

# Back Actuators for Segmented Mirrors and Other Applications

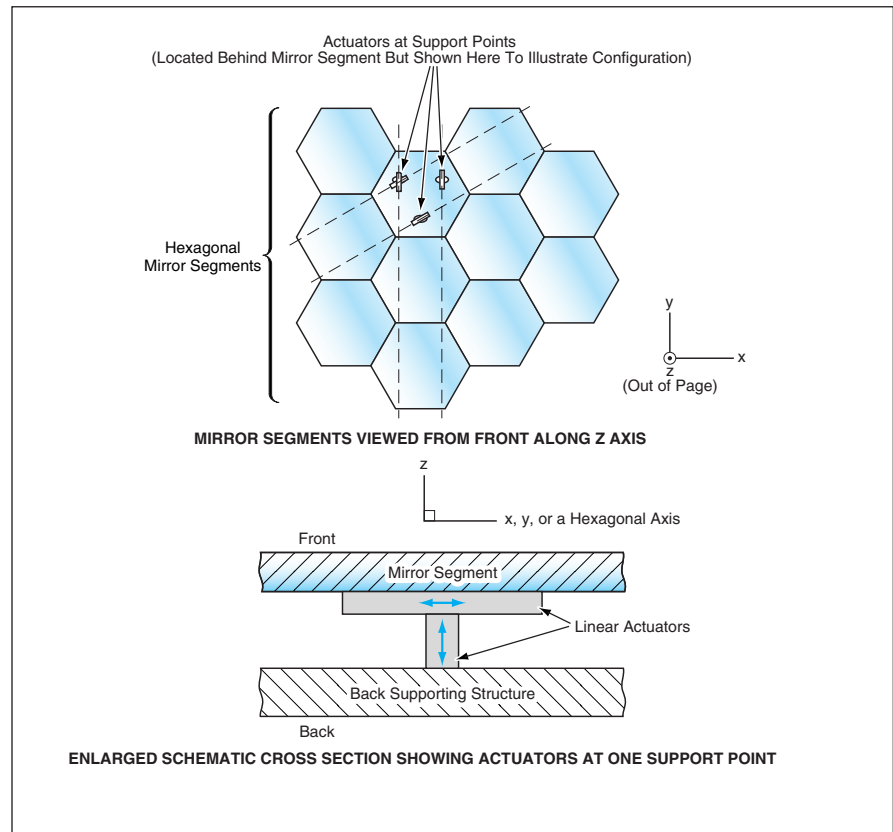
Actuation mechanisms could be simpler.

NASA's Jet Propulsion Laboratory, Pasadena, California

Back actuators have been proposed as alternatives to edge actuators considered previously for use in aligning hexagonal segments of lightweight segmented astronomical mirrors planned for use in outer space. The proposed back actuators could also be useful on Earth as parts of wafer-conveyance systems in the semiconductor industry.

Whereas the prior edge actuators were required to impose rotations and torques (in addition to forces and displacements) at joints between mirror segments, the proposed back actuators would be required to impose only forces and displacements (sometimes accompanied by small incidental torques and rotations). The advantages of the back-actuation approach, relative to the edge-actuation approach, are that the actuation mechanisms could be made simpler and a single overall actuation scheme could incorporate what were previously separate actuation schemes for (1) orienting the mirror segments at the required angles and (2) placing the mirror segments at the required distances along the optical axis from the focus.

Each hexagonal mirror segment would be supported at three points by sets of linear actuators (see figure). The linear actuators at each support point would include one to impose displacement along the optical axis (the  $z$  axis in the figure) plus one or two to impose displacement along one or two of the hexagonal axes. The linear actuators could be, for example,



Actuators would be located on the backs of hexagonal mirror segments instead of at the edges between mirror segments as before. The combination of linear displacements along the relevant coordinate axes at the three support points of each segment would suffice to align all of the mirror segments in both position and orientation.

shape-memory-alloy actuators or piezoelectric actuators that move in the manner of an inchworm like those described in several previous NASA Tech Briefs articles.

This work was done by Eui-Hyeok Yang and Dean Wiberg of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-30550

# Mechanism for Self-Reacted Friction Stir Welding

This mechanism performs better than others that have been tried.

Marshall Space Flight Center, Alabama

A mechanism has been designed to apply the loads (the stirring and the resection forces and torques) in self-reacted friction stir welding. This mechanism differs somewhat from mechanisms used in conventional friction stir welding, as described below.

The tooling needed to apply the large reaction loads in conventional friction stir welding can be complex. Self-reacted

friction stir welding has become popular in the solid-state welding community as a means of reducing the complexity of tooling and to reduce costs. The main problems inherent in self-reacted friction stir welding originate in the high stresses encountered by the pin-and-shoulder assembly that produces the weld.

The design of the present mechanism solves the problems. The mechanism

(see figure) includes a redesigned pin-and-shoulder assembly. The welding torque is transmitted into the welding pin by a square pin that fits into a square bushing with setscrews. The opposite or back shoulder is held in place by a Woodruff key and high-strength nut on a threaded shaft. The Woodruff key reacts the torque, while the nut reacts the tensile load on the shaft.



This Mechanism Applies All the Loads needed for self-reacted friction stir welding.

The welding pin and shoulder can be assembled and disassembled quickly. An additional advantage of the present mechanism is that it affords positive seal-

ing on the root-side shoulder to reduce winking of the material being welded. This mechanism has been proven superior to all mechanisms tried before in

self-reacted friction stir welding.

*This work was done by Richard Venable and Joseph Bucher of Lockheed Martin Corp. for Marshall Space Flight Center. For further information, contact Gary L. Wilett at (504) 257-4786.*

*Title to this invention has been waived under the provisions of the National Aeronautics and Space Act {42 U.S.C. 2457(f)} to Lockheed Martin Manned Space Systems. Inquiries concerning licenses for its commercial development should be addressed to:*

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