Mechanics/Machinery

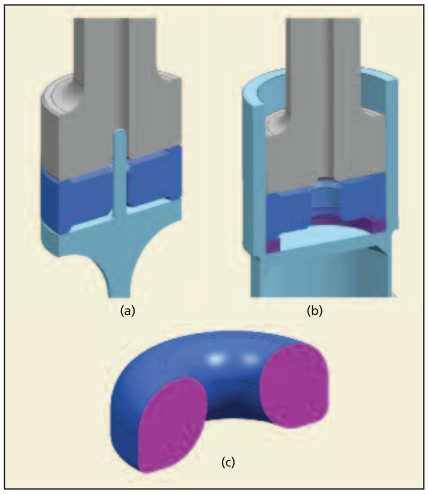
Free-Mass and Interface Configurations of Hammering Mechanisms

These mechanisms are applicable for construction or other industries requiring drills or actuators.

NASA's Jet Propulsion Laboratory, Pasadena, California

A series of free-mass designs for the ultrasonic/sonic driller/corer (USDC) has been developed to maximize the transfer of energy from the piezoelectric transducer through the horn to the bit, as well as to minimize potential jamming. A systematic development was made producing novel designs of free-mass configurations where the impact force is spread across a minimal area maximizing the impact on the bit. The designed free masses were made to operate at high temperatures (500 °C) as on Venus, and they can be made to operate at extremely low temperature, too.

In normal operation, the free mass bounces between the horn and the bit, impacting both repeatedly. The impact stress profile, maximum stress, contact time duration, and the required yielding stress for the materials of the free mass, bit, and horn are all affected by the contact area. A larger contact area results in lower stress in the contact region, and avoids yielding of the materials. However, before the excitation voltage is applied to the transducer, the horn, free mass, and the bit are pressed together. Larger contact area results in a stronger coupling of the bit to the horn transducer, which greatly changes the vibration characteristics of the transducer, and makes the USDC difficult to start.



In the improved **USDC Design**, the rod was eliminated, and a solid cylinder-shaped free mass retained with a "cup" was used. On the left (a) is shown the rod configuration for the retention of the free mass, and on the right (b) the cup configuration is shown for the free mass retention. Part (c) shows a free mass with flat and curved contact areas.

To obtain optimum performance, a catalog of free-mass designs is required, allowing maximum flexibility during trade-off for these conflicting contact area requirements.

For this purpose, seven different designs were conceived: point contacts, circular contacts, point/circular contacts, line contacts, ring contacts, line/ring contacts, and dashed line contacts. Besides point/circular and line/ring contacts, the free mass can be designed as any of the above shapes. Depending on the ratio of the diameter to the height, and the free-mass retention method used (the cup or rod), the free mass can be configured with one or more sliding surfaces on the outside or inside diameter surface or both. Matching horn tips and free mass may also offer some utility in maximizing the stress pulse.

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

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Wavefront Compensation Segmented Mirror Sensing and Control

Six degrees of freedom can be sensed at each segment edge.

NASA's Jet Propulsion Laboratory, Pasadena, California

The primary mirror of very large submillimeter-wave telescopes will necessarily be segmented into many separate mirror panels. These panels must be continuously co-phased to keep the telescope wavefront error less than a small fraction of a wavelength, to ten microns RMS (root mean square) or less. This performance must be maintained continuously across the full aperture of the telescope, in all pointing conditions, and in a variable thermal environment.

A wavefront compensation segmented mirror sensing and control system, consisting of optical edge sensors, Wavefront Compensation Estimator/Controller Software, and segment position actuators is proposed. Optical edge sensors are placed two per each segment-to-segment edge to continuously measure changes in segment state. Segment position actuators (three per segment) are used to move the panels. A computer control system uses the edge sensor