This work was done by Jasen L. Raboin, Gerard D. Valle, Gregg Edeen, Horacio M. De La Fuente, William C. Schneider, Gary R. Spexarth, and Christopher J. Johnson of **Johnson Space Center** *and Shalini Pandya of Lockheed Martin. For further information, contact the Johnson Commercial Technology Office at (281) 483-3809.*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-23024/92.

Double-Acting, Locking Carabiners

Lyndon B. Johnson Space Center, Houston, Texas

A proposed design for carabiners (tether hooks used in mountaineering, rock climbing, and rescue) is intended to make it possible to operate these devices even while wearing thick gloves. According to the proposal, the gate of a carabiner would be capable of swinging either toward or away from the hook body, relative to the closed position. The gate would be spring-biased to return to the closed position. An external locking collar would be pinned to an internal locking rod that would be spring-loaded to slide the collar longitudinally over the gate to lock the gate in the closed position. The gate would be unlocked by sliding the collar axially against the spring load. To reduce the probability of inadvertent unlocking, the rod-and-collar mechanism would include two locking buttons. Optionally, the rod-and-collar mechanism could be replaced with an external locking mechanism based on a longer collar.

This work was done by Chi Min Chang and Dominic Li Del Rosso of **Johnson Space Center** *and Gary D. Krch of ILC Dover. For further information, contact the Johnson Commercial Technology Office at (281) 483-3809.*
MSC-23163

Position Sensor Integral With a Linear Actuator

This sensor adds little to the bulk and weight of the actuator.

Marshall Space Flight Center, Alabama

A noncontact position sensor has been designed for use with a specific two-dimensional linear electromagnetic actuator. To minimize the bulk and weight added by the sensor, the sensor has been made an integral part of the actuator: that is to say, parts of the actuator structure and circuitry are used for sensing as well as for varying position.

The actuator (see Figure 1) includes a C-shaped permanent magnet and an armature that is approximately centered in the magnet gap. The intended function of the actuator is to cause the permanent magnet to translate to, and/or remain at, commanded x and y coordinates, relative to the armature. In addition, some incidental relative motion along the z axis is tolerated but not controlled. The sensor is required to measure the x and y displacements from a nominal central position and to be relatively insensitive to z displacement.

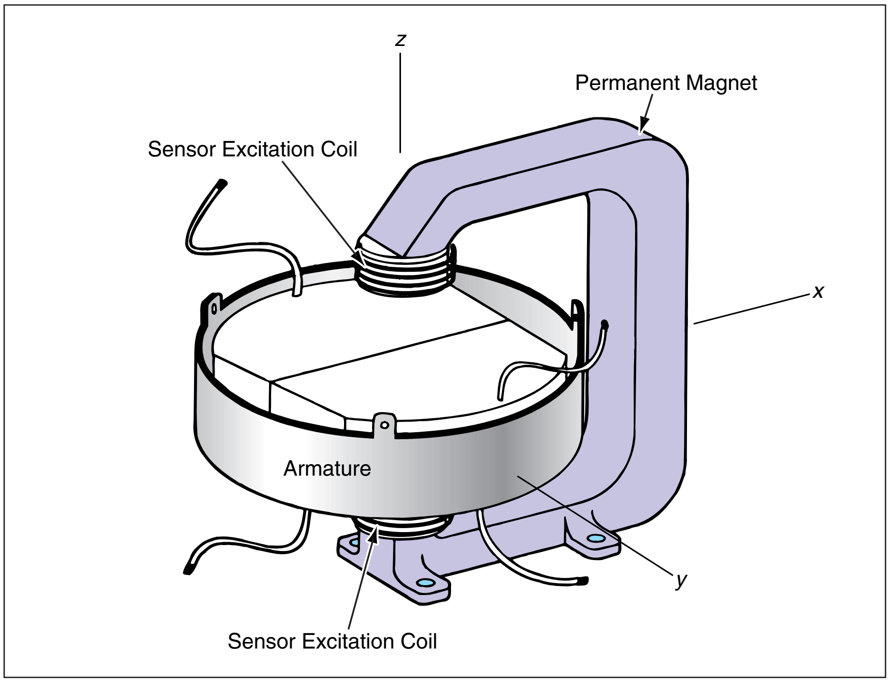

Figure 1. **Sensor Excitation Coils** are the only parts added to the actuator. The electromagnet windings of the actuator are utilized as sensor pickup coils.

The armature contains two sets of electromagnet windings oriented perpendicularly to each other and electrically excited in such a manner as to generate forces in the x,y plane to produce the required motion. Small sensor excitation coils are mounted on the pole tips of the permanent magnet. These coils are excited with a sine wave at a frequency of 20 kHz. This excitation is transformer-coupled to the armature windings. The geometric arrangement of the excitation coils and armature windings is such that the amplitudes of the 20-kHz voltages induced in the armature windings vary nearly linearly with x and y displacements and do not vary significantly with small z displacements. Because the frequency of