

granular samples. This tube-shaped component can be extracted upon completion of the sampling, and the bottom can be capped by placing the bit onto a corklike component. Then, upon removal of the internal tube, the top section can be sealed. The novel features of this device are:

- A mechanism of acquiring and retaining granular samples using a coring bit without a closed door.

- An acquisition bit that has internal structure such as a waffle pattern for compartmentalizing or helical internal flute to propel the sample inside the bit and help in acquiring and retaining granular samples.
- A bit with an internal spiral into which the various particles wedge.
- A design that provides a method of testing frictional properties of the granular samples and potentially seg-

regating particles based on size and density. A controlled acceleration or deceleration may be used to drop the least-frictional particles or to eventually shear the unconsolidated material near the bit center.

This work was done by Yoseph Bar-Cohen, Mircea Badescu, and Stewart Sherrit of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47606

⚙️ Very-Low-Cost, Rugged Vacuum System

Applications include portable analytical instruments such as mass spectrometers and leak detectors.

Goddard Space Flight Center, Greenbelt, Maryland

NASA, DoD, DHS, and commercial industry have a need for miniaturized, rugged, low-cost vacuum systems. Recent advances in sensor technology have led to the development of very small mass spectrometer detectors as well as other miniature analytical instruments. However, the vacuum systems to support these sensors remain large, heavy, and power-hungry. To meet this need, a miniaturized vacuum system was created based on a very small, rugged, and inexpensive-to-manufacture molecular drag pump (MDP). The MDP is enabled by the development of a miniature, very-high-speed, rugged, low-power, brushless DC motor optimized for wide temperature operation and long life. Such a pump represents an order-of-magnitude reduction in mass, volume, and cost over current, commercially available, state-of-the-art vacuum pumps.

The vacuum system consists of the MDP coupled to a ruggedized rough

pump (for terrestrial applications or for planets with substantial atmospheres). The rotor in the MDP consists of a simple smooth cylinder of aluminum spinning 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 diaphragm or scroll pump. This pump delivers very high performance in a very small envelope. The design was simplified so that a smaller compression ratio,

easier manufacturing process, and enhanced ruggedness can be achieved at the lowest possible cost.

The machining of the rotor and stators is very simple compared to that necessary to fabricate TMP (turbo molecular pump) rotor and stator blades. Also, the symmetry of the rotor is such that dynamic balancing of the rotor is greatly simplified. Finally, because of the simplified design, the number of parts in the unit is cut by nearly a factor of three. In fact, there are only five parts, not counting the motor and off-the-shelf screws and O-rings. This reduces the amount of machining and also makes fit-up much simpler while allowing the maintenance of close tolerances.

This work was done by Robert Kline-Schoder, Paul Sorensen, Christian Passow, and Steve Bilski of Creare Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16695-1