CAMCO FURNACE
Manufacturers of High Temperature & High Vacuum Equipment
1017 Bransten Road | Phone (650) 593-1064
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Specification Sheet

Equipment Model: H-COM-16
Combination Hydrogen and High-Vacuum Furnace

Type	Vertical “Bell” Style, High Vacuum (Turbo Pumped)
Chamber	Electropolished Stainless Steel Coldwall
Maximum Temperature	1600° C.
Hot Zone	11.5” (29 cm) Dia. x 18” (45 cm) H. Nominal
Overall Equipment Dimensions	65” (165 cm) W. x 28” (71 cm) D. x 90” (228 cm) H.
Power Requirements	480V 3 Ph. 60A 60 Hz. | 208/240V 3 Ph. 120A 60 Hz
	415V 3 Ph. 60A 50 Hz.
Gas Requirements	25 – 50 psig, Nitrogen (1/4” Swagelok)
Compressed Air	80 – 100 psi (1/4” Swagelok)
Element style	.125 Molybdenum wire, Single Zone

Process Hydrogen at +1/3 PSI (Above ambient pressure)
Process Vacuum at temperature 10^{-6} Torr
Vacuum in 10^{-7} Torr range at ambient temperature

Cooling Requirements - 25 psig at 4 gallons per min.
Note: Maximum back pressure is 15 psig.

Heat up ramp rate 100° C per minute - empty chamber.
Heating elements and heat shields are constructed of Molybdenum. Insulators are all high-alumina ceramic.

Standard Features:

- 600 L/S Turbo Pump
- High Vacuum Isolation Valve
- Equipment on casters to roll into place
- Precise and Stable PID Controllers
- Digital Chart Recorder
- Ethernet Connectivity / Webserver / FTP
- Active Braze Control with survey thermocouple
- 19 Programs - 20 segments per program
- Sight glass for calibration melts
- Fully automatic - One button push starts the run. Automatically it will rough pump/cross over to high vaccum - ramp to temperature and soak - cooldown - let up to ~760 torr and allow chamber access.

Options:

Dry Scroll Pump
Partial Pressure Operation
Tower Indicating Lights - 3 color
Survey Thermocouples (up to 6)
Residual Gas Analyzer (RGA)
Computer Controls
Cryo Pump, Achieves 10^{-8} Torr

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Equipment Description

CAMCO Model H-COM-16

Combination Positive Pressure Hydrogen, Turbo-Pumped High Vacuum Furnace
Hoist Operated Chamber and Hot Zone
For Automatic, Programmed Operation to 1600° C

Overview

This Furnace is the result of almost 30 years of evolution of our coldwall furnaces. From their inception, the top loading model B furnaces was always one of the most popular products, but a demand for a hoist operated chamber remained present. The model H was born out of such a need for delicate loading of parts, and having the chamber and hot zone lower around the work charge. Other than overall height and loading configuration, this furnace is otherwise identical to the Model B in temperature range, work zone volume and operation.

This furnace's bell type chamber assembly is raised off the bottom chamber assembly to expose a 12”(300mm) diameter hearth plate that is located at a convenient height to load and unload parts of up to 18” (450mm) in height. It incorporates a low voltage, three phase Molybdenum heating element powered by its’ 350 ampere electrodes. These include Teflon and Alumina insulation and Viton seals. The element surrounds the 12” diameter by 18” high work area. The chamber has cylindrical heat shield packs of pure molybdenum are long lived and easy to replace if necessary.

A double wall, water-jacketed stainless steel chamber contains these items as well as the water cooled, insulated power feedthroughs, and control and overtemp thermocouples. A Nickel-plated Copper water-cooled baffle within the chamber isolates the pumping neck from heat radiated by the furnace. A 5/8" ID vertical sightport is located at the front of the chamber. The sight port is vital for watching delicate brazes and is incredibly helpful for process engineering.

Base Unit

The base unit measures approximately 63" wide by 29" deep (to fit through a standard door) by 90" high when the hoist is fully extended. Its' substantial frame is constructed of heavy wall square steel tubing. Service access is readily gained through a hinged steel front door and removable front, side and rear panels. The plate steel floor within the left third of the base unit supports the heavy transformer and closes the bottom. This left section, containing the power components and electronics is, for safety, isolated from the right two thirds by an internal airflow-directing baffle. A fan at the rear of the base unit draws cooling air through a replaceable filter element to cool the power control unit and transformer.

The floor within the right section of the base unit supports the mechanical pump. In addition, the base frame supports and houses the instrument console, chamber, high vacuum plumbing and complete hoist assembly. A convenient feature is the inclusion of recessed heavy-duty casters. The unit is easily rolled into place, and the leveling feet lowered to immobilize and level the equipment. The stainless steel top provides an area for convenient load preparation, and completes closure of the base unit. The finish used on this, and all CAMCo equipment, is environmentally friendly powder coating, chosen for its' durability. Camco has 30+ year old equipment that has been holding it's powder coating in corrosive environments and continues to look great.

System and Temperature Control

Temperature control and monitoring functions are achieved using two high temperature type “C” thermocouples. Multi-stage programmed control is achieved through use of a Honeywell DCP302 process controller which receives its' input signal from the thermocouple located in close proximity to the heating element. Automatic time/temperature ramp and soak programmed control of up to nineteen different, 19 segment programs may be stored. The operator is required only to insert the load, specify a program by letter and press the start button to operate the furnace. The process controller, in conjunction with the vacuum gauge control, also provides necessary vacuum system control functions.

Load temperature monitoring is provided by a second thermocouple located within close proximity to the load. It drives a Honeywell UDC2500 process monitor, which provides digital readout of the load area at high temperatures as well as an overtemperature shutdown signal. The process monitor also provides a safe chamber access interlock and access signal for the operator.

A Thermocouple feedthrough at the side of the chamber and related holes in the cylindrical shields allow survey thermocouples to be inserted to monitor actual temperature of load. These thermocouples can be used in conjunction with the “Active Closed Loop Braze Option” (The furnace comes standard with one type “K” Inconel sheathed survey thermocouple that can be attached to the workload. This thermocouple drives a second channel on the program controller that can be integrated with the process control. This thermocouple is rated for use up to 1200^{o} C.

Operation

The work is loaded onto the 12”(300mm) diameter hearth plate and the chamber is lowered via the hoist switch. One of nineteen selectable, user programmed thermal profiles is chosen, and the "start" key pressed. Chamber clamps close automatically at the start of the run. The high vacuum isolation valve opens and the chamber is rough pumped through the idle 160 mm, 600 L/PS turbo molecular pump. At a pre-defined vacuum setpoint (approx. 5.0^{-1} Torr) a process relay turns the turbo pump on and the system is further pumped down to the 10^{-7} Torr pressure range within approximately 15 minutes. The furnace then performs the pre-programmed ramp & soak temperature profile, cool down, and vent to nitrogen. Upon completion of the cooldown portion of the program, the chamber clamps will release and the hoist is ready to lift and unload the furnace. With the exception of raising and lowering the hoist, all events are completely automatic.

Vacuum System

This automatically controlled, turbo pumped furnace is designed for clean, oil-free elevated temperature in a high vacuum atmosphere. From a cold start, the clean furnace will evacuate to the 10^{-7} Torr range in approximately 15 minutes, and is capable of maintaining six-scale vacuum at temperature. When pumped for a longer period, lower pressures are easily attained. The vacuum plumbing is designed to provide convenient component access, and to provide maximum practical conductance to the chamber. Mass spectrometer leak checks are performed on all high vacuum assemblies.

The high vacuum system is specifically designed to handle the large gas loads presented by vacuum furnaces. An ISO160 flanged, 600 L/Sec. ceramic bearing turbo molecular pump, capable of 10^{-9} scale ultimate vacuum, is used for the application. The turbo-pump is capable of very rapid 3 thru 7 scale pumping of air and water vapor typically evolved during the earlier outgassing part of the firing cycle. For maximum pumping speed, it is close-coupled to the chamber pumping neck through the high conductance high vacuum gate valve, as are the chamber vacuum gauges and inert gas let-up valve. Chamber roughing is accomplished through the turbo pump by a quiet, direct drive mechanical pump. The foreline includes a backstreaming trap and electro-pneumatic foreline valve. At acceptable foreline pressure, the turbo-pump is automatically powered up. For ultra clean operations, a dry scroll or diaphragm pump can be substituted for the mechanical pump.

Vacuum Instrumentation and Control

An Instrutec digital gauge control unit with process control module, supporting two Convectron (Pirani) gauges and one Bayard-Alpert (Ion) gauge is included to monitor system pressure. The Bayard-Alpert gauge tube, and the Convectron that measures chamber pressure are located on the ISO160 flanged chamber neck. The second Convectron is located to measure pressure at the roughing/backing line. A circuit receiving a signal from an ion gauge related setpoint can be used to toggle the program between run and hold to keep below a programmed vacuum cap during periods of high gas load (vacuum/heat ramp delay). Linearized, analog output provided by the gauge control may be coupled to a recorder when a recorder is ordered.

Power Control

Power is proportionally controlled through use of a digitally controlled SCR three phase power module. This unit is phase angle fired control, and includes three phase current limiting. In the event of a power outage at higher temperature, the load temperature would drop to a level where a hard application of heat might thermally shock damage the parts. In this event, an abort relay will trip, and the program will resume and time out under process atmosphere without the application of heat. Impedance match of the heating elements to the incoming power is accomplished through the conservatively rated 40 KVA transformer driven by this power module. A circuit receiving a signal from the turbo-pump power-up setpoint shuts down the gates of the SCR if this setpoint is exceeded, to preclude application of voltage with inadequate vacuum.

Note: Facility voltage should be specified at time of order. Camco's equipment is capable of conforming with any primary voltage and frequency used both domestic and international.

Atmosphere Control

Our vacuum furnaces can be ordered with Combination Vacuum and Inert Reducing Atmosphere control. Through programming, either vacuum or atmosphere can be chosen to make this an ideal R & D or laboratory furnace. When this option is ordered, the furnace can run either Nitrogen or Argon as the purge gas. The process gas can be Hydrogen, Hydrogen Argon or Hydrogen Nitrogen. A Bubbler to humidify the process gas would come standard with this option. A burn-off column to ignite excess process gas is also standard. As with our standard atmosphere furnaces, this combination furnace comes with all the safety interlocks required with Hydrogen operation.

Safety Features

- Thermocouple break protection (Thermocouple burn-up) assures that heating power is removed from the furnace in the event of sensor failure.

- Overtemperature indication is read on a separate control module from the monitor thermocouple. This overtemp alarm causes the heating elements to shut down as a further backup.

Other numerous interlock functions protecting the operator and equipment include:

- Panel Interlock
- High Cabinet Temperature
- Low Coolant Flow
- Low Gas Pressure Switches
- Vacuum Ramp Delay
- Gross-Leak detection
- Thermal overload protection for the Turbo Molecular Pump
- High Vacuum isolation valve to protect the Turbo Pump during vent and quick cooling of the hot zone.

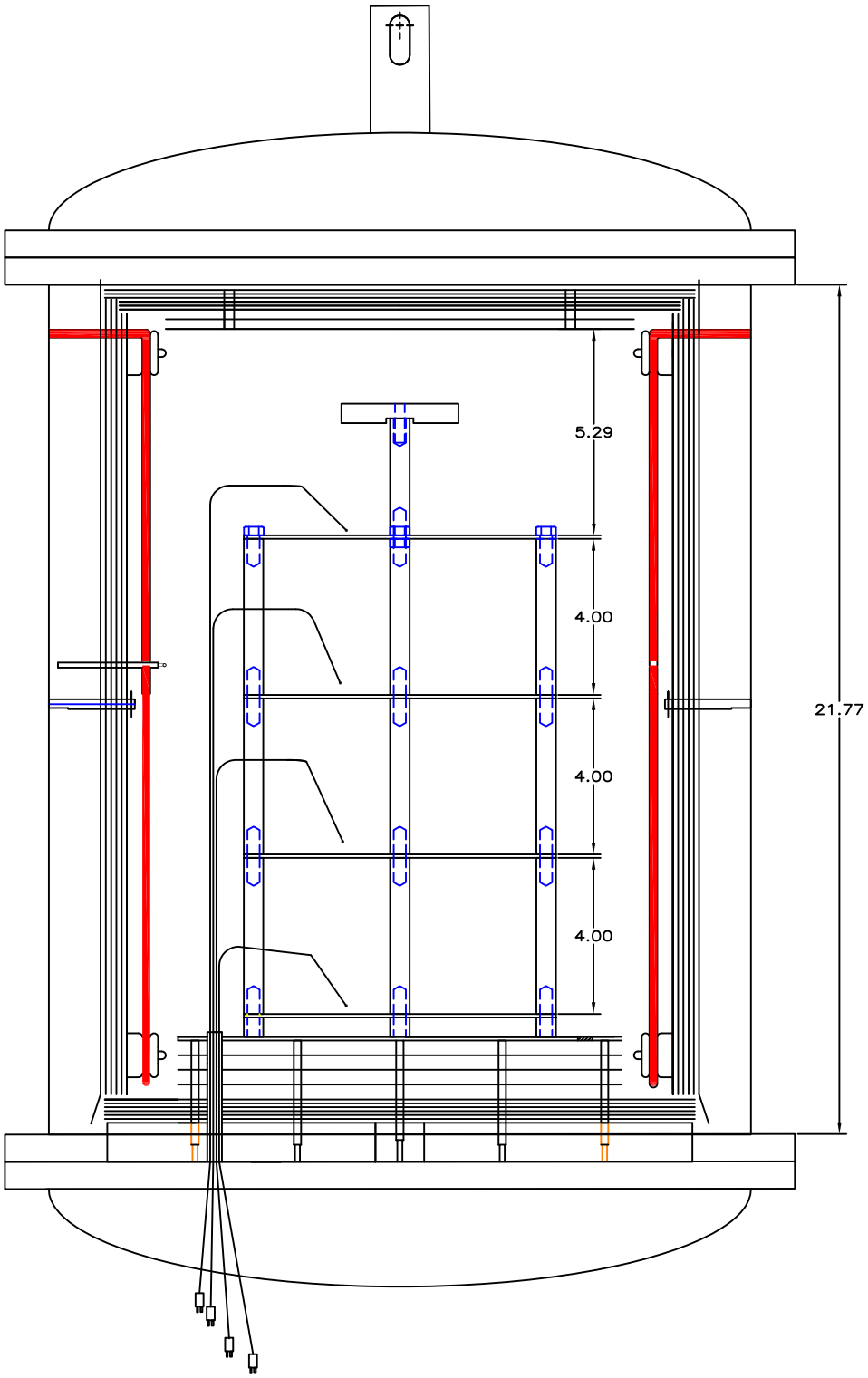
Documentation

Facilities information is supplied to assist in site preparation for installation. An operating manual is supplied with the equipment. Worksheets included in the manual provide a convenient form to depict the desired process for entry into the microprocessor controller. The worksheets also serve as a hard copy of the program. The unit is shipped with an example program stored in memory, depicted by the example worksheet. Wiring and plumbing schematics along with a published spare parts list are also included in the manual. Vendor supplied manuals for the program controller, overtemp, SCR, recorder, dewpointer, and other small items are supplied in our documentation. A program and operation section has a complete button-by-button push instruction for installation of a generic program. The relatively simple operation of the furnace is well described and documented in the manual.

CAMCO FURNACE
1017 Bransten Rd, San Carlos, CA 94070
(650)-593-1064 • CamcoFurnace.com

A Computer-Controlled Model H Furnace
Shown open, with optional 4-shelf Molybdenum rack

REV.	DATE	DESCRIPTION



H–FURNACE	626
USED ON TASK	FWO

TOL'S EXCPT AS NOTED
fract. ±1/32
.XX ±.010
.XXX ±.005
.XXXX ±.0005
ANGLES ±1/2°

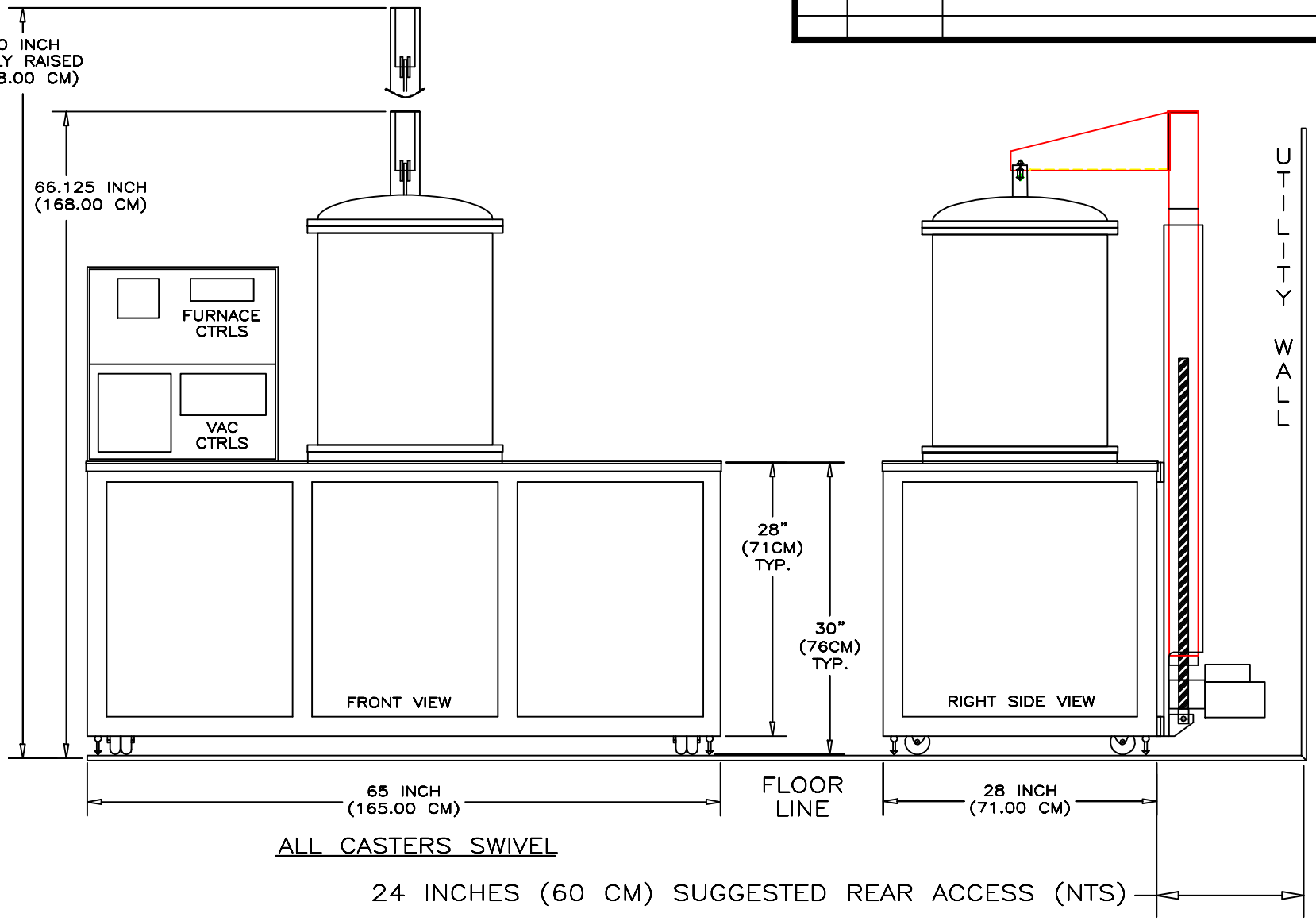
DRN.BY: T BARULICH
APP.BY:
DATE: 9–7–16
MAT:
FINISH:

Concepts & Methods Company, Inc.

TITLE: H–CHAMBER LAYOUT w/ Rack+TCs

DWG.NO: 89775 | SHEET 1 OF 6 | REV:

REV.	DATE	DESCRIPTION



ALL CASTERS SWIVEL

24 INCHES (60 CM) SUGGESTED REAR ACCESS (NTS)

H–COM	626
H–VAC	
USED ON TASK	FWO

TOL'S EXCPT AS NOTED
fract. ±1/32
.XX ±.010
.XXX ±.005
.XXXX ±.0005
ANGLES ±1/2°

DRN.BY: T BARULICH
APP.BY:
DATE: 11/29/16
MAT:
FINISH:

Concepts & Methods Company, Inc.

TITLE: H–VAC OVERALL DIMENSIONS

DWG.NO: 89755 | SHEET 3 OF 6 | REV: