necessary to use propellant acquisition devices so that gas-free propellant can be made available during all phases of a mission.

Inasmuch as prior work with spherical and cylindrical tankage had shown that propellant acquisition devices which utilize surface tension phenomena for separation of liquids from gases are superior to others with regard to weight and operational complexity, a comparative evaluation of available concepts was made; studies of the results of the evaluations and analyses led to the design of the acquisition system illustrated in the diagram.

The system consists of four radially disposed communication channels spaced 90° apart and attached to a propellant-retaining ring situated at the bottom of the toroidal tank. The combination of the ring and channels provides a continuous flow path from the propellant mass (which is distributed rather uniformly on the periphery of a spinning toroidal tank) to the outlet in the tank bottom. When the tank is not spinning, the propellant mass is in direct contact with the ring at the bottom. As indicated in the diagram, the ring and channels are square in cross-section, and are fabricated from a fine stainless steel screen that is supported by a perforated stainless steel plate having 50-percent open area.

The ring-and-channel acquisition system design provides uniform propellant distribution within the spinning tank during all mission phases; the propellant-retaining ring subdues propellant sloshing when axial thrusts of the spacecraft propulsion system cause movement of the propellant mass from the outer wall to the tank bottom. Similarly, the communication channels act as baffles and tend to maintain uniform propellant distribution in the tank when spacecraft spin rates are increased or decreased. Thus, in addition to providing gas-free propellant, the device controls propellant distribution and movement within the tank, and minimizes the requirements placed on the spacecraft attitude-control system.



Other advantages of the ring-and-channel system include good expulsion efficiency, low mass, and minimum impact on the toroidal shape and design. The same design can be used in both oxidizer and fuel tanks.

(continued overleaf)

Note:

Requests for further information may be directed to:

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Patent status:

NASA has decided not to apply for a patent.

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