specific design and operating conditions. The probe rod had a diameter of 1/8 in. (≈3 mm) and a length sufficient to enable penetration to a depth of 3 ft (≈91 cm). The piezoelectric stack was driven at a 20-percent duty cycle, with a combination of automatic and manual adjustments of the frequency of the driving signal to compensate for changes in the resonance frequency induced by changes in mechanical loading and by temperature rise during operation.

The design of the horn and a piezoelectric-stack-backing structure was optimized for coupling power from the stack to the horn and for amplification of the longitudinal displacement. The optimization was accomplished with the help of a computer program that numerically solved the governing equations to perform impact and vibration-mode analyses. The modal analysis was used to determine the dimensions of the horn and backing for a resonance frequency in the required range and to further adjust the dimensions of the horn so that the neutral plane matched the mounting plane to minimize adverse effects of transducer vibration on a supporting structure. The impact analysis, in which the focus was on the interaction between the free mass and the horn, was used to derive an optimal weight of the free mass.

In experiments, an axial force of 7 lb (≈31 N)] was found to be sufficient to cause the probe tip to reach a depth of 3 ft (≈91 cm) in a packed soil sample. In contrast, the axial force that would be needed to make an equivalent probe tip penetrate to the same depth by ordinary steady pushing has been estimated to be about 200 lb (≈890 N), which is large enough to easily cause buckling of the probe without a holding mechanism and to damage a buried barrel.

This work was done by Xiaoqi Bao, Yoseph Bar-Cohen, Zensheu Chang, Stewart Sherrit, and Randall A. Stark of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-41666

Miniature, Lightweight, One-Time-Opening Valve

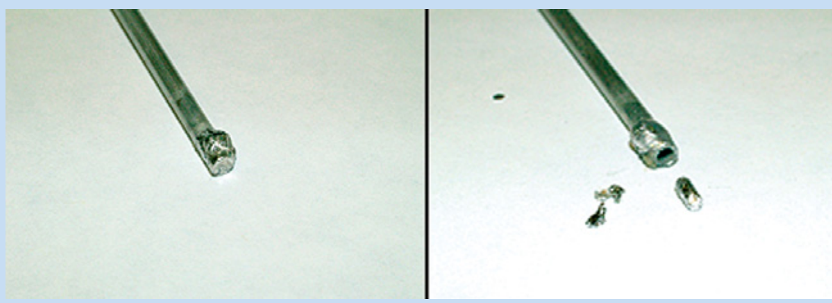
A small solder plug is melted to release a pressurized gas.

NASA's Jet Propulsion Laboratory, Pasadena, California

The figure depicts the main parts of a prototype miniature, lightweight, one-time-opening valve. Like some other miniature one-time-opening valves reported in previous issues of *NASA Tech Briefs*, this valve is opened by melting a material that blocks the flow path. This valve is designed to remain closed at some temperature between room temperature and cryogenic temperature until the time of opening.

The prototype valve includes a 1/8-in. (3-mm) aluminum tube, one end of which is plugged with a solder comprising about 37 weight percent of lead and 63 weight percent of tin. The tube and the solder both have a coefficient of thermal expansion of 23 micron/m-K at room temperature. Before plugging, the interior surface of the plug end of the tube is cleaned with a commercial flux paste developed specifically for preparing aluminum for bonding with lead/tin solder. The solder is then melted into the cleaned end of the tube, forming the plug.

In a test, the plugged tube was pressurized to 1,000 psi (6.9 MPa) with helium and leak-tested. It was then cooled to a temperature of 77 K (about –196 °C) and again leak-tested at the same pressure. Finally, at a lower pressure, the plugged end of the tube was heated to about 200 °C (the melting temperature of the solder is 183°C), causing the solder plug to be ejected (see figure). It has been estimated that in a subsequent version of the valve, the plug could be melted by electrical heating, using a nichrome wire having a mass of only 10 g.



SOLDERED ALUMINUM TUBE BEFORE HEATING

SOLDERED ALUMINUM TUBE AFTER HEATING

The **Solder Plug Was Ejected** from the pressurized aluminum tube when the plugged end was heated to about 200 °C.

This work was done by Jack Jones, Juinn Jenq Wu, and Robert Leland of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-42236