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.

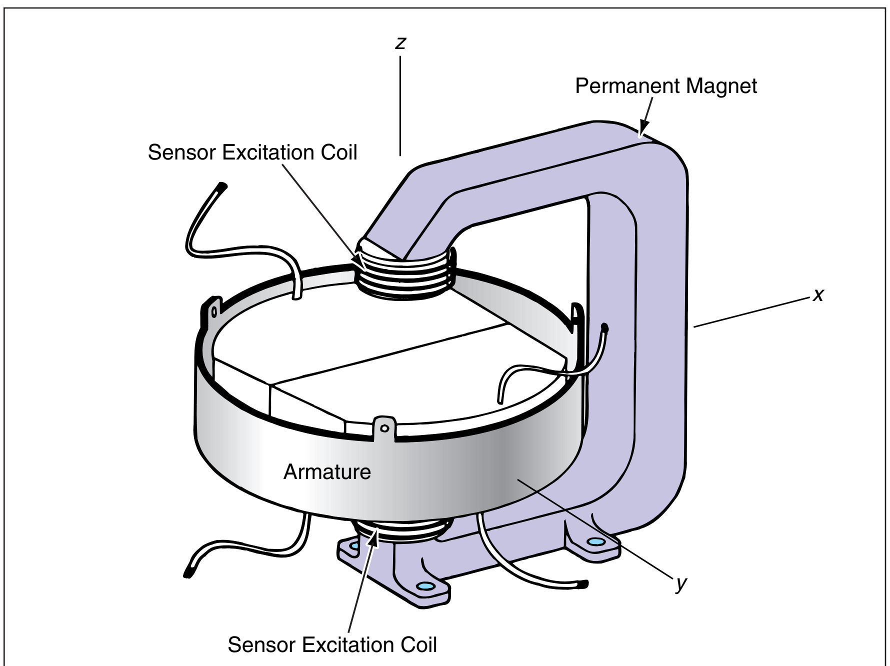


Figure 1. **Sensor Excitation Coils** are the only parts added to the actuator. The electromagnet windings of the actuator are utilized as sensor pickup coils.

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

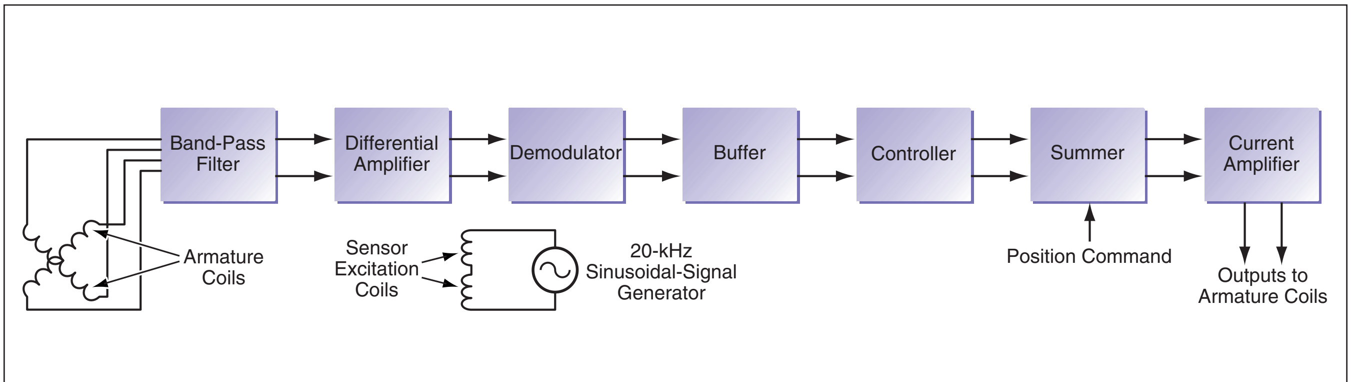


Figure 2. The **Sensor Circuitry Is an Integral Part** of the actuator position-control circuitry. The actuator displacements in *x* and *y* give rise to feedback position-control voltages.

20 kHz is much greater than the maximum frequency characteristic of the actuation signals applied to the armature windings, there is no appreciable interference between actuator and sensor functions of the armature windings.

The voltages across the armature windings are fed as inputs to the circuitry depicted in simplified form in Figure 2. First, the voltages are band-pass filtered at the 20-kHz sensor excitation frequency to minimize lower frequency actuation components and higher-frequency noise components. The filtered voltages are processed through a differential amplifier and a demodulator to obtain voltages proportional (in both magnitude and sign) to the *x* and *y* displacements. These voltages are fed, through a buffer, as inputs to a proportional + integral + derivative (PID) control circuit. The output of the PID controller is summed with a position-command voltage to obtain a control signal that is fed as input to a current amplifier. The output of the current amplifier, characterized by frequencies much below 20 kHz, is applied to armature coils to control the *x* and *y* displacements.

This work was done by David E.Howard and Dean C. Alhorn of **Marshall Space Flight Center**.

This invention has been patented by NASA (U.S. Patent No. 6,246,228). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to Sammy Nabors, MSFC Commercialization Assistance Lead, at (256) 544-5226 or sammy.a.nabors@nasa.gov. Refer to MFS-31218.

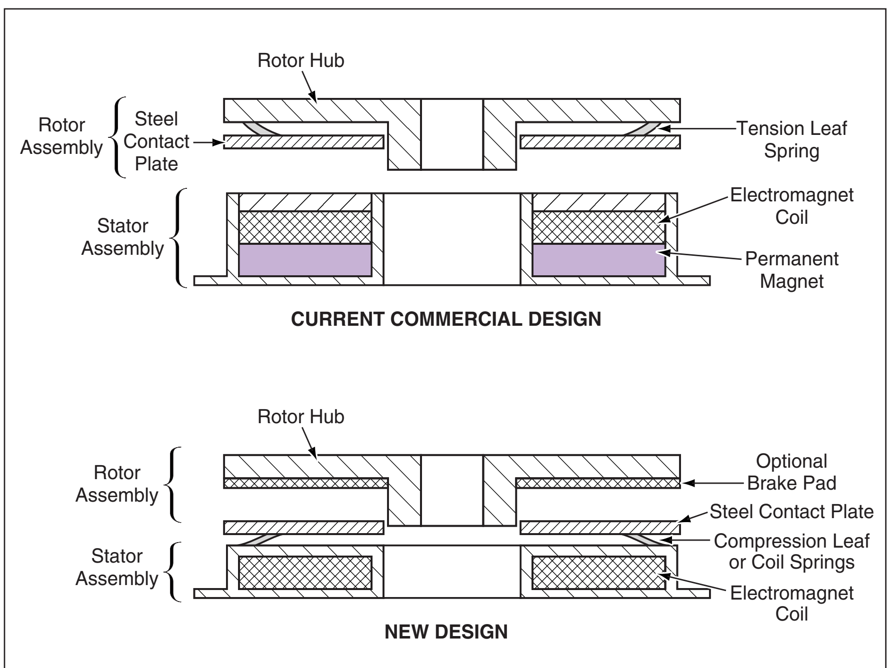
Improved Electromagnetic Brake

Fail-safe operation would not depend on maintenance of tight tolerances.

Lyndon B. Johnson Space Center, Houston, Texas

A proposed design for an electromagnetic brake would increase the reliability while reducing the number of parts and the weight, relative to a prior commercially available electromagnetic brake. The reductions of weight and the number of parts could also lead to a reduction of cost.

A description of the commercial brake is prerequisite to a description of the proposed electromagnetic brake. The commercial brake (see upper part of figure) includes (1) a permanent magnet and an electromagnet coil on a stator and (2) a rotor that includes a steel contact plate mounted, with tension spring loading, on an aluminum hub. The stator is mounted securely on a stationary object, which would ordinarily be the housing of a gear drive or a motor. The rotor is mounted on the shaft of the gear drive or motor.



Current and Proposed Electromagnetic Brakes are depicted here in simplified, partly schematic meridional cross sections.

The commercial brake nominally operates in a fail-safe (in the sense of normally braking) mode: In the absence of current in the electromagnet coil, the