Technology Focus: Mechanical Components

Miniature, Variable-Speed Control Moment Gyroscope

Goddard Space Flight Center, Greenbelt, Maryland

The Miniature Variable-Speed Control Moment Gyroscope (MVS-CMG) was designed for small satellites (mass from less than 1 kg up to 500 kg). Currently available CMGs are too large and heavy, and available miniature CMGs do not provide sufficient control authority for use on practical satellites. This primarily results from the need to greatly increase the speed of rotation of the flywheel in order to reduce the flywheel size and mass. This goal was achieved by making use of a proprietary, space-qualified, high-speed (100,000 rpm) motor technology to spin the flywheel at a speed ten times faster than other known miniature CMGs under development.

NASA is supporting innovations in propulsion, power, and guidance and navigation systems for low-cost small spacecraft. One of the key enabling technologies is attitude control mechanisms. CMGs are particularly attractive for spacecraft attitude control since they can achieve higher torques with lower mass and power than reaction wheels, and they provide continuous torque capability that enables precision pointing (in contrast to on-off thruster control).

The aim of this work was to develop a miniature, variable-speed CMG that is sized for use on small satellites. To achieve improved agility, these spacecraft must be able to slew at high rate, which requires attitude control actuators that can apply torques on the order of 5 N·m. The MVS-CMG is specifically designed to achieve a high-torque output with a minimum flywheel and system mass. The flywheel can be run over a wide range of speeds, which is important to help reduce/eliminate potential gimbal lock, and can be used to optimize the operational envelope of the CMG.

This work was done by Steve Bilski, Robert Kline-Schoder, and Paul Sorensen of Creare Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15887-1

NBL Pistol Grip Tool for Underwater Training of Astronauts

Goddard Space Flight Center, Greenbelt, Maryland

A document discusses a lightweight, functional mockup of the Pistol Grip Tool for use during underwater astronaut training. Previous training tools have caused shoulder injuries. This new version is more than 50 percent lighter [in water, weight is 2.4 lb (≈1.1 kg)], and can operate for a six-hour training session after 30 minutes of prep for submersion.

Innovations in the design include the use of lightweight materials (aluminum and Delrin®), creating a thinner housing, and the optimization of internal space with the removal of as much excess material as possible. This reduces tool weight and maximizes buoyancy. Another innovation for this tool is the application of a vacuum that seats the O-rings in place and has shown to be reliable in allowing underwater usage for up to six hours.

This work was done by Michael Liszka, Matthew Ashmore, Mark Behnke, Walter Smith, and Tod Waterman of ATK Spacecraft, Systems and Services for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16060-1

HEXPANDO Expanding Head for Fastener-Retention Hexagonal Wrench

Goddard Space Flight Center, Greenbelt, Maryland

The HEXPANDO is an expanding-head hexagonal wrench designed to retain fasteners and keep them from being dislodged from the tool. The tool is intended to remove or install socket-head cap screws (SHCSs) in remote, hard-to-reach locations or in circumstances when a dropped fastener could cause damage to delicate or sensitive hardware. It is not intended for application of torque.

This tool is made of two assembled portions. The first portion of the tool comprises tubing, or a hollow shaft, at a length that gives the user adequate reach to the intended location. At one end of the tubing is the expanding hexagonal headfitting with six radial slits cut into it (one at each of the points of the hexagonal shape), and a small hole drilled axially through the center and the end opposite the hex is internally and externally threaded. This fitting is threaded into the shaft (via external threads) and staked or bonded so that it will not loosen. At the other end of the tubing is a knurled collar with a through hole into which the tubing is threaded. This knob is secured in place by a stop nut.

The second assembled portion of the tool comprises a length of all thread or solid rod that is slightly longer than the