

BRAZING OF ELECTRIC POWER INTERRUPTERS IN VACUUM FURNACE SPECIALLY DESIGNED FOR THE PROCESS

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Four vacuum furnaces, specially designed by engineers of Vacuum Furnace Systems Corp., Souderton, PA, will be used to braze electric power interrupter assemblies of the vacuum arc suppression type.

These interrupters are used extensively in electric power industries by utilities and heavy electric power users in electrical switch gear. Two of the furnaces for brazing the assemblies already have been installed. Fig. 1 shows one of the vacuum brazing furnace systems.

Design and Control of Furnaces

What makes these furnaces unique by industry standards is that they attain deep vacuum without prolonged vacuum pumping time. The 5 ft. dia.

by 6 ft. deep vacuum chamber and hot zone reach 1×10^{-7} Torr in approximately one hour after work loading, and maintain a pressure in the 10^{-6} Torr range during the brazing cycle to 1600°F.

Instead of the standard high vacuum diffusion pump, the cryogenic CryoPump (C. T. I.) utilized for each facility and other system modifications allow deep vacuum processing (see Fig. 2). The high vacuum operation is accomplished by means of the

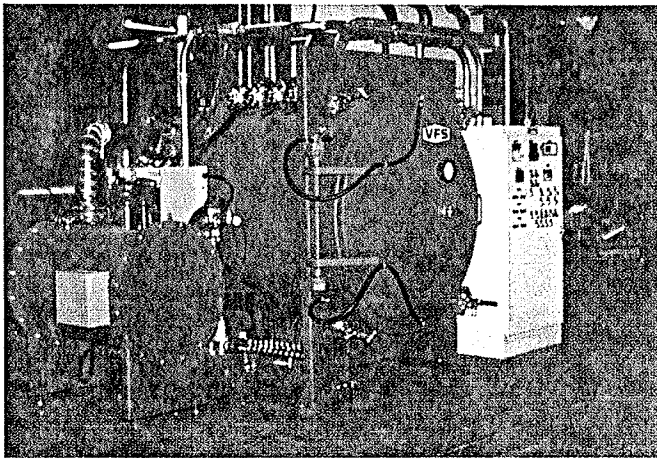


Fig. 1 Vacuum furnace facility for brazing electric power interrupter assemblies principally comprise cryogenic CryoPump, the furnace and instrumentation for process control.

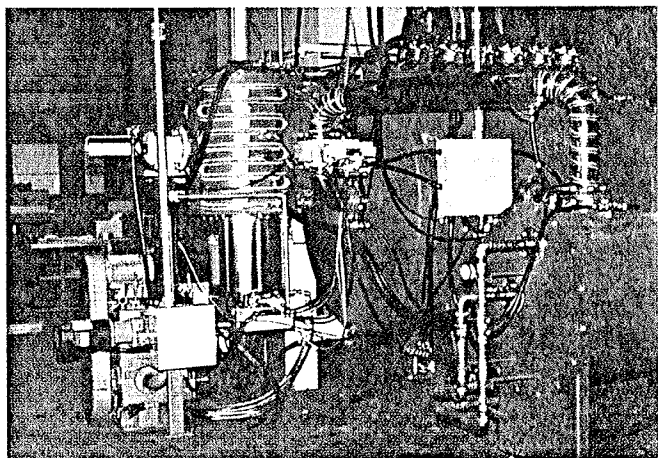


Fig. 2 View of cryogenic vacuum pumping system.

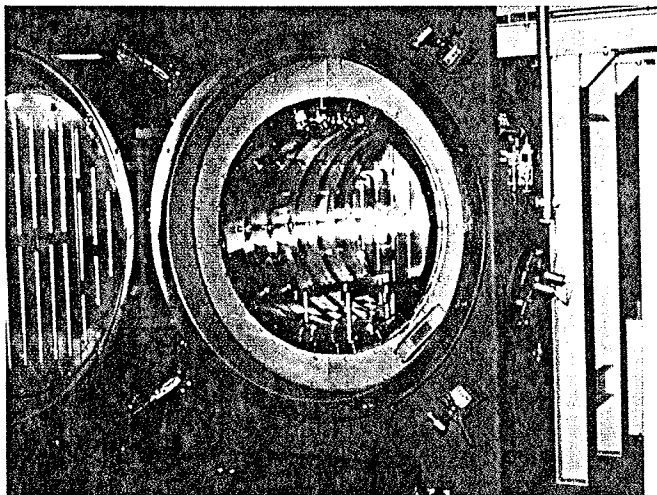


Fig. 3 Vacuum furnace chamber for brazing cycle is designed with five all-metal heat shields and moly heating elements.

Table 1 Vacuum Furnace Brazing Cycle for Electric Power Interrupter Assemblies

1. Hold at 20°C (68°F) for 0.05 min. (Starting Point)
2. Ramp (heat) to 30°C (86°F) at rate of 2°/min.
3. Soak at 30°C (86°F) for 1 min.
4. Ramp (heat) to 850°C (1562°F) at rate of 15°/min.
5. Soak at 850°C (1562°F) for 5 min.
6. Ramp (heat) to 980°C (1796°F) at 12°/min.
7. Soak at 980°C (1796°F) for 10 min.
8. Cool in Vacuum Furnace to 400°C (752°F)
9. Soak at 400°C (752°F) for 2 min.
10. Argon Quench to 50°C (122°F)
11. Hold at 50°C (122°F) for 30 min. Before Discharge

CryoPump without residual oil back-streaming—a special requirement of this process.

The hot zone, which is a more or less standard VFS design, utilizes five (5) all metal heat shields and the standard moly heating element 3 in. wide by .025 in. thick, arranged in a traditional round configuration (see Fig. 3).

Each furnace is microprocessor controlled with programmable logic controller (Allen Bradley) and a vacuum controller (C. T. I.) for automatic regeneration of the CryoPump, all interlocked with a programmable controller (Honeywell Model 550) for temperature and process cycle control.

The furnaces also include a separate external recirculating argon gas blower and gas-to-water heat exchanger arrangement, with high vacuum seal off gate valves to allow increased cooling of the product below 1000°F to ambient temperature, to reduce process time.

Example of Vacuum Brazing Cycle

A typical cycle for vacuum furnace brazing of electric power interrupter assemblies of stainless steel material is shown in Fig. 4 and Table I. ▼

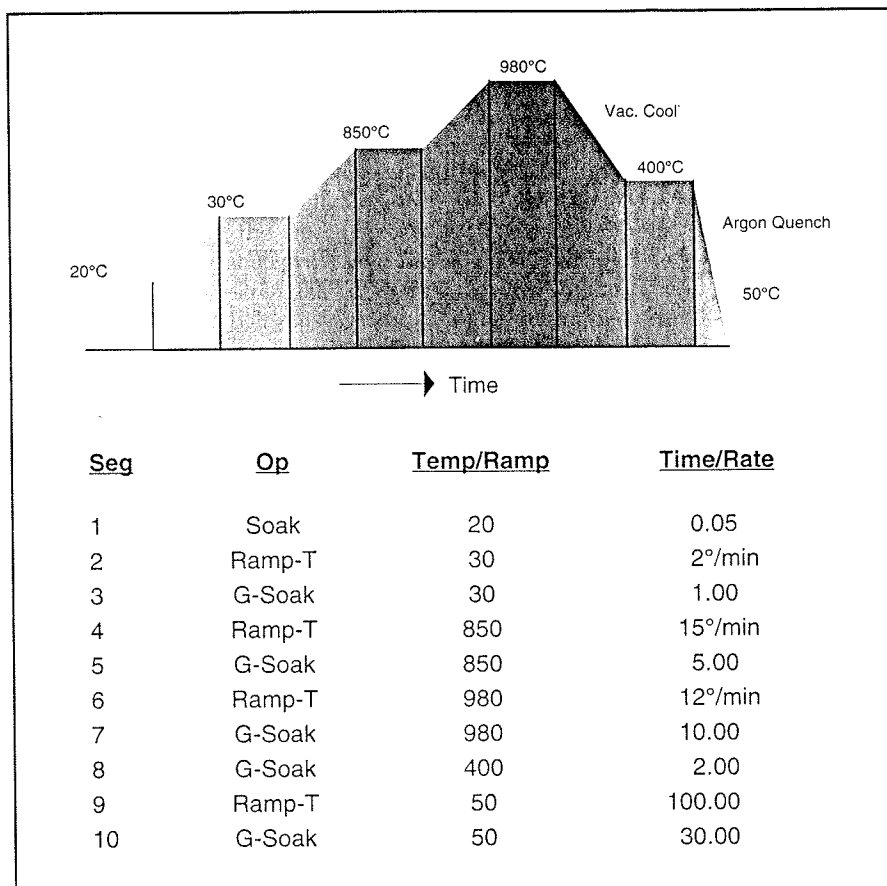
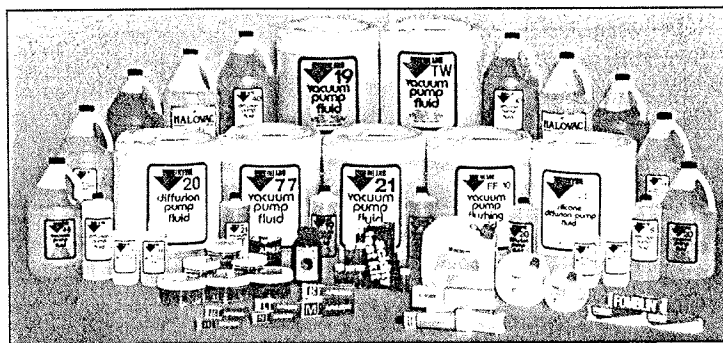


Fig. 4 Diagram of typical vacuum furnace brazing cycle.

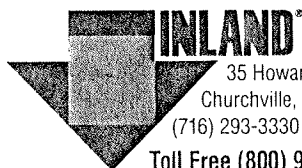
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