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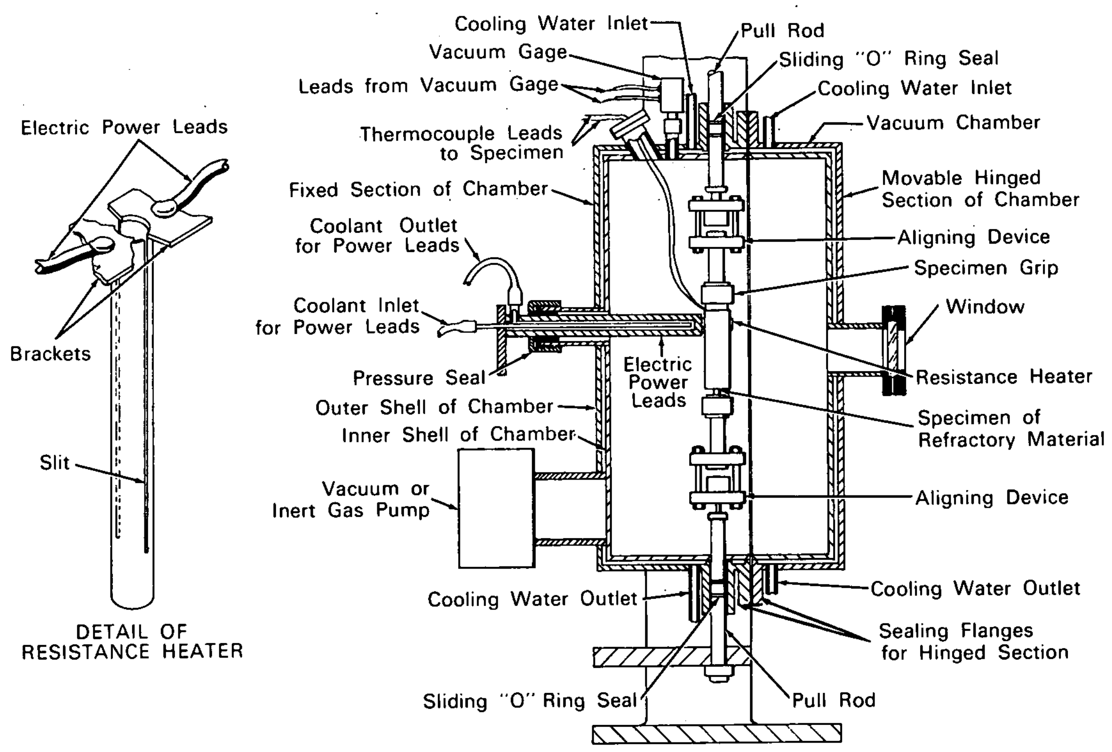
# NASA TECH BRIEF

This NASA Tech Brief is issued by the Technology Utilization Division to acquaint industry with the technical content of an innovation derived from the NASA space program.

## Apparatus Facilitates High-Temperature Tensile Testing in Vacuum




**The problem**: To design an apparatus for heating specimens of refractory materials to high temperatures (above 2,500°F) in vacuum or inert atmospheres during tensile testing of the specimens. The method of direct electrical heating through the ohmic resistance of refractory-metal test specimens is not applicable to refractory-ceramic materials. Indirect methods that have been used for heating ceramic tensile specimens in vacuum or inert atmospheres are cumbersome and may introduce contaminants into the ceramic material.

**The solution**: An apparatus that includes a water-cooled stainless steel vacuum chamber containing a resistance heater consisting of a slit tube of tantalum or tungsten that encloses the tensile test rod.

**How it's done**: The stainless steel vacuum chamber is hinged longitudinally at one side approximately one inch from its longitudinal axis. Ports are provided in the chamber for the introduction of water-cooled power leads for the heater, a window, the introduction of thermocouple leads to the test specimen, and

(continued overleaf)

the connection of a vacuum or inert-gas pumping system. The heater consists of a cylindrical tube of refractory metal (tantalum or tungsten) slit longitudinally to a short distance from the bottom. Electrical leads are attached to brackets at the top of the heater. The brackets support the heater at the upper end only to permit unrestricted expansion and contraction during heating and cooling. Current flows from one power lead through the bracket to the heater tube, where it flows downward along one side of the tube and upward along the opposite side to the bracket and out to the other power lead. A pair of hemicylindrical thermal radiation shields enclose the heater tube to concentrate the heat on the specimen.

To run a test, the hinged section of the vacuum chamber is opened and the specimen, with thermocouple connections, is inserted in the heater and attached to the load train through the specimen grips, aligning devices, and pull rods. The hinged section of the chamber is then closed and secured, the vacuum pump started, and coolant fluid turned on. When the desired pressure is reached within the chamber, power is applied to the heater to allow the specimen to reach a specified temperature. The tensile load is then applied to the specimen.

Specimens have been successfully heated to temperatures as high as 5,400°F by the heater. For example, a 5/8-inch-diameter seamless tube of tantalum 5 inches long, with a pair of diametrically opposed slits extending to within 1/2 inch from the bottom of the tube was used to heat a 1/8-inch-diameter specimen.

**Note:**

For further information about this innovation inquiries may be directed to:

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Reference: B63-10345

**Patent status:** NASA encourages the immediate commercial use of this invention. It is owned by NASA, and a patent application has been filed. When patented, royalty-free nonexclusive licenses for its commercial use will be available. Inquiries concerning license rights should be made to NASA Headquarters, Washington, D.C. 20546.

Source: P.F. Sikora
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