between the frame at the outer end and the drive at the inner end. The jamming of the inner sprag against the drive would prevent rotation of the drive relative to the drive housing, so that clockwise torque would be exerted on the drive. At the end of the clockwise torque-application stroke, the operator would twist the outer sprag to relieve the contact forces as described above. Then by exerting a small counterclockwise force on the outer-sprag portion of the handle, the operator could further unjam the sprags to complete the disengagement with the drive, and turn the handle counterclockwise to the starting position for the next clockwise torque-application stroke. Except for reversal of the directions of all forces, torques, and rotations, counterclockwise ttorquing and ratcheting would be the same as in the clockwise case described above.

This work was done by John M. Vranish of Goddard Space Flight Center. For further information, contact the Goddard Innovative Technology Partnership (ITTP) Office at (301) 286-5810. GSC-14682-1

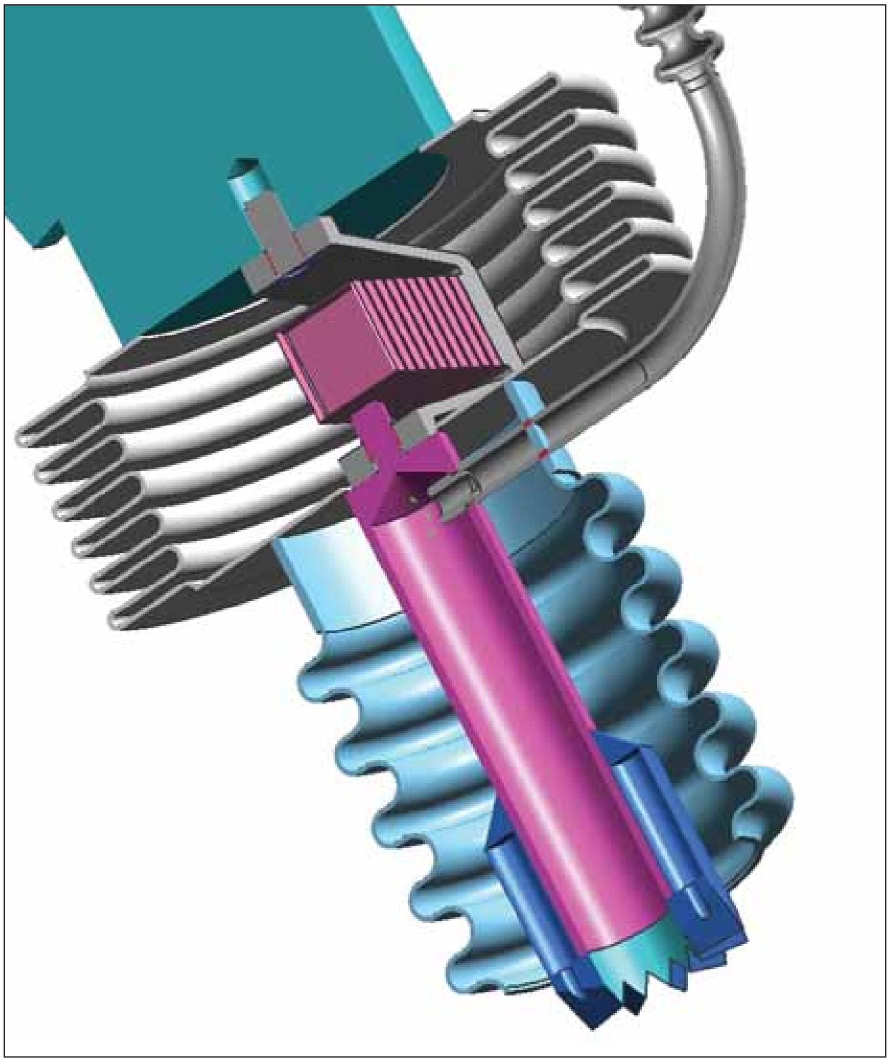
Miniature Low-Mass Drill Actuated by Flextensional Piezo Stack

This extremely small impact drill can be used for testing soil for toxic chemicals, and other analytical tests.

NASA's Jet Propulsion Laboratory, Pasadena, California

Recent experiments with a flextensional piezoelectric actuator have led to the development of a sampler with a bit that is designed to produce and capture a full set of sample forms including volatiles, powdered cuttings, and core fragments.

The flextensional piezoelectric actuator is a part of a series of devices used to amplify the generated strain from piezoelectric actuators. Other examples include stacks, bimorphs, benders, and cantilevers. These devices combine geometric and resonance amplifications to produce large stroke at high power density. The operation of this sampler / drill was demonstrated using a 3×2×1-cm actuator weighing 12 g using power of about 10-W and a preload of about 10 N. A limestone block was drilled to a depth of about 1 cm in five minutes to produce powdered cuttings.



The **Miniature Drill**, the bit, and the covering of both the actuator and bit using bellows are shown. The tube with bellows also is shown.

It is generally hard to collect volatiles from random surface profiles found in rocks and sediment, powdered cuttings, and core fragments. Toward the end of collecting volatiles, the actuator and the bit are covered with bellows-shaped shrouds to prevent fines and other debris from reaching the analyzer. A tube with a miniature bellows (to provide flexibility) is connected to the bit and directs the flow of the volatiles to the analyzer. Another modality was conceived where the hose is connected to the bellows wall directly to allow the capture of volatiles generated both inside and outside the bit. A wide variety of commercial bellows used in the vacuum and microwave industries can be used to design the volatiles' capture mechanism.

The piezoelectric drilling mechanism can potentially be operated in a broad temperature range from about –200 to <450 ºC. The actuators used here are similar to the actuators that are currently baselined to fly as part of the inlet funnel shaking mechanism design of MSL (Mars Science Laboratory). The space qualification of these parts gives this drill a higher potential for inclusion in a future mission, especially when considering its characteristics of low mass, small size, low power, and low axial loads for sampling.

Such a tiny penetrator can be integrated with instruments for life and water detection as well as materials characterization for planetary applications. It is also a useful tool for gaining subsurface access, an exploration goal that is an essential element of future missions. Terrestrially speaking, this tool has applications with regard to testing soil for toxic chemicals, the presence of moisture, and various other analytical tests.

This work was done by Stewart Sherrit, Mircea Badescu, and Yoseph Bar-Cohen of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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 NPO-45857, volume and number of this NASA Tech Briefs *issue, and the page number.*

Inline Electrical Connector Mate / Demate Pliers

These pliers are designed for use in tight spaces and recessed electrical panels.

John F. Kennedy Space Center, Florida

Military and aerospace industries use Mil-Spec type electrical connections on bulkhead panels that require inline access for mate and demate operations. These connectors are usually in tight proximity to other connectors, or recessed within panels. The pliers described here have been designed to work in such tight spaces, and consist of a mirrored set of parallel handles, two cross links, two return springs, and replaceable polyurethane-coated end effectors. The polyurethane eliminates metal-to-metal contact and provides a high-friction surface between the jaw and the connector.

Operationally, the user would slide the pliers over the connector shell until the molded polyurethane lip makes contact with the connector shell edge. Then, by squeezing the handles, the end effector jaws grip the connector shell, allowing the connector to be easily disconnected by rotating the pliers. Mating the connector occurs by reversing the prescribed procedure, except the connector shell is placed into the jaws by hand. The molded lip within the jaw allows the user to apply additional force for difficult-to-mate connectors.

The **Mate/Demate Pliers**, shown in their open and closed configurations, feature cross-link springs to ensure they remain in the open position until adequate force is applied to close them.

Handle design has been carefully examined to maximize comfort, limit weight, incorporate tether locations, and improve ergonomics. They have been designed with an off-axis offset for wiring harness clearance, while placing the connector axis of rotation close to the user's axis of wrist rotation. This was done to eliminate fatigue during multiple connector panel servicing. To limit handle opening width, with user ergonomics in mind, the pliers were designed using a parallel jaw mechanism. A cross-link mechanism was used to complete this task, while ensuring smooth operation.

Forward slides allow the links to change position during opening and closing. Springs were added to the cross links to ensure that the pliers remain in the open position until adequate force is applied to close them. The jaw end effectors can be easily removed and replaced to accommodate a range of connector sizes. Because the pliers were designed with the intent of reducing the risk of foreign object debris (FOD), the end effectors contain two capturing features. They are held in place by means of two captive screw retainers while a secondary detent feature holds the jaws in case the screw retainers fail or become loose.

This work was done by Brian Yutko, Michael Dininny, Gerard Moscoso, and Adam Dokos of Kennedy Space Center. Further information is contained in a TSP (see page 1). KSC-13322