

THERMAL TECHNOLOGY INC

HIGH TEMPERATURE EXPERTS

OPERATING AND MAINTENANCE INSTRUCTIONS

SMALL THERMAL TECH FURNACE

MODEL # APF-0716-MS
FURNACE SERIAL # F9006019
POWER SUPPLY SERIAL # C017-9006
ASTRO JOB # 1041-90

Customer: GENERAL ELECTRIC CO.
PART 1 OF 2 PARTS

IMPORTANT

Read and understand this manual completely before attempting to operate the system. Carefully follow the various "SAFETY & SPECIAL PRECAUTIONS" at all times. Follow all inspection and installation procedures before beginning operation of system.

Please be sure these instructions reach the person in charge of the equipment.

MANUAL APPROVED BY

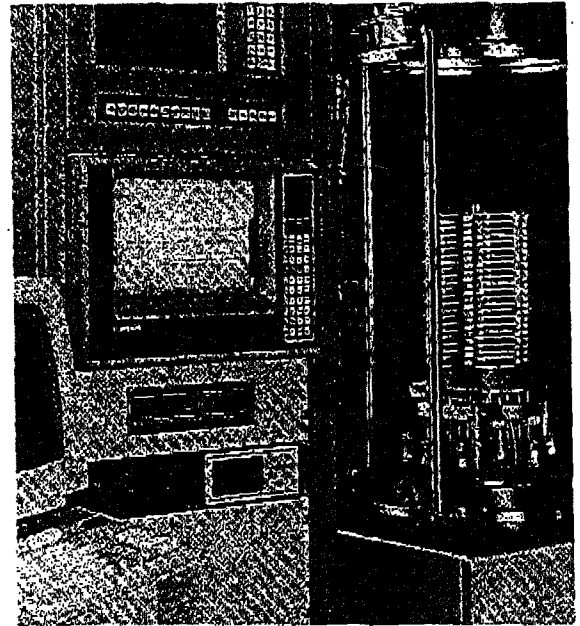
DATE 10/26/90

astro DIVISION

AUTOMATIC PROCESSING FURNACE SYSTEMS

These new Automatic Processing Furnace Systems (APF) and Ceramic Processing Furnace Systems (CPF) are from the Astro Division of Thermal Technology. They provide fully automatic, unattended operation at temperatures to 2000° C. Parts processing may be cycled in under two hours with rapid temperature ramp up (100° C/min) and ramp down (300° C/min). Hot zones are designed to operate in wet or dry hydrogen, fully dissociated dry ammonia, inert gases, nitrogen, or vacuum. The large surface area heating elements provide excellent temperature uniformity within the working volume. Molybdenum sheet, molybdenum wire mesh, or tungsten wire mesh heating elements are used, depending on the operating temperature. A variety of work volumes, temperatures, and processing capabilities are offered to match the system to the customer's requirements.

The APF/CPF systems are cold wall, radiation shielded, bell-style hatch furnaces. The double-wall, all stainless steel furnace chamber hydraulically lifts off the base plate and hearth, providing full work area access for loading parts and instrumentation. The furnace system uses a microprocessor for digital temperature control and processing sequences. More than 25 separate, complete processing programs may be held in memory at one time. Programs are easily entered and may be modified during operation on a temporary or permanent basis. After loading and starting, operation is fully automatic. An audio/visual alarm signals the end of a cycle.



APF system showing optional controls, work rack, and bottom heating element.

APF Features:

- Excellent Temperature Uniformity
- Fast Cycle Time
- Fast Thermal Response
- Precision Programming and Control
- Dew Point Monitoring
- Process Sequence Control
- Wet and Dry Hydrogen Operation
- Easy Loading
- Temperatures to 2000° C

Application Proven

Astro APF furnaces are in use throughout the world. They have been used for research, development, and production by many major manufacturers. These furnace systems are easy to use, dependable in operation, repeatable in production, and are easily adaptable for research and development. Their reputation for long, trouble-free life is impressive.

CERAMIC PROCESSING FURNACE SYSTEMS

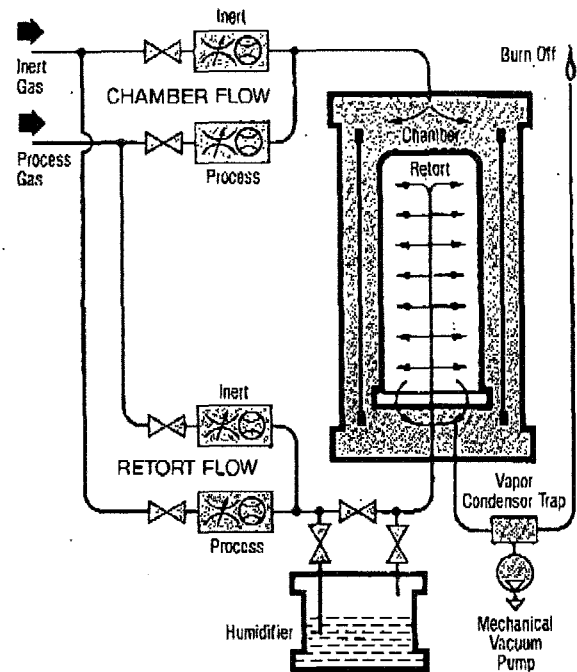
The Astro Ceramic Processing Furnace Systems (CPF) utilize many of the field-proven features of the APF furnace system.

The CPF system provides fully automatic, unattended cofiring of metallized ceramic products reliably, consistently, and dependably. Like the APF system, the CPF is designed for micro-processor controlled operation in wet or dry hydrogen, inert gas, fully dissociated dry ammonia, and any other reducing atmosphere.

Typical applications for the CPF system include printed circuit interconnect boards, multi-layer chip carriers, other cofiring requirements, binder removal/dewaxing sintering, powder metal sintering and ceramic sintering.

The CPF utilizes several additional specific components to help solve the problems associated with the cofiring of metallized ceramic products. A containment vessel (retort) encloses the work zone to provide more accurate control of the environment. Injection and vent tubes are provided for better distribution of gas in the work zone, and a condensation trapping system is provided for removing condensable binders from the exhaust gases. Additional controls are provided to separate the gases directed into the containment vessel from those gases that envelope the heating elements and heat shields. A heater arrangement is added to the standard APF humidifier assembly which allows inlet gas dewpoints to $+40^{\circ}\text{C}$.

The CPF system utilizes a molybdenum hot zone designed for continuous operation to 1700°C . Lower temperature units have been built for special applications.



Typical gas flow diagram for the CPF system.

CPF Features:

- Problem Free Cofiring of Metallized Ceramics
- Atmosphere Containment for Accurate Control
- Large Range of Sizes and Capacities
- Automatic Processing
- Fast Response to Parameter Changes
- Field-Proven Trouble-Free Performance
- Easy Access for Loading
- Temperatures to 1700°C

More Choices

Thermal Technology Inc designs, manufactures, and provides worldwide support for a wide range of high temperature furnaces — with more choices to suit your specific needs. From small R&D sizes, through pilot and full production models. For a wide range of applications including Sintering and Delubing, Hot Pressing, Pressure Assisted Sintering, Metallizing and Cofiring, Heat Treating & Brazing, Reaction Bonding, CVD and Crystal Growing, and Physical Testing. For further information write or call today.

APF/CPF SYSTEM OPTIONS

A variety of special options are available for both the APF and CPF systems to enhance their use in special situations. The Astro division is accustomed to working with customers to provide further special features that are not listed here. For further information, please contact your nearest Thermal Technology office.

Faster Cool Down

Cooling rates of up to 500°C/min may be achieved with a recirculating gas heat exchanger.

Ultra Uniform Temperatures

With the addition of top and bottom heating elements, the thermal uniformity is further enhanced within the work zone.

Special Controls

Additional temperature probes, gas controls, vacuum controls, dewpoint measurements, humidifier controls, can all be integrated into the furnace system.

Computer Interface

Additional visual and hardcopy readouts are readily available and may be easily connected through various communication ports. This interface is also convenient for connecting to an external computer for further data processing and storage.

Improved Vacuum Performance

Turbo- and cryogenic vacuum pumping systems are available for cleaner, faster pump-down and improved vacuum.

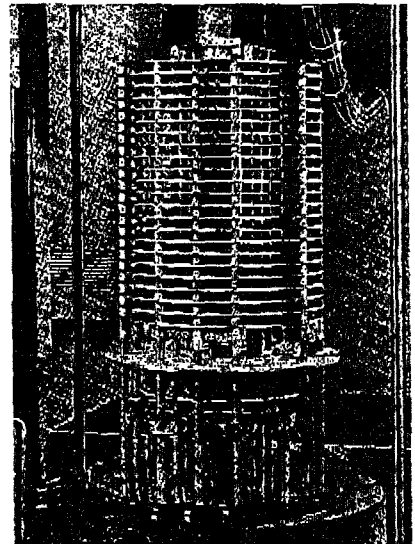
Special Loading Devices

A variety of special electrical and hydraulic loading and positioning devices are available to simplify furnace loading and unloading.

Tooling

A wide variety of well-engineered work-load support structures and shelves for special loading requirements are available.

This APF system is equipped with special work trays for convenient and consistent loading.



STANDARD WORK ZONES

Model No.	Work Zone Size	Work Zone Volume	Max Work Load
APF-0716	6" diameter x 12" high	0.2 cubic feet	40 pounds
APF-0925	8" diameter x 16" high	0.5 cubic feet	75 pounds
APF-1230	10" diameter x 20" high	0.9 cubic feet	150 pounds
APF-1836	15" diameter x 28" high	3.1 cubic feet	500 pounds
APF-2444	20" diameter x 36" high	6.5 cubic feet	1000 pounds
APF-3060	24" diameter x 48" high	12.6 cubic feet	1500 pounds
CPF-0716-MS	4" diameter x 10" high	0.1 cubic feet	40 pounds
CPF-0925-MS	5.5" diameter x 14" high	0.2 cubic feet	75 pounds
CPF-1230-MS	8.5" diameter x 16" high	0.5 cubic feet	150 pounds
CPF-1836-MS	12.5" diameter x 20" high	1.4 cubic feet	500 pounds
CPF-2444-MS	18.5" diameter x 24" high	3.7 cubic feet	1000 pounds
CPF-3060-MS	24.0" diameter x 36" high	9.4 cubic feet	1500 pounds

THERMAL TECHNOLOGY INC

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SPECIFICATIONS**MODEL APF-0716-MS FURNACE SYSTEM**F sln
PSAPF-0716-MS
F9006019
C017-9006
1047-90

J#

1.0 GENERAL DESCRIPTION

This furnace system is a coldwall, radiation-shielded, periodic furnace utilizing the bell-loading configuration. The furnace configuration is similar to that which is described in the standard specifications for Astro Group 1700 "APF" Furnaces. It will operate continuously at 1300 deg. C with dry atmospheres of hydrogen, nitrogen or inert gas at a pressure of +2 psig.

Power is delivered to the main radial heating element by a three-phase SCR stepless, current-limited regulator working into a stepdown power transformer.

The heating element is fabricated from molybdenum sheet with approximately 260 square inches of radiating surface area facing the work. The heating element dimensions are approximately 7" diameter x 16" high, yielding a work zone of approximately 6" diameter x 12" high.

The hot zone temperature is programmed and controlled by a MicRistar microprocessor-based temperature programmer/controller. The microprocessor is interfaced to a Gould logic controller to provide a fully automated process that can be operated unattended from start to finish.

2.0 UTILITIES TO BE SUPPLIED BY THE CUSTOMER

- 2.1 POWER: 460 volts, 3-phase, 60 Hz, 50 amps AC Service.
- 2.2 WATER: 7 gpm at 55 psig differential from inlet to outlet, non-fluctuating water pressure at 65-85 deg. F.
- 2.3 PROCESS GAS (hydrogen): 15 SCFH at +10 psig, regulated, dried and free of impurities. Regulator diaphragm to withstand vacuum on the system side.
- 2.4 PURGE GAS (argon): 25 SCFH at +10 psig, regulated, dried and free of impurities. Regulator diaphragm to withstand vacuum on the system side.

2.5 COMPRESSED AIR: Nominal amounts of lubricated compressed air at 70 psig to operate the vacuum.

3.0 DESIGN CONSTRUCTION

3.1 PROCESS VESSEL: All stainless steel, chemically cleaned and polished.

3.1.1 Bell: Approximately 12" diameter x 22" high with 13.5" diameter flanges. Includes one (1) viewport halfway down the hot zone and water-jacketed cooling.

3.1.2 Top Cover: Approximately 13.5" diameter with penetrations as follows - power feedthroughs, water feedthroughs, control and overtemperature thermocouples, and gas inlet.

3.1.3 Base Plate: Approximately 13.5" diameter with penetrations as follows - vacuum pumping port, gas exhaust, water feedthrough, and thermocouple feedthroughs and blanked accessory ports. Work support hearth of molybdenum plate-on-post construction.

3.1.4 Water-Cooled Copper Heat Sinks: Top of hot zone and beneath hearth.

3.1.5 The process vessel is supplied with all associated hardware, Viton O-rings and flanges as required.

3.2 PUMPING EQUIPMENT

3.2.1 Mechanical Pump: Varian DVP-500, customer supplied. To be installed at our facility.

3.2.2. Isolation Valve: Air operated, stainless steel.

3.2.3 Vacuum Manifold: Copper/stainless steel, silver-brazed, chemically cleaned.

3.3 INSTRUMENTS & CONTROLS

3.3.1 Granville-Phillips Model 275 digital convectron gauge and vacuum sensor.

- 3.3.2 Compound mechanical gauge.
- 3.3.3 Purge flowmeter and throttling valve.
- 3.3.4 Process flowmeter and throttling valve.
- 3.3.5 Purge gas solenoid shutoff valve.
- 3.3.6 Process gas solenoid shutoff valve.
- 3.3.7 Uninterruptable power supply with battery back-up for restarting process after power interruption of ten (10) seconds or less.
- 3.3.8 Overtemperature alarm control with thermocouple.

3.4 FURNACE COMPONENTS

- 3.4.1 Heating Element: Hanging design, fabricated entirely from molybdenum. Dimensions approximately 7" diameter x 16" high (plus current pins).
- 3.4.2 Radiation Shields: Fabricated entirely from refractory metals, utilizing .010" and .005" molybdenum. The heating element is surrounded by a total of five (5) radiation shields.
- 3.4.3 Hearth: Fabricated entirely from molybdenum, plate-on-post.
- 3.4.4 Power Feedthroughs: Copper, coaxially water-cooled. No mechanical, brazed or welded joints holding water back from the interior of the process chamber.

3.5 POWER SUPPLY

- 3.5.1 Control Console: Relay-rack electronics cabinet with locking rear doors.
- 3.5.2 Stepdown Power Transformer: Three-phase, air-cooled, in enclosure and sized for furnace operation to 1300 deg. C.

- 3.5.3 SCR Power Regulator.
- 3.5.4 Power Contactor.
- 3.5.5 Control/Isolation Transformer.
- 3.5.6 Power Control Panel with indicator lamps, element volt/ammeters.
- 3.5.7 MicRistar Microprocessor programmer/controller with Gould logic controller.
- 3.5.8 Pilot Flame Starter/Monitor, dual element.
- 3.5.9 Process Gas Pressure Switch.
- 3.5.10 Purge Gas Pressure Switch.
- 3.5.11 Water Flow Interlocks.
- 3.5.12 Current Transformers.
- 3.5.13 High Current Cables (water-cooled).
- 3.5.14 Control Thermocouple (tungsten 5% rhenium vs. tungsten 26% rhenium).

3.6 STRUCTURES

- 3.6.1 Furnace with base and bell lift, hydraulic powered lift and clamp cylinders.
- 3.6.2 Water manifold.
- 3.6.3 Electronics console.
- 3.6.4 Power supply/high voltage enclosures.

3.7 OPERATING & MAINTENANCE INSTRUCTION MANUAL

- 3.7.1 Includes text, component manuals, parts lists, assembly drawings, diagrams and schematics.

3.8 FIELD SERVICE

- 3.8.1 Manufacturer shall furnish a field technician to check-out the installation and conduct final test at customer's facility. Customer shall be responsible for hooking up the system to power and water prior to this final testing.

4.0 OPTIONAL ACCESSORIES

- 4.1 Work fixture, four (4) six inch diameter shelves.
- 4.2 Recorder, 2 pen, Honeywell Versaprint 131.
- 4.3 Calibration port with quick disconnect.
- 4.4 Emergency "off" circuitry and breaker.

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