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FABRICATION OF STRAIN-ISOLATED CERAMIC COATED COMBUSTOR COMPONENTS

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Avco is investigating the use of strain-isolated ceramic coated material to produce an AGT1500 combustor scroll-shaped transition duct which requires no air for film cooling. The scroll receives the exhaust of the can-style combustor liner and turns it into the annular inlet of the high pressure gas producer turbine nozzle.

Strain-isolation of plasma sprayed thermal barrier coating is achieved by placing a compliant pad between the structural base metal and the ceramic coating. The compliant pad is brazed to the metal structure. In order to achieve a good braze bond, the strain-isolating compliant pad and base metal must be closely matched in shape and tightly fixtured for joining. The complex geometry of the AGT1500 scroll makes it impractical to attach pads to the supporting structure in its finished shape. Instead the pads are brazed to flat stock and post-formed into scroll sections.

While test samples were successfully post-formed, plasma sprayed, and subjected to cyclic heating, the forming of full scale parts by normal methods resulted in tearing of the Hastelloy-X base metal because of embrittlement by the braze material. Several solutions were explored which finally resulted in the successful forming of full scale scroll parts.

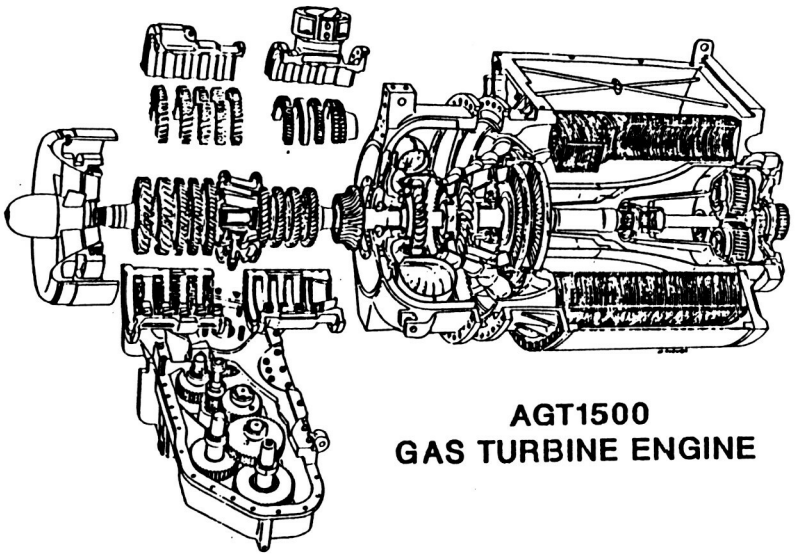

Figure 1.

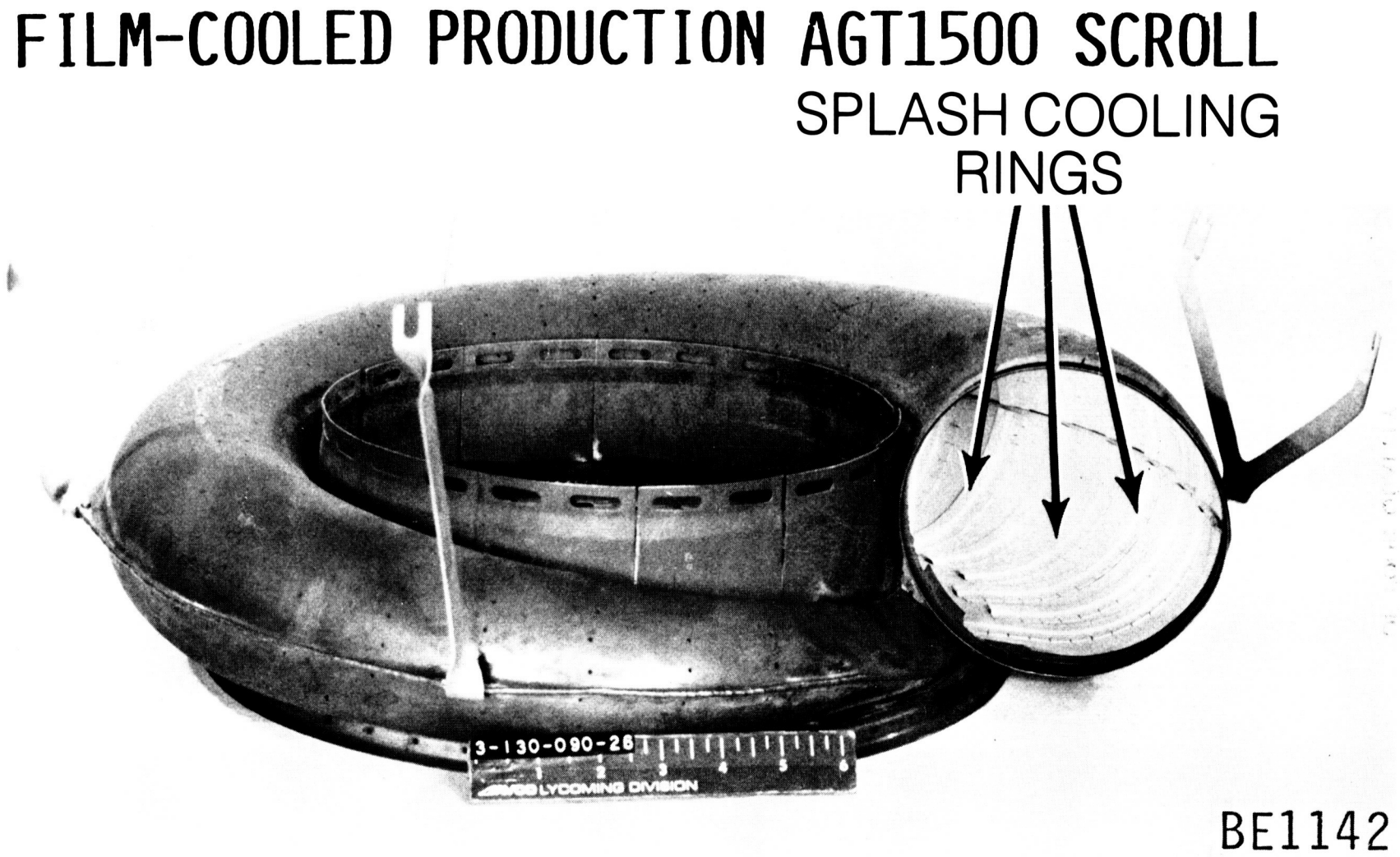

Figure 2.

SCHEMATIC OF STRAIN-ISOLATED CERAMIC COATING SYSTEM

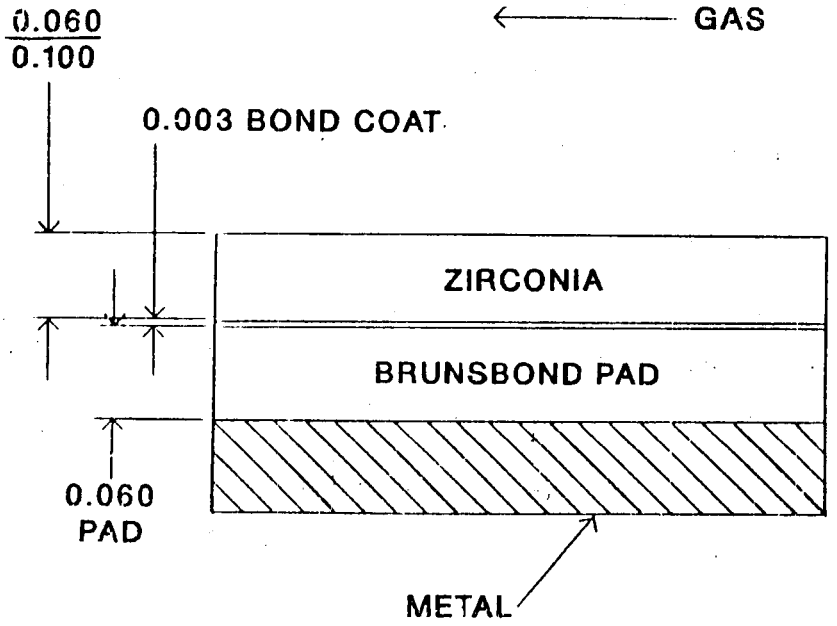

Figure 3.

THERMAL ANALYSIS

- Objective
  - Determine if the BRUNSBOND scroll can replace the existing scroll
  - Find if combustor exhaust temperatures can be increased by the use of BRUNSBOND
- Result
  - BRUNSBOND scroll saves 27% of combustor inlet air
  - Combustor exhaust temperature increase of 200 degrees F possible

Figure 4.

FABRICATION

- Problem
  - Scroll is complex shape
  - BRUNSBOND pad and substrate shape must be matched and tightly fixtured for brazing
- Solution
  - Apply BRUNSBOND to flat stock
  - Post form to final dimension
  - Apply TBC afterward

Figure 5.

FULL SCALE PARTS

Scroll formed from 2 halves

Each half made from 2 parts

One part die formed; the other part hydroformed

Die formed parts

Tore in high stretch areas

Base metal embrittled by braze

Flat stock trimmed to minimize stretch

Parts successfully formed

Figure 6.

TESTING

- Test panels fabricated
  - BRUNSBOND samples of 35% density laid over 2" by 2" Hastalloy-X
  - Post formed over a 1 inch steel ball
  - Pad compressed to 48% density
- Thermal cyclic testing
  - Alternate heating and cooling to develop 1400 degree F gradient
  - 500 cycles completed, 1800 F to 400 F

Figure 7.

SCHEMATIC OF THE BRUNSBOND TEST PIECE

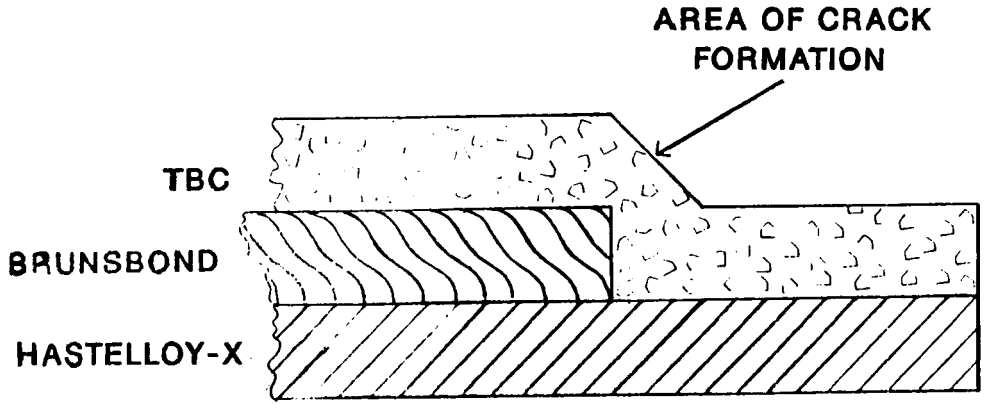

Figure 8.

DIE FORMED BRUNSBOND SCROLL SEGMENT

1 in.

BK1386

Figure 9.

HYDROFORMING

- One scroll half successfully formed
  - Improved ductility material developed
- One half not yet made
  - Improved ductility material not sufficient
  - Formability study initiated

Figure 10.

STATUS

- Formability
  - Establish draw limits with 8 inch diameter test discs

    Form to limit followed by heat treat
- Testing
  - Full scale parts to be subjected to rig test to validate thermal analysis
  - Engine durability test to follow

Figure 11.