Mechanics/Machinery

Low-Cost, Rugged High-Vacuum System

Goddard Space Flight Center, Greenbelt, Maryland

A need exists for miniaturized, rugged, low-cost high-vacuum systems. Recent advances in sensor technology have led to the development of very small mass spectrometer detectors as well as other analytical instruments such as scanning electron microscopes. However, the vacuum systems to support these sensors remain large, heavy, and power-hungry. To meet this need, a miniaturized vacuum system was developed based on a very small, rugged, and inexpensive-to-manufacture molecular drag pump (MDP). The MDP is enabled by a miniature, very-high-speed (200,000 rpm), rugged, low-power, brushless DC motor optimized for wide temperature operation and long life.

The key advantages of the pump are reduced cost and improved ruggedness compared to other mechanical high-vacuum pumps. The machining of the rotor and stators is very simple compared to that necessary to fabricate rotor and stator blades for other pump designs. Also, the symmetry of the rotor is such that dynamic balancing of the rotor will likely not be necessary. Finally, the number of parts in the unit is cut by nearly a factor of three over competing designs. The new pump forms the heart of a complete vacuum system optimized to support analytical instruments in terrestrial applications and on spacecraft and planetary landers.

The MDP achieves high vacuum coupled to a ruggedized diaphragm rough pump. Instead of the relatively complicated rotor and stator blades used in turbomolecular pumps, the rotor in the MDP consists of a simple, smooth cylinder of aluminum. This will turn at approximately 200,000 rpm inside an outer stator housing. The pump stator comprises a cylindrical aluminum housing with one or more specially designed grooves that serve as flow channels. To minimize the length of the pump, the gas is forced down the flow channels of the outer stator to the base of the pump. The gas is then turned and pulled toward the top through a second set of channels cut into an inner stator housing that surrounds the motor. The compressed gas then flows down channels in the motor housing to the exhaust port of the pump. The exhaust port of the pump is connected to a commercially available diaphragm or scroll pump.

This work was done by Paul Sorensen and Robert Kline-Schoder of Creare Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15838-1

Static Gas-Charging Plug

Lyndon B. Johnson Space Center, Houston, Texas

A gas-charging plug can be easily analyzed for random vibration. The design features two steeped O-rings in a radial configuration at two different diameters, with a 0.050-in. (≈1.3-mm) diameter through-hole between the two O-rings. In the charging state, the top O-ring is engaged and sealing. The bottom O-ring outer diameter is not squeezed, and allows air to flow by it into the tank. The inner diameter is stretched to plug the gland diameter, and is restrained by the O-ring groove.

The charging port bushing provides mechanical stop to restrain the plug during gas charge removal. It also prevents the plug from becoming a projectile when removing gas charge from the accumulator.

The plug can easily be verified after installation to ensure leakage requirements are met.

This work was done by William Indoe of Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-25059-1

Floating Oil-Spill Containment Device

This triangular device can be used for oil and natural gas containment.

NASA's Jet Propulsion Laboratory, Pasadena, California

Previous oil containment booms have an open top that allows natural gas to escape, and have significant oil leakage due to wave action. Also, a subsea pyramid oil trap exists, but cannot move relative to moving oil plumes from deep-sea oil leaks.

The solution is to have large, moveable oil traps. One version floats on the sea surface and has a flexible tarp cover and a lower weighted skirt to completely entrap the floating oil and natural gas. The device must have at least three sides with boats pulling at each apex, and sonar or other system to track the slowly moving oil plume, so that the boats can properly locate the booms. The oil trap device must also have a means for removal of the oil and the natural gas.

A second design version has a flexible pyramid cover that is attached by lines to