a means with which to monitor the relative alignment over time.

This innovation does not require extremely good thermal stability on the primary mirror and can thus be used in any thermal environment and with cheaper materials. This factor could be critical in enabling the construction of very large telescopes, and provides a means for testing a very large telescope as it is being assembled. In addition to this, the architecture lets one phase (or align) the primary mirror independent of whether a star or scene is in the field. The segmented, spherical primary allows for cost-effective three-meter class (e.g. Midex and Discovery) missions as well as enabling 30-meter telescope solutions that can be manufactured in a reasonable amount of time. The continuous wavefront sensing and control architecture enables missions for low-Earth-orbit.

This work was done by Lee Feinberg, John Hagopian, Bruce Dean, and Joe Howard for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-14982-1

Micro-Resistojet for Small Satellites

Goddard Space Flight Center, Greenbelt, Maryland

An efficient micro-resistojet has been developed with thrust in the millinewton level, with a specific impulse of approximately 250 seconds and power input of 20 watts or less that is useful for applications of up to 1,000 hours of operation or more. The essential feature of this invention is a gas-carrying tube surrounding a central heating element. The propellant is flashed into vapor and then passes through a narrow annulus between the tube and the heater where it is cracked (in the case of methanol, into CO and H_2) before being discharged through a de Laval nozzle to produce thrust.

A multi-layer radiation shield around the gas tube minimizes heat loss. Also, if methanol is used as the propellant, the simultaneous heating and cracking does not need an additional device. This unit would be especially useful for small satellites, with mass up to 100 kg, and for delta v up to 500 m/sec, and is suited for use with "green" methanol as the propellant where a specific impulse of 220 seconds is expected. Noble metal alloys are the optimal materials of construction. While the microresistojet is especially suited to methanol, many other propellants may be used such as water or, in the case of de-orbiting, many other residual liquids onboard the vehicle.

This work was done by Thomas Brogan, Mike Robin, Mary Delichatsios, John Duggan, Kurt Hohman, and Vlad Hruby of Busek Co. Inc. for Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15053-1

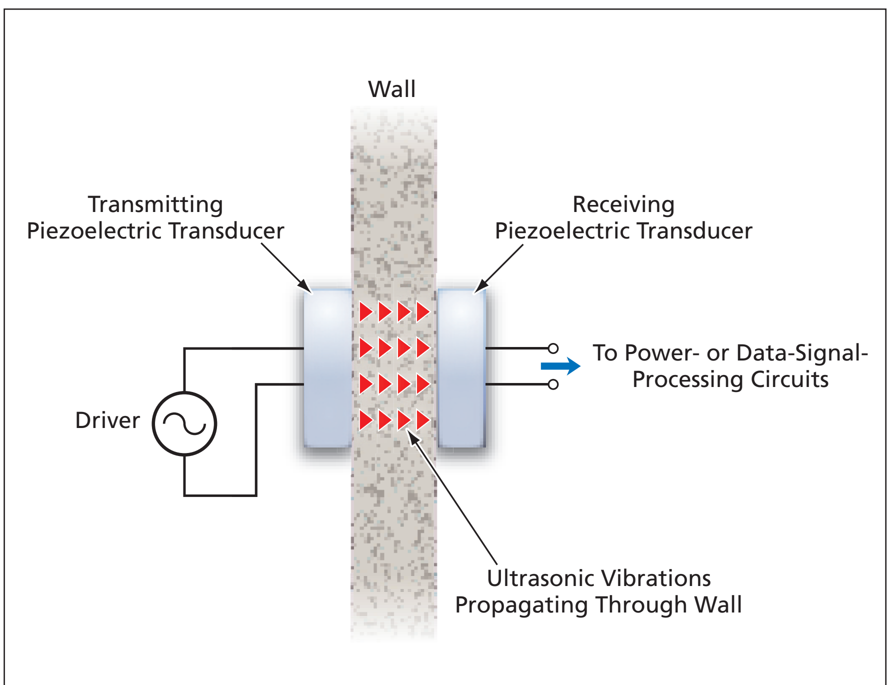
Using Piezoelectric Devices To Transmit Power Through Walls

It would not be necessary to make holes in walls for wires.

NASA's Jet Propulsion Laboratory, Pasadena, California

A method denoted wireless acoustic-electric feed-through (WAEF) has been conceived for transmitting power and/or data signals through walls or other solid objects made of a variety of elastic materials that could be electrically conductive or nonconductive. WAEF would make it unnecessary to use wires, optical fibers, tubes, or other discrete wall-penetrating signal-transmitting components, thereby eliminating the potential for structural weakening or leakage at such penetrations. Avoidance of such penetrations could be essential in some applications in which maintenance of pressure, vacuum, or chemical or biological isolation is required.

In a basic WAEF setup (see figure), a transmitting piezoelectric transducer on one side of a wall would be driven at resonance to excite ultrasonic vibrations in the wall. A receiving piezoelectric transducer on the opposite side of the wall would convert the vibrations back to an ultrasonic AC electric signal, which would then be detected and otherwise



Ultrasonic Waves would be used to transmit a power or data signal through a wall.

processed in a manner that would depend on the modulation (if any) applied to the signal and whether the signal was used to transmit power, data, or both.

The basic WAEF concept admits of variations. In one potentially important class of variations, different frequencies (in particular, those of lower- and higher-order resonances) would be used to transmit different signals through a wall in the same direction or in opposite directions. For example, an exterior ultrasonic transducer on a vessel could be excited at the fundamental resonance frequency to transmit power through the wall to an interior ultrasonic transducer to activate instrumentation inside the vessel, while the interior ultrasonic transducer could be excited at the frequency of a higher-order resonance to transmit data signals from the interior instrumentation to an external computer.

An electromechanical-network model has been derived as a computationally efficient means of analyzing and designing a WAEF system. This model is a variant of a prior model, known in the piezoelectric-transducer art as Mason's equivalent-circuit model, in which the electrical and mechanical dynamics, including electromechanical couplings, are expressed as electrical circuit elements that can include inductors, capacitors, and lumped-parameter complex impedances. The real parts of the complex impedances are used to account for dielectric, mechanical, and coupling losses in all components (including all piezoelectric-transducer, wall, and intermediate material layers). In an application to a three-layer piezoelectric structure, this model was shown to yield the same results as do solutions of the wave equations of piezoelectricity and acoustic propagation in their full complexity.

This work was done by Stewart Sherrit, Yoseph Bar-Cohen, and Xiaoqi Bao of Caltech for NASA's Jet Propulsion Laboratory. For further information, contact iaoffice@jpl.nasa.gov. NPO-41157

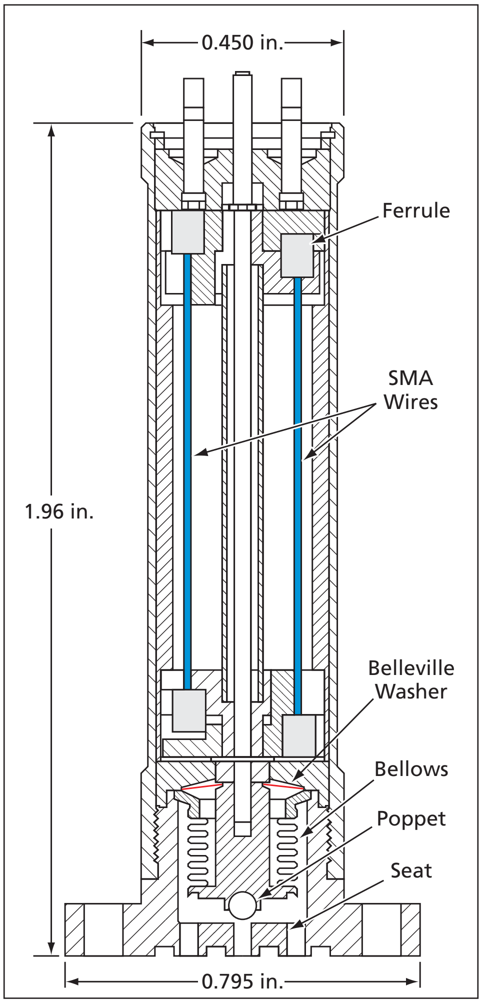
Miniature Latching Valve

This valve remains either open or closed when power is not supplied.

Goddard Space Flight Center, Greenbelt, Maryland

A miniature latching valve has been invented to satisfy a need for an electrically controllable on/off pneumatic valve that is lightweight and compact and remains in the most recently commanded open or closed state when power is not supplied. The valve (see figure) includes a poppet that is moved into or out of contact with a seat to effect closure or opening, respectively, of the flow path. Motion of the poppet is initiated by electrical heating of one of two opposing pairs of nickel/titanium shape-memory alloy (SMA) wires above their transition temperature: heated wires contract to their "remembered" length, applying tension to pull the poppet toward or away from the seat. A latch consisting mainly of a bistable Belleville washer (a conical spring) made of a hardened stainless steel operates between two stable positions corresponding to the fully closed or fully open state, holding the poppet in one of these positions when power is not applied to either pair of SMA wires.

The reason for using SMA wires is that in comparison with other linear actuators of the same mass and size, SMA wires produce more work output. The light weight and compactness of the SMA-wire actuators and the Belleville-washer latch make it possible for this valve to be smaller and less massive than are prior valves of comparable performance.



The **Miniature Latching Valve**, shown here in the open state, is actuated between the open and closed states by means of the SMA wires and the Belleville washer.

To obtain maximum actuation force and displacement, the SMA wires must be kept in tension. The mounting fixtures at the ends of the wires must support large tensile stresses without creating stress concentrations that would limit the fatigue lives of the wires. An earlier design provided for each wire to be crimped in a conical opening with a conical steel ferrule that was swaged into the opening to produce a large, uniformly distributed holding force. In a subsequent design, the conical ferrule was replaced with a larger crimped cylindrical ferrule depicted in the figure.

A major problem in designing the valve was to protect the SMA wires from a bake-out temperature of 300 °C. The problem was solved by incorporating the SMA wires into an actuator module that is inserted into a barrel of the valve body and is held in place by miniature clip rings.

This work was done by A. David Johnson of TiNi Alloy Co. and Glendon M. Benson of Aker Industries for Goddard Space Flight Center.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to GSC-14881-1, volume and number of this NASA Tech Briefs *issue, and the page number.*