INSTRUCTION MANUAL

EXPLORER FURNACES

FURNACE DESIGNATION GPS-1

Transheat
VIQ-41-436
Equipm. No EPS-1 3/74

- Installation
- Operation
- Maintenance

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FIGURES

1.0 INTRODUCTION

The Explorer line of furnaces is designed for production or laboratory processing with a given time/temperature cycle. Resistive/conductive ink firing, glassing, glazing and many other processes may be performed in the Explorer. The unit consists of four component systems.

a. Muffle (Work Chamber)
b. Conveyor System
c. Temperature Control System
d. Atmosphere Control System

The basic furnace consists of two sections. A burnout section raises the product to a median temperature or full process temperature. A firing section raises the product to full process temperature and sustains it at that point.

2.0 DESCRIPTION

2.1 Muffle

The main muffle section is made of fused quartz. Quartz reduces the amount of contaminants generated within the work chamber. Quartz also offers the most efficient uniform heat transfer with low static mass.

Metal sections are provided at entrance and exit for strength where high temperatures are not required.

An optional heat barrier is provided for rapid cooling of the product.

2.2 Conveyor System

The product is carried through the furnace on a closed belt conveyor. (See figure 1.)

Shear pins or a clutch are provided at the drive sprocket to prevent overloading and damage, should the belt jam.

The belt is driven by a dc motor which is continuously adjustable over its designed operating range. The motor is regulated by a speed controller.

Speed controls are optional but two basic types are used:

a. The Speed Control, which sets the desired belt speed and reads out on a zero to one hundred percent dial. The voltage to the dc motor field is proportional to the line voltage while the armature voltage is determined by the output of a variable transformer feeding a rectifier bridge.

2.2 Conveyor System (continued)

b. The Speed Prop sets the speed and automatically controls to ±1/4% with a closed loop system. A feedback signal from the motor output shaft is applied to a solid state circuit to automatically control the motor armature voltage. Potentiometer settings determine the actual speed while readout is on a direct indicating meter.

2.3 Temperature Control System

Resistance heating elements (Kanthal wire wound in ceramic tile) are in proximity to the muffle. Element location and insulation are chosen for optimum control and minimum heat loss to ambient.

Temperature within the furnace is sensed by a thermocouple. The signal from the thermocouple (mv.) is compared to the control instrument set point (mv.). The difference is amplified by the control instrument into a higher level control signal (dc.). The dc signal is then used to control the SCR power regulators (Power Props). Output from the SCR's regulates the heat generated within the furnace.

In some designs a single instrument may be used to control more than one zone. In such cases, voltage dividing trim potentiometers (one per zone) are used to adjust for profile requirements. (See figure 3.)

A display meter (refer to instrument manual) indicates the percentage of power being used at stable control and is useful in determining various conditions of the system.

The most commonly used thermocouple materials are Chromel-Alumel (type K) or Platalloy (type KPB).

Color Coding:

	Extension Cable	Negative	Positive
K	Yellow	Red	Yellow
KPB	Black	Red	Gray

A precision solid state Accutrol 128 temperature control instrument is used to maintain a control accuracy of ±1/2°C. The internal null amplifier uses a variable voltage reference within the instrument to set the desired temperature and correct for deviations sensed by the thermocouple. The proportional band (gain control) centers about the null point and allows for adjustable response to variations in the control mode. Reset provides the correcting signal for the difference between theoretical control (center of proportional band) and the actual control conditions. It also speeds recovery with an additional correcting signal during control deviation.

2.3 Temperature Control System (continued)

Thermocouple break protection (TCB) is provided in the form of full up scale drive of the control and complete shutdown of the control output. This will be displayed on the deviation meter and will occur with any set point within the operating range.

Temperature differences will exist between the set point digital readout and the actual process temperature as exhibited on a furnace temperature profile. This difference is attributed mostly to:

a. Digital set point correction as shown in the instrument manual. Corrections are necessary, due to non-linearity of temperature readout to calibrating mv.

b. Control instrument calibration errors which are acceptable up to one percent of the range.

c. The difference in location and surrounding mass of the control and profile thermocouples.

d. The cooling effect of muffle atmosphere

2.4 Atmosphere Control System (VIQ model)

The atmosphere control system ensures uniform flow of controlled, conditioned atmosphere in the burnout and firing sections.

2.4.1 Burnout Section

Removal of product contaminants and the reduction of muffle back pressure is controlled by the ejection of air from the entrance exhaust venturi located within the entrance flue.

Burnout atmosphere (large volume-high velocity) is supplied in a manner which ensures even distribution and uniform flow over the product.

An adjustable internal damper located at the junction of the two sections, minimizes contaminant carryover to the firing section.

2.4.4 Firing Section

Separation of Burnout and Firing Section atmospheres is achieved with the use of a heat/gas exhaust port.

Gas removal and back pressure are controlled by the exhaust venturi located within the exhaust port.

The exhaust port damper can be adjusted to minimize efficiency of atmosphere removal.

Firing section atmosphere is preheated and diffused to create a controlled uniform flow.

Exit baffle Curtains are mounted at the exit of the muffle to minimize introduction of external atmosphere.

2.4.3 Atmosphere Selection

Atmosphere to the unit is supplied through a common inlet. Air is most commonly used but gases such as Nitrogen or Argon may be used, if desired.

3.0 INSTALLATION

3.1 Unpacking

The furnace is completely assembled and tested before shipment. Because of the fragile nature of furnace components, packing may be incorporated to prevent damage in shipment.

Before operating, comply with all tags and instructions taped to unit.

3.2 Location

The unit should be located where there is minimum draft. It may be necessary to provide a shield for this purpose.

3.3 Gas Supply

Supply gas at the rear of the gas panel, where marked. Consult plumbing drawing for supply requirements.

NOTE: Air input lines should be filtered for oil and dust.

3.4 Electrical Connections

Make electrical connections. Terminals are normally located on the power panel. Supply voltage and wattage are listed on both the unit power label (attached to power panel) and the main wiring diagram.

Check that the proper input voltage is connected and that furnace frame is solidly grounded.

3.5 Setup of Conveyor System

3.5.1 In order to regain factory alignment of the belt, the furnace should be leveled. Check that belt travel (between tables, trays, muffles, etc.) is level or slightly down hill. Forcing the belt to climb to a higher level can cause excessive wear to belt and may result in hang-ups.

3.5.2 Before starting motor, all pulley alignments must be checked. All pulleys should be horizontal with axis perpendicular to the muffle. If necessary, realign within provided slots. It should not be necessary to make any radical modifications as this belt has already been run before being disassembled for shipment.

3.5 Setup of Conveyor System (continued)

Flanged pulleys should be centered with the muffle. The belt should be centered for travel through the muffle. Forced guiding of the belt with the sides of the muffle will cause excessive wear and warping of the belt at higher temperatures.

Double check above alignments by pulling the belt through by hand.

Check that product has free path through furnace.

3.6 Water Jackets (optional)

If furnace has a water jacket, connect water supply to "Water Inlet". Installation should include a shut-off valve.

CAUTION: "Water Outlet" connection must be made to an open drain to avoid build-up of excessive pressure.

When using internal connections, precautions should be taken to avoid condensation from dripping onto electrical components. Taping or other suitable means may be used.

3.7 Furnace Exhaust

It is desirable in most facilities to have the fumes emitted by the furnace exhausted from the building.

Exhaust vent connections must not be made directly to the furnace assembly. This will cause instability in the furnace and affect product processing. Hood assemblies should be a minimum of 12" from exhaust vents.

3.8 Tilt Adjustment

This furnace was tested at the factory set for a 2° angle of tilt. In most cases, this setting will result in optimum process requirements. However, should it become necessary or desirable to change the angle of tilt, a mechanical adjustment must be performed.

NOTE: Always maintain level from front to rear.
2° equals a rise of 2 3/32 inches in 5 feet.

Explorer furnaces are provided with adjusting bolts and a pivot support. Prior to shipment, the furnace is bolted down at a zero degree.

To adjust:

Remove the locking "U" bolt at the pivot point. Adjust the positioning bolts for desired tilt. Loosely reinstall the "U" bolt for future shipping.

4.0 OPERATION

4.1 Atmosphere Control

Natural draft or controlled atmosphere may be used. Refer to figure 4.

4.1.1 Natural Draft:

Tilt furnace to desired level. Set the adjustable sliding door at exit and the exhaust rotating damper for desired draft.

For optimum results, it is essential that a proper flow of atmosphere through the furnace muffle be maintained. The following is a series of notes on Draft Control that should serve as a guide in setting up the furnace.

Uniform flow - Flow must be maintained uniformly and at a constant rate to assure repeatable results.

a. Angle of tilt

A chimney effect is created by tilting the furnace at a slight angle from the horizontal. As the angle is increased, both the rate of flow and the tendency towards turbulence increase. A two degree tilt has been found satisfactory for most applications.

b. Doorways openings:

Vertically adjustable sliding doorways are provided at entrance and exit ends. The exit end is normally kept at the minimum opening required to allow passage of the products and the entrance doorway two to three times this opening.

c. Room exhaust fans should be located where they do not create air currents in the vicinity of the muffle ends.

4.1.2 Controlled Atmosphere:

Furnace horizontal

a. Adjust exhaust port damper to open position.

b. Set firing section flowmeter to desired flow. Optimum setting should be determined by product reaction.

c. Set burnout flowmeter to a value which will ensure proper burnout of initial contaminants.

d. Set exhaust venturi flows for positive removal of muffle atmosphere.

e. Adjust entrance damper height for process requirements.

f. Adjust internal damper for sufficient product clearance.

4.1.3 Combination of above control systems.

4.2 Start Up

4.2.1 Check operation of belt by turning on speed controller. Check that belt does not hang up on guides. Set controller to desired speed.

4.2.2 The instrument control fuse, in some cases, is removed to prevent applying heat before performing unpacking and installation procedures. Check that all packing was removed and the fuse installed.

4.2.3 Turn instrument power ON.

4.2.4 Set the zone temperature controls to 300°C or minimum control temperature. Unless otherwise specified, set trim potentiometers to 100%.

4.2.5 Turn the "HEAT" switch to ON. If furnace has a reset button, push to energize heaters.

% Power Meters, which are located on the control panel, may require setting at this time to indicate 100% output at full zone power. A screw driver adjustment is provided.

NOTE: Select the higher output for calibrating when meter is switched for multiple output readings.

4.2.6 If furnace has a water jacket, start water flow.

NOTE:
If water is turned on after furnace has become hot, the water jacket may be damaged. On the other hand, excessive cooling while the furnace is cold, may cause condensation within the muffle.

4.2.7 While the furnace is still heating, check that the Overheat Protection System is operative by turning the maximum temperature indicator below furnace temperature. Heat to the furnace should be automatically shut off. Note that, on some furnaces, a time delay is provided.

4.2.8 Check that furnace comes into control at the preset temperatures. Allow furnace to soak at this temperature for one hour to drive out any moisture absorbed by the insulation.

4.2.9 Increase temperatures in steps of 300°C, allowing for one hour soak at each step, until temperatures are set for 50 °C below normal operating temperatures.

NOTE: It is quicker to adjust up to temperature than it is to cool an over heated zone.

4.2.10 Set for desired atmosphere (refer to 4.3). After the furnace has soaked, make final adjustments by running a temperature profile in accordance with the procedure outlined in section 7.0.

4.3 Flow Chart (in standard cubic feet per hour)

Recommended initial flow range. Optimum flows may be determined from process requirements.

früher Schramm

Exhaust Venturi entrance	20-60	30	20	
Burnout Section	20-40	25	30	turbulent
Firing Section	10-30	17,5	10	laminar
Exhaust Port Venturi	0-15	7,5	10	

20.7.81

Horst Schramm

ϑ_1 300°

ϑ_2 550° 20.7.81

ϑ_3 850°

ϑ_4 850°

5.0 MAINTENANCE

5.1 Thermocouples

Thermocouples tend to age after extended use as exhibited by a gradual reduction in generated emf. To check, it is recommended that the furnace be profiled at least once every three months. Thermocouple aging will be indicated by:

a. Gradual increase in the temperature of one zone, resulting in the need to set the controller lower.

b. Overheat meter indicating a lower than normal temperature without a corresponding change in furnace temperature.

c. A broken or open thermocouple which causes the associated controller to indicate full up scale.

5.2 Instrumentation

Refer to manufacturer's instructions in rear of manual for standard maintenance procedures.

5.3 Drive System

Make the following checks periodically;

a. Pulleys are level and perpendicular to muffle.

b. Belt does not climb, causing excessive wear of under side.

c. Belt is not riding against edge of muffle.

d. Lubricating instructions attached to gear box are being followed.

e. NOTE: DO NOT oil pulley bearings.

f. Length of belt - All belts stretch with use and it may become necessary to shorten belt to obtain proper operation. Locate connection pin by running belt through furnace at maximum speed. The connecting pin differs from the other pins in that the ends are not welded to the belt.

5.4 Belt Cleaning

a. To remove brittle, flaky or non adherent materials, use a stainless steel wire brush and vacuum. This may be performed without removing belt from furnace.

b. Materials which can not be removed by brushing, may be removed with a solvent.

CAUTION: Do not use chlorinated hydrocarbons or fluorinated hydrocarbons such as trichlorethylene, perchlorethylene or freon. These materials will decompose into hydrochloric or hydrofluoric acid respectively. At high temperatures, these acids can damage the muffle, belt and product.

Use pure hydrocarbon solvents such as mineral spirits, naptha. toluene, zylene or acetone. These materials should be used with due regard to fire hazards.

5.5 Belt Wear

When belt has shown extensive wear on one side, it may be turned over and rotated (point of weave opposite to direction of travel). This will considerably extend the life of the belt.

6.0 TROUBLESHOOTING

6.1 Temperature Control System

6.1.1 Symptoms

a. Operation of an Overheat Protection device.
b. A reading outside the normal range on an output meter.
c. A change in the quality of the product as it leaves the furnace.

6.1.2 Isolation of fault

a. If any doubt exists as to whether the furnace is functioning properly, carefully check belt speed and run a profile.

b. If cause is not obvious, check belt drive system (refer to Section 6.2).

c. Thermocouples - See Section 5.1

d. Heater - Heater failure is indicated by a full scale reading of the output meter combined with a low temperature in that zone. An ohmmeter may be used to check continuity with power off and element disconnected.

e. Fuse - Failure of a main power fuse will result in loss of power to one or more zones. Failure of an instrument fuse will generally shut down the entire furnace. In replacing a fuse, check that fuse holder is making good contact with the fuse. In general, a fuse failure is a symptom of a failure of some other component. Check carefully for shorts or grounds in the circuit before turning furnace on. If fault cannot be located, check that currents do not exceed fuse ratings when furnace is on.

f. Overheat device - Short out thermocouple leads. If device still indicates overheat, unit should be replaced.

g. Power Prop - Possible symptoms of Power Prop failure as indicated on output meter:

1) Output meter reads full scale all the time or until a power fuse blows or overheat device shuts down. SCR trigger may be in a continuous firing condition or SCR may be shorted.

Disconnect controller input to Power Prop. If firing is still continuous, shut down power and check SCR for shorting.

If firing stops, the problem may be in the control instrument or a Power Prop trigger. Exchanging the questionable device with an identical component of known quality will, in most cases, expose the failed component.

2) Power meter reads half scale when control instrument is calling for full output.

This is an indication that one SCR of a full wave system is open. Shut down power and perform continuity check on both SCR's.

3) Power meter does not go to zero with controller calling for zero output.

6.1.2 Isolation of fault (continued)

Turn off controller instrument power. If meter still indicates, the mechanical zero set may require adjustment.

Restart power - a clamp-on ammeter may be used to check undesired current at the power prop. The BIAS potentiometer (10 turn) may be used to just cut off the power as monitored on the clamp-on ammeter. Refer to Power Prop instruction manual.

h. Controller - A controller failure may give some of the same read-out conditions as the thermocouple or the power prop failure. However, the controller failure will normally result in a non-steady state condition or be unable to turn on or off. This may be checked by monitoring the controller dc output. Refer to control instrument manual. Care should be taken, when swapping or replacing units, that an identical instrument is used. Refer to instrument manual.

Possible symptom of controller failure:

A steady oscillation of temperature about set point. If oscillation can not be damped out by proportional band, rate or reset adjustments (see instrument manual), the controller should be replaced.

6.2 Belt Drive System

6.2.1 Belt does not move

a. Broken shear pin - Determine cause of overloading and replace. Extra shear pins are taped to the drive assembly. There is also a tag attached to the assembly which states the configuration, size and material of the pin.

Do not use heavier shear pins than those provided or specified; to do so may damage the belt and void the warranty.

b. Belt slipping on the drive drum - This could be caused by insufficient pressure against the drive drum by an adjustable spring-loaded pulley.

Lagging of drive pulley may also be worn or have a deposit which acts as a lubricant.

Check that belt can be pulled through furnace and return assembly by hand. Free any hangup and repair as required.

c. Motor failure - Check speed control fuses - check dc input to motor. Normally variable 0-100 VDC.

6.2.2 Speed control failure

a. Belt runs at maximum speed and can not be regulated. Check fuses of speed control.

b. Belt runs at random speed and does not appear to control. (Optional regulating speed controls.)

Check that speed control is regulating properly by attempting to stop the belt by hand. Increased loading should not cause a permanent change in speed.

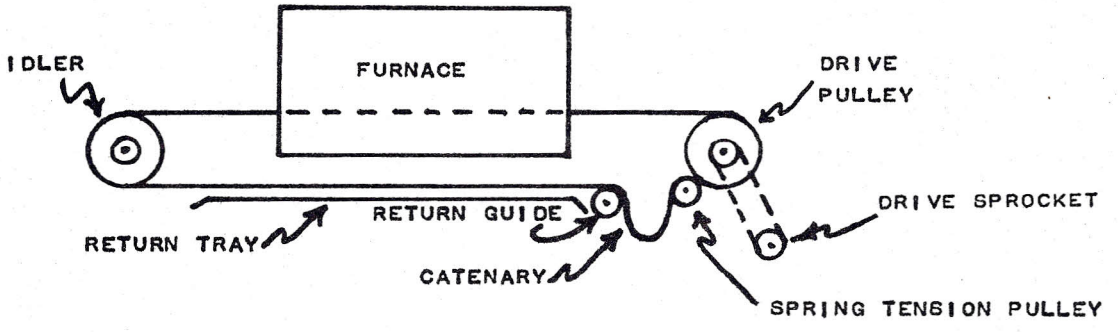
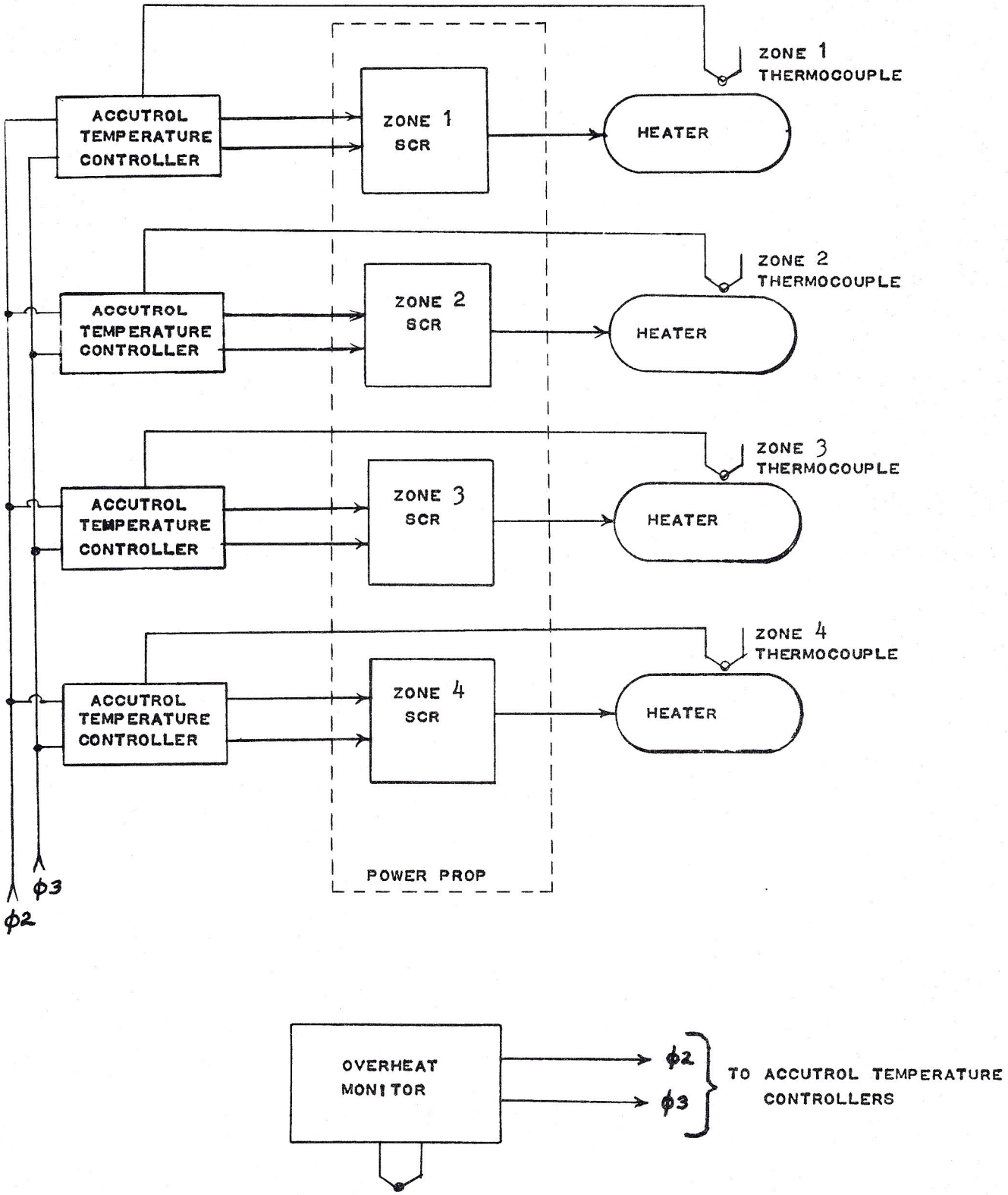


FIGURE 1. CONVEYER SYSTEM

figure 2. Temperature control system, block diagram



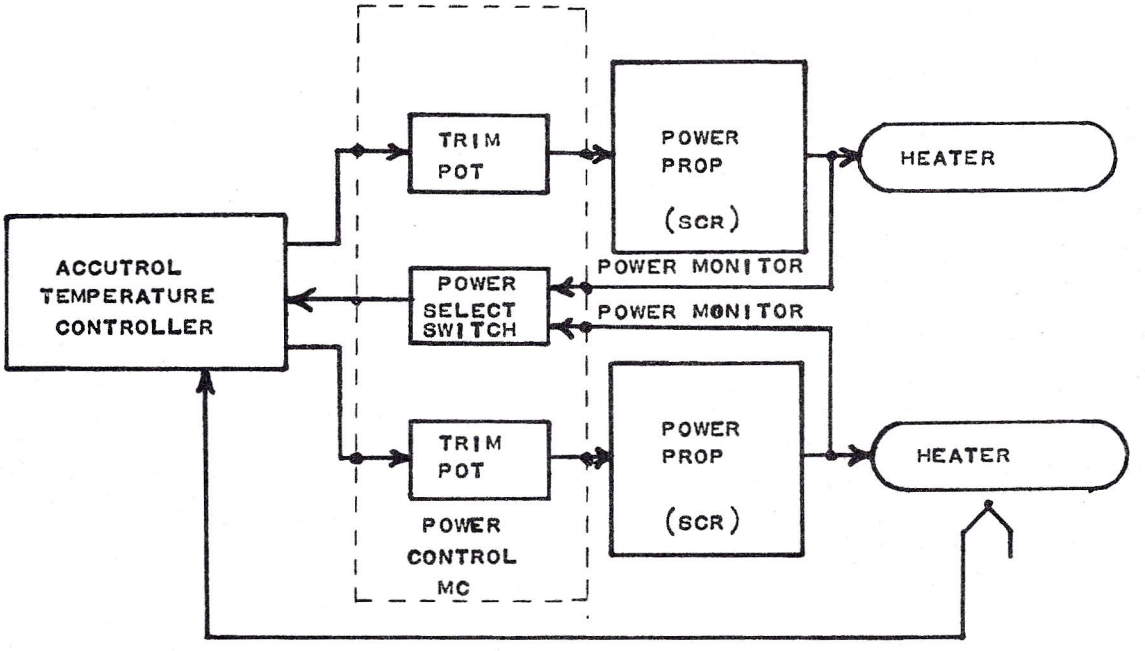
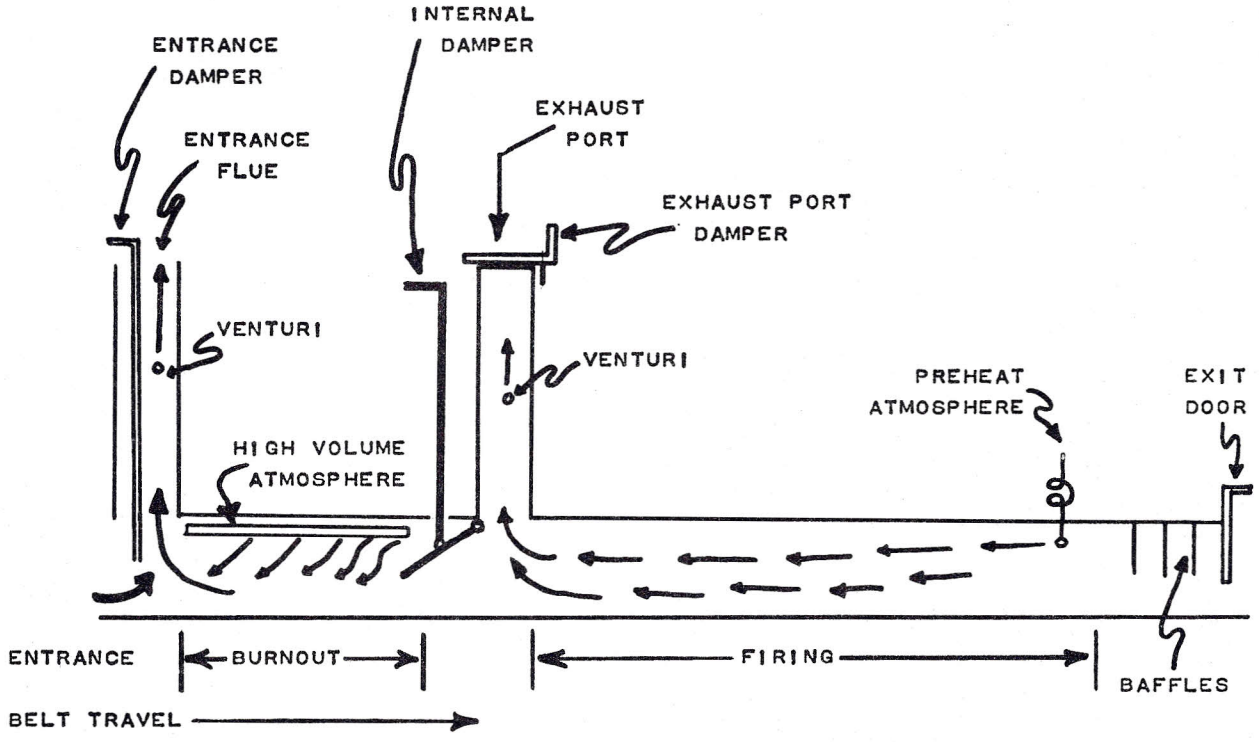


FIGURE 3.
MULTI-ZONE CONTROL CONFIGURATION



NOTE:

FOR MAXIMUM NATURAL DRAFT CONTROL: FURNACE IS TILTED TWO DEGREES, ENTRANCE DAMPER IS LOWERED TO MINIMIZE OPENING, INTERNAL DAMPER IS RAISED, EXHAUST PORT DAMPER IS CLOSED, VENTURIES ARE DEACTIVATED.

FIGURE 4.

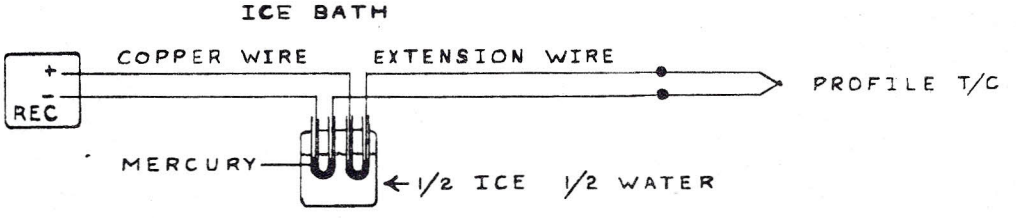
ATMOSPHERE CONTROL

7.0 PROFILING

7.1 Test Equipment

a) Recorder - Any recorder which will register a 0-50 millivolt signal may be used, Where more than one thermocouple is to be used, a multipoint recorder is recommended. If recorder does not have thermocouple compensation for ambient, a simple ice bath may be used.

Figure 5



NOTE: Some recorders may show signs of pickup while the profile T/C is passing through the furnace heated section. This in most cases can be eliminated by an isolation or voltage regulating transformer.

b) Profile Thermocouple - Type "K" T/C wire is recommended for greatest durability with reasonable accuracy and economy.

Wherever possible, the profile T/C should be representative of the customer's product in terms of mass and response to radiation. Ideally, the T/C may be sandwiched between, attached to or buried in a product sample.

Where maximum accuracy is required, the T/C should be calibrated prior to use and periodically thereafter. This calibration factor may be applied to the profile recording for more accurate data.

c) Spooling Device - A drum type device should be used to hold and feed the profile T/C. The spool will allow proper handling of the T/C and eliminate the cold working effect caused by sharp bending. The spooling diameter should be a minimum of 20".

Strain relief of the profile T/C can be achieved by attaching a tow line to the spool in the same manner as the profile T/C. The tow line is attached to the belt so as to rotate the spool without strain on the T/C. The tow line material may be #16 or #14 AWG chromel or alumel or other high temperature material.

d) Profile Notes - Before profiling, be sure that the profile T/C has proper clearance through the furnace. The furnace should be allowed to stabilize for one day after initial heatup.

After making a change to the controller, at least one half hour should be allowed in a stable condition before reprofiling.

e) Profile Procedure - Load the belt with simulated or sample product while the belt is traveling at its normal speed. Attach the T/C within the sample load with high temperature wire. When using multiple T/C's, make sure that the T/C's are located in a straight line across the belt. This will minimize response errors due to depth of penetration.

Attach tow line to prevent strain on T/C's.

Note on the recorder chart the time and position where the T/C enters the furnace. From this reference point any distance within the furnace can be calculated, knowing belt speed and recorder chart speed.

When the T/C emerges at the exit, mark the recorder chart. This will form a record of belt speed for future reference. Cut and remove the fastening wires. Reel the T/C back carefully, taking care that they do not hang up.

It is important that the conditions of profiling and accumulated data be carefully recorded. A change in profile technique could result in lost time, improper corrections or unnecessary service.

f) Profile Data

It is recommended that all furnace profiles contain the following information:

Furnace number
Date and time
Entrance and exit points
Belt speed readout
Recorder chart speed
Recorder temperature range
Type of loading
Operator's name

A profile log should also be kept with a record of each controller setting and meter readout at stable control.