

Self-Reacting Friction Stir Welding for Aluminum Alloy Circumferential Weld Application

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Robert Carter

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for
Aluminum Alloy Circumferential Weld Application
Aeromat 2003**

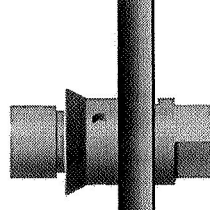
XX June 2003

**Gerry Bjorkman
Lockheed Martin Space Systems
Huntsville Technical Operations**

**Dr. Mark Cantrell
Lockheed Martin Space Systems
Michoud Operations**

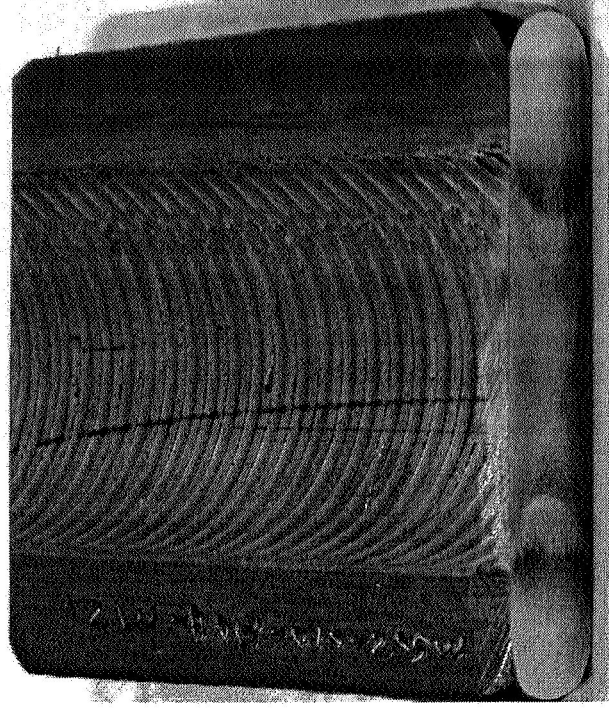
**Robert Carter
NASA
Marshall Space Flight Center**

SR-FSW for Aluminum Alloy Circ. Weld Application

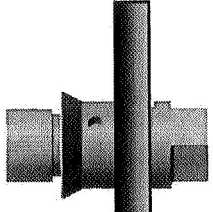


Overview

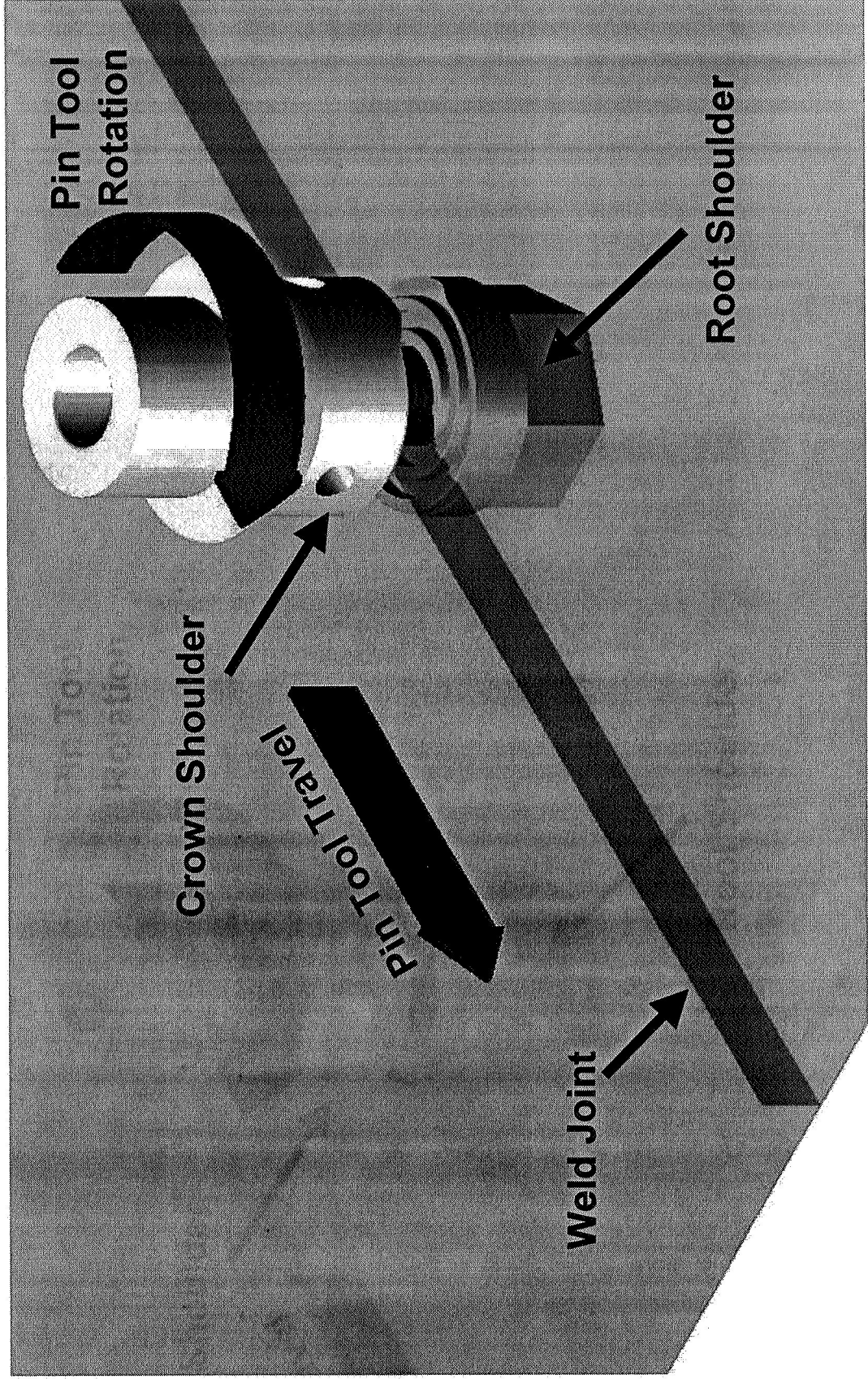
- Introduction
- Thin Gage 2XXX/2XXX Weld Development
- Tack Weld Development
- Ring Fabrication
- Circumferential Weld Demonstration
- Conclusions



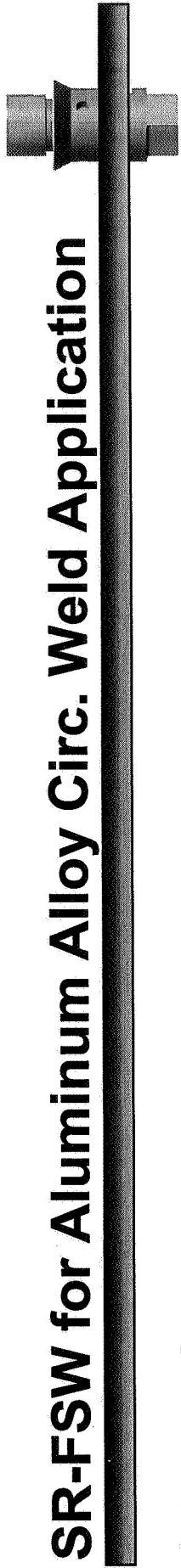
SR-FSW for Aluminum Alloy Circ. Weld Application



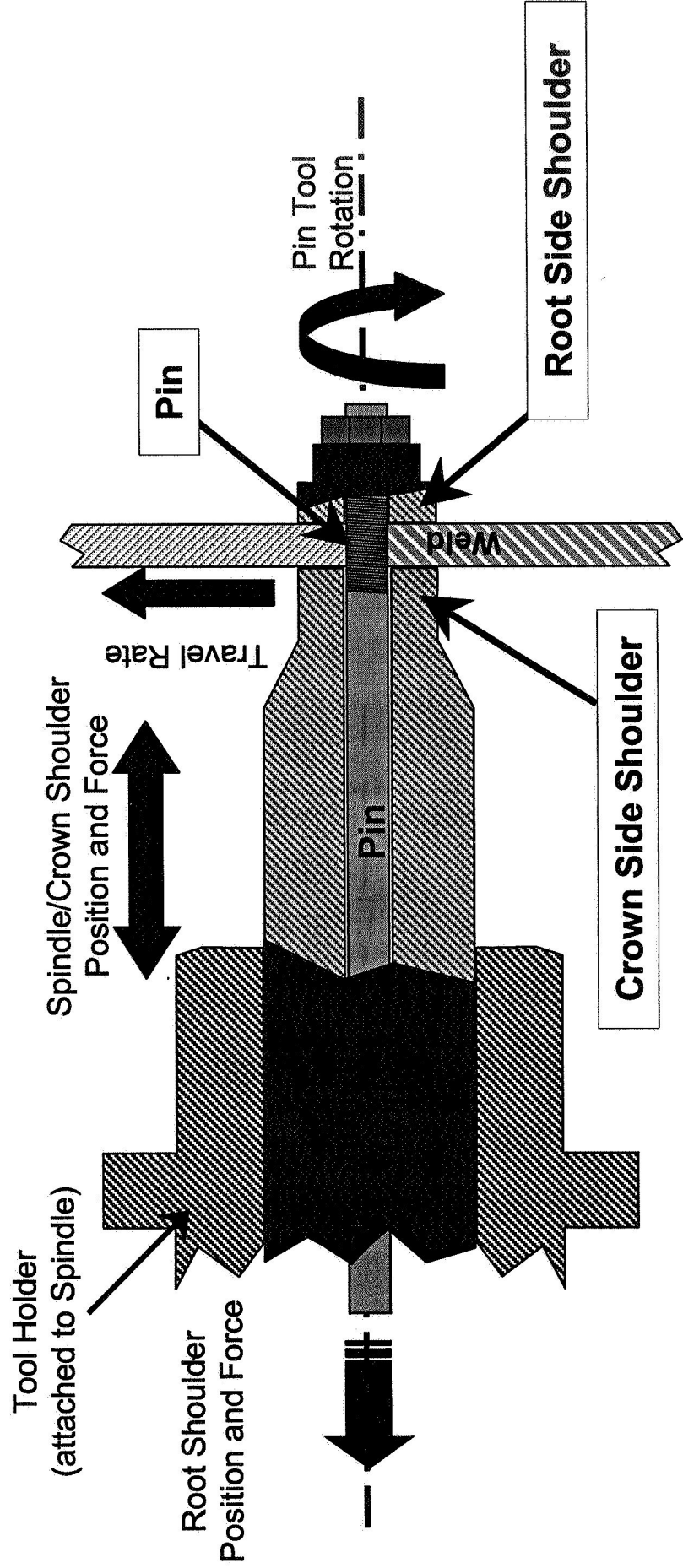
Introduction



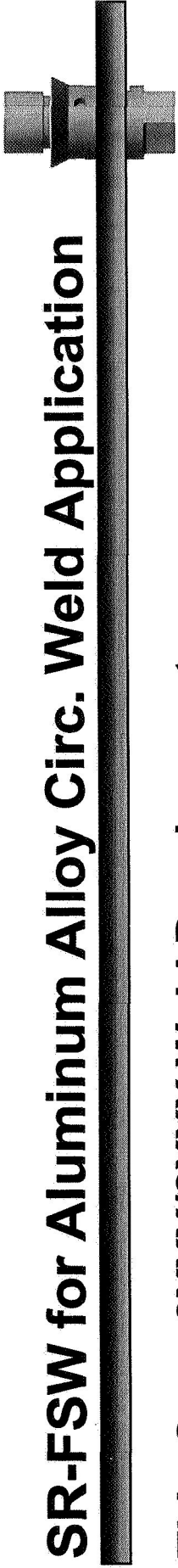
SR-FSW for Aluminum Alloy Circ. Weld Application



Introduction

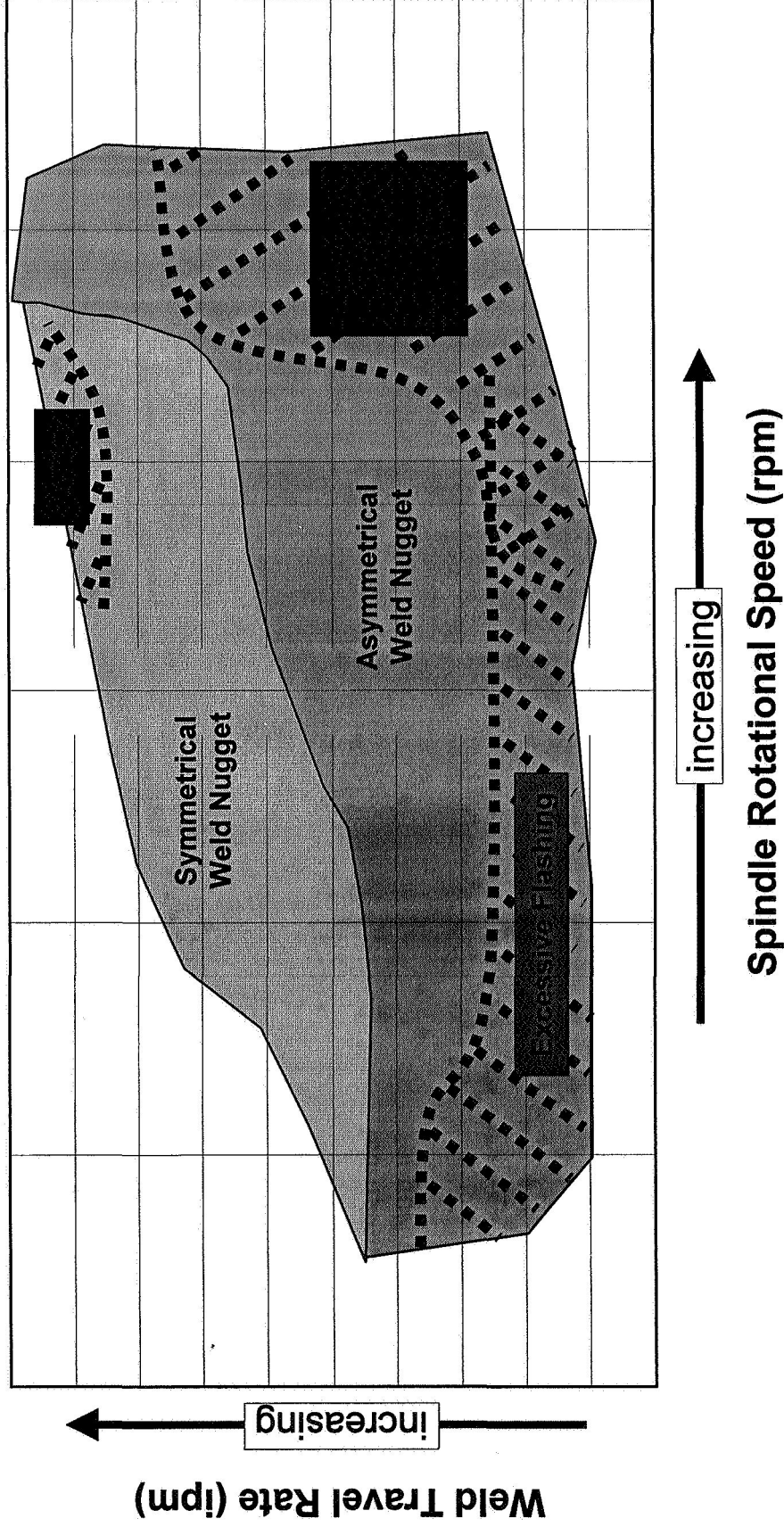


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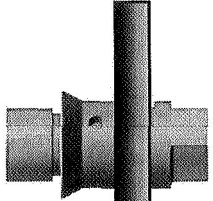


Thin Gage 2XXX/2XXX Weld Development

- Process Map – Preliminary Pin Tool Design

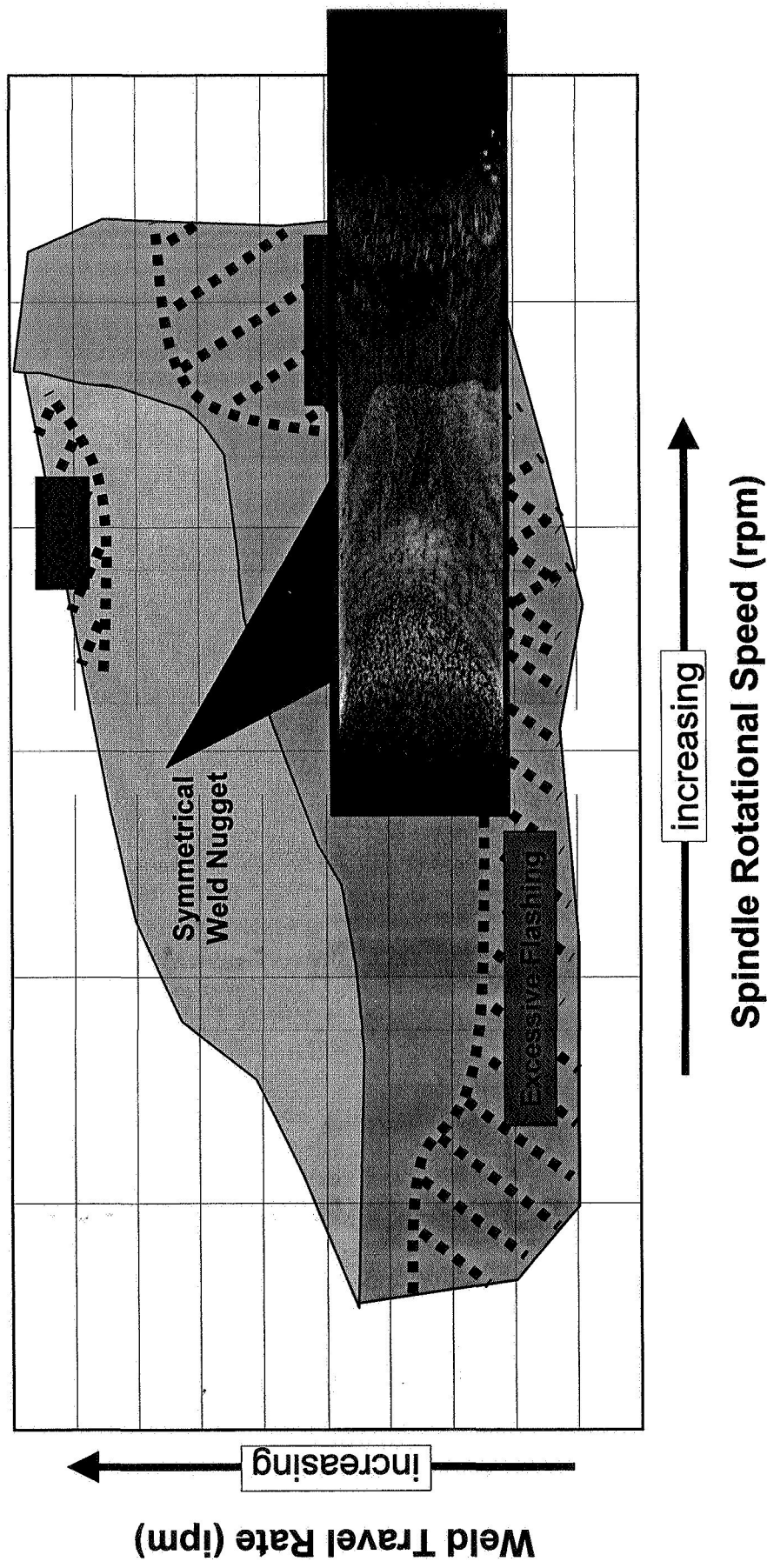


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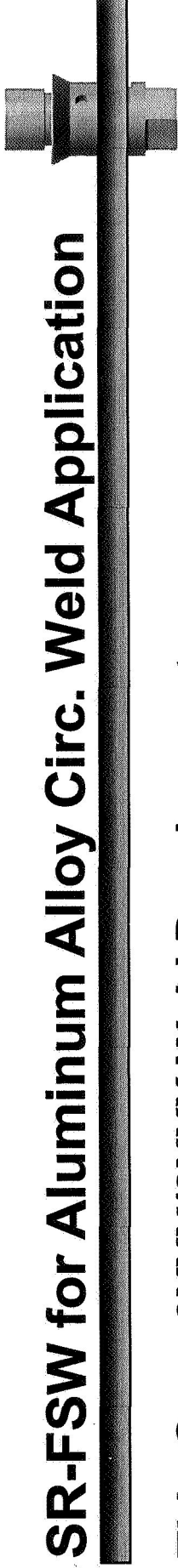


Thin Gage 2XXX/2XXX Weld Development

- Process Map – Preliminary Pin Tool Design

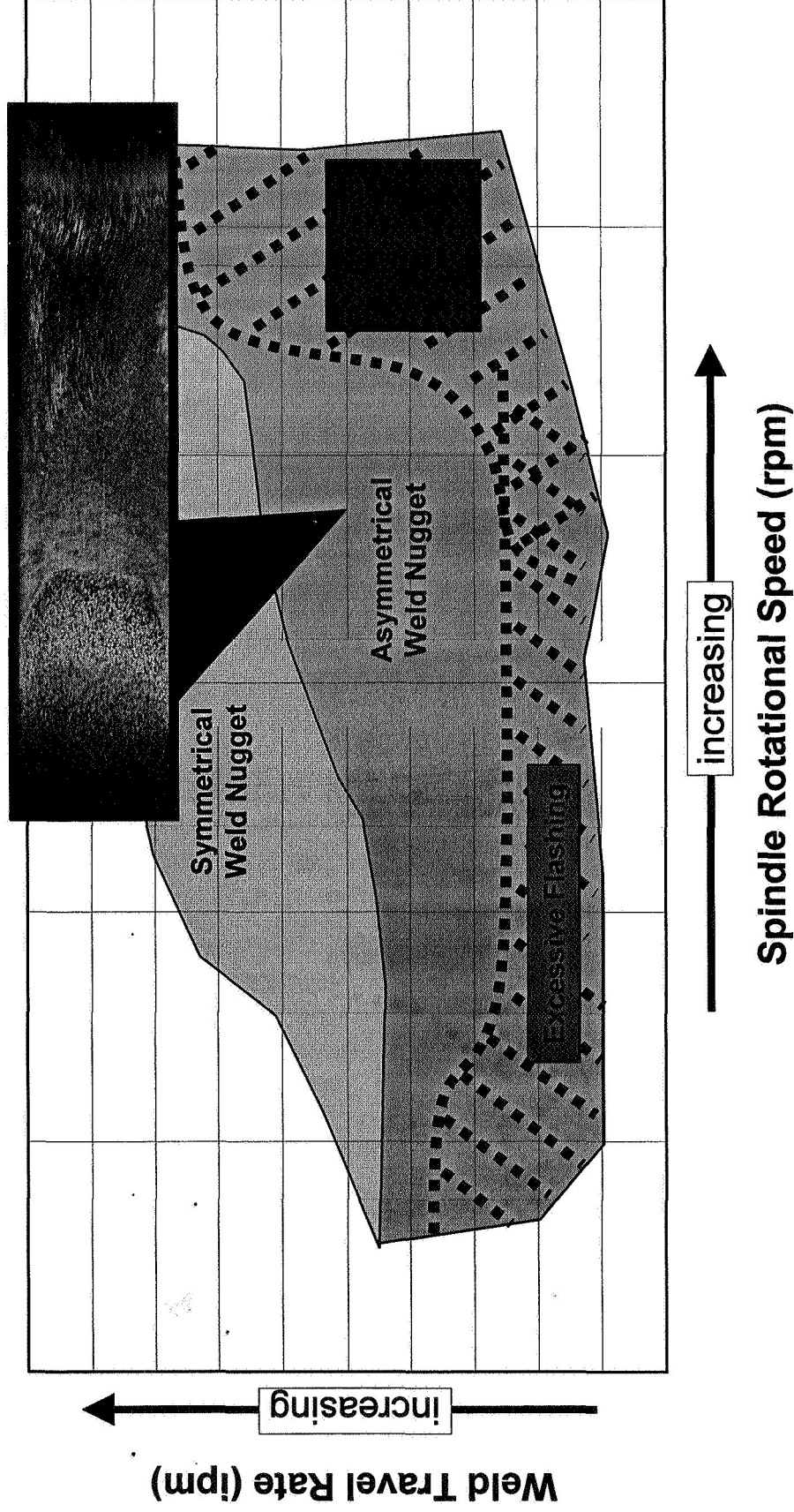


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Thin Gage 2XXX/2XXX Weld Development

- Process Map – Preliminary Pin Tool Design

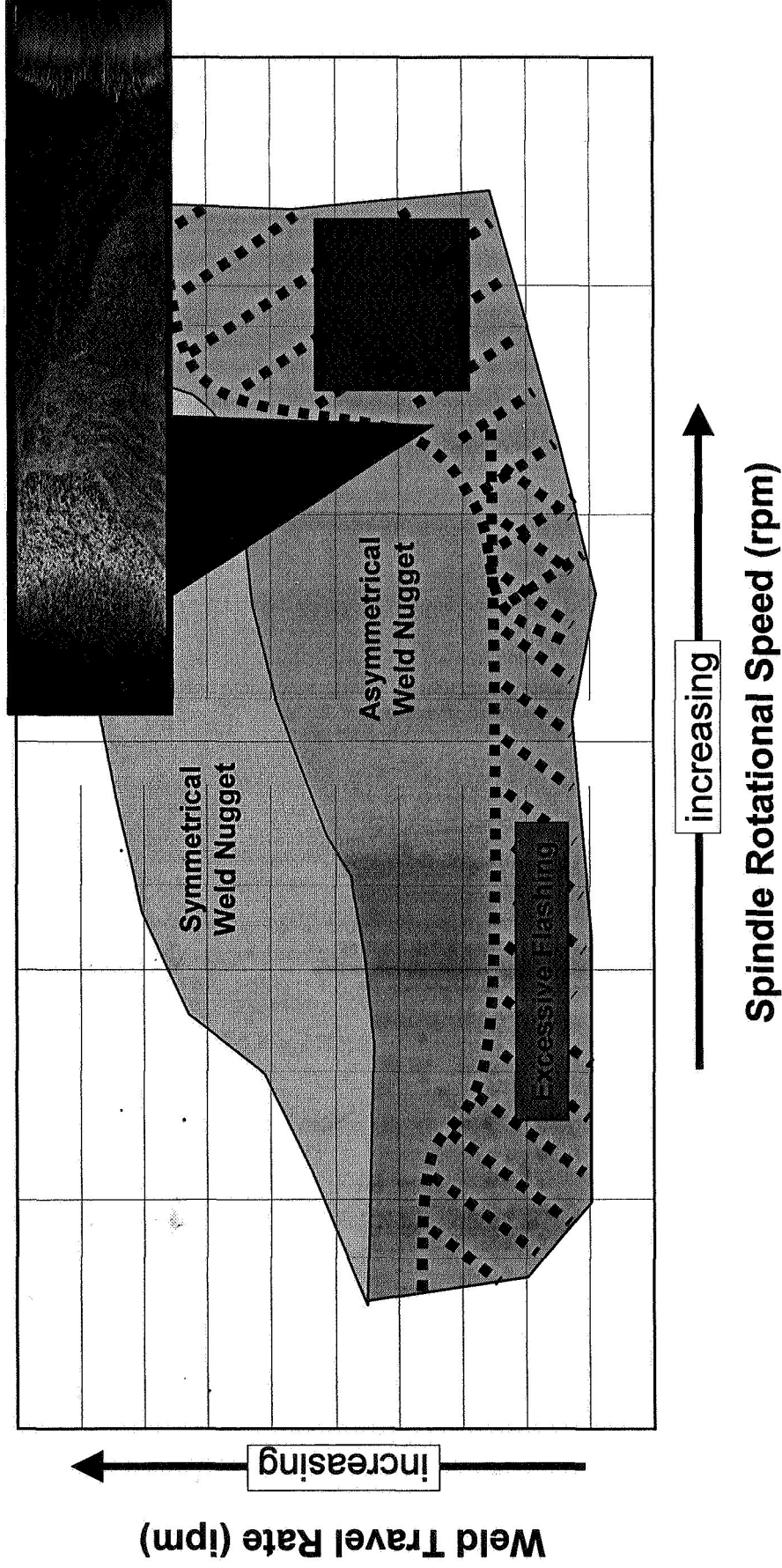


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Thin Gage 2XXX/2XXX Weld Development

- Process Map – Preliminary Pin Tool Design

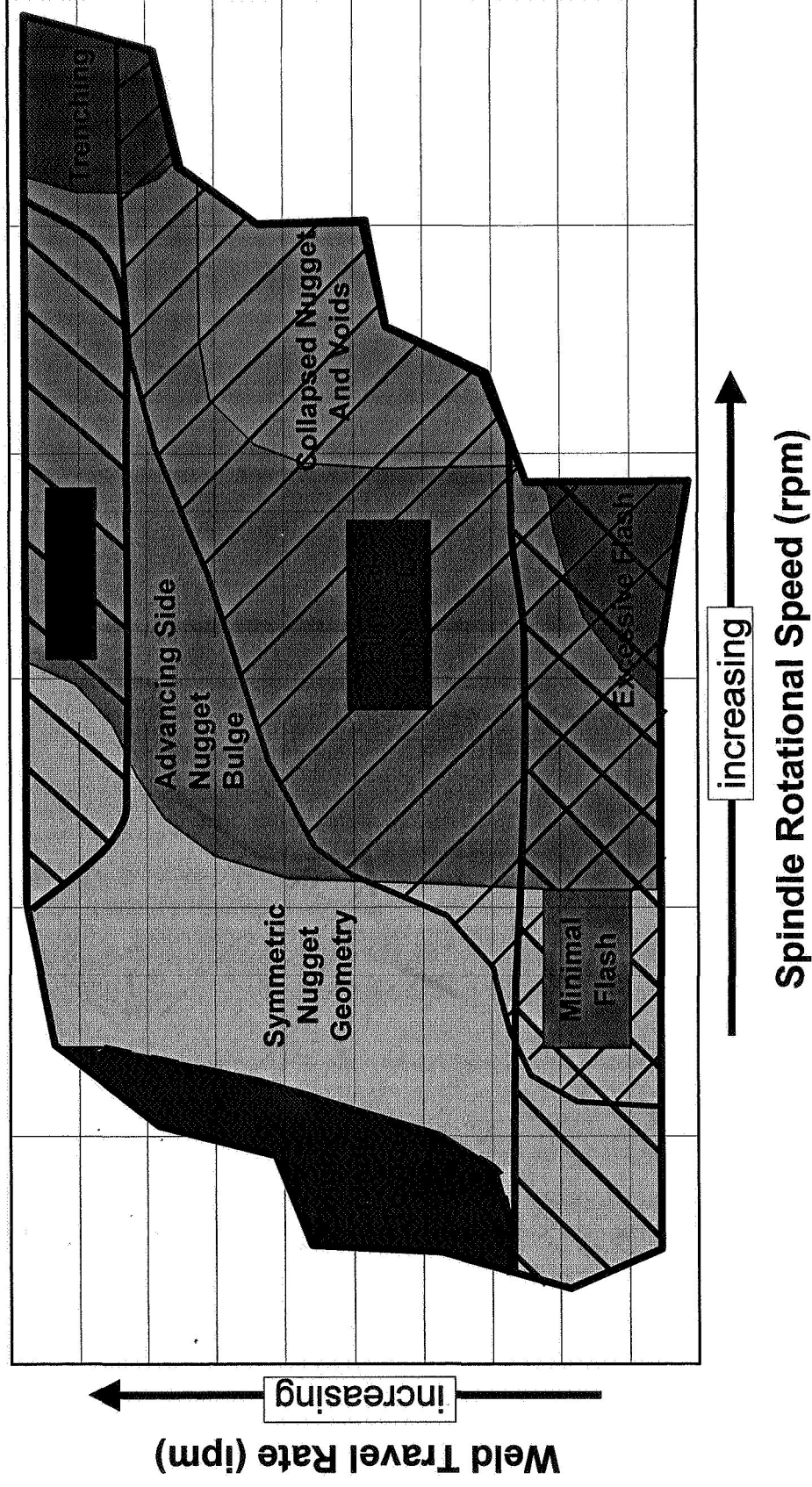


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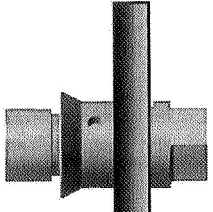


Thin Gage 2XXX/2XXX Weld Development

- Process Map – Optimized Pin Tool Design

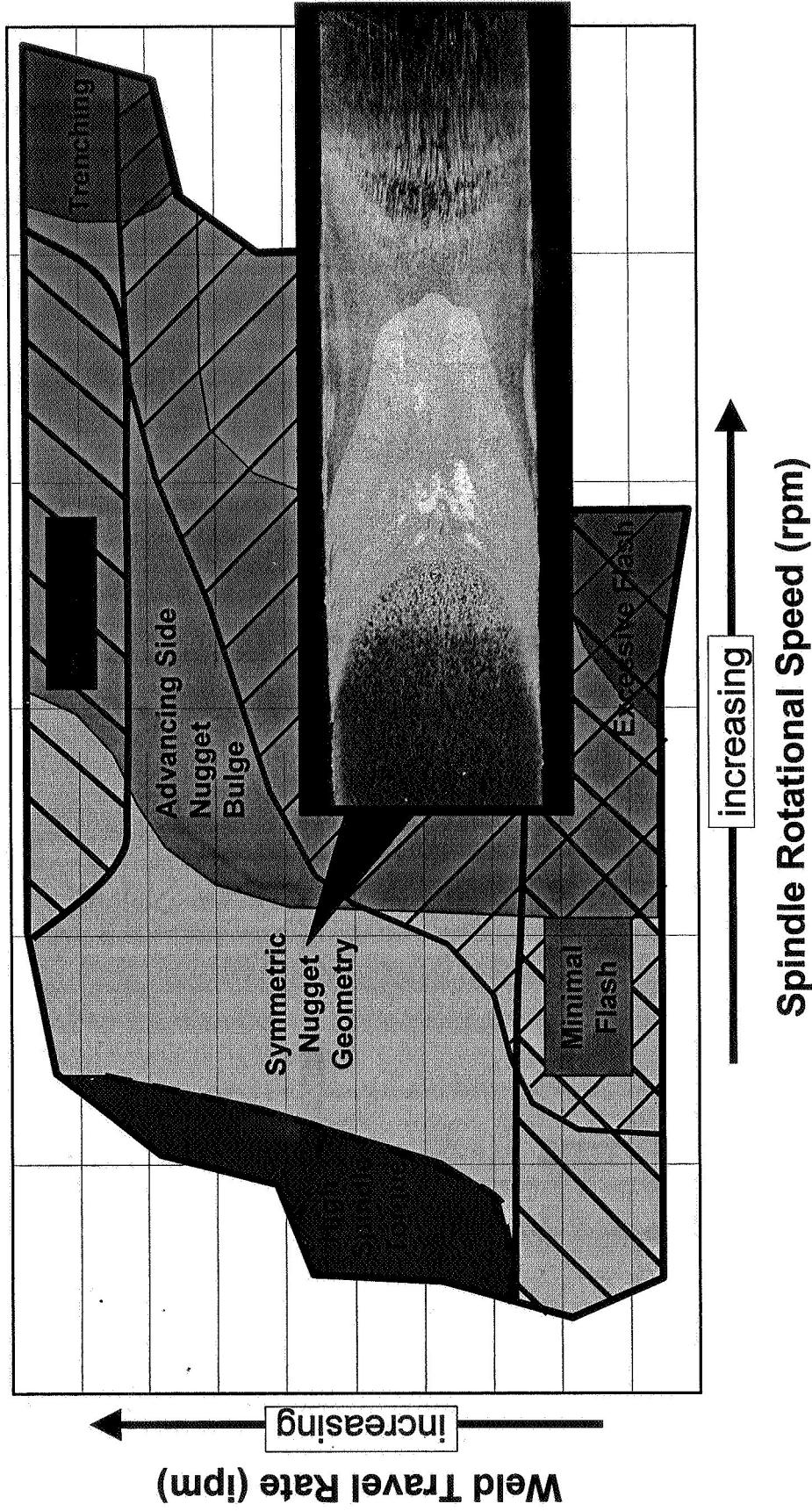


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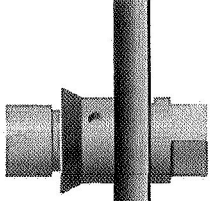


Thin Gage 2XXX/2XXX Weld Development

- Process Map – Optimized Pin Tool Design

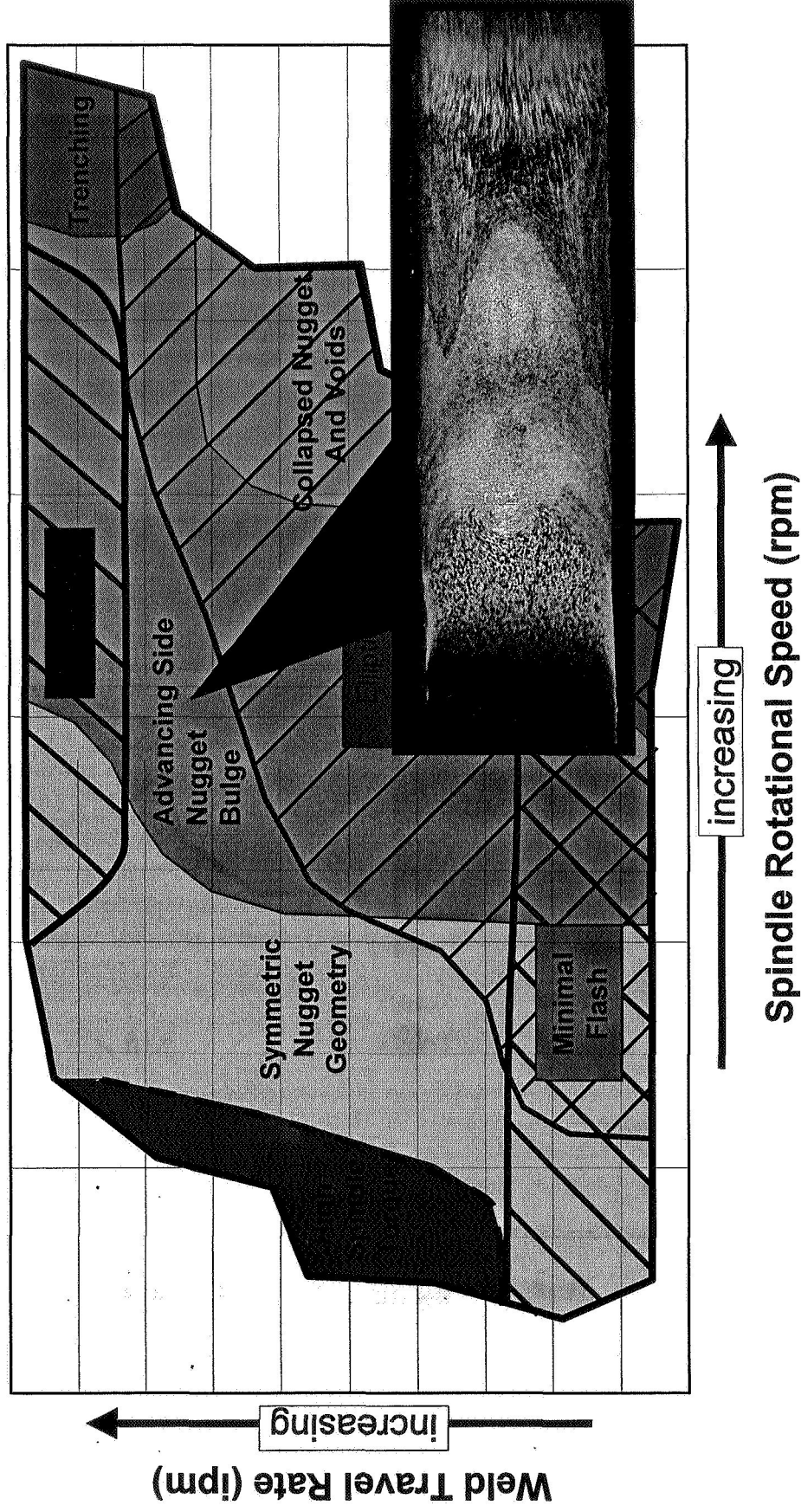


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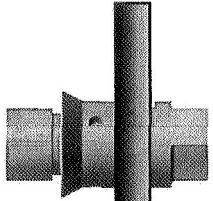


Thin Gage 2XXX/2XXX Weld Development

• Process Map – Optimized Pin Tool Design

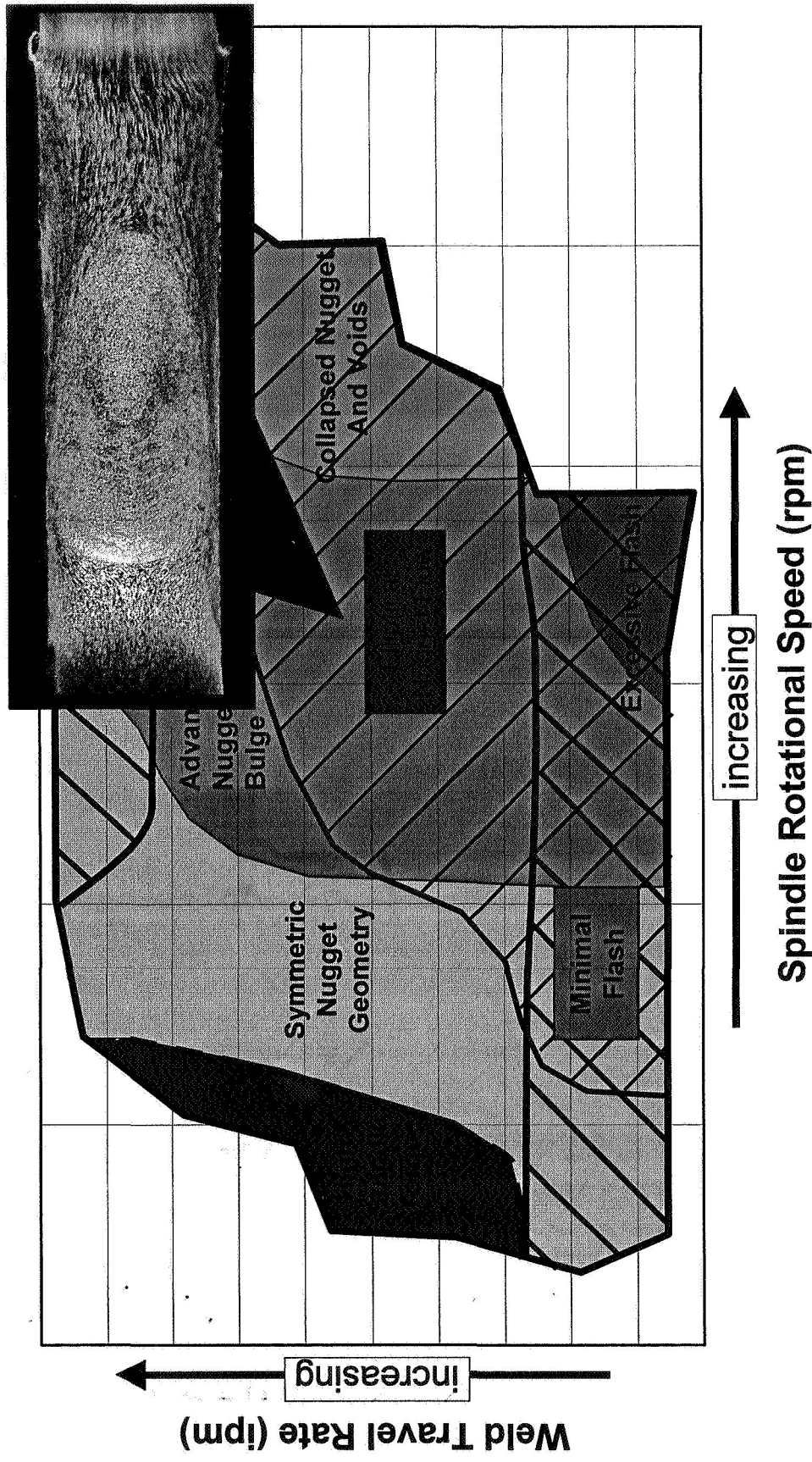


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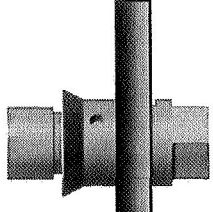


Thin Gage 2XXX/2XXX Weld Development

- Process Map – Optimized Pin Tool Design

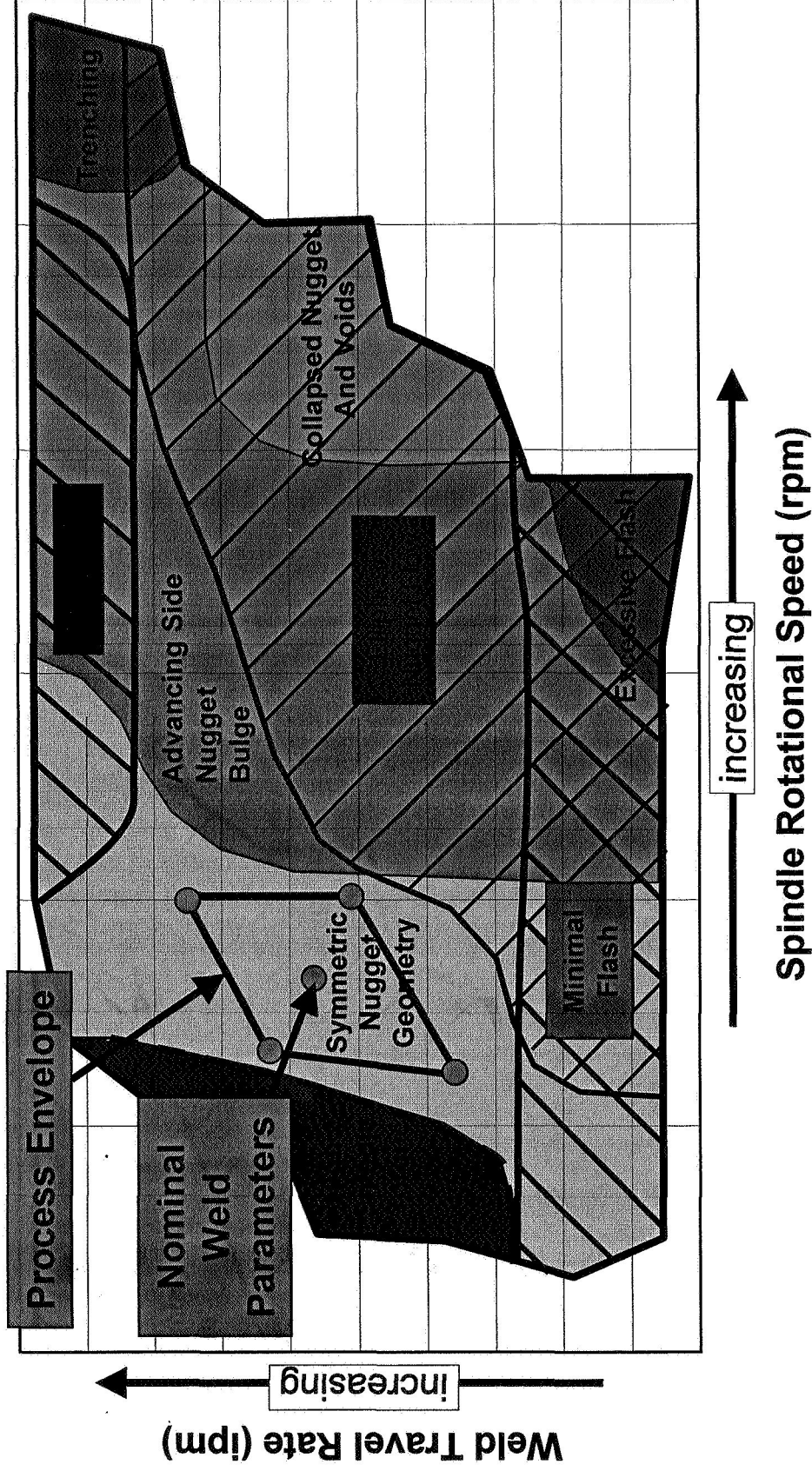


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Thin Gage 2XXX/2XXX Weld Development

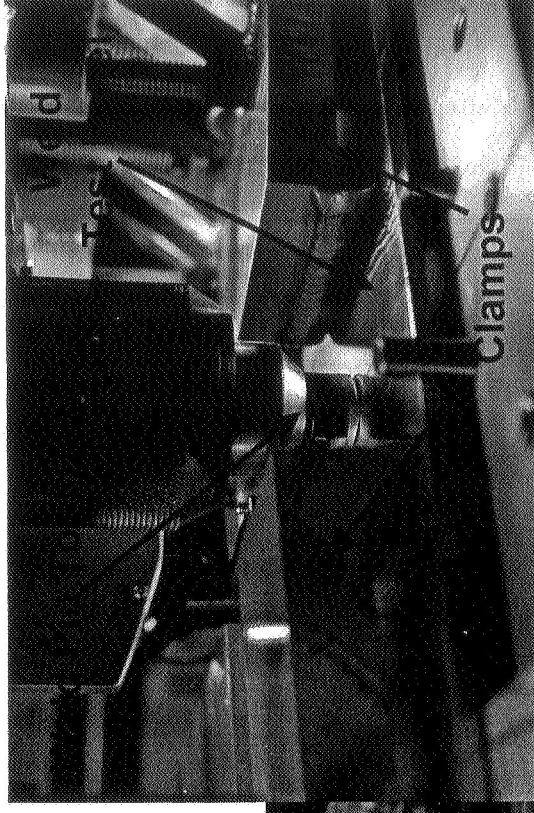
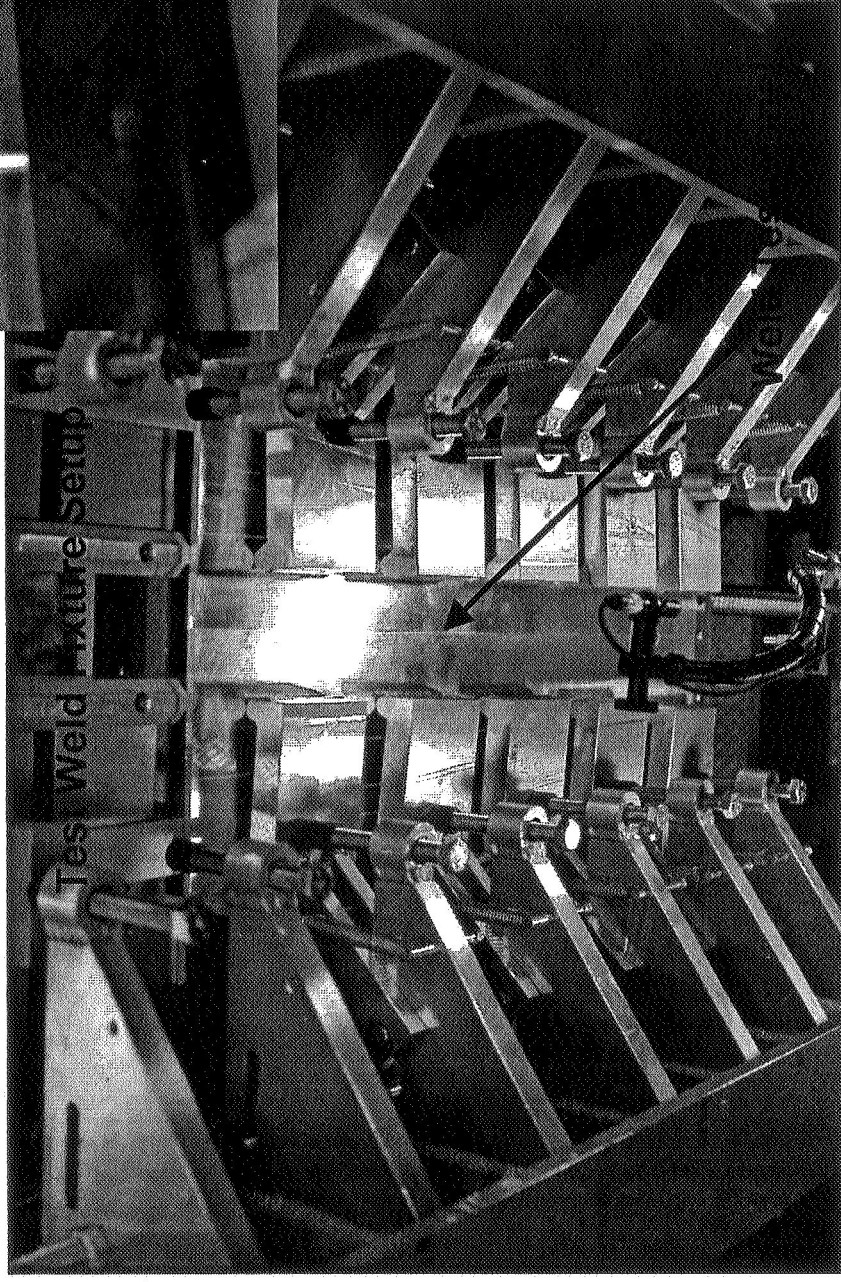
- Process Envelope – Optimized Pin Tool Design



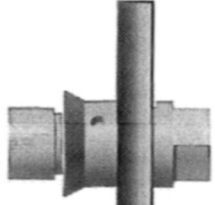
SR-FSW for Aluminum Alloy Circ. Weld Application

Tack Welding Development

- “No tack” welding
- Gas tungsten arc (GTA) tack welding
- Friction stir welding



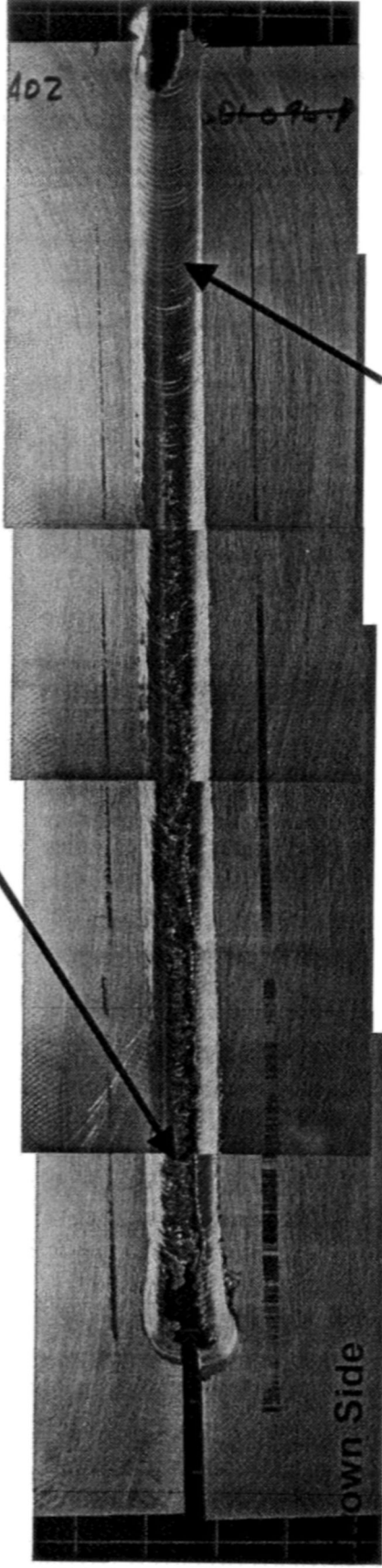
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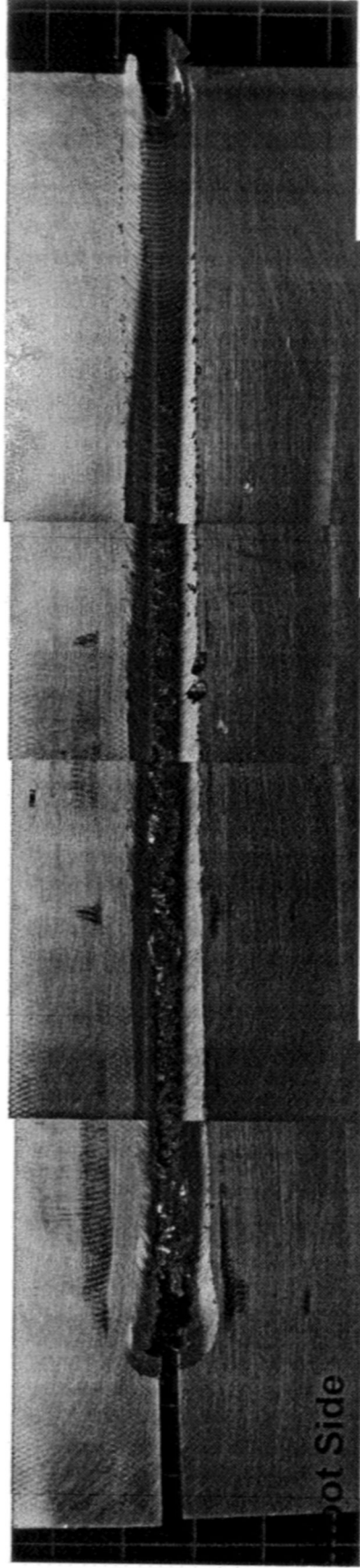
Tack Weld Development

- "No Tack" Welding

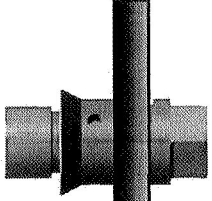
Butt Joint Opened Up



Closed up at end

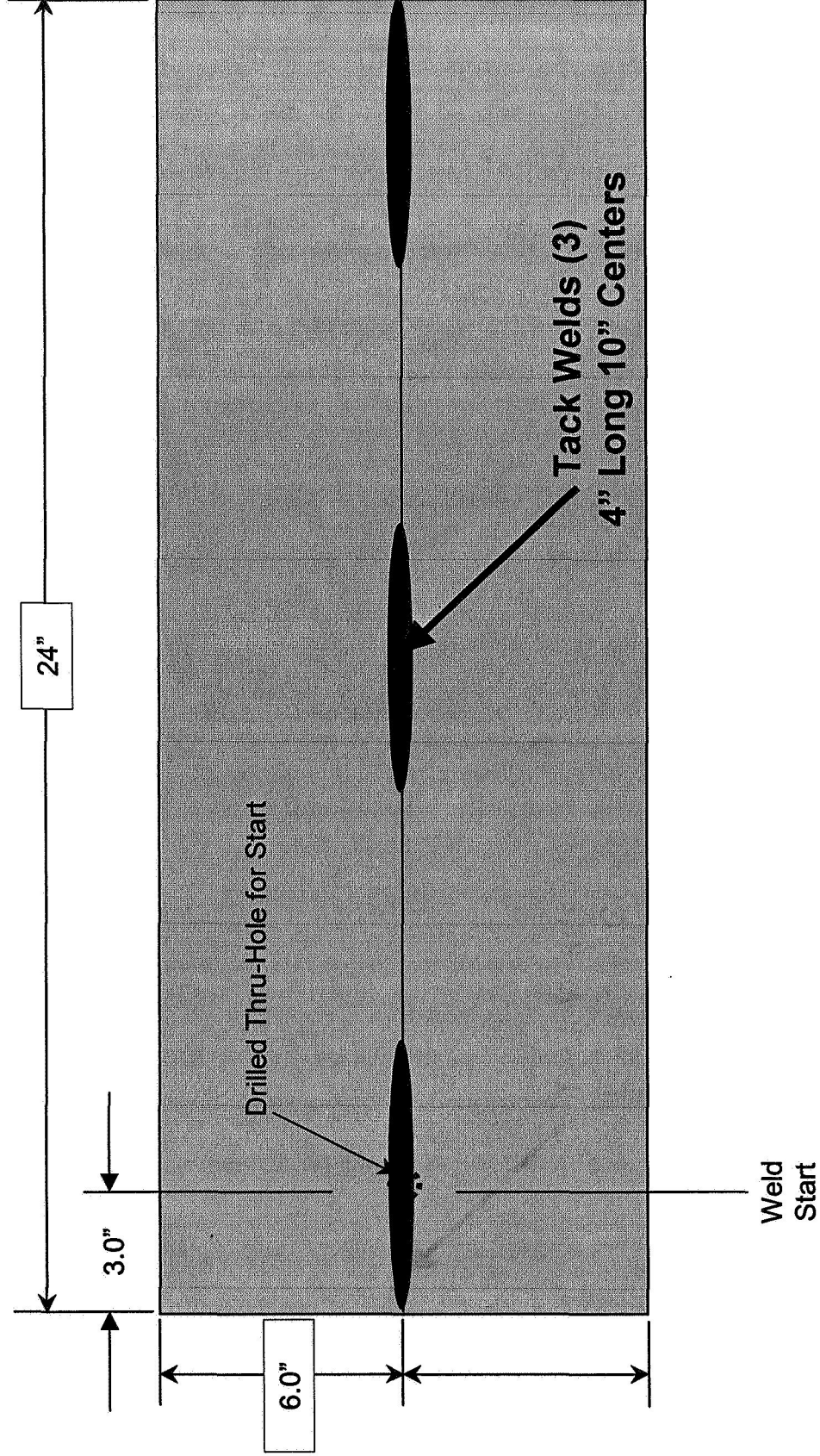


SR-FSW for Aluminum Alloy Circ. Weld Application



Tack Weld Development

- Tack Weld Layout



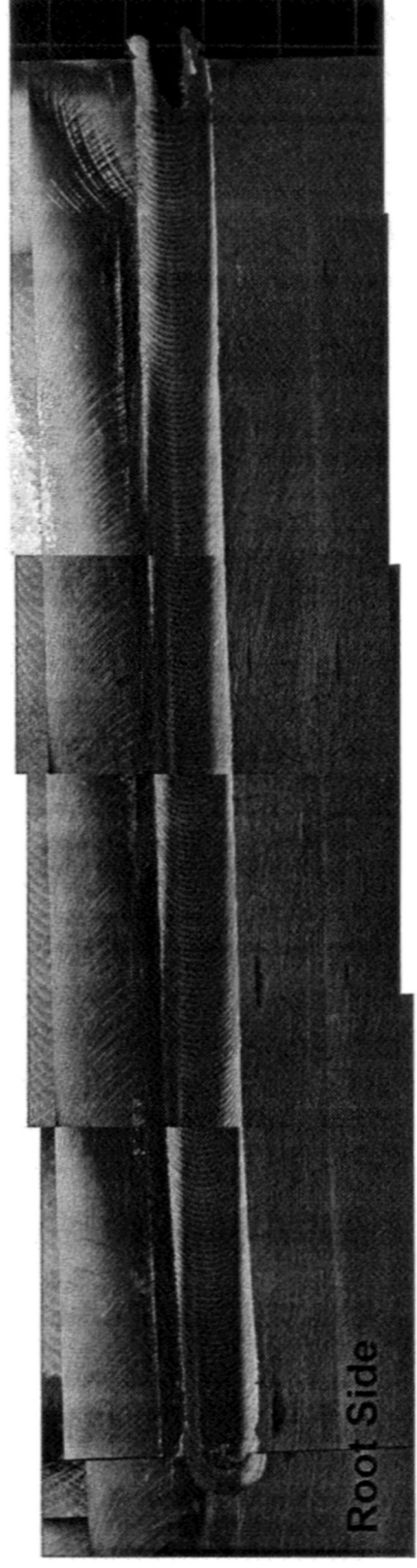
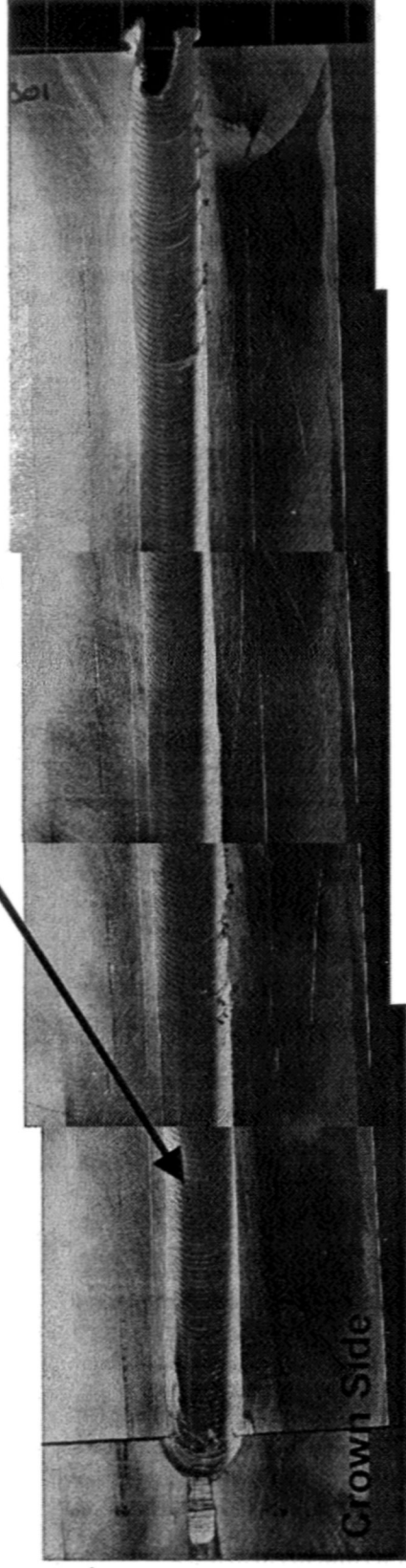
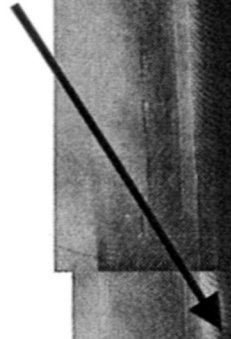
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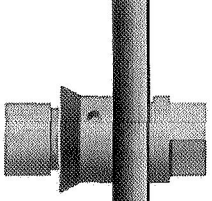
Tack Weld Development

- GTA Tack Welding

No Panel Separation



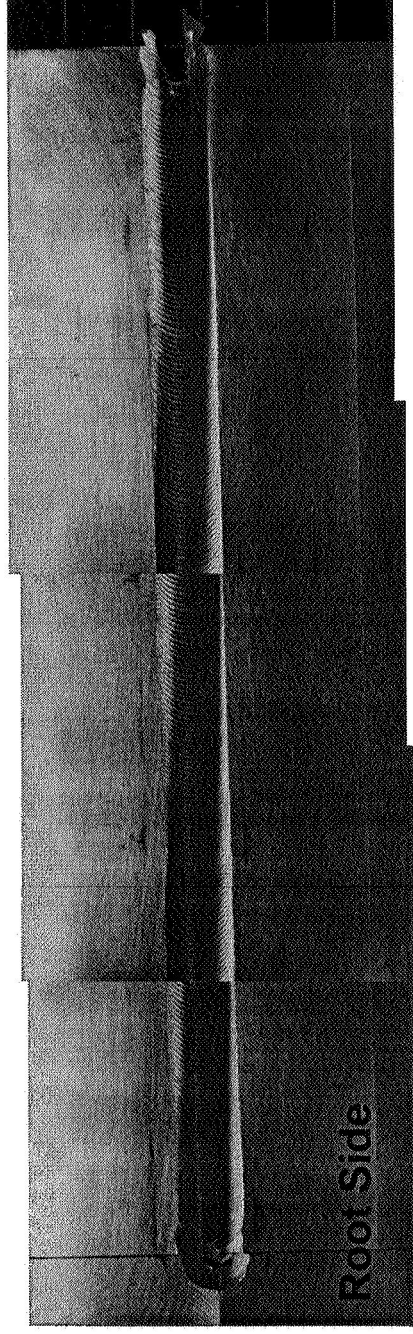
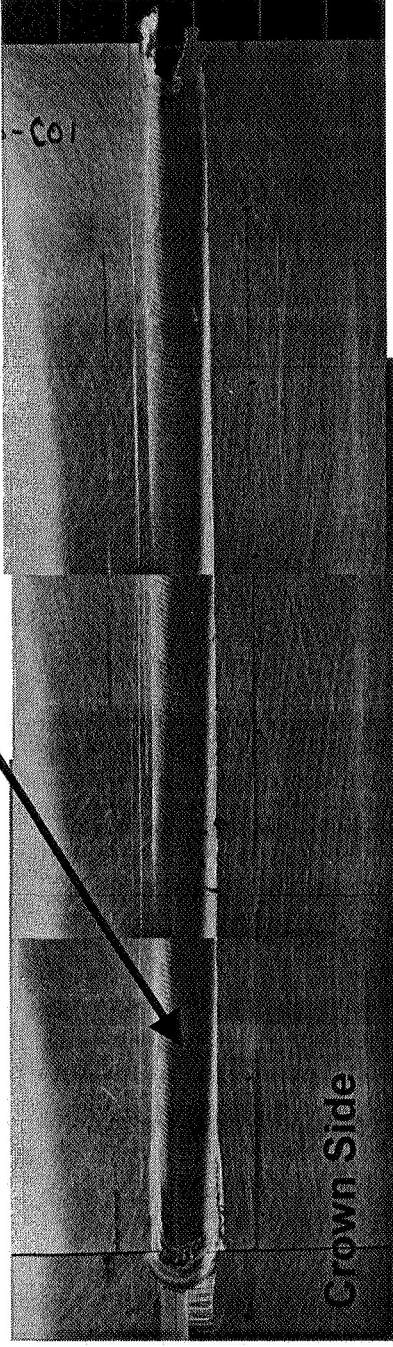
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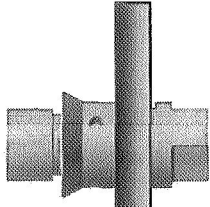
Tack Weld Development

- Friction Stir Tack Welding

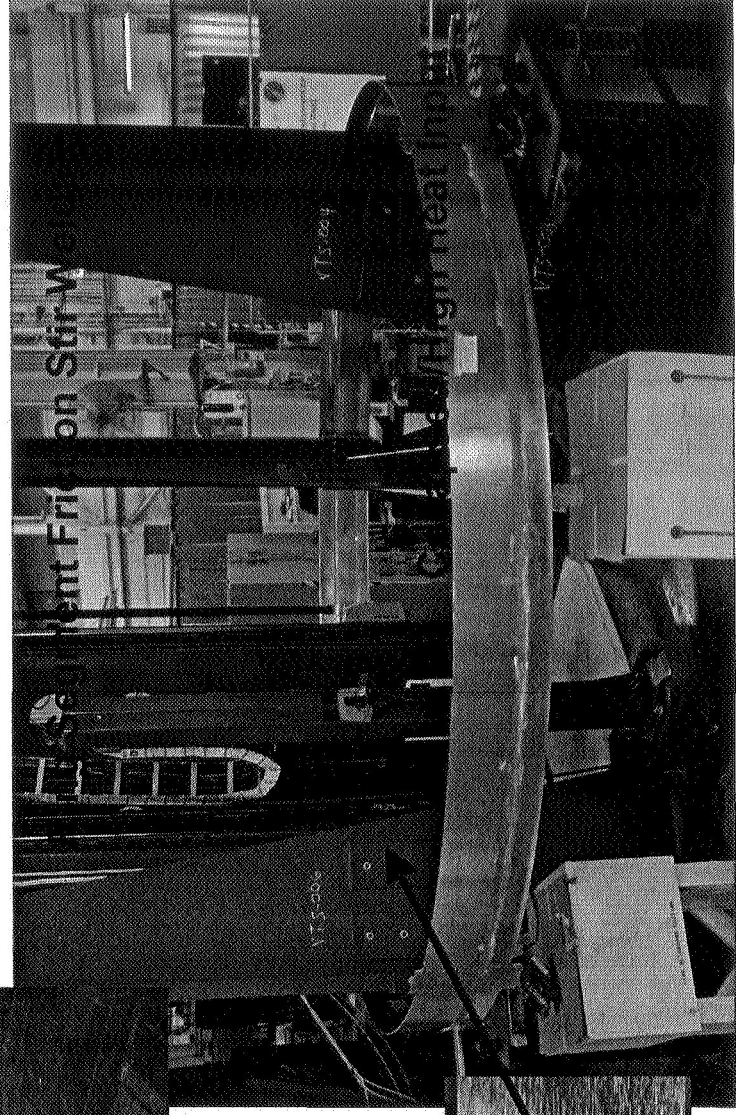
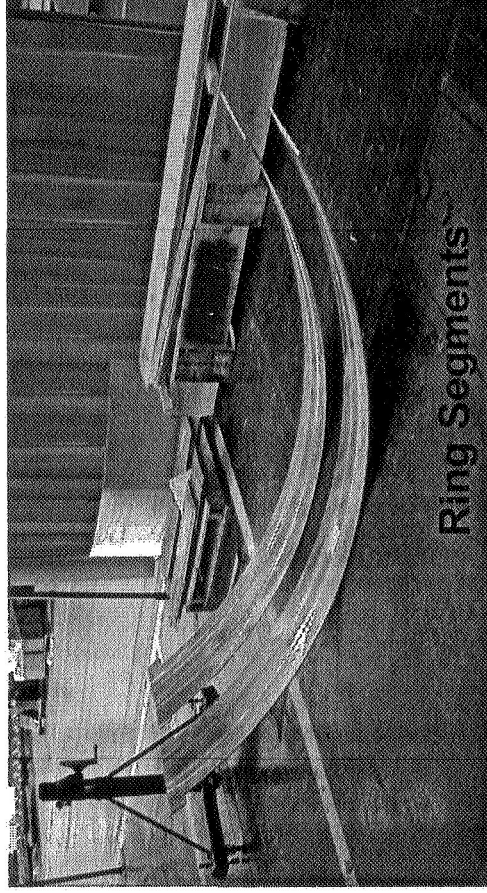
No Panel Separation



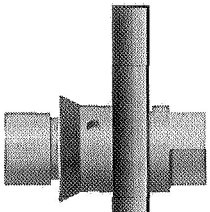
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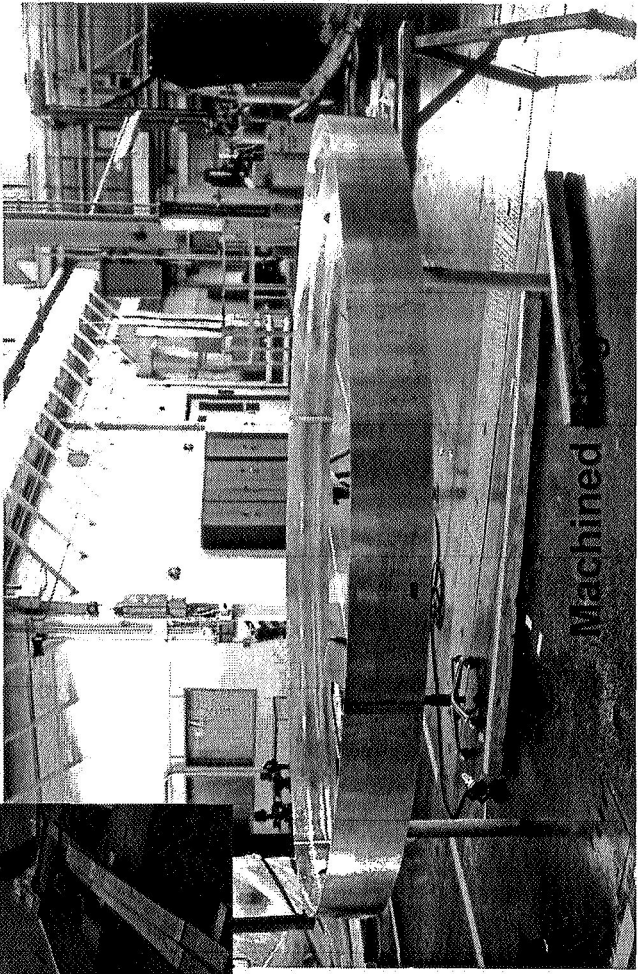
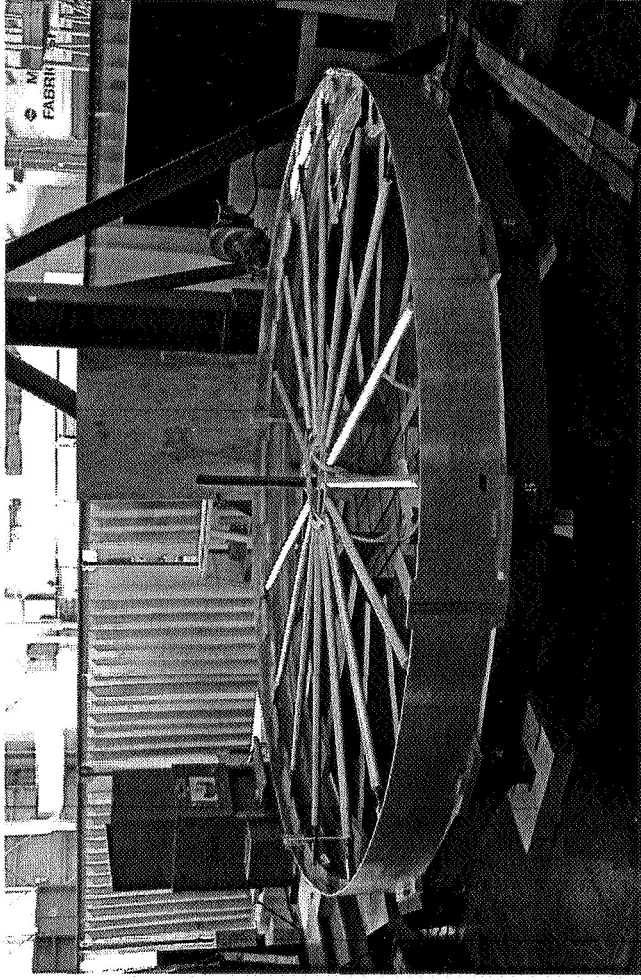
Ring Fabrication – Thin Gage 2XXX/2XXX Friction Stir Welding



SR-FSW for Aluminum Alloy Circ. Weld Application

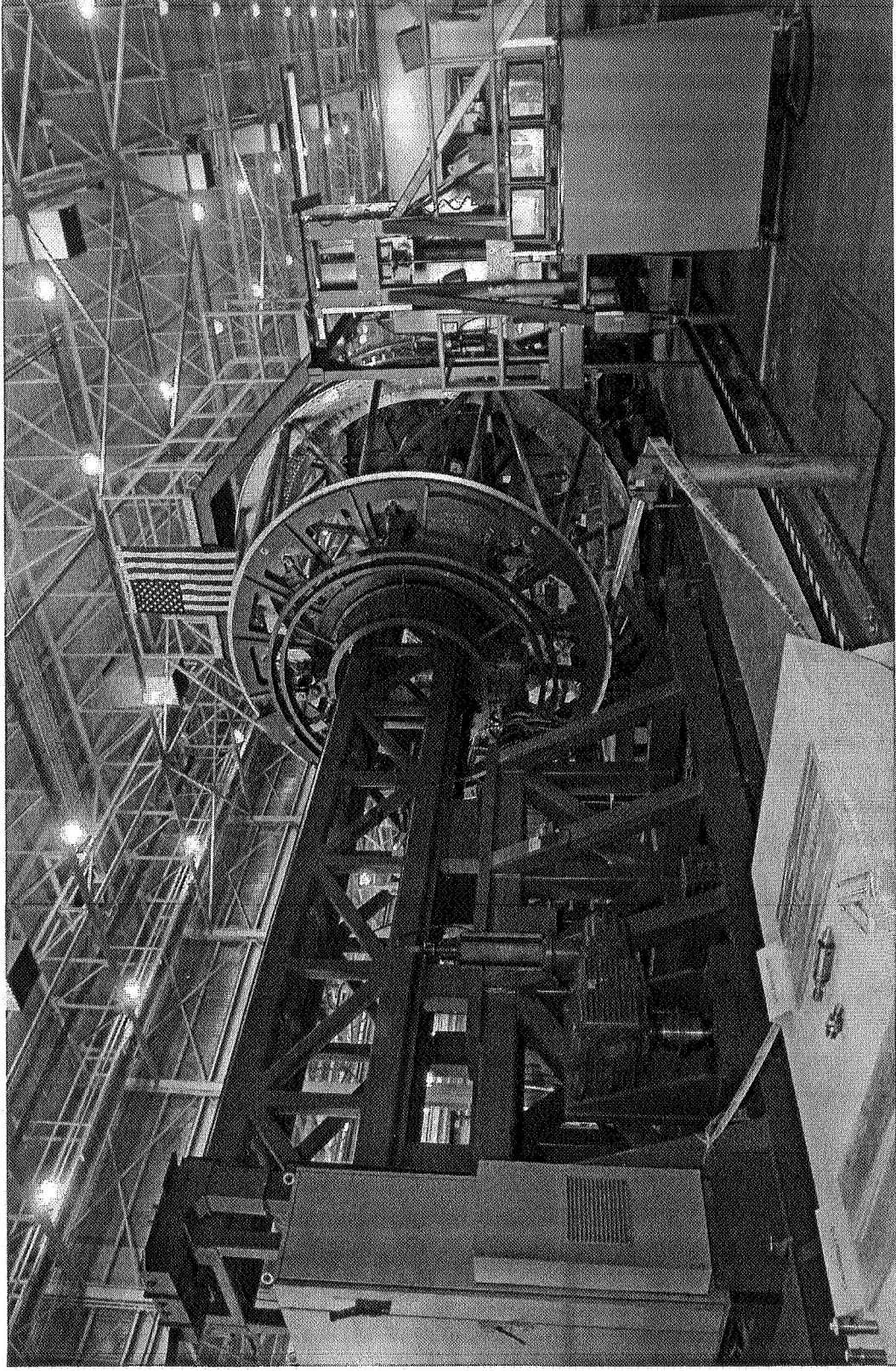


Ring Fabrication – Machining of Friction Stir Welded Ring

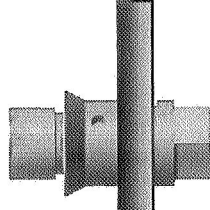


SR-FSW for Aluminum Alloy Circ. Weld Application

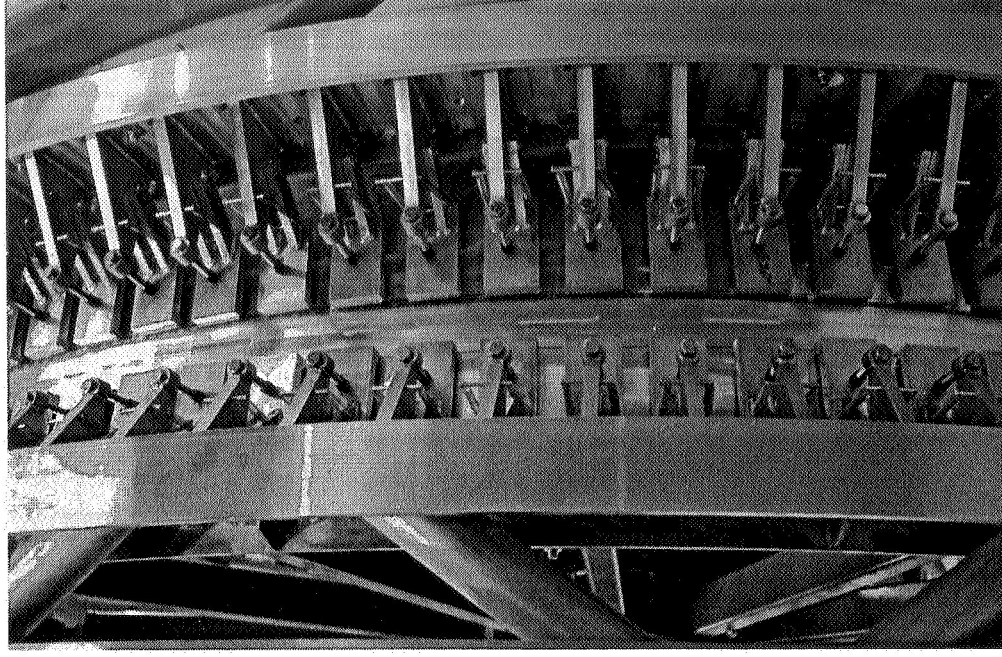
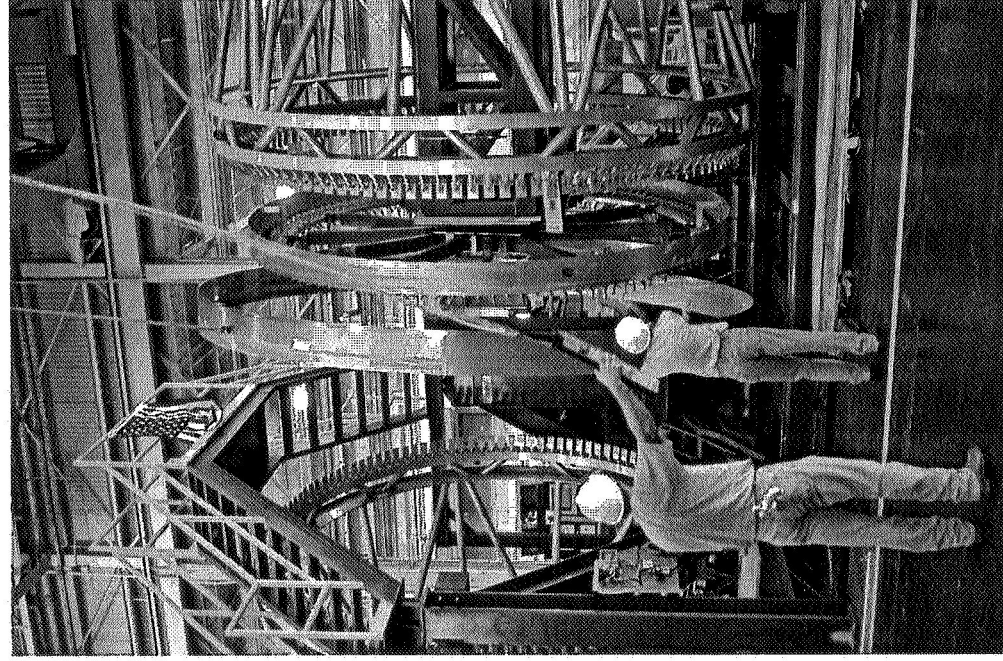
Circumferential Weld Tool at MSFC



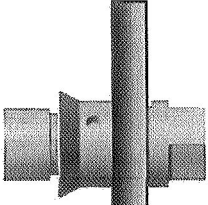
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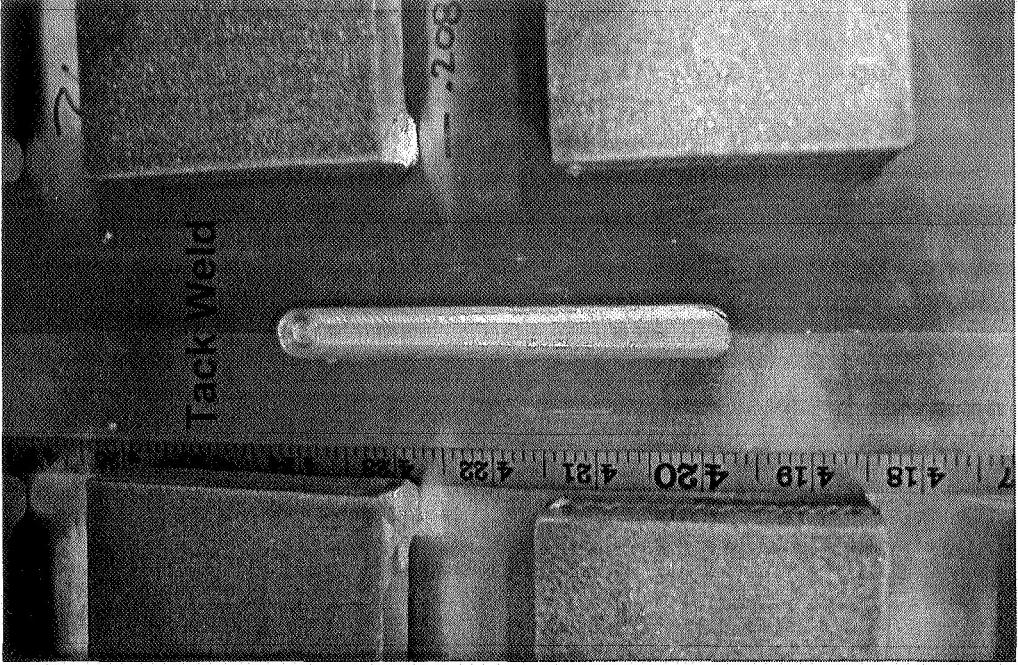
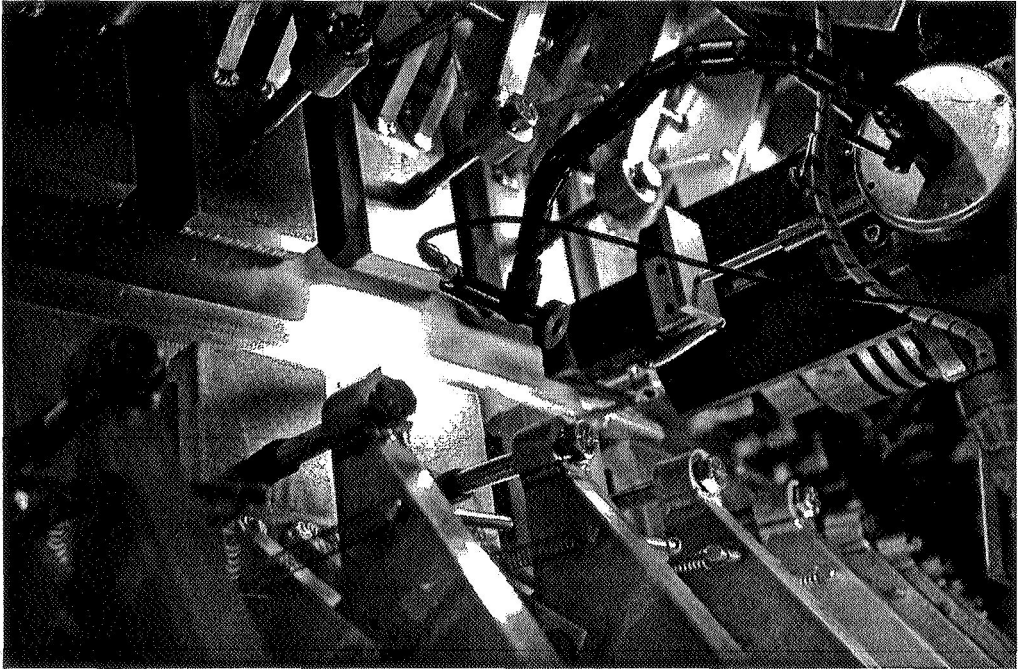
Loading Rings Into Circumferential Weld Tool



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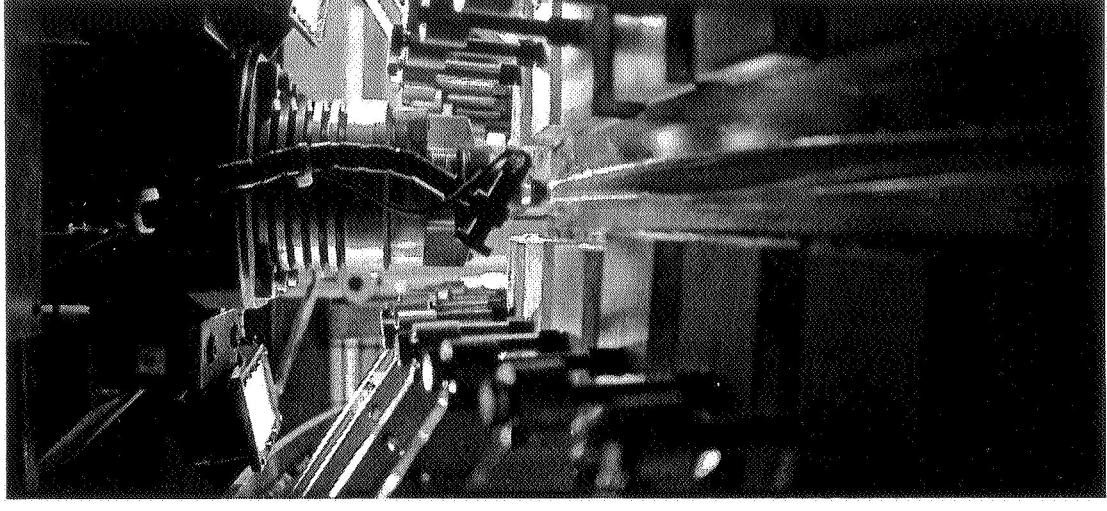
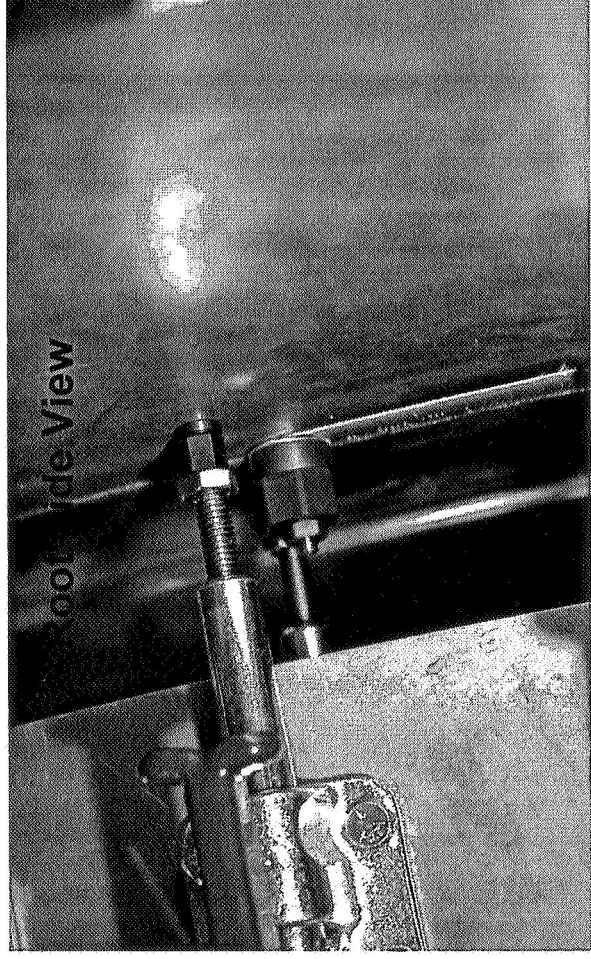
Friction Stir Tack Welding of Rings



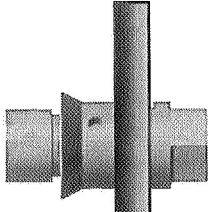
SR-FSW for Aluminum Alloy Circ. Weld Application

Ring Welding

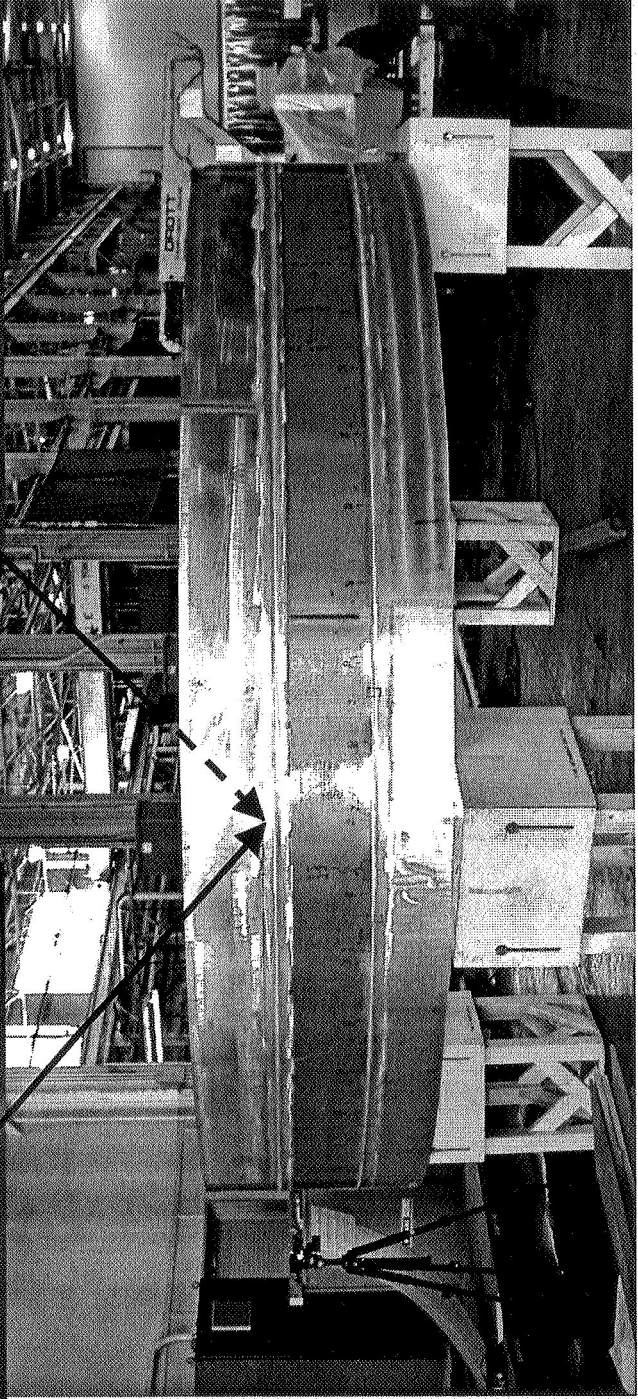
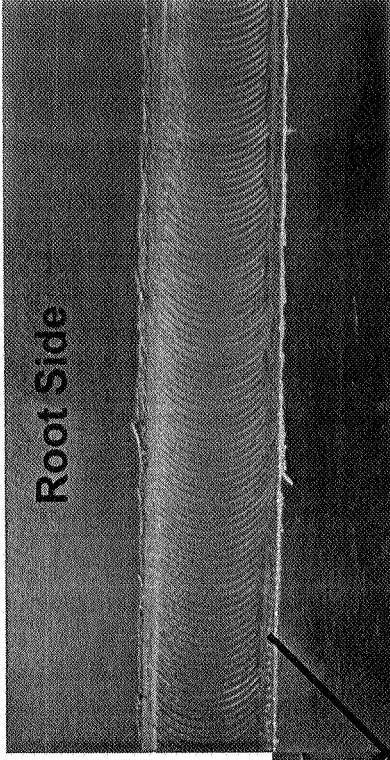
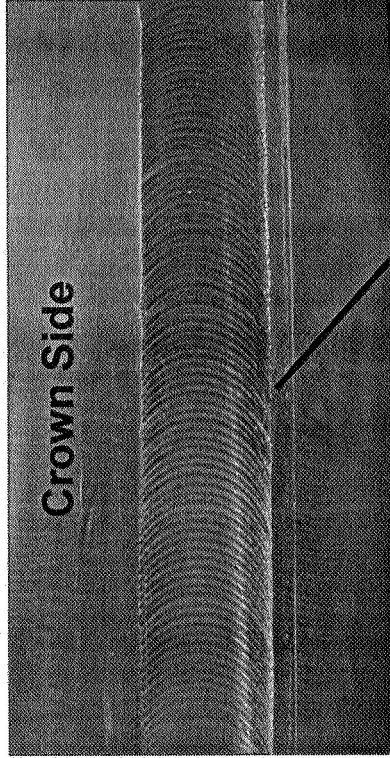
- Data Acquisition
 - Spindle Rotational Speed (rpm)
 - Travel Rate (ipm)
 - Reaction Force (lbs)
 - Torque (ft-lbs)
 - Plow Force (lbs)
 - Plunge Force (lbs)



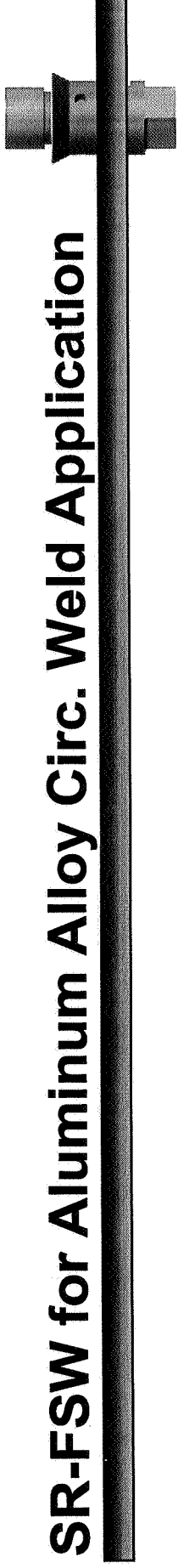
SR-FSW for Aluminum Alloy Circ. Weld Application



Welded Rings



SR-FSW for Aluminum Alloy Circ. Weld Application



Conclusions

- Friction stir tack welding was able to be performed without the use of an anvil
- During SR-FS welding, friction stir tack welding along with basic fusion weld tooling held the rings together.
- The selected SR-FS weld pin tool design did not fail during the fourteen-foot diameter circumferential weld.

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