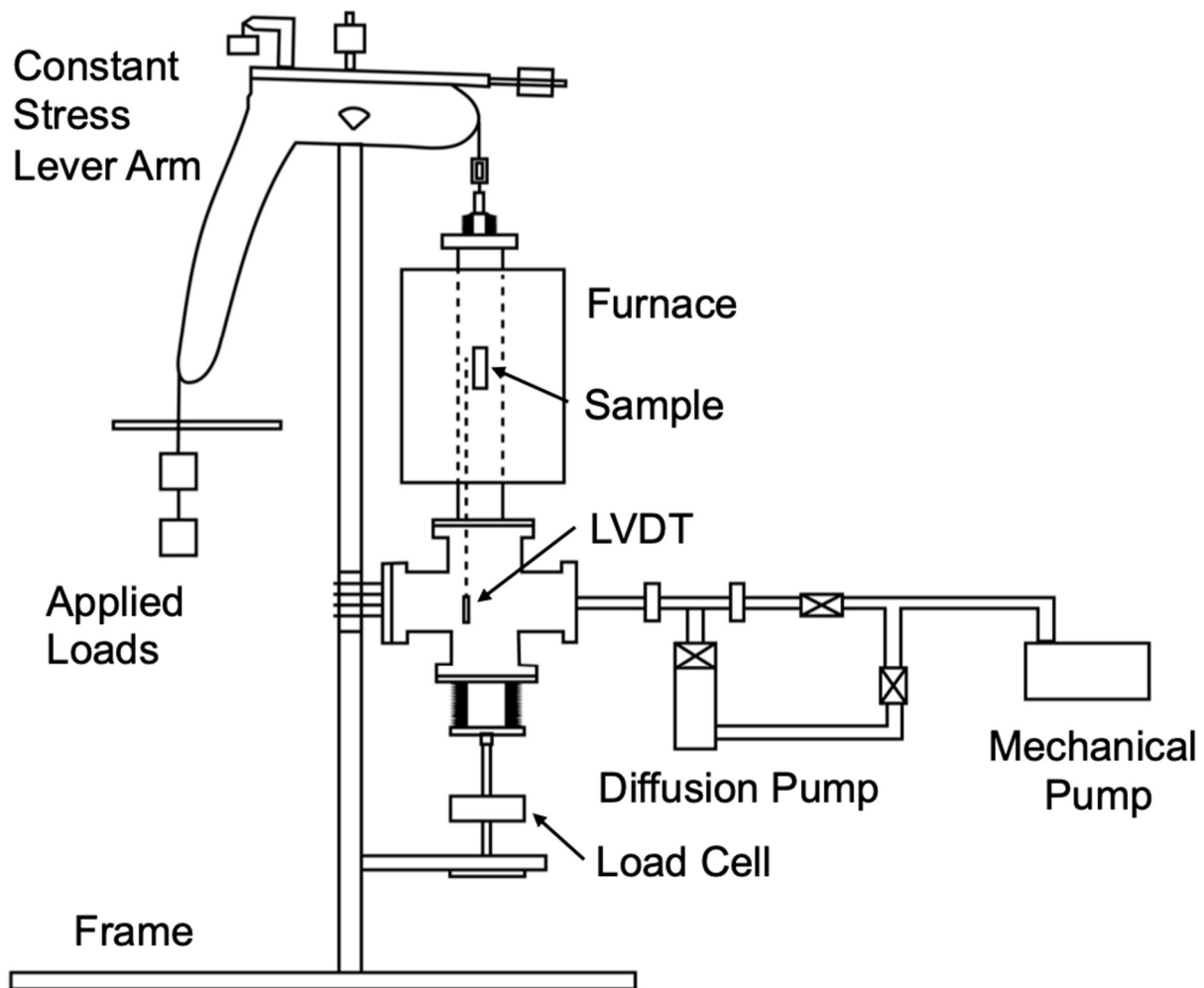


Stress Reduction Creep Machine

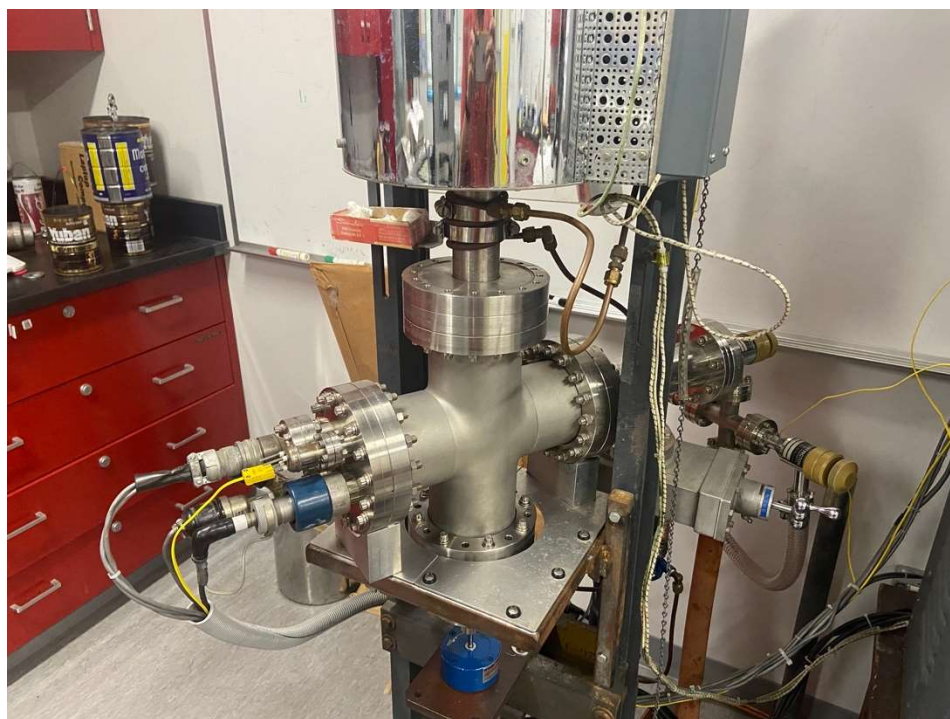
Overview

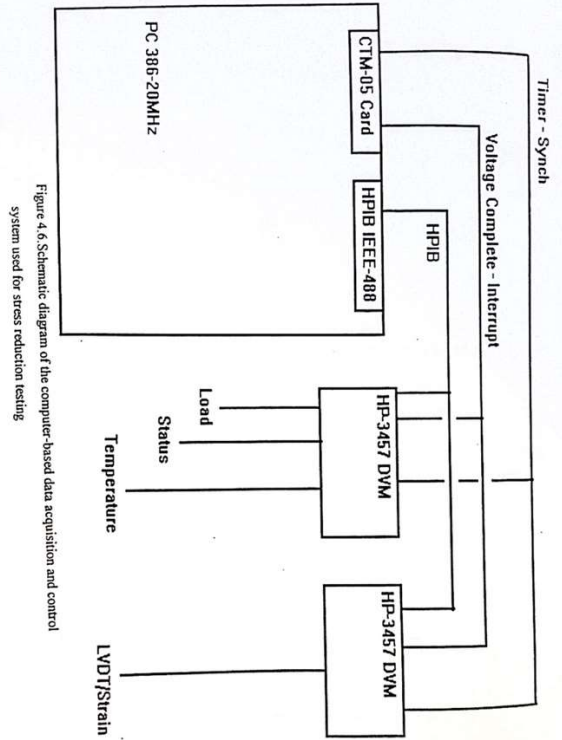
The stress reduction creep machine tests the materials' creep properties at both constant stresses and stress reductions at elevated temperatures up to 1273 K under vacuum $<2 \times 10^{-5}$ Torr. Constant true stress is achieved by utilizing an Andrade Chalmers cam lever. Strain is measured by a linear variable differential transformer (LVDT) that resides inside the furnace via a quartz rod-tube fixture. Stress reduction transients are obtained by high-speed data acquisition achieved by an external CTM-5 counter timer card and high resolution DVMs.

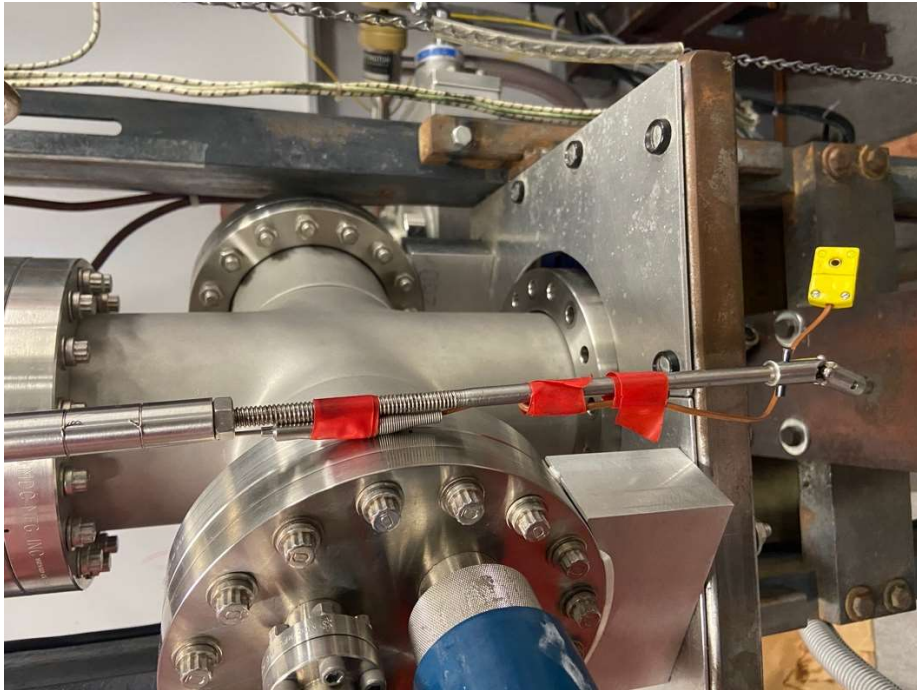
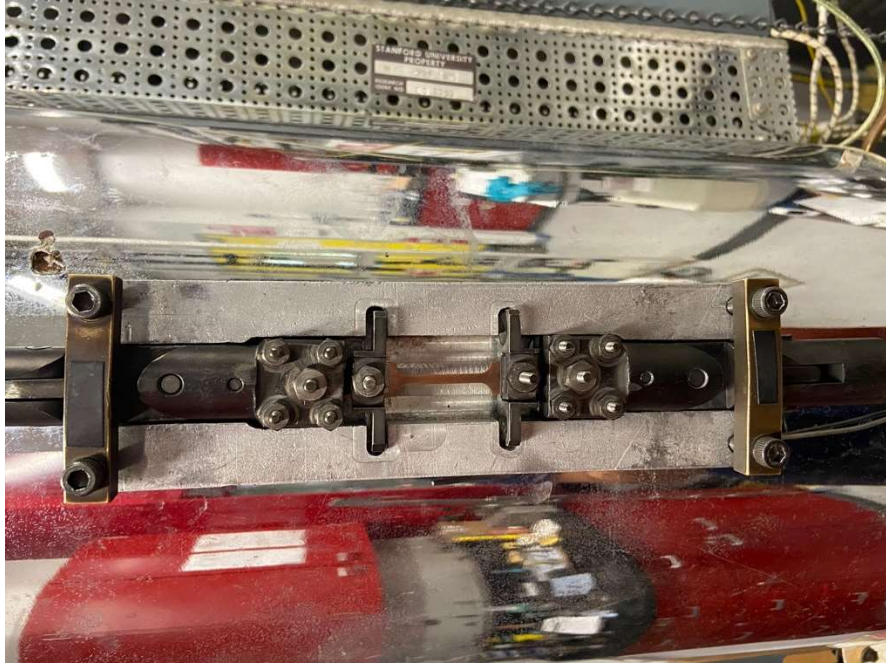


Individual Parts









Pictures for individual parts

Mechanical and Data Acquisition

1. **Arm:** custom-built Andrade Chalmers lever arm for constant true stress testing. Comes with counterweights.
2. **Vacuum counterweight:** an external weight (currently 1538 g) hung on the arm to counter-balance the vacuum force and the weight of the upper linkage.
3. **Weights:** weights put in two cans so that the lower can can be removed for stress reduction. Connected to the arm with a hook.
4. **LVDT:** Schaevitz 250 MHR LVDT. Should be tuned to +2.5 V to start.
5. **LVDT quartz fixture:** Quartz rod: Diameter: 2.5mm, Length: 23", Ball diameter: ~3.3mm. Quartz tube: Inner diameter: 3mm, Outer diameter: 5mm, Length: 20", Flare diameter: 8mm. The LVDT core is screwed on a custom-made Al part that connects with the quartz rod by superglue. The LVDT shell sits inside a custom-made Al tube case that connects with the quartz tube by superglue. See figure and test procedures for more details. The weight of the quartz rod/tube fixture is countered by a 5g attachment on the upper bracket for the rod and a 64 g attachment on the lower bracket for the tube.
6. **Conditioner:** two Daytronics model 3230 LVDT conditioners/indicators
7. **DVMs:** two HP 3457 A high resolution digital multimeters.
8. **Computer and test program:** HP 486/33M computer connected to the creep machine via GPIB interface. Custom test program written by Stuart Broyles in QuickBasic. For the test program to work, the data floppy disk must have a CRPINFO file for sample information and an empty folder with the same name as the test name. See testing procedures for more information.
9. **Counter/timer card:** The computer is installed with a MetroByte (now Keithley) CTM-05 counter/timer card for high-speed (MHz) data acquisition.
10. **Thermocouple:** Omega TJ36-CAXL-116G-18 type K thermocouple. Also have an Omega TJC36-CAXL-032G-18 spare.
11. **Cold junction:** Omega-CJ measurement thermocouple cold junction compensator. Uses one Type N battery.
12. **Sample grips and fasteners:** Inconel grips carrying the test specimen. Sample is fastened by four 5-40 * 3/4" and eight 4-40 * 3/4" high temperature TZM hex screws and nuts from Extreme bolts and fasteners with alumina anti-seize.
13. **Upper bellows:** upper seal for the test system with for #14(0.25")-28 * 1.25" hex bolts and nuts with washers. Pitch number is flexible.
14. **Lower bellows:** lower seal for the test system. Duniway Stockroom G600 6" conflat type disposable Cu gasket inside to seal for vacuum. The lower bellows are attached to the creep machine by #20(0.3") * 2" flange bolts and nuts with washers. Pitch number is flexible.
15. **Rod with universal joint:** rod that connects the sample grips linkage with the load cell. Has a universal joint on one side for flexible installation and threads on the other side to connect with the load cell.
16. **Cu spacers:** Cu blocks that prevent the bellows from crushing under vacuum. The spacers must be put in before vacuum is pulled! Three 1.625" length spacers for the upper bellows; and three 2.375" spacers and three 1.625" spacers for the lower bellows.
17. **Load cell:** Interface Model 1420-FS load cell, 500 lbs capacity for load monitoring.

Sample Loading

18. Mounting block: custom-made mounting block for sample installation outside furnace.

Vacuum System

19. Mechanical pump: Alcatel Z 2012 H type mechanical pump.

20. Diffusion pump: Consolidated Vacuum Corporation (CVC) 2-inch oil diffusion pump type PMC-115.

21. Vacuum gauges: Rough gauge: Duniway Stockroom 531 thermocouple vacuum gauge; High vacuum gauge: CVC Type GPH-100A discharge vacuum gauge.

22. Cooling water: necessary for cooling the furnace and diffusion pump. Proteus flow switches in room (see figure). Can check status by the flow switch impeller near the diffusion pump.

23. Piping, fittings, and hoses: MDC MFG Inc. flanges and tubing. Huntington EV-100 roughing and foreline valves. CVC VCS gate valve for diffusion pump. Copper tubing for cooling water. Orange vacuum hoses. Has a cross-shaped chamber that holds the thermocouple and LVDT connections (see **Appendix** for drawing).

Furnace

24. Furnace: Marshall vertical split tube furnace, 110 V, max 15 Amps. Max temperature 2200 F (~1000 C).

25. Furnace controller: LFR series 230 furnace controller.

26. Power rack: LFR model 4010 power rack.

Other Electronics

27. Relays: Tyco P&B KR series 5-10 Amp general purpose relays. Tyco P&B KUL series 10 Amp magnetic latching relay. Tyco P&B series 10-50 Amp heavy duty AC or DC power relay.

28. Toggles: NKK series S toggles.

29. Power strips: industrial grade power strips.