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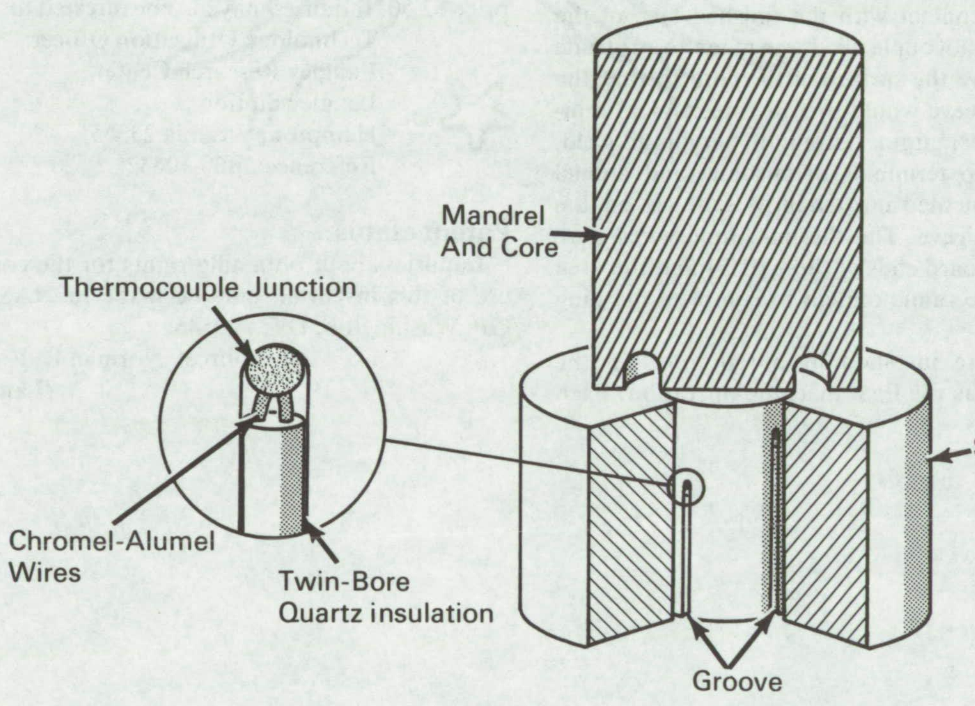
Accurate Depth Control Provided for Thermocouple Junction Locations



An objective of a series of flight reentry experiments was to define the total heating on a blunt-nosed body of fairly large scale to provide data anchor points for comparison with results obtained from ground facilities and theoretical prediction methods.

The reentry package had a blunt forebody and conical afterbody. The maximum diameter was about 67 cm and the weight (mass) about 86 kg. Total heating was measured by use of calorimeter techniques. Since a usable calorimeter material could not be expected to last through the reentry heating period, a layered forebody construction was used. Three beryllium layers were heavily instrumented with thermocouples for use as calorimeters, and each layer provided total (convective plus absorbed radiative) heating data until surface melt occurred.

The thermocouple installations were designed to provide the minimum feasible disturbance of the local heat flow with a technique that provided accurate depth control of the thermocouple junction locations. Four chromel–alumel thermocouples were mounted at controlled depths in beryllium plugs

(continued overleaf)

which were inserted into the beryllium calorimeters.

The pertinent details of a thermocouple plug are shown. The thermocouple mounting core was machined on the end of a rod which served as a mandrel for handling and installation. The core and the sleeve were made from the same billet used for the beryllium dishes to insure identical material properties. Three thermocouple junctions were installed in grooves, the fourth junction was welded on the back face of the core. A weld bead was first formed on the small thermocouple wires and then resistance welded into the forward end of each groove. The distance from the mandrel shoulder to the center of each junction bead was measured under a microscope and recorded for every junction. The core was then pressed into the sleeve, with a shrink fit, until the mandrel shoulder was in contact with the finished face of the sleeve. Each thermocouple bead was made to protrude very slightly above the surface of the core so that the pressure of the sleeve would provide mechanical reinforcement of the marginal strength beryllium weld. Small ribbon-strip terminals of chromel and alumel were ceramic cemented into shallow grooves on the rear face of the sleeve. The thermocouple wires were welded to the inboard ends of these strips and the area was potted with ceramic cement to complete the plug assembly.

The plugs were installed in bored holes in the beryllium dishes as the final machine operation. Each plug was pressed into place with a shrink fit so that the face of the sleeve was flush with the adjacent surface of the beryllium dish. The mandrel was then machined off and the core face was hand finished flush with the sleeve surface. It is estimated that the distance from the calorimeter face to the center of each thermocouple bead was known with an error less than ±0.05 mm after the final installation.

Note:

Additional details are contained in NASA Technical Note TN D-364, "Project Fire Instrumentation for Radiative Heating and Related Measurements", by Norman R. Richardson, October 1966, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virigina 22151—price $2.50. Inquiries may also be directed to:

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Reference: B66-10632

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C., 20546.

Source: Norman R. Richardson
(Langley-289)