Mechanics/Machinery

Capacitors Would Help Protect Against Hypervelocity Impacts

Marshall Space Flight Center, Alabama

A proposal investigates alternatives to the present "bumper" method of protecting spacecraft against impacts of meteoroids and orbital debris. The proposed method is based on a British high-voltage-capacitance technique for protecting armored vehicles against shaped-charge warheads.

A shield, according to the proposal, would include a bare metal outer layer separated by a gap from an inner metal layer covered with an electrically insulating material. The metal layers would constitute electrodes of a capacitor. A bias potential would be applied between the metal layers. A particle impinging at hypervelocity on the outer metal layer would break apart into a debris cloud that would penetrate the electrical insulation on the inner metal layer. The cloud would form a path along which electric current could flow between the metal layers, thereby causing the capacitor to discharge. With proper design, the discharge current would be large enough to vaporize the particles in the debris cloud to prevent penetration of the spacecraft.

The shield design can be mass optimized to be competitive with existing bumper designs. Parametric studies were proposed to determine optimum correction between bias voltage, impacting particle velocity, gap space, and insulating material required to prevent spacecraft penetration.

This work was done by David Edwards, Whitney Hubbs, and Mary Hovater of Marshall Space Flight Center. Further information is contained in a TSP (see page 1).
MFS-31995-1

Diaphragm Pump With Resonant Piezoelectric Drive

Resonance is used to amplify the stroke and thus the flow rate.

Lyndon B. Johnson Space Center, Houston, Texas

A diaphragm pump driven by a piezoelectric actuator is undergoing development. This pump is intended to be a prototype of lightweight, highly reliable pumps for circulating cooling liquids in protective garments and high-power electronic circuits, and perhaps for some medical applications. The pump would be highly reliable because it would contain no sliding seals or bearings that could wear, the only parts subject to wear would be two check valves, and the diaphragm and other flexing parts could be designed, by use of proven methods, for extremely long life. Because the pump would be capable of a large volumetric flow rate and would have only a small dead volume, its operation would not be disrupted by ingestion of gas, and it could be started reliably under all conditions.

The prior art includes a number piezoelectrically actuated diaphragm pumps. Because of the smallness of the motions of piezoelectric actuators (typical maximum strains only about 0.001), the volumetric flow rates of those pumps are much too small for typical cooling applications. In the pump now undergoing development, mechanical resonance would be utilized to amplify the motion generated by the piezoelectric actuator and thereby multiply the volumetric flow rate.

The prime mover in this pump would be a stack of piezoelectric ceramic actuators, one end of which would be connected to a spring that would be part of a spring-and-mass resonator structure. The "mass" part of the resonator structure would include the pump diaphragm (see Figure 1). Contraction of the spring would draw the diaphragm to the left, causing the volume of the fluid chamber to increase and thereby causing fluid to flow into the chamber. Subsequent expansion of the spring would

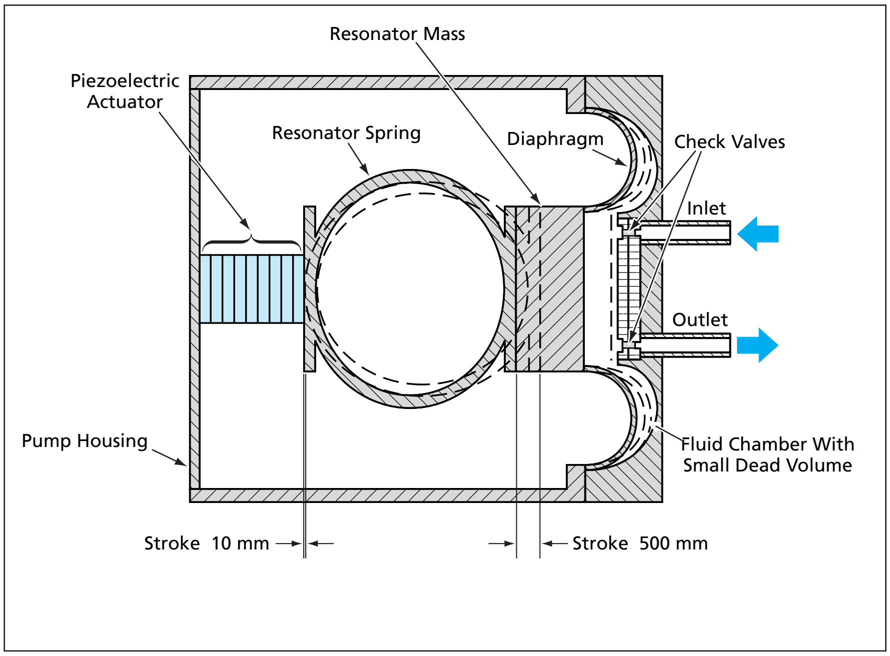

Figure 1. The **Spring-and-Mass Resonator**, if properly designed and constructed, would amplify the stroke of the piezoelectric stack by a factor of the order of 20.