leaking into the dome. Instead the affected stack gas stream pressure rises detectably, thereby enabling a system shutdown. All electrical and fluid connections to the stack are made inside the pressure dome and require special plumbing and electrical dome interfaces for this to be accomplished. Further benefits of the dome are that it can act as a containment shield in the unlikely event of a catastrophic failure.

Studies indicate that, for a given active area (and hence, cell ID), frame outside diameter must become ever larger to support stresses at higher operating pressures. This can lead to a large footprint and increased costs associated with thicker and/or larger diameter endplates, tie-rods, and the frames themselves. One solution is to employ rings that fit snugly around the frame. This complicates stack assembly and is sometimes difficult to achieve in practice, as its success is strongly dependent on frame and ring tolerances, gas pressure, and operating temperature. A pressure dome permits an otherwise low-pressure stack to operate at higher pressures without growing the electrolyzer hardware.

The pressure dome consists of two machined segments. An O-ring is placed in an O-ring groove in the flange of the bottom segment and is trapped by the flange on the top dome segment when these components are bolted together with high-strength bolts. The pressure dome has several unique features. It is made (to ASME Pressure Vessel guidelines) in a high-strength aluminum alloy with the strength of stainless steel and the weight benefits of aluminum. The flange of the upper dome portion contains specially machined flats for mounting the dome, and other flats dedicated to the special feedthroughs for electrical connections. A pressure dome can be increased in length to house larger stacks (more cells) of the same diameter with the simple addition of a cylindrical segment.

To aid in dome assembly, two stainless steel rings are employed. One is used beneath the heads of the high-strength bolts in lieu of individual hardened washers, and another is used instead of individual nuts. Like electrolyzers could be operated at low or high pressures simply by operating the electrolyzer outside or inside a pressurized dome.

This work was done by Timothy Norman and Edwin Schmitt of Giner Electrochemical Systems, LLC for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18772-1.

Cascading Tesla Oscillating Flow Diode for Stirling Engine Gas Bearings

John H. Glenn Research Center, Cleveland, Ohio

Replacing the mechanical check-valve in a Stirling engine with a micromachined, non-moving-part flow diode eliminates moving parts and reduces the risk of microparticle clogging.

At very small scales, helium gas has sufficient mass momentum that it can act as a flow controller in a similar way as a transistor can redirect electrical signals with a smaller bias signal. The innovation here forces helium gas to flow in predominantly one direction by offering a clear, straight-path microchannel in one direction of flow, but then through a sophisticated geometry, the reversed flow is forced through a tortuous path. This redirection is achieved by using microfluid channel flow to force the much larger main flow into this tortuous path.

While microdiodes have been developed in the past, this innovation cascades Tesla diodes to create a much higher pressure in the gas bearing supply plenum. In addition, the special shape of the leaves captures loose particles that would otherwise clog the microchannel of the gas bearing pads.

This work was done by Rodger Dyson for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18862-1.

Compact, Low-Force, Low-Noise Linear Actuator

This actuator has potential uses in military and automotive applications.

NASA's Jet Propulsion Laboratory, Pasadena, California

Actuators are critical to all the robotic and manipulation mechanisms that are used in current and future NASA missions, and are also needed for many other industrial, aeronautical, and space activities. There are many types of actuators that were designed to operate as linear or rotary motors, but there is still a need for low-force, low-noise linear actuators for specialized applications, and the disclosed mechanism addresses this need.

A simpler implementation of a rotary actuator was developed where the end effector controls the motion of a brush for cleaning a thermal sensor. The mechanism uses a SMA (shape-memory alloy) wire for low force, and low noise. The linear implementation of the actuator incorporates a set of springs and mechanical hard-stops for resetting and fault tolerance to mechanical resistance. The actuator can be designed to work in a pull or push mode, or both. Depending on the volume envelope criteria, the actuator can be configured for scaling its volume down to $4\times2\times1$ cm^3. The actuator design