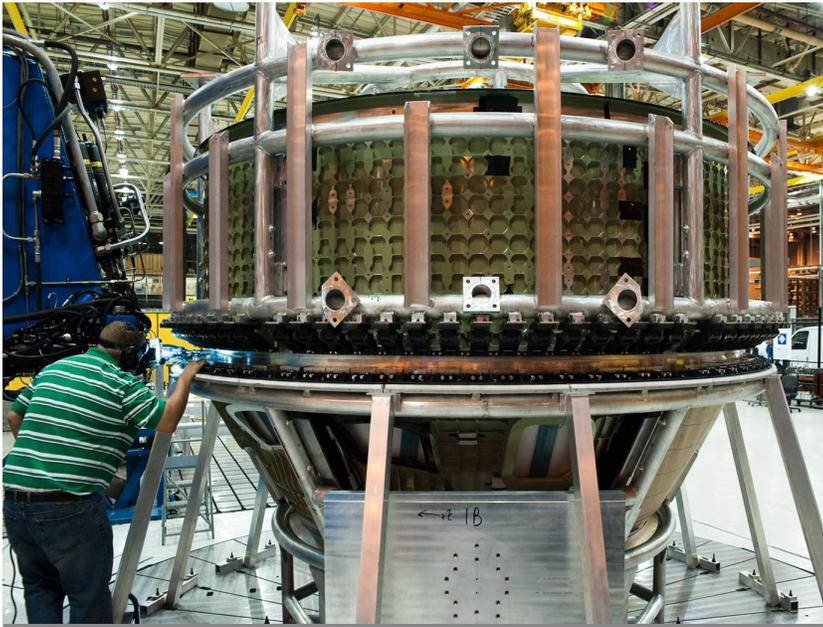




TECHNOLOGY SOLUTION

Manufacturing



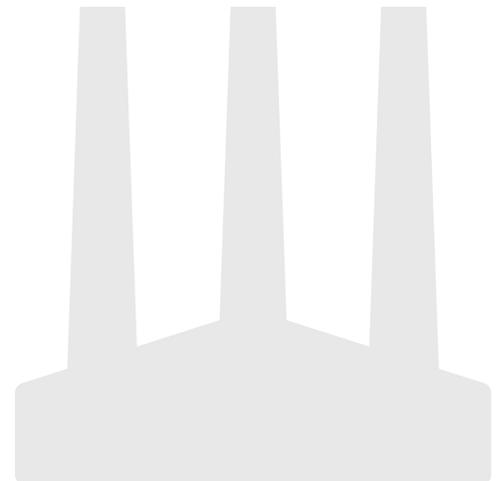
Stronger Plug for Friction Pull Plug Welding of Thick Plates

Hybrid Plug with Steel Shank Enables Thicker Welds of Different Alloys

NASA and Geocent, LLC innovators adapted a plug to improve aluminum friction pull plug welding (FPPW). The rugged plug is less vulnerable to snapping off and helps reduce chatter. FPPW is the process that is necessary to plug the hole that is left behind as a friction stir weld (FSW) joint is completed and the pin tool of the welder retracts from the joint. The inventors have replaced the plug support with steel to improve its strength to endure the forces of the FPPW process. NASA adapted the plug to enable FPPW processing for the thicker welds and different alloys needed for NASA's new Space Launch System (SLS). This new plug helps solve the well-known FPPW challenges of plug welding on thicker plates that have caused weld defects in the past such as substantial plug necking and plug rotational stalling. The new plug has been tested and used in building NASA equipment.

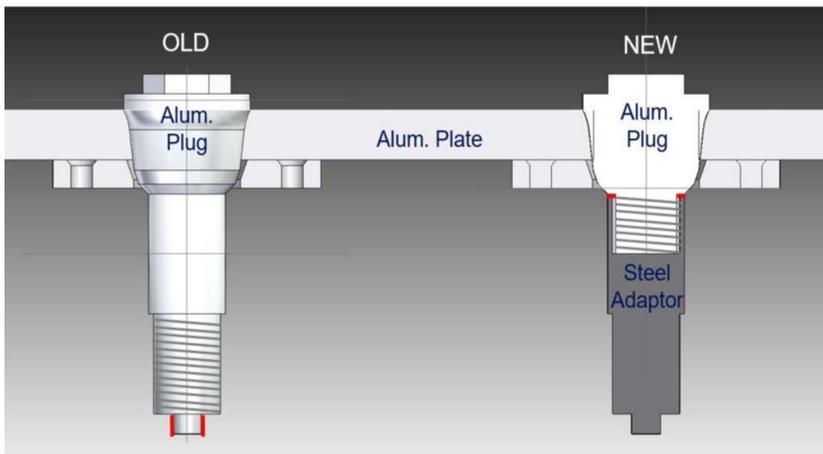
BENEFITS

- Supports Thicker Welds of up to 0.625" (of 2019 Aluminum)
- Enables FPPW on More Alloys of Aluminum including 2019, 2025
- Reduces vulnerability to breaking via lower torsion and normal stresses on the plug's threads
- Reduces Plug Necking and Plug Rotational Stalling
- Helps Make the FPPW Process More Practical and Robust
- Prevents the plug chattering and related stalling



THE TECHNOLOGY

Friction Pull Plug Welding (FPPW) is the process necessary to plug the hole that is left behind as a friction stir weld (FSW) joint is completed and the pin tool of the welder retracts from the joint. FPPW involves a small, rotating part (plug) being spun and simultaneously pulled (forged) into a hole in a larger part. Much work has been done to fully understand and characterize the process and its limitations. FPPW worked very well for building large rocket sections such as the circumferential welds of the upper stages of NASA's Ares rocket, and to repair the external tank. Engineers were challenged to adapt FPPW to accommodate the thicker plates new alloy combinations of the SLS. The new hybrid plug solves the issue of the plugs snapping due to the increase torsion and moment stresses when joining thicker plates. The new hybrid plug, with a steel shank, makes FPPW more practical and robust. The new plug has been used to make space-qualified parts at NASA, and the plug welds are as strong as initial welds.



Compared to the full-length aluminum shank illustrated by the "Old" plug on the left, the new High Tensile Strength Shank Assembly adaptor interfaces with the plug at the location indicated by the red lines on the right.

APPLICATIONS

The technology has several potential applications:

- FPPW is mostly used on cylindrical and pressurized vehicles in the following industries
- Aerospace: NASA, military/defense applications
- Future commercial ships: large aluminum vessels for transport
- Army lightweight vehicles and hybrid armor (Humvee, e.g.)
- Naval ships and littoral combat ships that also use thick aluminum plates

PUBLICATIONS

Patent Pending