

GE Aviation's Perspective on Titanium Availability

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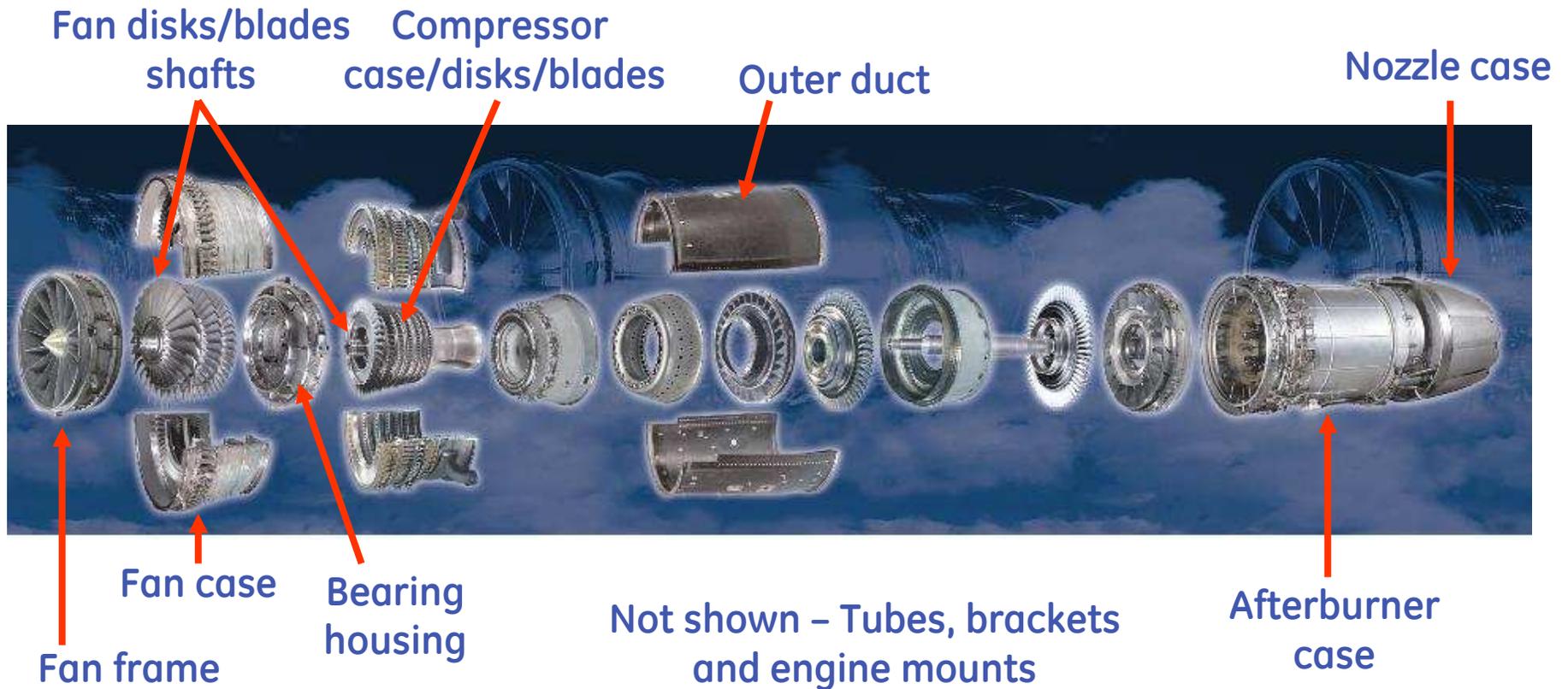
DoD/DLA Titanium Symposium

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imagination at work

Typical Application of Ti Alloys in Military Engines



~50M lb of Ti Used in Propulsion for the Industry Annually

GE Aviation: Ti Alloy Grades

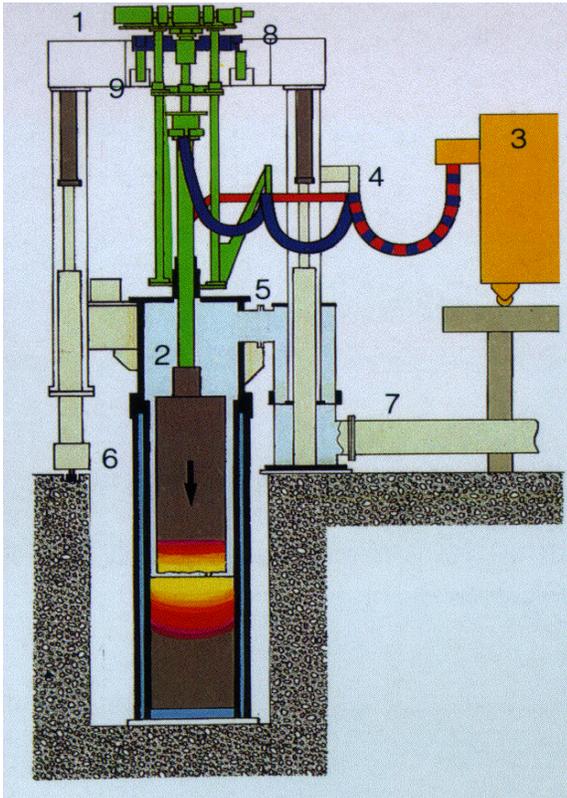
Premium Quality (PQ)

- Ti alloy products purchased to an internal GE specification
- Enhanced quality compared to equivalent Aerospace Material Specification (AMS) grade materials
- Key material integrity controls related to raw materials, melting, conversion, traceability, etc.

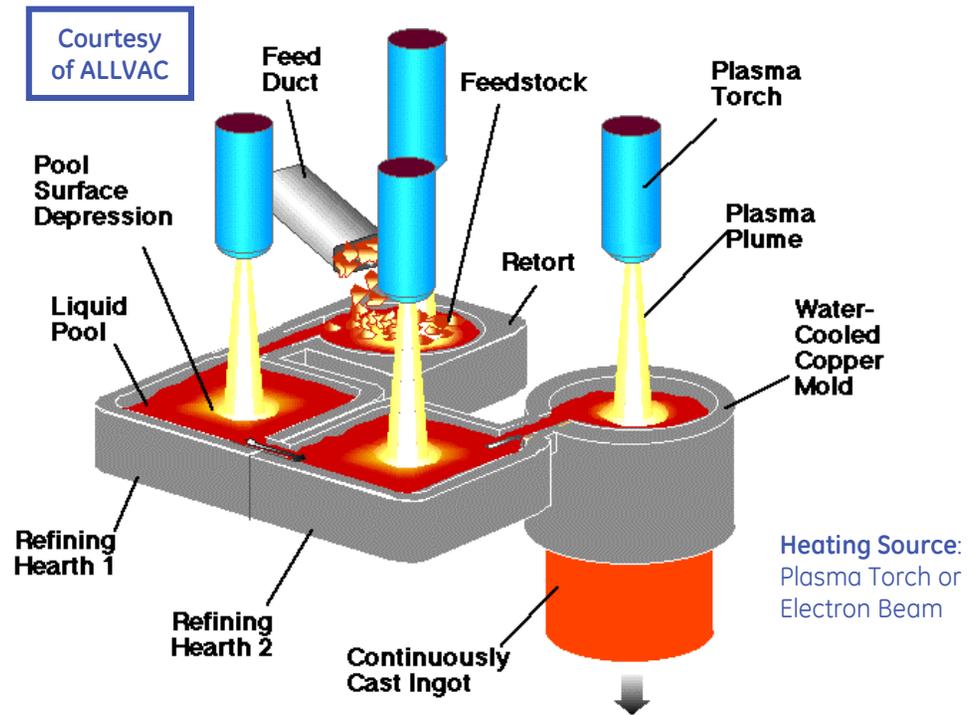
Non-PQ - Standard Grade

- Material purchased to aerospace standard specifications
 - Example: AMS4911 – Ti-64 sheet, strip, plate

Typical Ti Melting Processes



Vacuum Arc Remelting



Cold Hearth Melting

- Leveraged initial Army development
- GE funded implementation of this robust process for PQ Ti alloys



Titanium Availability

- GE Aviation has no major concerns with PQ Ti alloy availability
 - > GE is a Leading Consumer of PQ Ti alloys
- GE requires Ti alloy rotating hardware to be forged from PQ ingots produced primarily by cold hearth melt processes
- Currently there is excess cold hearth melting capacity for PQ heats, which has led to reduced lead and cycle times
- GE has moved away from triple Vacuum Arc Remelting (VAR) melt process for rotating hardware
 - > VAR capacity is not being expanded as rapidly as Cold Hearth Melting
 - > Cold Hearth Melting allows for greater flexibility with use of scrap

Forging Procurement Planning

- GE's planning processes allows forgers to efficiently schedule forge and heat treat facilities
 - > Standard sized billets and leveling of orders over time
 - > Avoids production feast or famine material planning which results in long lead times and very little schedule flexibility
- This best practice enables level loading at forgers, and optimizes capacity utilization and scheduling flexibility

Reclamation & Recycling

- GE has launched programs to reclaim and recycle critical aviation materials, such as:
 - > Ti alloys
 - > Ni- and Co-alloys
- Focus on manufacturing, overhaul, & customer shops
- Key participants include include Commercial (global) and Military customers
- This initiative is expected to help the entire aviation industry, not just GE

Summary

GE has managed Ti alloy availability and source capacity concerns by:

- Use of cold hearth melt process for PQ Ti alloys
- Added capacity at the sources
- Use of reclaimed and recycled materials
- Advanced planning with suppliers and customers
- Standardization of orders