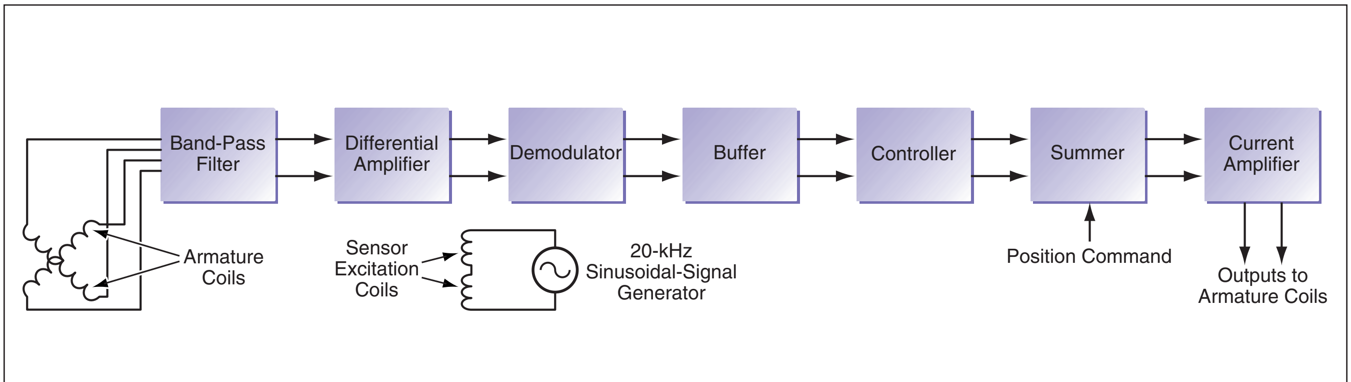


Figure 2. The **Sensor Circuitry Is an Integral Part** of the actuator position-control circuitry. The actuator displacements in *x* and *y* give rise to feedback position-control voltages.

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

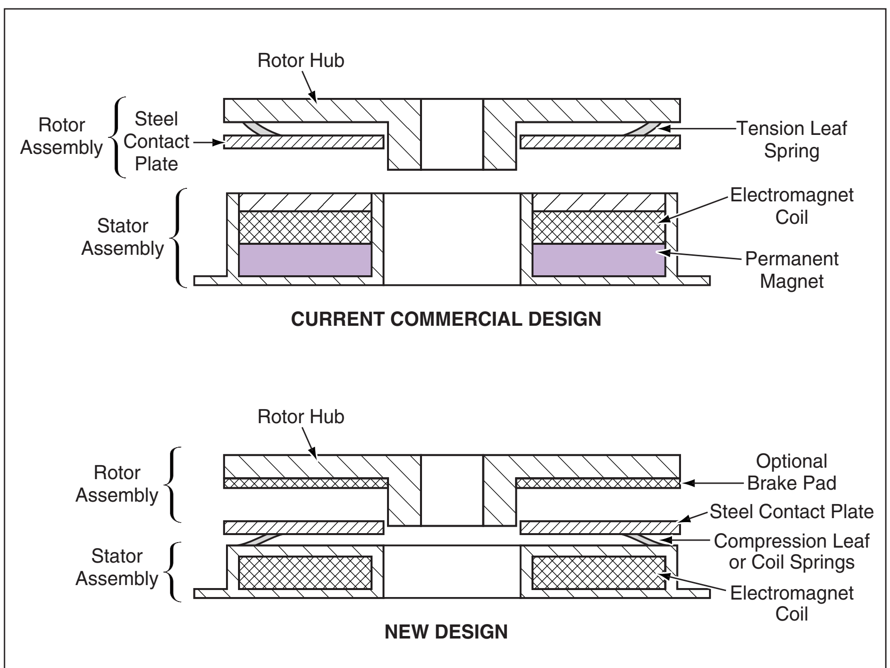
Fail-safe operation would not depend on maintenance of tight tolerances.

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.

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



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

permanent magnet pulls the contact plate, against the spring tension, into contact with the stator. To release the brake, one excites the electromagnet with a current of the magnitude and polarity chosen to cancel the magnetic flux of the permanent magnet, thereby enabling the spring tension to pull the contact plate out of contact with the stator.

The fail-safe operation of the commercial brake depends on careful mounting of the rotor in relation to the stator. The rotor/stator gap must be set with a tolerance between 10 and 15 mils (between about 0.25 and about 0.38 mm). If the gap or the contact pad is thicker than the maximum allowable value, then the permanent magnetic field will not be strong enough to pull the steel plate across the gap. (For this reason, any contact pad between the contact plate and the stator must also be correspondingly thin.) If the gap exceeds the maximum allowable value because of shaft end play, it becomes impossible to set the brake by turning off the electromagnet current. Although it may still be possible to set the brake by applying an electromagnet current to aid the permanent magnetic field instead of canceling it, this action can mask an out-of-tolerance condition in the brake and it does not restore the fail-safe function of setting the brake when current is lost.

In the proposed brake (see lower part of figure), the contact pad would be mounted on the stator via compression springs instead of on the rotor via tension springs. Optionally, a steel or ablative brake pad would be mounted on the rotor. There would be no permanent magnet. Instead of using a permanent magnet to pull the contact plate across the rotor/stator gap, one would use the compression springs to push the contact plate into the rotor. An electromagnet would be used to pull the contact plate against the compression springs to release the brake. If the critical gap between the contact plate and the electromagnet were to grow beyond the reach of the electromagnetic field, the brake could not be released: the contact plate would remain pushed against the rotor — that is, in the braked or fail-safe configuration.

In the proposed design, longitudinal movement of the shaft could be accommodated by increasing the throw of the compression springs. The tolerance on the rotor/stator gap could be increased to as much as tenths of an inch (several millimeters), and the failure mode would change from not being able to set the brake to not being able to release the brake. Also, inasmuch as the frictional braking contact would no longer be between the steel contact plate and the actuating electromagnet, a contact pad of any thickness or material could be mounted on the rotor.

This work was done by Toby B. Martin of **Johnson Space Center**. *For further information, contact the Johnson Commercial Technology office at (281) 483-0837.*
MSC-23226

Flow Straightener for a Rotating-Drum Liquid Separator

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A flow straightener has been incorporated into a rotary liquid separator that originally comprised an inlet tube, a shroud plate, an impeller, an inner drum, an outer drum, a housing, a pitot tube, and a hollow shaft motor. As a consequence of the original geometry of the impeller, shroud, inner drum, and hollow shaft, swirl was created in the airflow inside the hollow shaft during operation. The swirl speed was large enough to cause a significant pressure drop. The flow straightener consists of vanes on the back side of the shroud plate. These vanes compartmentalize the inside of the inner drum in such a way as to break up the flow path and thereby stop the air from swirling; as a result, the air enters the hollow shaft with a predominantly axial velocity instead of a swirl. Tests of the rotary liquid separator at an airflow rate of 10 ft^3/min (0.0047 m^3/s) revealed that the dynamic pressure drop was 8 in. of water (≈2 kPa) in the absence of the flow straightener and was reduced to 1 in. of water (≈0.25 kPa) in the presence of the flow straightener.

This work was done by James R. O'Coin, David G. Converse, and Donald W. Rethke of Hamilton Sundstrand Space Systems International, Inc., for **Johnson Space Center**. *For further information, contact*

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