



## Fastener Starter

**This tool is superior to prior screw and nut starters.**

*John F. Kennedy Space Center, Florida*

The Fastener Starter is a creative solution to prevent the loss of small fasteners during their installation. This is the only currently available tool that can firmly grip and hold a single screw, bolt, nut, washer, spacer, or any combination of these parts. Other commercially available fastener starters are unable to accommodate a variety of parts simultaneously. The Fastener Starter is a more capable and easier tool to use than prior tools. Its compact size allows it to be used effectively in cramped, difficult-to-see locations. Its design also allows it to be used with or without handles and extenders in other difficult-to-reach locations. It provides better protection against cross threading and loss of fasteners and associated parts. The Fastener Starter is non-magnetic and does not off-gas, thus meeting flight hardware requirements.

The Fastener Starter incorporates a combination of features of several commercially available tools, providing an improved means of installing small fasteners. The Fastener Starter includes a custom molded insert that can be removed easily and replaced with a con-

ventional tool bit (e.g., a screwdriver or hex-driver bit). When used with the insert, the Fastener Starter prevents cross threading and damage to internal threaded holes. This is achieved by allowing the fastener to slip within the tool insert when used without a conventional tool bit. Alternatively, without the insert and with a tool bit, the Fastener Starter can torque a fastener. The Fastener Starter has a square recess hole that accepts a conventional square drive handle or extension to accommodate a variety of applications by providing flexibility in handle style and length.

In a typical operation sequence, the user opens the tool, places a screw, screw/washer combination, nut, or nut/washer combination against and within the insert (or tool bit), and closes the tool, which firmly grasps the hardware. The user then guides the fastener to its destination and turns the tool to attach the fastener. Once the fastener is attached, the user simply pulls back on the tool to open it and release the fastener.

In tests that involved the installation of more than 300 screws and washers, in

several orientations and at different distances from the users, the tool did not drop any parts. In addition, most of the users participating in the tests expressed their preference to use this tool rather than only their hands to start a fastener installation.

*This work was done by Faith Chandler, Harry Garton, Bill Valentino, and Mike Amett of The Boeing Company for Kennedy Space Center.*

*Title to this invention, covered by U.S. Patent No. 6,606,924, has been waived under the provisions of the National Aeronautics and Space Act {42 U.S.C. 2457(f)}, to The Boeing Company. Inquiries concerning licenses for its commercial development should be addressed to:*

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## Multifunctional Deployment Hinges Rigidified by Ultraviolet

**These hinges provide both structural support and electrical connections.**

*John H. Glenn Research Center, Cleveland, Ohio*

Multifunctional hinges have been developed for deploying and electrically connecting panels comprising planar arrays of thin-film solar photovoltaic cells. In the original intended application of these hinges, the panels would be facets of a 32-sided (and approximately spherical) polyhedral microsatellite (see figure), denoted a PowerSphere, that would be delivered to orbit in a compact folded configuration, then deployed by expansion of gas in inflation bladders. Once deployment was complete, the hinges would be

rigidified to provide structural connections that would hold the panels in their assigned relative positions without backlash. Such hinges could also be used on Earth for electrically connecting and structurally supporting solar panels that are similarly shipped in compact form and deployed at their destinations.

As shown in section A-A in the figure, a hinge of this type is partly integrated with an inflation bladder and partly integrated with the frame of a solar panel. During assembly of the

hinge, strip extensions from a flexible circuit harness on the bladder are connected to corresponding thin-film conductors on the solar panel by use of laser welding and wrap-around contacts. The main structural component of the hinge is a layer of glass fiber impregnated with an ultraviolet-curable resin. After deployment, exposure to ultraviolet light from the Sun cures the resin, thereby rigidifying the hinge.

1. In the original intended satellite application, it would protect the under-