Machinery/Automation

Ultrasonically Actuated Tools for Abrading Rock Surfaces

These offer the same advantages as do ultrasonically actuated drilling and coring tools.

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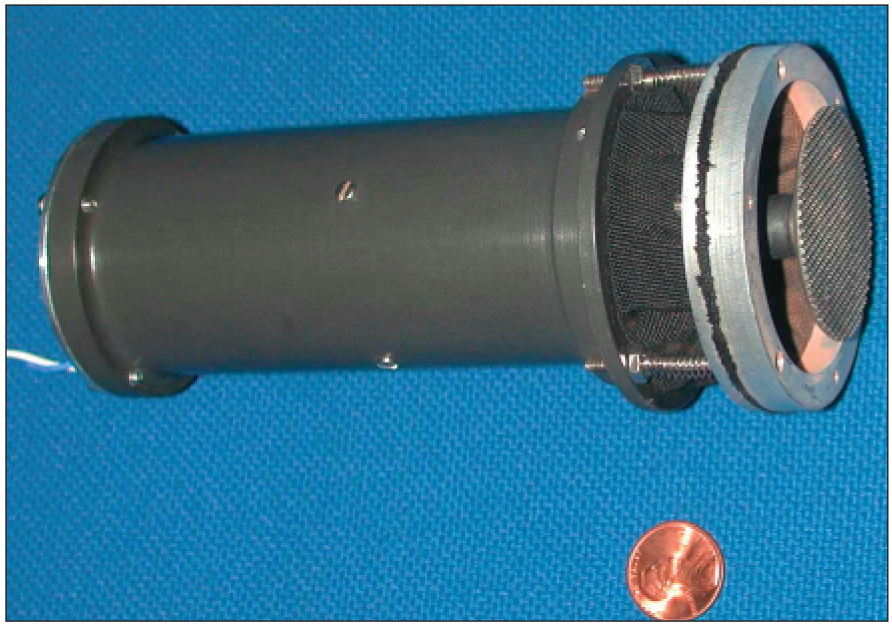
An ultrasonic rock-abrasion tool (URAT) was developed using the same principle of ultrasonic/sonic actuation as that of the tools described in two prior *NASA Tech Briefs* articles: "Ultrasonic/Sonic Drill/Corers With Integrated Sensors (NPO-20856), Vol. 25, No. 1 (January 2001), page 38 and "Ultrasonic/Sonic Mechanisms for Drilling and Coring" (NPO-30291), Vol. 27, No. 9 (September 2003), page 65. Hence, like those tools, the URAT offers the same advantages of low power demand, mechanical simplicity, compactness, and ability to function with very small axial loading (very small contact force between tool and rock).

Like a tool described in the second of the cited previous articles, a URAT includes (1) a drive mechanism that comprises a piezoelectric ultrasonic actuator, an amplification horn, and a mass that is free to move axially over a limited range and (2) an abrasion tool bit. A URAT tool bit is a disk that has been machined or otherwise formed to have a large number of teeth and an overall shape chosen to impart the desired shape (which could be flat or curved) to the rock surface to be abraded. In operation, the disk and thus the teeth are vibrated in contact with the rock surface. The concentrated stresses at the tips of the impinging teeth repeatedly induce microfractures and thereby abrade the rock. The motion of the tool induces an ultrasonic transport effect that displaces the cuttings from the abraded area.



This **Prototype URAT** is one of several that have been constructed thus far. It has a total mass of 0.4 kg, a length of 5.65 in. (14.4 cm), and a maximum diameter of 2.5 in. (6.35 cm). The textured disk at the right end is the tool bit.

The figure shows a prototype URAT. A piezoelectric-stack/horn actuator is housed in a cylindrical container. The movement of the actuator and bit with respect to the housing is aided by use of mechanical sliders. A set of springs accommodates the motion of the actuator and bit into or out of the housing through an axial range between 5 and 7 mm. The springs impose an approximately constant force of contact between the tool bit and the rock to be abraded. A dust shield surrounds the bit, serving as a barrier to reduce the migration of rock debris to sensitive instrumentation or mechanisms in the vicinity. A bushing at the tool-bit end of the housing reduces the flow of dust into the actuator and retains the bit when no axial load is applied.

This work was done by Benjamin Dolgin, Stewart Sherrit, Yoseph Bar-Cohen, Richard Rainen, Steve Askin, Donald Bickler, Donald Lewis, John Carson, Stephen Dawson, Xiaoqi Bao, and Zensheu Chang of Caltech and Thomas Peterson of Cybersonics for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
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Active Struts With Variable Spring Stiffness and Damping

These struts would act as linear actuators and controllable shock absorbers.

Langley Research Center, Hampton, Virginia

Controllable active struts that would function as linear actuators with variable spring stiffness and damping have been proposed as components of advanced suspension systems of future wheeled ground vehicles. The contemplated advanced suspension systems would include computer-based control subsystems that would continually adjust the actuator responses to obtain optimal combinations of safety and comfort under operating conditions ranging from low speeds over smooth roads to high speeds over rough, unpaved ground. The proposed struts and suspen-