

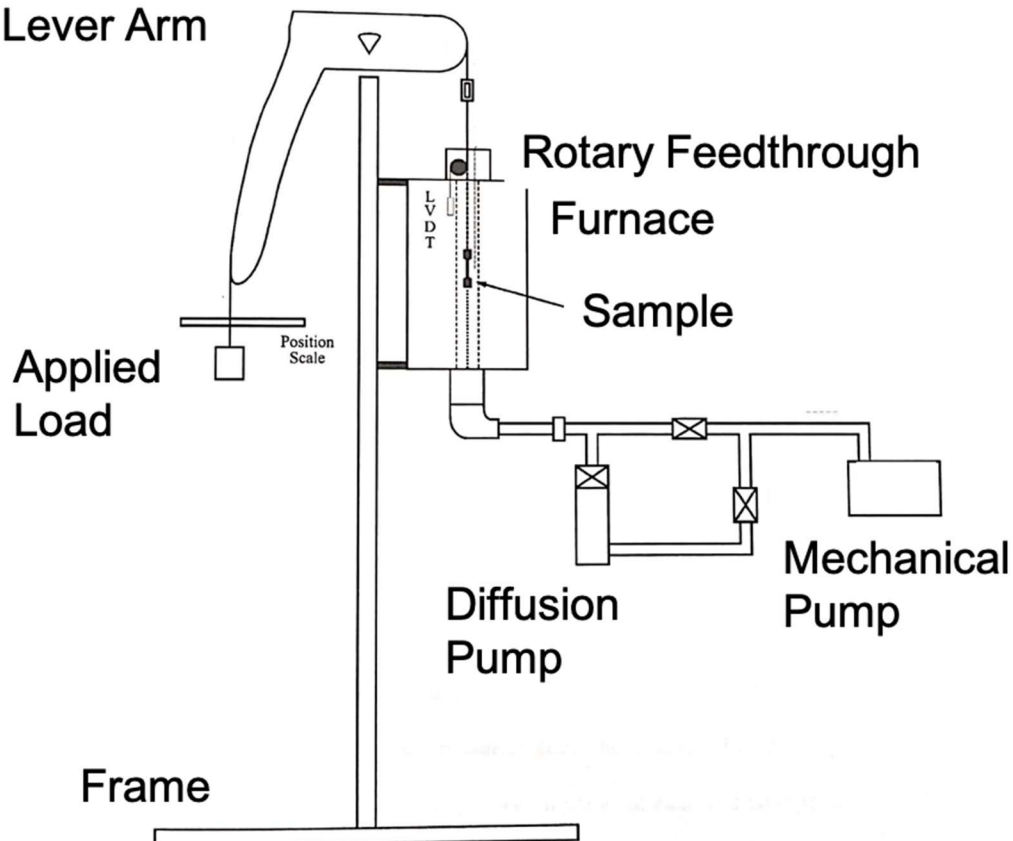
Complete Manual of the Two Creep Machines in Gibeling Lab

Constant Stress Creep Machine (“Green” Creep Machine)

Overview

The constant stress creep machine tests the materials’ creep properties 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 connects to the sample by a rotary feedthrough.

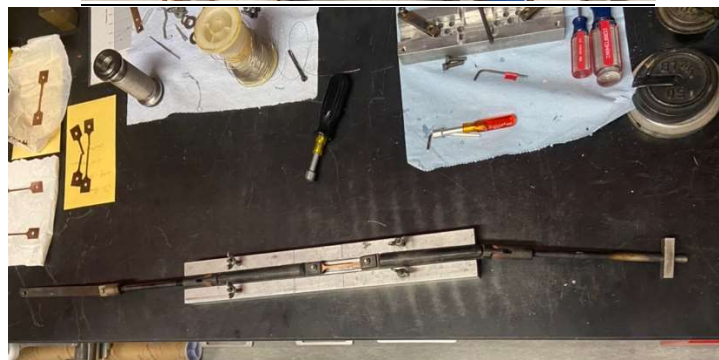
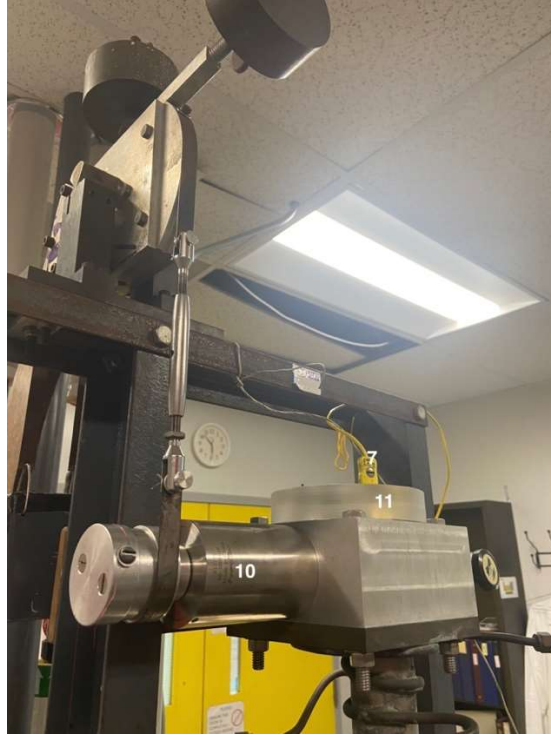
Constant Stress Lever Arm



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. **Weights:** removable weights connected to the arm with a hook.
3. **LVDT:** Schaevitz 300 HR LVDT. Should be tuned to ~ -5.5 V to start.
4. **Conditioner:** two Daytronic 3130 LVDT conditioners. The left-hand one is used for this system.
5. **DVMs:** two Fluke 8840 A Multimeters. One for LVDT output and the other for thermocouple output.
6. **Computer and test program:** HP Vectra 486/33N connected to HP 3497A data acquisition/control unit via GPIB interface. Custom test program written in HP BASIC capable of data acquisition for multiple creep frames and file conversion.
7. **Measurement Thermocouple:** Omega type K high-temperature probe thermocouple with lead wire and compact joint.
8. **Cold junction:** Omega-CJ cold junction compensator for measurement thermocouple. Uses one Type N battery.
9. **Sample grips and fasteners:** Inconel grips carrying the test specimen. Sample is fastened by 2 * 8-32 * 9/16" hex screws and nuts or metric M4-0.7*16 hex and nuts with alumina anti-seize.
10. **Rotary feedthrough:** FerroTec E13175 load transmitting device. See figure.
11. **Upper acrylic lid:** upper seal for the test system with measurement thermocouple connection.
12. **Lower elbow:** lower seal for the test system with brazed cooling water tubes. Needs to be extra lubed because it fits very tightly with the main tube and can be very difficult to detach.
13. **Lower bellows, clamps, and o-rings:** bellows connecting the lower elbow to vacuum piping. Two captured o-rings attached.

Sample Loading

14. **Mounting block:** custom-made mounting block for sample loading outside furnace.

Vacuum System

15. **Mechanical pump:** Rebuilt Edwards E2M5 from Duniway Stockroom.
16. **Diffusion pump:** Consolidated Vacuum Corporation (CVC) 2-inch oil diffusion pump type PMC-115.
17. **Vacuum gauges:** Rough gauge: Duniway Stockroom 531 thermocouple vacuum gauge; High vacuum gauge: CVC Type GPH-100A discharge vacuum gauge.
18. **Cooling water:** necessary for cooling the furnace and diffusion pump. Proteus flow switch near the diffusion pump (see figure). Can check status by the flow switch internal wheel.
19. **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. Transparent plastic vacuum hoses.

Furnace

- 20. Furnace:** Marshall vertical split tube furnace, 110 V, max 16 Amps. Max temperature 2200 F (~1000 C).
- 21. Furnace controller:** Eurotherm Thyristor furnace controller. Uses a Type K control thermocouple inserted into the bottom of the furnace.
- 22. Power rack:** Eurotherm LFR model 4010 power rack.

Other Electronics

- 23. Relays:** Idec GT3F timer with 8-pin screw terminal. Tyco P&B CB series CMOS IC time delay relay. 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. The time delay relay is wired to ensure that brief power disruptions (e.g. when the building emergency generator is tested) do not cause the test to shut down prematurely.
- 24. Toggles:** NKK series S toggles.
- 25. Power strips:** Conext battery backup 500 and APC Backups ES-500 for emergency or inadvertent power shut down.