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Brief B71-10405

NASA TECH BRIEF

Lewis Research Center

Combined High Vacuum/High Frequency Fatigue Tester

Elevated temperature creep and high frequency fatigue test capabilities have been combined with an ultra-high vacuum environment in a single apparatus to provide a unique device for testing

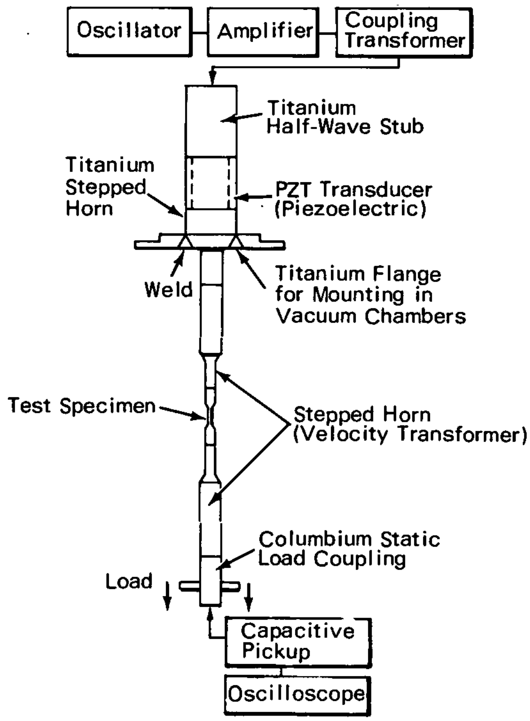

Figure 1. Ultrasonic Drive Train

refractory alloys. The high frequency fatigue test capability permits the application of a significantly greater number of cycles or, alternatively, an equivalent number of cyles in a much shorter time than with conventional fatigue test devices. The ultra-high vacuum test environment eliminates problems associated with high temperature oxidation and with the sensitivity of refractory alloy behavior to atmospheric contamination.

The unit permits the application of a constant stress to a test specimen in addition to the varying fatigue stress. This capability allows interactions between creep and high temperature fatigue to be conveniently studied. In addition, the significantly decreased test time provided by the high frequency fatigue testing reduces the effort required for fatigue design characterization in structural materials.

The technique consists of introducing a standing longitudinal displacement wave into a load train which is mechanically tuned to resonate at the desired test frequency (see Fig. 1). In order that the load train can be incorporated into a vacuum chamber (see Fig. 2), the system is designed so that the vacuum seal occurs at a displacement node (a zero-displacement point) on the load train, thereby permitting a rigid, metal-to-metal, ultra-high vacuum seal. The load train is suspended vertically in the furnace and test chamber and is designed so that the center of the test specimen is also a displacement node. Static loads, when used, are normally applied externally from the bottom through a metal bellows seal and, again, are coupled to the load train at a displacement node. The resonant load train is driven from the top, using a piezoelectric transducer driven by an amplifier and high frequency oscillator. Stepped horns are used in the load train to mechanically amplify the strain.

Optical strain measurements are made through windows in the furnace and vacuum chamber.

(continued overleaf)

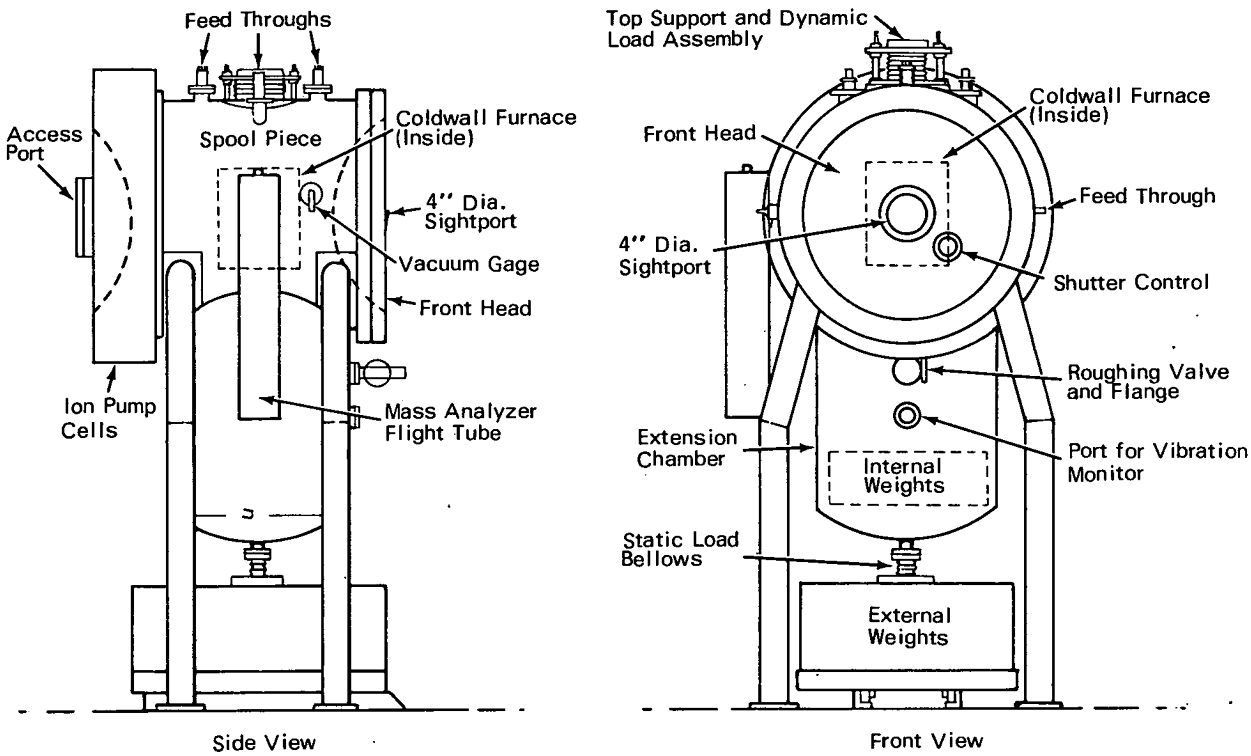

Figure 2. Vacuum Fatigue System

These windows also permit optical temperature measurements to be made as supplements to the potentiometric methods used for primary temperature measurement and control.

Tests were conducted at temperatures up to 2600° F. The theoretical temperature limit of the apparatus approaches 4000° F, depending on the material being tested and the ability of the load train to handle the load at that temperature.

Notes:

1. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $6.00
   (or microfiche $0.95)

   Reference:
   NASA CR-72241 (N67-2736), Elevated Temperature Fatigue of TZC Molybdenum Alloy Under High Frequency and High Vacuum Conditions

2. Technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B71-10405

Patent status:

No patent action is contemplated by NASA.

Source: C. R. Honeycutt and T. F. Martin of TRW Inc.
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(LEW-11210)