

## Chapter 7

# BILLET AND LOG FEED SYSTEMS

## Billet/Log Infeed Conveyor

**Log/Billet Feed Table.** The equipment for feeding logs or pre-cut billets into the press feed line and heater varies considerably according to the equipment manufacturer and the age of the installation, and also whether logs or billets are the raw material. Most common is a gravity-feed table on which logs or billets are loaded individually or in bundle form; they are allowed to roll down to a stop where an indexing device feeds them out, one-by-one as called for. Also common are chain-feed tables or conveyors. In general, the following maintenance is required:



Figure 7-1: Log feed table and conveyor (Photo courtesy of OMAV)

- Check the air supply filter-lubricator to the actuating cylinder weekly; clean or add oil as needed.
- Check limit or proximity switches of the indexing mechanism weekly for proper functioning.
- Check the air cylinder packing or seals monthly, and repair as needed.
- If a chain-conveyor is installed, check the drive and moving parts for wear or damage monthly.
- Check the condition of all other moving parts (shafts and bearings) monthly and repair as needed.
- Tighten all mounting or attachment bolts annually.

**Chain-Bottom Furnace.** Although newer billet/log furnaces have replaced most chain-bottom designs due to poor energy efficiency (typically 18 to 20%), a few remain in service. With this design, a chain system below the oven is fitted with extended carrier arms which pass up through a slot in the furnace bottom to support and transport the billets. Due to the high temperatures involved, the carrier castings must be made of high-temperature alloys, and must be bathed in a curtain of cold air which is swept into the furnace (thus decreasing energy efficiency).

The carrier castings are spaced on 3 to 4-inch centers and are typically driven by a parallel pair of roller chains located beneath the furnace. The head sprockets of the twin chains are mounted on a common shaft with ball bearing mounts; this shaft is driven through an intermediate chain and sprocket drive by a gear reducer and an electric motor fitted with a electric brake. A shear-pin type drive sprocket is normally used to limit mechanical damage. A brush-type chain oiler may also be fitted, with automatic solenoid operator, to lubricate the chains. A fire-safe lubricant should be used, for example, Houghton #227.

Routine maintenance of the chain-bottom type billet conveyor will include:

- Check and fill chain lubricator (weekly).
- Check condition of chains, sprockets, bearings, and shafts for wear or damage; clean and repair as needed (monthly).
- Tighten all bolts and set screws (monthly).

**Cylinder-type Pusher.** Used primarily on billet furnaces, a pneumatic or hydraulic cylinder located behind or underneath the furnace pushes the column of billets forward, far enough to allow space for loading the next billet into the column. Then it advances the column again on signal from the control circuit. Billets are supported on hourglass-shaped rollers which are mounted in the bottom of the closed-bottom heating tunnel.

Routine maintenance of the cylinder-type pusher system includes:

- Check cylinder packing/seals for leaks and condition (monthly).
- If pneumatic, check the air supply filter-lubricator to the actuating cylinder weekly; clean and/or add oil as needed.
- If hydraulic, check hydraulic fluid level (daily); check for leaks or high fluid temperature (weekly). General maintenance and trouble-shooting tips for hydraulic systems are also described in Chapter 5 Hydraulic Equipment.
- Check limit or proximity switches of the indexing mechanism weekly for proper functioning.
- Check the condition of the guide mechanism for the pusher, for wear or damage (monthly).



Figure 7-2: Log feed conveyor gear drive (Photo courtesy of OMAV)

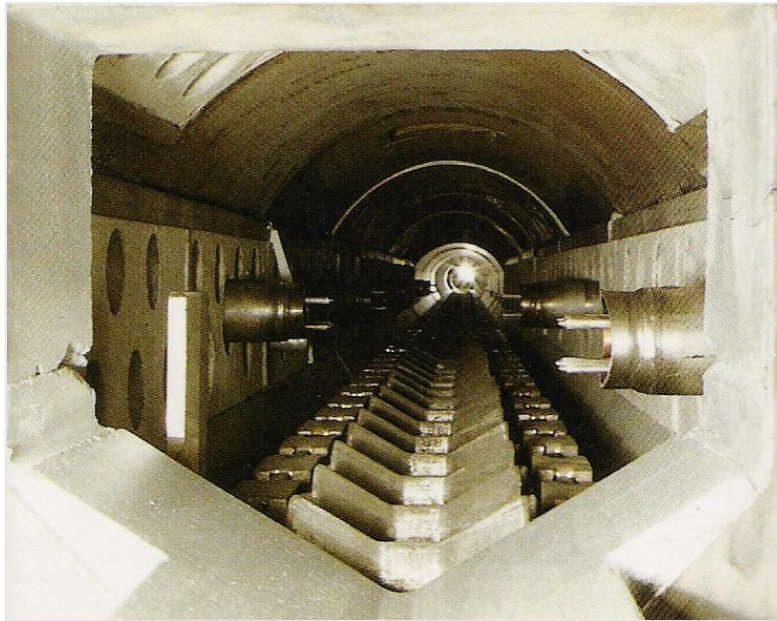


Figure 7-3: Cast alloy support rollers (Photo courtesy of OMAV)

**Chain-type Pusher.** This design is commonly used for log shearing systems, due to longer travel required. A single chain and sprocket system is driven by either hydraulic or electric motor(s); design requirements include reversability and precise stopping. Maintenance requirements vary according to the design, but include:

**General lubrication.** All grease nipples should be lubricated and drive chains oiled, weekly unless indicated otherwise in manufacturer's instructions.

**Chain tensioning.** Inspect chains for proper tensioning and adjust as needed, on a monthly basis.

**Support Rollers and/or Sliding Surfaces.** Check condition of rollers and sliding surfaces weekly and clean any matter which might interfere with log movement or damage the teeth of the drive chain and sprocket. Blow clean with compressed air.

**Drive gear reducer** (if installed). Check the oil level monthly, change oil every 6 months (unless recommended otherwise by manufacturer).

**Hydraulic system.** For pushers powered by hydraulic motor, the hydraulic system is usually shared with the log shear – described on page 7-30 below. General maintenance and trouble-shooting tips for hydraulic systems are also described in **Chapter 5 - Hydraulic Equipment**.

**Foundation and Mounting Bolts.** Check and tighten all bolts annually, due to high impact loads.

**Proximity or Limit Switches.** Check limit switches for loose mountings, loose wires, loose arms, etc.; check limit switches for proper tripping. Check the position of proximity switches for proper actuation. The lenses of photoelectric switches require periodic cleaning with a soft dry cloth, and reflective devices used in conjunction with photoelectric switches also require periodic cleaning. Do not use solvents or cleaning agents on the lenses or reflectors. Replace any damaged lenses and reflectors.

### **Gas-Fired Billet and Log Heaters<sup>1,2</sup>**

**Function.** Gas-fired heaters preheat the logs or pre-cut billets to the desired temperature for extrusion. A key objective is to produce an accurate and consistent temperature from billet to billet. Some designs seek to provide a temperature gradient from one end of the billet to the other, in order to compensate for the heat gained in each billet during extrusion. While this “taper heating” has traditionally been achieved with electric induction heaters, the lower cost of gas energy has resulted in the development of several design variations:

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1. Bugai, John, Granco-Clark; “Billet/Log Furnace and Shear Maintenance,” papers presented at AEC Press Maintenance Seminars, (1991 and 1995), Chicago.

2. Luscombe, Jon, Belco; “Log Furnace Maintenance,” presented at AEC Press Maintenance Seminar, (1995), Chicago.



Figure 7-4: Gas-plus-induction billet heater (Photo courtesy of IAS)

- water quenching one end of the billet after preheating
- adding a row of gas booster burners for one end of the billet
- gas preheating with an induction boost to one end of the billet **(Figure 7-4)**

Note that considerable temperature variation is common in gas-fired billet heaters, varying from billet to billet, from end to end, and from outside to center. The problem is compounded by the method of measurement (intermittent probes) and the inherent variability in accuracy between thermocouples.

A second objective in the design of billet/log heaters is to reduce energy costs. Most modern designs now use direct flame impingement, with the hot combustion gases then counter-flowing along the incoming logs/billets to preheat them and recover some of the waste heat. Various oven designs then:



Figure 7-5: Gas-fired log heater with combustion air preheat (Photo courtesy of OMAV)

- expose incoming billets to the waste heat for an extended period,
- recirculate the hot gases to high velocity impingement nozzles to enhance heat transfer to the logs/billets, or
- use the hot gases to preheat combustion air (**Figure 7-5**).

Current designs are tightly sealed and well-insulated to minimize heat losses. Low-mass refractory and PLC-based controls now allow improved temperature control.

### Refractory and Insulation

Burner tiles should be checked monthly for proper sealing between the burner tiles and burners, and to insure that the burners are inserted the proper distance into the tiles. Both are critical to proper flame retention and temperature uniformity. Badly cracked or broken tiles must be replaced. With tiles of cast refractory, the burners may be wrapped with fiberglass tape or ceramic fiber to achieve a proper seal. If tiles of the newer ceramic fiber type are used, the burners should fit snugly by twisting them slightly when inserting them into the tiles.

Crown blocks, whether made of cast refractory, formed ceramic fiber, or alloy-encased fiber, should be inspected every 3 to 6 months for signs of deterioration. Cracks or open joints should be caulked with ceramic fiber. Most problems occur when the blocks are removed, for example in case of billet meltdown or other malfunction. Cast blocks tend to fall apart or continue to spall following re-assembly. Most furnaces may be retro-fitted with formed ceramic or alloy-encased fiber to eliminate such problems.

## Furnace Doors and Seals

Each week, check all doors for proper sealing and functioning of lift cylinders and/or closure clamps; adjust as needed. Inspect the seal around the log entry into the furnace and repair or replace as needed.

## Thermocouple Probes

Reliable temperature probes are absolutely critical to the functioning of the log/billet heater: a single breakdown may result in a meltdown with considerable cost and downtime.

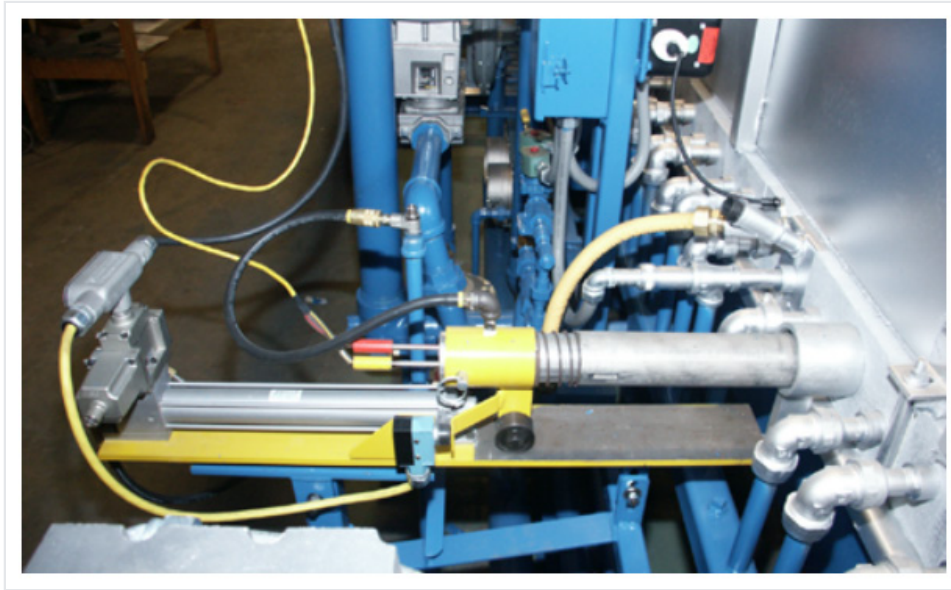


Figure 7-6: Thermocouple probe assembly

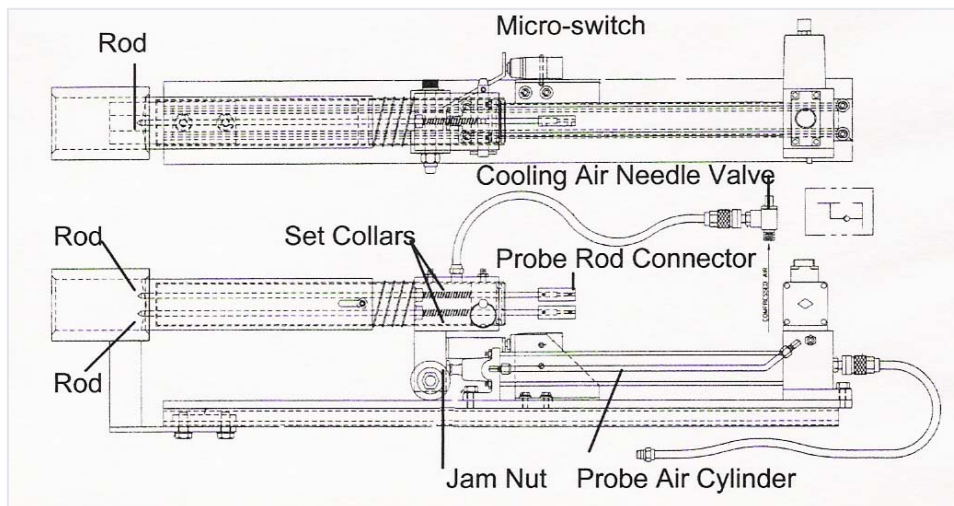


Figure 7-7: Diagram of thermocouple probe assembly. (Illustrations courtesy of Belco)

**Daily Maintenance:**

- Check the condition and function of probes.
- Clean the rod tips with emery cloth and re-sharpen the rods if necessary (45o angle).
- Check the tightness of the probe rod connections.
- Check the compressed air line filter and drain excess moisture.

**Weekly Maintenance:**

- Check the functioning of the probe air cylinders.
- Adjust air flow and pressure settings as needed; pressure greater than specified by the manufacturer may result in billets being pushed off of the support rollers.
- Check and adjust cooling air to the probes.
- Some extruders change out the rods or entire probe assemblies weekly in order to minimize unexpected downtime.

**Recommended Adjustment for Granco-Clark Thermocouple Probe Assemblies**

**Compressed Air Supply Adjustment:** Adjust the air regulator to a maximum of 30 psi. If the pressure is higher than 30 psi, a small billet may be pushed off the rollers.

**Horizontal Adjustment:** There are two 3/8" hex bolts under the probe assembly. Remove the bolts and push the probe upper assembly toward the furnace until the air seal contacts the furnace. Reinstall the two 3/8" bolts. This is the correct horizontal position for all billet or log diameters.

**Vertical Adjustment:** Remove the air hose from the probe using the quick disconnect at the probe solenoid valve. Manually push the probe all the way into the furnace and against the billet or log. Open the furnace door so that the probe shield can be seen. The probe shield should meet the billet or log squarely so that flame will not touch the probe tips. Adjust the probe assembly up or down as necessary so that the rods are adequately protected from flame. Readjust whenever changing billet diameter.

**Note:** After the horizontal and vertical adjustments are completed for one zone, measurements can be duplicated for the other zones.

**Probe Rod Adjustment:** Remove the pin from the probe barrel and pull out the probe rods with the set collars and the nylon insulator. Adjust the set collars to the following dimensions: 19" from tip to internal set collar; 4½" between set collars. This should give approximately ½" to ¾" of spring compression when the probe contacts the billet or log.

**Probe Rod Sharpening:** The probe rods should be sharpened approximately every third 8-hour shift. More frequent sharpening may be required when running hard alloys or with insufficient probe cooling.

Courtesy of Granco Clark

## Recommended Rod Removal and Adjustment for Belco Thermocouple Probes



Figure 7-8: Disassembled components of thermocouple probe assembly (Photos courtesy of Belco)

### Rod Removal Procedure:

- Unplug the thermocouple wire connection.
- Place a round rod into the hole and pry the Teflon retainer from the head.
- When the O-ring on the Teflon retainer is free of the head, grasp the retainer and pull the rod assembly from the head.
- Remove the pin from the probe head.
- Clean the probe rods.
- Make sure the set collars on the probe rods are tight.
- Make sure that the dimension from the face of the set collar to the tip of the rod is between 12 $\frac{3}{4}$ " and 13".
- Tighten and check thermocouple connections and wires.
- Replace in reverse order.

### Adjustment of Probes in Furnace:

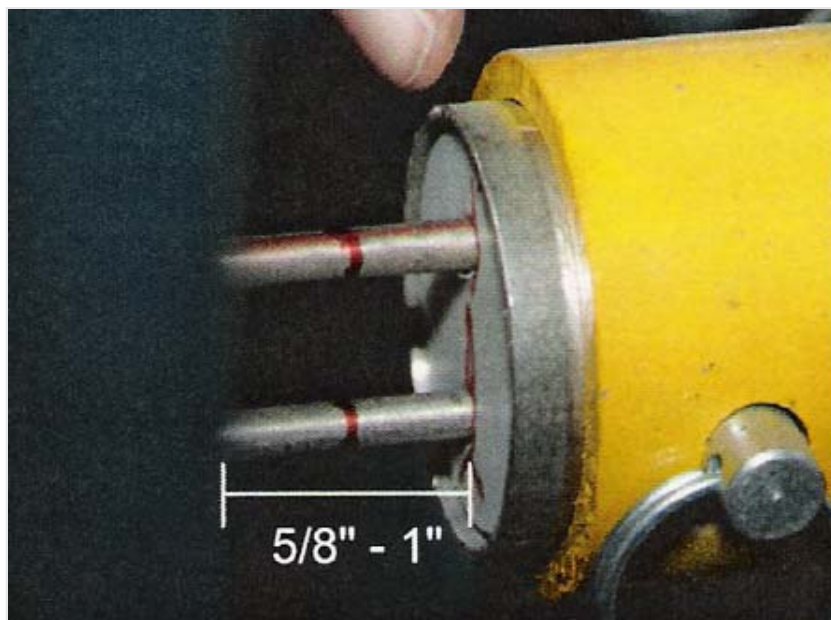
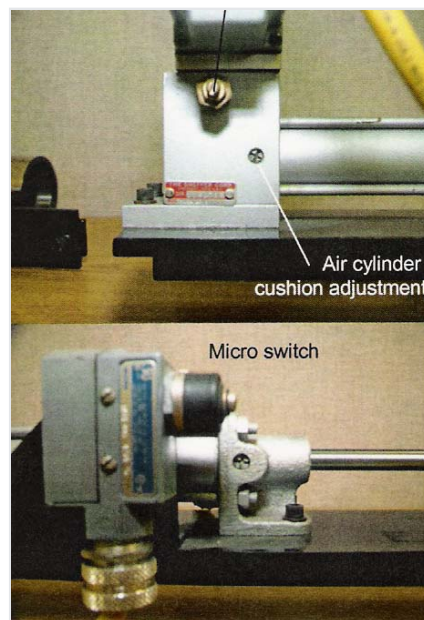


Figure 7-9: Adjustment of thermocouple probes (Photos courtesy of Belco)





Air flowcontrol

- Disconnect the air line to the probe cylinders.
- Push the probe head in, towards the billet.
- Measure the probe rod retraction when contacting the billet: set at approximately 5/8" to 1".
- Make sure that the probe ceramic insulator is not contacting the billet.
- If the adjustment is incorrect: loosen the 3/8" bolts in the probe stand base and move the base in or out until the correct adjustment is achieved.

- Set compressed air pressure at the probe line regulator to 20/30 psi and make sure that the probe does not push the billet off of the rollers.
- Reconnect the air line to the probe cylinder.
- Adjust the compressed air flow controls by first loosening the lock nut, then use a screwdriver to adjust the screw until the operation is smooth.
- Be sure that the bolts on the micro-switch are tight.
- Make sure that the micro-switch is making contact when the cylinder is in the full-back position.
- Reconnect the thermocouple wire connector.

**If the thermocouple wires are:**

- **Short circuited** - the temperature controllers will register the ambient temperature at the point of the short circuit.
- **An open circuit** - for any reason (broken wires, bad connections), the temperature controllers will register high or over range.

### Troubleshooting Thermocouples<sup>3</sup>

When there is a significant difference (50 to 100oF) between the set point on a controller and the billet, there are several things that should be checked:

- Verify that the controller and all components are the correct type and that the controller is programmed correctly.
- Check for an incorrect thermocouple: if a type K thermocouple is used, the millivolt output is significantly lower than it would be with type J, and will give a reading at the instrument much lower than the actual temperature.
- Check for incorrect wire: incorrect wire will give a false reading at the instrument. Verify that the wire is correct for the application.
- Check for double reversal of wires:
- A reversal of the wires connecting the instrument to the thermocouple will drive the instrument down scale.
- A double reversal will give false readings at the instrument of as much as 50 to 100 degrees.
- Check to verify that the instrument, the connecting wires, and the thermocouple are wired correctly by checking for magnetism at all junctions.

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3. Luscombe, Jon, "Billet Heaters and Log Shears: Servicing for Optimum Performance," presentation at AEC Maintenance Seminar, , April, 2002.

### Identifying Thermocouple Types:

**Type J: Iron-Constantan (I/C)** one wire silver and one wire bronze

Iron: Magnetic Positive

Constantan: Non-magnetic Negative

**Type K: Chromel/Alumel (C/A)** both wires silver

Chromel: Non-magnetic Positive

Alumel: Magnetic Negative

Verify type with a digital millivolt meter by:

- Connecting the magnetic wire to the positive side and the non-magnetic wire to the negative side.
- Heating the thermocouple will cause the voltage to rise positively if it is a type J. If the voltage goes down or is negative, it is type K.

### Identifying Wire Types:

#### **Type J: Iron-Constantan (I/C)**

White: Iron Magnetic Positive

Red: Constantan Non-magnetic Negative

#### **Type K: Chromel/Alumel (C/A)**

Yellow: Chromel Non-magnetic Positive

Red: Alumel Slightly magnetic Negative

Red is always negative for both type wires.

Note: Thermocouple lead wire must be located in a dry, grounded, steel conduit and separated from power wiring. Do not use wire-pulling lubricant.

### Combustion System

Most gas-fired log/billet heaters use pre-mix type burners, with a single ratio control regulator for each control zone. For each zone, fuel gas is supplied through an atmospheric or “zero pressure” regulator, which maintains the gas supply at zero pressure to a mixer unit,<sup>4</sup> as described in the illustrations on pages 7-15 and

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<sup>4</sup> Some newer furnaces equipped with hot gas recirculation may have the atmospheric regulator “biased” with furnace air pressure applied to the back side of the regulator, or connected to the combustion air pressure, in order to compensate for higher pressures inside the furnace. These methods of control are described in the illustrations on pages 7-17 and 7-18.

7-16. Combustion air is also supplied to the mixer, and “aspirates” or draws a flow of the fuel gas in direct proportion to the amount of air flowing. Air flow to the mixer is varied by a motorized damper on a signal from the temperature controller. The air-gas mixture is delivered to the different burners of each zone, pre-mixed in the correct ratio for combustion. Fuel-air ratio adjustment for low fire is made by means of a gas adjustment valve on the mixer, and a limiting orifice in the gas line before the mixer is used to regulate the fuel-air ratio more precisely at high fire.

Adjustment procedures are described in more detail below. Because the vast majority of billet/log heater combustion systems in use in were supplied by North American Mfg. Co., detailed instructions from North American are included below, reprinted with their permission. Similar principles may apply to systems supplied by other manufacturers, but the original maintenance and safety instructions for your equipment must take precedence.

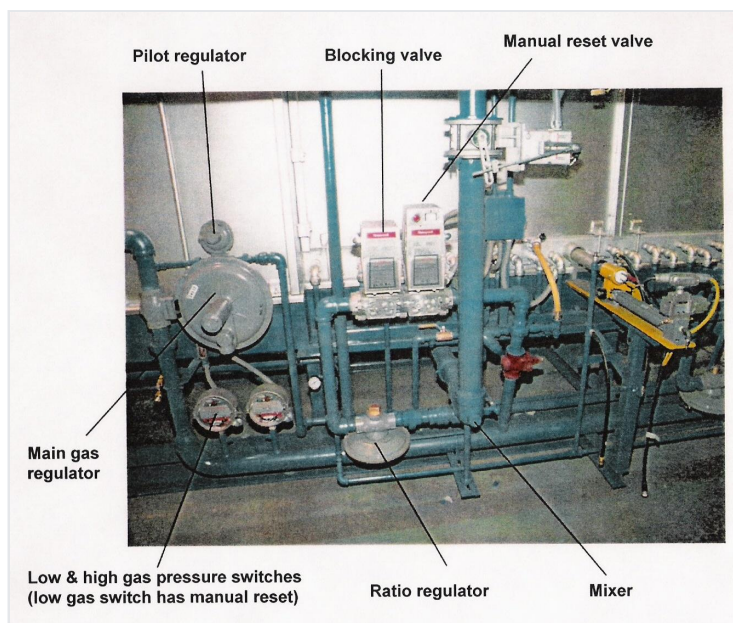


Figure 7-10: Billet/log oven combustion system (Photo courtesy of Belco)

**Safety devices, interlocks, purge cycles, and flame detectors must be maintained in proper working condition. Never allow a safety device or system to be defeated or by-passed, and check often to insure that all such devices and systems are working properly.**

The main gas train which feeds each zone of the oven is equipped with safety shut-down devices as dictated by fire (NFPA) and insurance (FM or IRI) codes, typically:

- main gas shut-off valve
- main gas pressure regulator
- high gas pressure safety switch
- low gas pressure safety switch

- manual reset blocking valve (main safety valve)
- safety vent valve (with discharge piped through the building roof)
- second blocking valve (auto-reset)
- test cocks and/or pressure gauges

Also recommended is a main gas meter for measuring the gas consumption of the furnace. The meter should be equipped with pressure-compensation for accuracy. Read the meter weekly and record the total consumption as well as the BTU/pound (or Kcal/Kg). A running plot of these values will provide a good indication of any malfunction of furnace controls or combustion system adjustment.

**Recommended tools for Combustion System Setup:**

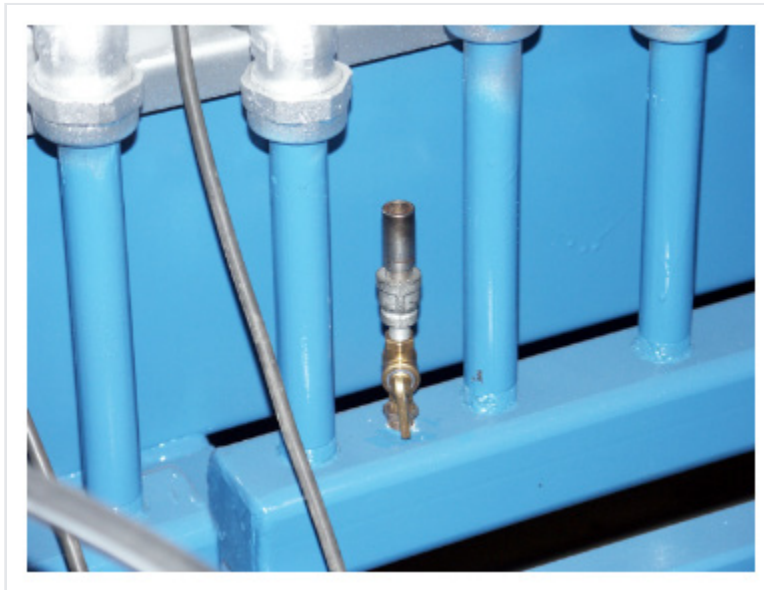


Figure 7-11: Tools for combustion setup (Photo courtesy of Belco)



- North American Test Tip, Part #8666
- Magnehelic Pressure Gauge or equal, Part #2025C, Range 0-25 inches of water
- Alnor AXD530 Digital Micromanometer, Range 0-10 inches WC (water column) or equal

### Adjustment of Combustion Settings

Values for combustion settings for each zone, both before and after adjustment, should be recorded in a permanent log. The sequence of adjustments for each zone is as follows:

**1. Adjust the Combustion Air Pressure.** High- and low-fire settings are established by adjusting the combustion air control damper's linkage as indicated on North American Mfg. Co. Instructions Bulletin 1230, following on page 7-14.

**Note:** set combustion air according to your manufacturer's recommendations. Typical values at mixer inlet:

- High fire: 8 to 10 ounces/in<sup>2</sup> (damper  $\frac{3}{4}$  open)
- Low fire: 1 ounce/in<sup>2</sup> (damper  $\frac{1}{8}$  open)

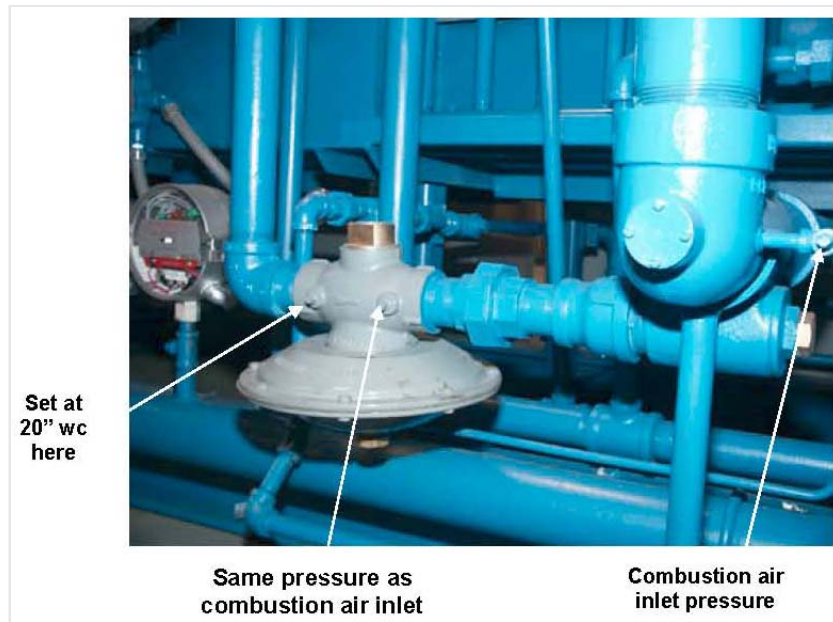


Figure 7-12: Adjustment of fuel gas supply pressure (Photo courtesy of Belco)

**2. Adjust the Fuel Gas Supply Pressure.** With the air blower off, set the main gas supply regulator to deliver the correct pressure (20 inches WC for North American Mfg. systems) to the inlet of the atmospheric regulator (**Figure 7-11**).

**3. Pre-adjust the Atmospheric Regulator.** Adjust the spring of the atmospheric regulator as needed to achieve 0 inches WC at the outlet. (See North American Mfg. recommendations concerning typical settings on page 7-18.) Note: if the ratio regulator is cross-connected it requires a higher pressure; in this case the outlet pressure of the ratio regulator will be the same as the impulse regulator.



Figure 7-13: Pilot burner and flame detector (Photo courtesy of Belco)

**4. Start the System.** Start the blower, purge as required by code (typically a minimum of 4 to 5 air changes), and ignite the pilots.

**5. Adjust the Pilot Flame.** Set the outlet pressure of the main pilot regulator at 20 inches WC. Set the combustion air inlet to the pilots at 14 inches WC. (New JL pilots should be set at 8 inches WC.) Ignite the pilots and adjust by sight: the flame should be sharp and forceful, with a well-defined light blue inner cone and a deeper blue outer envelope. A long, bushy green, yellow or orange flame indicates a rich ratio. A short, pale blue or violet flame indicates a lean ratio. Rich or lean flames may cause a failure to satisfy the flame rod or UV detector, or failure to ignite the burners.

**Note:** see the North American Mfg. recommendations for **pilot adjustment** on page 7-20.

**6. Light the Main Burners.** Set the air control valve on low fire position. Open the gas adjustment of the aspirator mixer valve 3 or 4 turns. Then open the main gas safety shut-off valve. If the burners do not light, close the gas shut-off valve, open the aspirator mixer valve one more turn and repeat the purge and lighting sequence. Continue to repeat this sequence until the burners light. (See North American Mfg. recommendations on page 7-21).

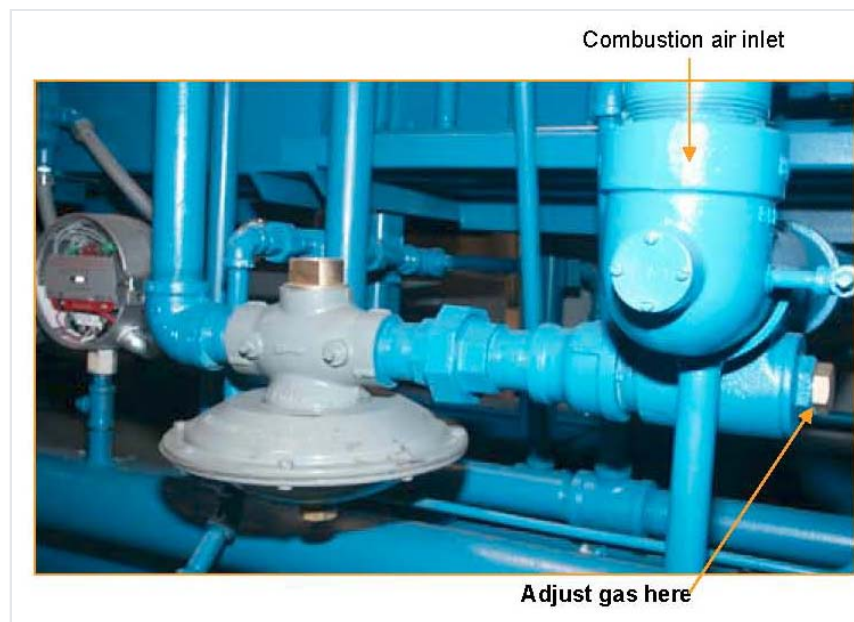


Figure 7-14: Adjusting the main burners (Photo courtesy of Belco)

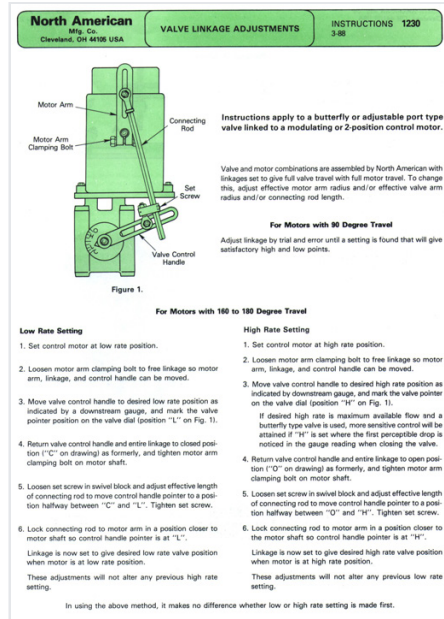
**7. Check the Flame Characteristics.** The furnace should be powered on according to established procedures and one zone ignited, with the controller set on manual or thermocouples manually shorted out to keep the system on **high fire**. Flame adjustment may be made by use of the Testip, as described on page 7-23. Another option is by visual judgment: while observing the flame through the exit door, adjust the limiting orifice (on the inlet of the atmospheric regulator) as needed to obtain good flame characteristics:

- a flame that is primarily blue with flecks of yellow
- a flame that wraps around the billet
- little flame above the billets (secondary combustion)

**Note:** also see **judging flames**, from North American Mfg. on page 7-23.

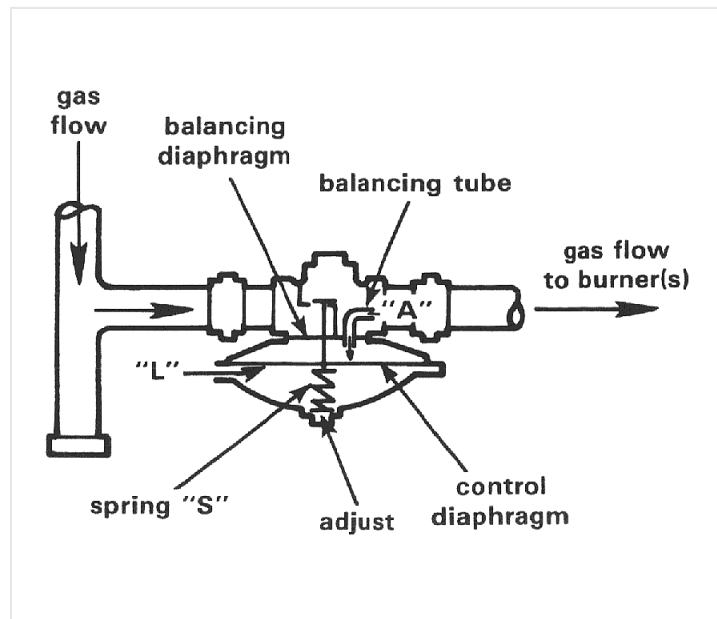
Next adjust the **low-fire** characteristics. Set the controller for the low position and observe the flame: it should be burning only to the face of the burner tiles. If too high, reduce the gas setting with the adjusting screw of the atmospheric regulator. If the flame goes out or is unstable, increase gas with the same adjusting screw. (Clockwise to increase gas, counter-clockwise to decrease.)

Finally, return to high fire and re-check the setting. Some fine tuning may be required to settings. Continue until all zones have been set.



**Note:** in case of a "double" zone (10 feet or 3 M long) which is controlled by a single controller, the section which is farther from the probe should be adjusted to a slightly lower air setting on high fire, to prevent overheating.

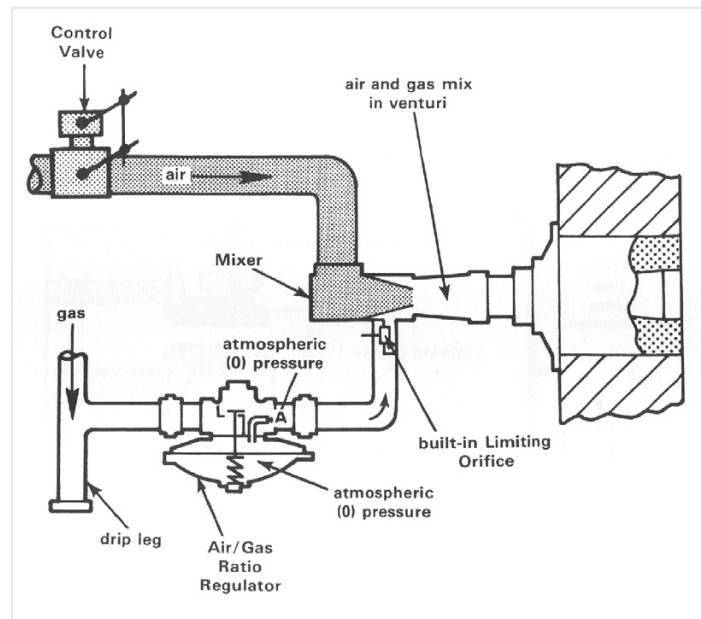
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## ATMOSPHERIC REGULATOR (ZERO GOVERNOR)

This type of regulator is loaded by the controlled air pressure rather than by spring pressure and gives an outlet pressure at "A" equal to the pressure at "L" plus or minus the effect of the spring "S" adjustment. This type of regulator is shipped with spring set "neutral," just supporting the internals. The balancing diaphragm minimizes the effect of inlet pressure changes on outlet pressure.

From "Practical Pointers - Industrial Burner Control Systems," page 6, used with permission of North American Mfg. Co.

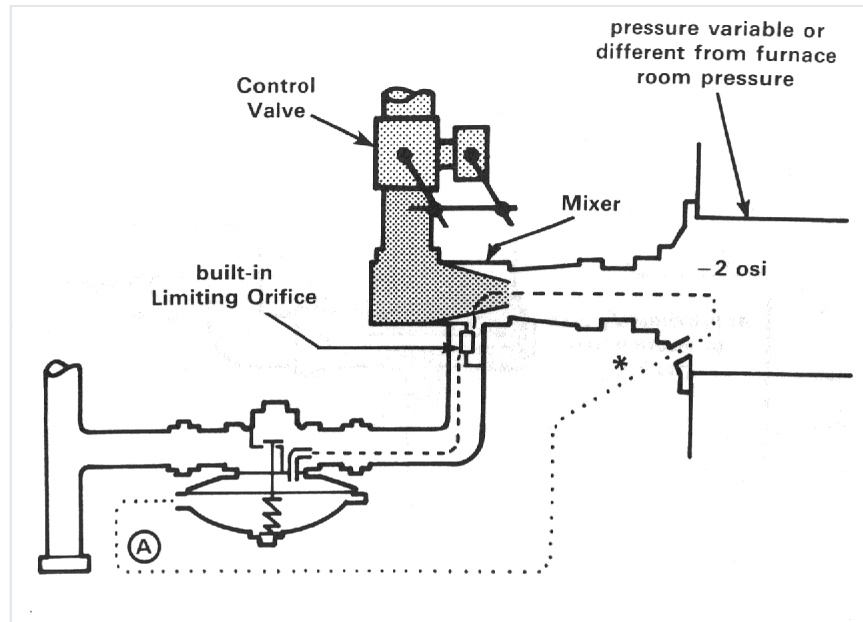


## ATMOSPHERIC REGULATOR

### SUPPLYING A PREMIX BURNER SYSTEM

As air flow through the venturi increases, increased suction causes more gas flow through the limiting orifice valve. This in turn slightly reduces the pressure at "A" which causes the regulator to open and allow more gas to flow and maintain the atmospheric or "zero gauge" outlet pressure. Because a slight amount of force is required to raise the internals and open the regulator, the pressure at "A" may drop off 1 or 2 tenths of an inch WC at full flow. This "droop" has only a minor effect on accuracy of control when the regulator is properly sized.

From "Practical Pointers - Industrial Burner Control Systems," page 7, used with permission of North American Mfg. Co.



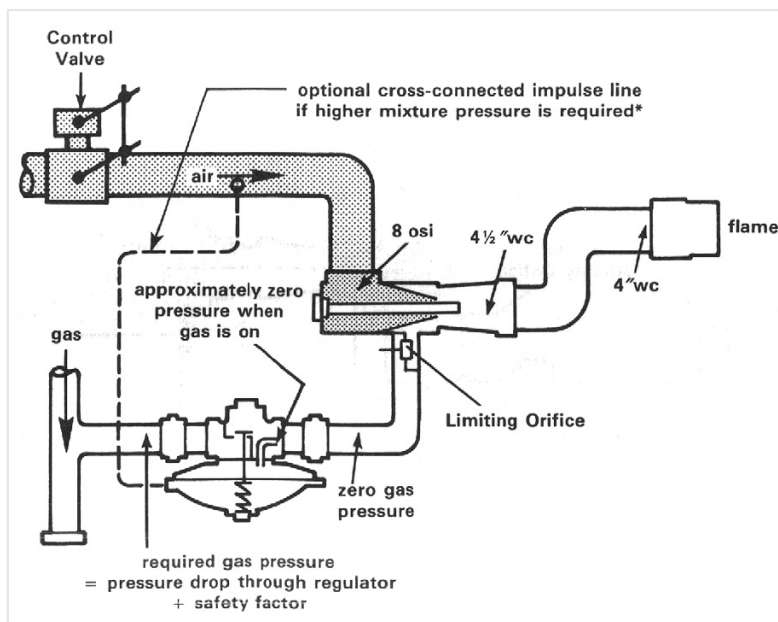
## EFFECT OF PRESSURE OR SUCTION IN COMBUSTION CHAMBER

### ON CONTROL WITH A ZERO OR ATMOSPHERIC SYSTEM

With the lower side of diaphragm open to atmosphere (without line A), a suction in the furnace is transmitted along the dashed line to the upper side of the control of the system. Similarly, a positive combustion chamber pressure will add a closing force and upset control of the system.

Addition of dotted line (A) compensates for variable combustion chamber pressure or balances any combustion chamber pressure higher or lower than the room pressure adjacent to the regulator. Line (A) will not cause trouble if installed where not required, so if in doubt about combustion chamber pressure, install it.

From "Practical Pointers - Industrial Burner Control Systems," page 14, used with permission of North American Mfg. Co.



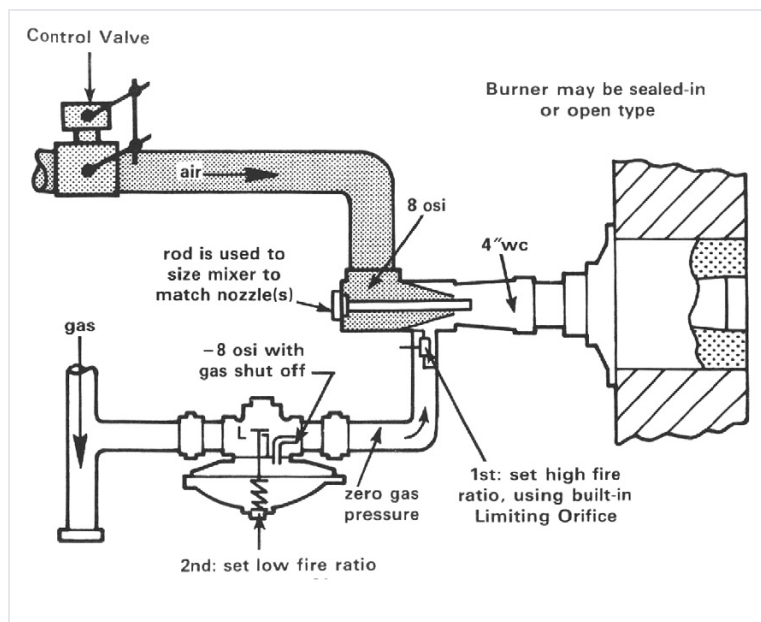
## PREMIX SYSTEM IN USE

As restriction in the mixture line is increased, the mixture pressure will rise and the suction will be reduced. If the restriction is sufficient to cause the suction to be too low to supply enough gas, a smaller capacity mixer and rod (or less outlet restriction) is required.

Mixture piping should be sized for a low pressure drop, 0.5" WC or less. In a typical installation, the regulator would be sized for 2 osi drop, and a safety factor of 1 osi would be allowed, requiring a gas supply pressure to the regulator inlet of 3 osi.

\*If necessary, the Atmospheric Regulator may be cross-connected to the air or mixture line to overcome the effect of high restriction in the mixture line or nozzle.

From "Practical Pointers - Industrial Burner Control Systems," page 13, used with permission of North American Mfg. Co.



## OPERATION OF AN ASPIRATOR MIXER

The nominal pressure ratios for a North American premix system are 8 osi air pressure. 8 osi suction, 4" WC mixture pressure. These are approximate. There is a wide range of control from slightly lean to rich (depending on the burner) with gas of 800 Btu/ft<sup>3</sup> or more.

If these pressures (or the same ratio of pressures) do not exist, check for excessive restrictions in the mixture line or burner.

From "Practical Pointers - Industrial Burner Control Systems." page 10, used with permission of North American Mfg. Co.

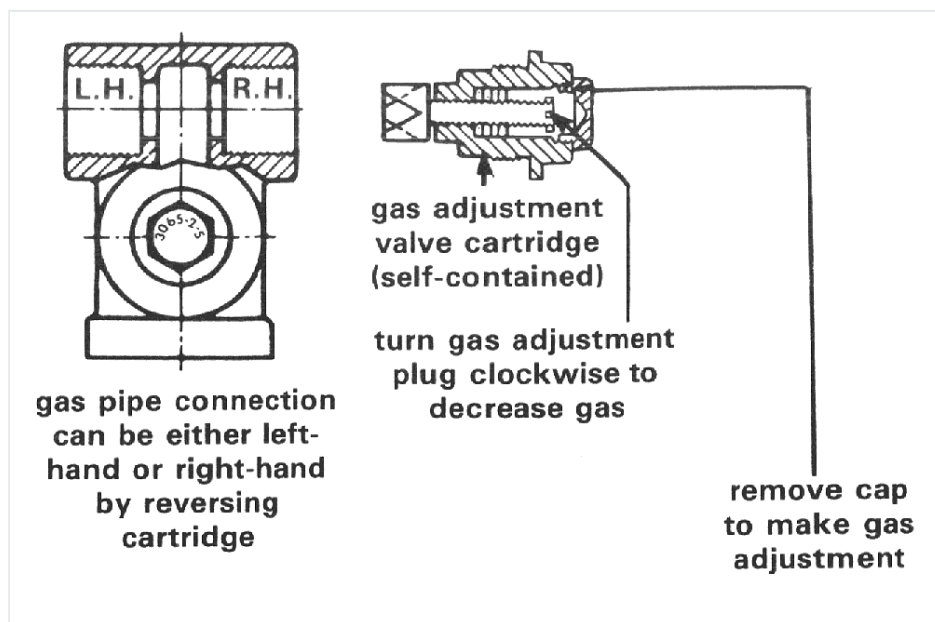
## PILOT ADJUSTMENT

- Before lighting any pilot, **make sure the furnace has been adequately purged.** This usually requires operating the main air blower long enough to make at least 4 air changes before ignition. Example: A 4' x 5' x 10' furnace (200 cuft volume) has a blower rated 460 cfm. It should be run (all air valves between blower and furnace wide open) for at least  $(4 \times 200 \text{ divided by } 460) = 1.74$  minutes air purge time.
- Adjust the pilot air valve for the required pilot air pressure -- generally osi at the 1/8" air pressure tap in the pilot mixer air connection.
- Starting from a fully closed position, open the pilot mixer gas adjusting screw about 4 turns (counterclockwise).
- Energize both the ignition spark transformer and the pilot gas solenoid valve. Spark plug gap should be 0.090 to 0.100". If the pilot does not light, turn the gas adjusting screw in or out, as required, until ignition occurs.

- FINE TUNE THE PILOT FOR BEST FLAME STABILITY, as follows:
- **First**, turn the gas adjusting screw clockwise until the pilot flame goes out. This is the “lean limit.”
- **Next**, counting the number of turns from the lean limit, turn the gas adjusting screw counterclockwise, lighting the pilot, and continuing until the rich limit is reached -- ragged flame appearance\* and loss of the sharp inner cone.
- **Then**, having counted the number of turns from lean to rich limit (generally 1 to 2 turns) set the gas adjusting screw at midpoint between the limits. This will result in a condition near correct air/fuel ratio.
- Slowly turn the pilot air pressure down to 1.0 osi. If the flame appears to go off ratio,\* remove the pilot regulator adjusting cap and adjust the pilot gas regulator spring until the flame looks correct. Turning the regulator spring adjusting screw clockwise increases the gas flow; counterclockwise decreases gas flow. Replace the cap. Turn the pilot air pressure back up to the original setting.
- With osi pilot air pressure, the mixture pressure at the 1/8" pressure tap on the mixer discharge should be 3 to 4" WC when the flame is burning. (Mixture pressures are valid only if measured when burning.) KEEP RECORDS.

\*Please read page 7-18 (page 59 in “Practical Pointers - Industrial Burner Control Systems”).

From “Practical Pointers - Industrial Burner Control Systems,” pages 56-57, used with permission of North American Mfg. Co.



## INSTALLATION AND LIGHTING OF PREMIX SYSTEMS

3065 Aspirator Mixers can be mounted in any position convenient to the user's piping. The gas adjustment valve cartridge is self-contained and can be mounted in either side of the mixer. Gas piping is perpendicular to the air line.

It is satisfactory to use one mixer for two or more burners, but flow distribution and pressure drops should be considered carefully when designing the manifold.

When mounting an Aspirator Mixer, allow side clearance for screwdriver setting of the gas adjustment valve. All mixers are shipped with the gas adjustment valve closed and with right-hand assembly as shown. Plugged taps (1/8") are provided for pressure readings.

**To light the burner(s):** Follow blower instructions to start the blower. All gas lines up to the 7218 Regulator must be purged. Before lighting any pilot or burner, **purge the firing chamber** -- see page 7-14. Follow pilot instructions to light the pilot(s). Set the main air valve at low fire position (1 or 2 psi pressure). Open the gas adjustment valve 3 or 4 turns.

Open the upstream gas shutoff valve(s) and the individual gas valve for one burner. If the burner does not light in a few seconds, close the nearest upstream gas shutoff valve (to prevent accumulation of unburned gas) and purge the chamber allowing sufficient time for a minimum of 4 changes of atmosphere. Then open the gas adjustment valve 1 more turn and reopen the shutoff valve. Repeat this procedure until the main flame lights.

From "Practical Pointers - Industrial Burner Control Systems," page 11, used with permission of North American Mfg. Co.

## Routine Combustion System Maintenance

On a daily basis, check the pilot flames for proper operation, and inspect the flame safety detectors (UV sensors or flame rods) to see that they are clean and functioning properly.

The following "tune up" procedures for the combustion system are recommended as indicated, or at least annually, unless experience dictates a different frequency:

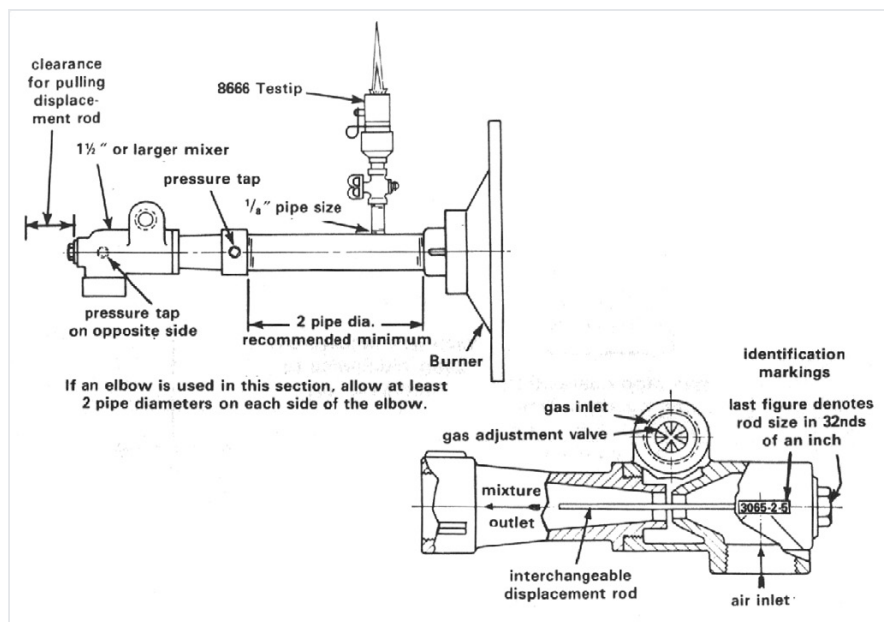
- Clean or replace inlet air filter of combustion blower and lubricate the bearings (monthly).
- Remove and clean pilot air strainers (monthly).
- Perform a leak test of the safety shut-off and vent valves (monthly).
- Check linkages on air damper control motors (monthly).
- Remove and clean or replace spark plugs.
- Clean and inspect flame detectors.
- Check the proper functioning of the purge cycle timer (monthly).

- Remove and clean the metering rods from the atmospheric regulators.
- Clean the inside body of the atmospheric regulators.
- Clean and inspect combustion blower impeller and housing.
- Check the fit of burners into the burner tiles (monthly), for proper sealing between the burner tiles and burners, and to insure that the burners are inserted the proper distance into the tiles. Badly cracked or broken tiles must be replaced. With tiles of cast refractory, the burners may be wrapped with fiberglass tape or ceramic fiber to achieve a proper seal. If the newer ceramic fiber tiles are used, the burners should fit snugly by twisting them slightly when inserting them into the tiles.

#### Ten Commandments for the Burner Service Technician

1. Always close off all manual fuel valves before starting a check out on a burner (and/or disconnect wiring to automatic valves).
2. Never stand in front of a burner or boiler when starting up the system.
3. Never manually push in relays unless the manufacturer's instructions advise to do so.
4. Never permanently block in relays with rubber bands, sticks or other devices.
5. Never change the safety switch timing of flame supervisory controls. If the system is locking out, correct the disease not the symptom.
6. Never permanently jumper or by-pass any safety interlock switches. This is criminal negligence.
7. Visually inspect every combustion chamber and assure yourself that there is no accumulation of combustibles prior to attempting to start.
8. Run a pilot turn-down test on every new job prior to start up and periodically thereafter.
9. Run a flame failure response test on each burner at start up and at least once a year thereafter.
10. Regard every system lockout as a safety lockout until proven otherwise.

Courtesy of Jon Luscomb, Belco Industries



## ADJUSTMENT OF PREMIX SYSTEMS

**Adjust the high fire air/gas ratio** by slowly turning the air valve to high fire position while adjusting the limiting orifice gas valve as needed to maintain the desired air/gas ratio.† Replace the valve cover.

**Adjust the low fire air/gas ratio.** Turn the air to low fire (about ½ psi). If more or less gas is required, remove the regulator's gas diaphragm cover plug and use a screwdriver to turn the spring adjusting plug -- clockwise\* for less gas. Replace the cover plug.

On sealed-in burners where flame is not visible, the following is recommended for a 1½" or larger mixer. Drill and tap a 1/8" hole in the pipe from mixer to burner; screw a **8666 Testip** into this hole and light it so that you can see a sample of main burner flame. Adjust the mixer for the type of flame desired†, using the flame from the Testip as a guide. (A purple-tinged flame denotes a lean fire; a greenish-blue inner cone denotes a rich flame.) The Testip can be removed, the hole plugged, and the Testip used on other burners.

Mixers have interchangeable displacement rods that permit changing mixer orifices to conform to field conditions or to get lower or higher mixture pressures (with consequent more or less suction, respectively). Rods can be interchanged without breaking piping. Recommended rod diameters are listed in North American Bulletin 3065 for burner(s), type of gas, and air pressure involved.

\*For North American 7218 Regulators. Others may be different.

†See "Judging Flames," page 7-24 (page 59 in "Practical Pointers - Industrial Burner Control Systems").

From "Practical Pointers - Industrial Burner Control Systems," page 12, used with permission of North American Mfg. Co.

## JUDGING FLAMES

It is difficult to describe what a flame should look like. In general, natural gas pilot and premix burner flames should be adjusted to produce a sharp, forceful, needle-like flame with a well-defined light blue inner cone in a deep blue outer cone.

Lean flames are pale blue or violet. Rich flames are longer, bushy, yellow-tipped, maybe green-tinged, less noisy. Either rich or lean flames may result in a pilot without enough length or drive to light the main burner or satisfy the flame monitoring system.

**Observation ports** should be installed to allow a side profile view of the flames. The observation ports built into burners rarely give an adequate viewing angle for adjusting flames. If a flame is viewed against a bright radiating background, it is very difficult to observe a flame satisfactorily.

### Choice of Flame Judging Methods:

**Visual** judging of flames for adjusting is not accurate, but must suffice for pilots and small open burners.

**Metering orifices** at every burner is the preferred method for nozzle mix burners.

**Flue gas analysis** is an easy way to adjust flames if there is only one zone, or preferably only one burner, and if the chamber has no leaks, no shutters, and no other air entries that cannot be metered.

From "Practical Pointers - Industrial Burner Control Systems," page 59, used with permission of North American Mfg. Co.

## Special Alert: Possible Malfunction of Safety Vent Valves

NFPA, FM, and IRI regulations require that a vent located between the blocking valves of the main gas train be opened automatically when the main safety valve closes for any reason. The purpose is to safely vent away any fuel gas which may leak through the main safety valve when it is closed. However, the solenoid vent valves are prone to sticking in the open position --- many furnaces have valves which are specified for horizontal installation only, incorrectly mounted in a vertical position. As a result, when the furnace is turned on, these valves often remain open, venting expensive (and dangerous) fuel gas through the roof. To control this problem, we recommend several steps:

- Make sure the vent solenoid valve is installed properly.
- Use gas meter readings to detect any sudden increase in gas usage.
- Install a test cock after the valve to permit testing for leaks; connect a rubber hose and put the other end into a glass of water to test for gas discharge.
- Install a visible sight flow indicator after the vent valve.

**Temperature Control System.** Temperature controllers should be checked at least monthly for calibration, to verify that temperatures are controlled at the set points. Maintenance and calibration of temperature control instruments is difficult and is usually best contracted to firms that specialize in instrument repair and maintenance.

**Furnace Pressure Controls.** Pressure inside the log/billet furnace is normally controlled at a slightly positive value (0.05 inches WC. maximum). If pressure in the furnace is negative, infiltration of cold air will dramatically effect fuel efficiency. Positive pressures greater than 0.05 inches WC will result in equipment damage due to flames coming out of cracks and doors.

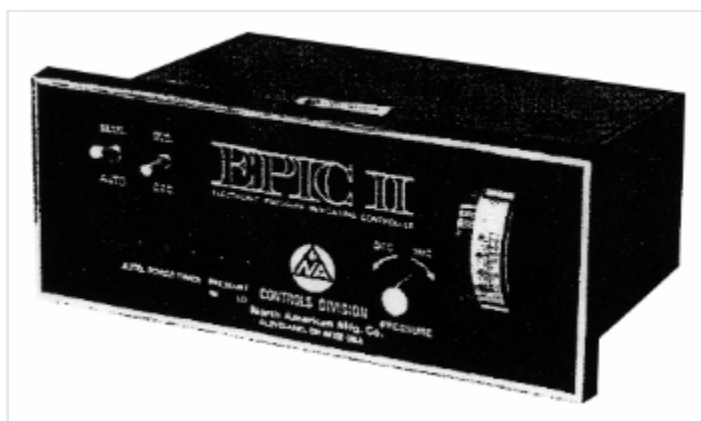


Figure 7-15: EPIC and Photohelic furnace pressure controllers



There are various types of systems for controlling furnace pressure:

- Some recirculation-type furnaces use the North American EPIC pressure controller or pressure transmitter; these devices require frequent testing and calibration, according to the North American

instructions for the particular EPIC model in use. Control is maintained by adjusting a control damper to vary the amount of recirculated hot air.

- A Photohelic pressure controller may be used in the same manner. It is a single control unit and may require less maintenance than the EPIC.
- Some newer furnaces use a pressure transducer to signal the control PLC, which in turn adjusts an exhaust damper or varies the speed of the exhaust blower by frequency variation.

Also, the high temperature blowers used by hot gas recirculation furnaces should have bearings lubricated weekly with high-temperature grease, and drive belts and shaft seals inspected monthly. If belts slip due to improper tension, pressure balance within the furnace will change and furnace efficiency will decrease. Control linkages for hot gas dampers should also be checked monthly.

**Conveyors and Support Rollers.** The interior area around the support rollers and/or sliding surfaces should be cleaned out each year, to remove dirt and metal flashings. Also check and replace the support rollers as needed; frequency will depend on the roller design and service life, but is usually every 3 to 12 months. Quick-change rollers and supports that are cast from high-duty alloys may be retro-fitted on most older ovens to improve roller life.

**Foundation and Mounting Bolts.** Check and tighten all bolts annually, due to high impact loads.

**Proximity or Limit Switches.** Check limit switches for loose mountings, loose wires, loose arms, etc.; check limit switches for proper tripping. Check the position of proximity switches for proper actuation. The lenses of photoelectric switches require periodic cleaning with a soft dry cloth, and reflective devices used in conjunction with photoelectric switches also require periodic cleaning. Do not use solvents or cleaning agents on the lenses or reflectors. Replace any damaged lenses and reflectors.

## Records of Combustion Settings for Gas Fired Furnaces

Values for combustion settings for each zone, both before and after adjustment, should be recorded in a permanent log. Other important data for the furnace should also be noted.

As an example, a typical **Service Report for Gas-Fired Furnace** on the following pages indicates the types of data that should be recorded for future reference.

| Service Report for Gas-Fired Furnace                                                                                                              |                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| Customer _____                                                                                                                                    |                                                     |
| Location _____                                                                                                                                    |                                                     |
| Furnace # _____                                                                                                                                   | Service # _____                                     |
| Service Technician _____                                                                                                                          |                                                     |
| Date _____                                                                                                                                        | Time _____                                          |
| <b>GAS</b>                                                                                                                                        |                                                     |
| Type: <input type="checkbox"/> Natural <input type="checkbox"/> Propane <input type="checkbox"/> Propane/Mix <input type="checkbox"/> Other _____ |                                                     |
| Pressure: Main Gas Regulator _____ "W.C.                                                                                                          |                                                     |
| Pilot Gas Regulator _____ "W.C.                                                                                                                   |                                                     |
| Low Gas Pressure Switch _____ "W.C.                                                                                                               |                                                     |
| High Gas Pressure Switch _____ "W.C.                                                                                                              |                                                     |
| <b>AIR</b>                                                                                                                                        |                                                     |
| Combustion Air Pressure Switch _____ "W.C.                                                                                                        |                                                     |
| Mixer Pressure:                                                                                                                                   | Zone 1      Zone 2      Zone 3      Zone 4          |
| High Inlet                                                                                                                                        | _____                                               |
| High Outlet                                                                                                                                       | _____                                               |
| Low Inlet                                                                                                                                         | _____                                               |
| Low Outlet                                                                                                                                        | _____                                               |
| Header High                                                                                                                                       | _____                                               |
| Header Low                                                                                                                                        | _____                                               |
| Pilot Mixer Pressures _____ "W.C.                                                                                                                 |                                                     |
| Inlet Pressures _____ "W.C.                                                                                                                       |                                                     |
| Outlet Pressures _____ "W.C.                                                                                                                      |                                                     |
| NOTE: Consult manufacturing maintenance manual for proper settings. © 2002 Biko Industries                                                        |                                                     |
| <b>TEMPERATURE</b>                                                                                                                                |                                                     |
|                                                                                                                                                   | Setpoint      Reading 1      Reading 2              |
| Zone 1                                                                                                                                            | _____                                               |
| Zone 2                                                                                                                                            | _____                                               |
| Zone 3                                                                                                                                            | _____                                               |
| Zone 4                                                                                                                                            | _____                                               |
| Zone 5                                                                                                                                            | _____                                               |
| High Limit                                                                                                                                        | _____                                               |
| <b>CONTROLLERS</b>                                                                                                                                |                                                     |
|                                                                                                                                                   | Zone 1      Zone 2      Zone 3      Zone 4          |
| Proportional Band                                                                                                                                 | _____                                               |
| Manual Reset                                                                                                                                      | _____                                               |
| Alarm 1                                                                                                                                           | _____                                               |
| Alarm 2                                                                                                                                           | _____                                               |
| <b>PRESSURE CONTROL</b>                                                                                                                           |                                                     |
| Left Switch / Low                                                                                                                                 | _____                                               |
| Right Switch / High                                                                                                                               | _____                                               |
| Damper                                                                                                                                            | _____                                               |
| <b>CHECK</b>                                                                                                                                      |                                                     |
| <input type="checkbox"/> Fan Rotation Correct                                                                                                     | <input type="checkbox"/> Belt Guards in Place       |
| <input type="checkbox"/> Chain Guards in Place                                                                                                    | <input type="checkbox"/> Bearing Bolts Tight        |
| <input type="checkbox"/> Set Collars Tight                                                                                                        | <input type="checkbox"/> Belt Tension               |
| <input type="checkbox"/> Belt Alignment is Correct                                                                                                | <input type="checkbox"/> Name Plates Correct        |
| <input type="checkbox"/> Warning Labels in Place                                                                                                  | <input type="checkbox"/> Setscrews in Shafts Tight  |
| <input type="checkbox"/> Motor Mount Screws Secure                                                                                                | <input type="checkbox"/> Brackets and Linkage Tight |
| © 2002 Biko Industries                                                                                                                            |                                                     |

| AMP READING         |         |       |       |           |       |       |
|---------------------|---------|-------|-------|-----------|-------|-------|
|                     | Startup |       |       | Operating |       |       |
|                     | L1      | L2    | L3    | L1        | L2    | L3    |
| Hydraulic Unit      | _____   | _____ | _____ | _____     | _____ | _____ |
| Recirculation Fan 1 | _____   | _____ | _____ | _____     | _____ | _____ |
| Recirculation Fan 2 | _____   | _____ | _____ | _____     | _____ | _____ |
| Recirculation Fan 3 | _____   | _____ | _____ | _____     | _____ | _____ |
| Combustion Blower   | _____   | _____ | _____ | _____     | _____ | _____ |
| Hydraulic Cooling   | _____   | _____ | _____ | _____     | _____ | _____ |
| Other _____         | _____   | _____ | _____ | _____     | _____ | _____ |
| Other _____         | _____   | _____ | _____ | _____     | _____ | _____ |
| Other _____         | _____   | _____ | _____ | _____     | _____ | _____ |

| RPMs                     |       |        |
|--------------------------|-------|--------|
|                          | Motor | Driven |
| Recirculating Fan Zone 1 | _____ | _____  |
| Recirculating Fan Zone 2 | _____ | _____  |
| Recirculating Fan Zone 3 | _____ | _____  |
| Combustion Blower        | _____ | _____  |



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## Induction Billet Heaters

**Function.** With induction furnaces one or more billets are placed in a water-cooled electric coil and heated by low frequency alternating currents passing through the coil. The heater uses the principle of a transformer, with the coil acting as the high-voltage primary and the billet as the secondary. The magnetic field generated by the primary induces a low-voltage current in the billet, causing it to gain heat. The principle works for heating any metal that is an electrical conductor.

The so-called “skin effect” results in a temperature difference between the surface and the interior of the billet, so a soak period is required for the billet to reach equilibrium.

A temperature probe contacts the front of the billet during heating, and the temperature controller varies the coil voltage through a transformer to achieve the desired temperature and production rate. Then the heated billet is discharged axially as a cold billet is fed into the coil.

Induction heaters offer more precise control of billet temperature, plus the possibility of taper-heating the billet with great accuracy and consistency. The induction heater is more energy efficient than gas-fired, but energy cost is greater due to the higher unit cost of electricity compared to gas. Induction heaters require less space and heat fewer billets at one time, but they cannot be used to feed a log shear.

## Maintenance Requirements for Induction Billet Heaters

**Heating Coils.** The coils are protected from heat and abrasion by special liners specifically designed to the purpose, and these liners require periodic maintenance. A layer of insulating paper is placed adjacent to the copper bar of the coil to provide thermal insulation. Then a liner of Inconel is inserted to protect the

insulation and to guide the billet. Due to wear, corrosion, and physical abuse, it is necessary to maintain spare liners for periodic replacement. The insulating paper will also require replacement due to contamination from oil, dirt, and saw chips.

It is recommended to replace each heating coil with a spare every 1 to 6 months, based on plant conditions and maintenance history. With bench reconditioning of the spare coil, failures and expensive repairs may usually be avoided. It is also recommended to check coils with a megohmmeter on a monthly basis, recording the readings for comparison, in order to measure resistance of the electrical insulation. It is also recommended to remove the coil liner and insulation and to inspect the coil regularly, at which time damaged liners and/or insulation may also be replaced.

The insulation liner is often damaged by excessively oily billets, which may be lessened by installing an air nozzle to dissipate the oil as it vaporizes in the entry of the coil.

**Cooling Water.** An adequate cooling water supply is critical for removing the excess heat generated in the heater coils and transformers. The water supply must meet minimum requirements:

- Minimum flow rate and pressure, and maximum temperature, to meet specifications of the heater manufacturer (check weekly).
- Water supply not affected by conditions elsewhere in the plant.
- Clean water, due to small passages through the equipment, with a strainer to trap any foreign material. (Clean the strainer weekly.)
- Soft water, treated to provide hardness below 170 ppm.
- Differential pressure switch to shut off power in case of water failure.

A recirculating system with an open cooling tower may be sufficient if adequate blowdown and treatment are provided.

**Transformers.** Water-cooled transformers are typically used, due to the high secondary currents required, and also to minimize the size. Therefore, maintenance of the cooling water requirements as previously described will be critical. Thermostats in the transformers open and close solenoid valves to regulate water flow as needed.

**Tap Switches.** Maintenance of the tap switches is minimal:

- Occasional lubrication: Apply a few drops of oil on the center switch rotor and a small amount of Shell Alvania Grease #2 or equal on the contact clip and blade, for easier operation and to prevent cutting.
- Cleaning of contacts: If blade or clip contacts become oxidized, they should be cleaned lightly with a fine cut file or emery paper.
- Check terminal connections: Check occasionally for tightness.

**Billet Loading.** Check the function of loading cylinders for proper, smooth operation; adjust the loader arm position according to manufacturer's instructions, in order to avoid damage to the coil or billet stop. Adjust the air pressure and flow as required. Clean the air strainer, drain any water from the bowl, and fill the lubricator weekly.

**Thermocouple Probe.** A spring loaded, open-style thermocouple, usually mounted in the billet stop, is used for temperature control. The springs must be adjusted so as to maintain firm contact with the billet end. Thermocouple rods must be cleaned often and kept sharpened to a fine point for proper contact; a daily check and cleaning is recommended.

**Temperature Control System.** Temperature controllers should be checked at least monthly for calibration, to verify that temperatures are controlled at the set points. Maintenance and calibration of temperature control instruments is difficult and is usually best contracted to firms that specialize in instrument repair and maintenance. Controllers should be "fail safe," stopping power in case of a thermocouple circuit failure or failure of the thermocouple to contact the billet. Controllers should not be located near the heater due to the magnetic field around the coil.

## Safety Devices

- A safety timer should be provided to shut off power after the normal heating period, in the event of failure of the temperature controller.
- A water pressure switch is required to shut off power in case of water loss, to prevent overheating.
- The tap switches are interlocked so as to prevent their operation under load.
- The billet stop must be up, actuating the limit switch, in order for power to be turned on; otherwise the induction forces would throw the billet out of the coil.
- An interlock prevents the operator from ejecting a billet while power is on.

**Foundation and Mounting Bolts.** Check and tighten all bolts annually, due to the potential for high impact loads in this equipment.

## Log Shear



Figure 7-16: Vertical-stroke log shear (Photo courtesy of Belco)

**Function.** The hot log shear cuts each billet to the correct size required for extrusion conditions, instead of depending on having the optimum length billets pre-loaded in the billet furnace in the correct sequence. The shear system is designed to provide the necessary tonnage to shear the hot log, using shearing dies which are designed to minimize distortion of the log from the shearing forces. After the desired length is sheared, the remaining log is returned to the furnace to be re-heated while waiting for the next cycle. In most operations the final short end piece of one log is mated with a portion of the next one to create a 2-piece billet of the desired total length. Because of difficulties in handling small pieces, remainders less than a certain minimum size must be avoided or discarded, usually by means of special mathematical PLC programs and other devices.



Figure 7-17: Vertical-stroke log shear (Photo courtesy of Granco Clark)

**General Operation and Adjustment.** Operation of the shear should be observed daily for smooth operation in the proper sequence. Check that log movement into and out of the furnace is smooth and alignment is correct. Check that all guards and safety devices are in place and working. Cylinder speeds should be checked monthly and adjusted as needed by means of the hydraulic flow controls. Also check all assembly bolts monthly for tightness, as temperatures and impact loads involved may cause them to work loose. During annual service, check wear surfaces and guide ways for wear.

**Shear Tools.** Observe the shear blades or cutting rings daily for clearance and metal build-up. Depending on design, clearances may require adjustment weekly or monthly – check the manufacturer's recommendations. Typical shear tooling clearance is 0.010 to 0.015 inches (0.25 to 0.38 mm) cold; or 0.004 to 0.008 inches (0.10 to 0.20 mm) hot.

Some shears require removal and cleaning of the shear tools in a caustic bath every 6 months.

**Lubrication.** Grease all points fitted with grease nipples, daily unless the manufacturer's instructions indicate otherwise.

**Hydraulic Unit.** Check daily for leaks, and check the oil level and temperature. Check pressure settings monthly; check and clean system filters and/or strainers monthly.

Monthly oil sampling and analysis is recommended – see **Oil Sampling and Analysis** in Chapter 5. For other general hydraulics information and recommendations, especially Filtration, see also the section on **Hydraulic Equipment** in Chapter 5.

**Note:** Because of high temperatures at the log shear and adjacent log furnace, press feed hydraulic systems commonly use fire resistant hydraulic fluids. Because seals must be specified compatible with the fluid used, refer to the manufacturer's specifications for the hydraulic fluid.

**Hydraulic Cylinders.** Some manufacturers recommend annual disassembly and replacement of seals for the log shear hydraulic cylinders.

**Limit and Proximity Switches and Photocells.** Check limit switches for proper actuation and for loose mountings, loose wires, loose arms, etc. Check the position of proximity switches for proper actuation. The lenses of photoelectric switches require periodic cleaning with a soft dry cloth, and reflective devices used in conjunction with photoelectric switches also require periodic cleaning. Do not use solvents or cleaning agents on the lenses or reflectors. Replace any damaged lenses and reflectors.



Figure 7-18: Horizontal-stroke log shear (Photo courtesy of OMAV)

**Foundation and Mounting Bolts.** Check and tighten all bolts annually, due to high impact loads.

## Hot Saw for Billets



Figure 7-19: Hot log saw (Photo courtesy of Belco)

A recent development is the hot saw for cutting billets after the log furnace. While long-term operating and maintenance experience are not yet available, some suggestions can be inferred based on experience with large saws for hot profiles.

**Blade lubrication:** sawing hot aluminum will adversely affect blade life, so the best blade lubrication system possible should be used. Sawing may be significantly improved by means of advanced coolant-lubricant products. The surface-wetting and heat removal properties of these fluids allow a significant reduction in the quantity of lubricant needed, so there is less fluid left on the product being sawed. Blade life is dramatically improved, and the quality of cut is much better. A special low-volume applicator is required due to the small quantity used. Typical supplier: Amcol Corporation, (Tel 248-414-5700, fax 248-414-7489), [www.amcolcorp.com](http://www.amcolcorp.com).

## Routine Maintenance of Hot Saws

### Daily:

- Check the sharpness of the blade. The best indicator will be the cut ends: excessive deformation indicates a dull blade or poor lubrication. Check for metal build-up on the blade.
- Clean the sawing area of chips and other debris which may interfere with operation.
- Check for proper functioning of saw clamping devices.
- Check for proper functioning of the blade actuation system (hydraulic).
- Check for leaks of hydraulic fluid or compressed air.
- Check the level of blade lubricant in the reservoir and check the function of the lubricant applicator; a piece of cardboard or brown paper held in front of each nozzle will quickly show the rate and pattern of lubrication.

- Check that all equipment safety guards are in place, and that any safety switches and interlocks are functioning properly.

**Weekly:**

- Lubricate all grease fittings.

**Monthly:**

- Service the hydraulic system: clean the tank; check and clean the hydraulic filter; clean and check for fluid leaks.
- Clean the saw and saw table thoroughly.
- Change the cloth chip collector bags; old bags may be restored by washing in warm water with laundry detergent, or dry cleaning, to remove accumulated oils.
- Check the blade drive motor's amperage.
- Check air line filters and lubricators for any components actuated by compressed air.
- Check limit switches for loose mountings, loose wires, loose arms, etc.; check limit switches for proper tripping. Check the position of proximity switches for proper actuation. The lenses of photoelectric switches require periodic cleaning with a soft dry cloth, and reflective devices used in conjunction with photoelectric switches also require periodic cleaning. Do not use solvents or cleaning agents on the lenses or reflectors. Replace any damaged lenses and reflectors.

**Annually:**

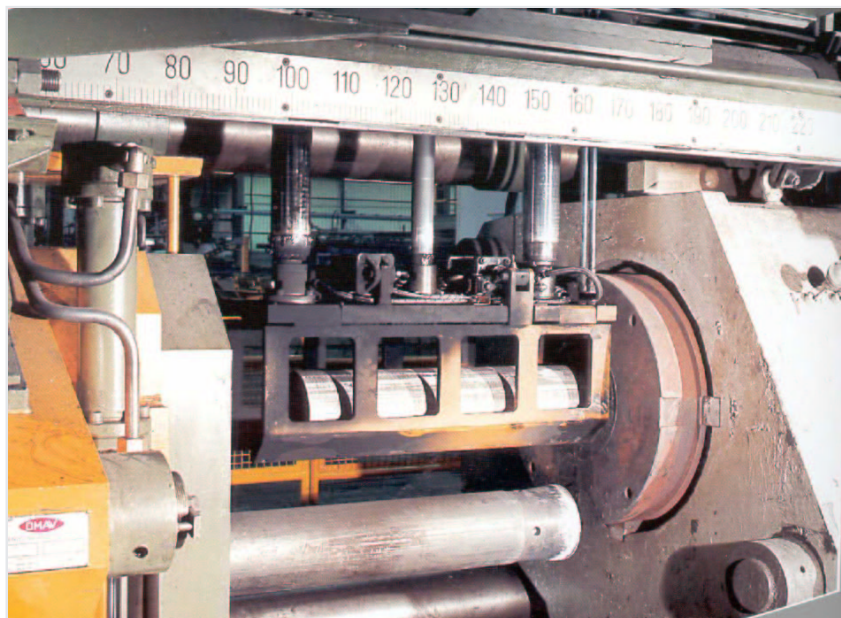


Figure 7-20: Overhead billet loader (Photo courtesy of OMAV)



Figure 7-21: Robot-type billet transfer & loader (Photo courtesy of OMAV)



Figure 7-22: Pivot-arm billet transfer

- Check the leveling and alignment of the saw and lead-out table with piano wire and machinist's level, to insure straightness and accuracy.
- Clean and lubricate the motors annually. If the windings become coated with oil and dirt they will run hotter, leading to premature motor failure. Likewise, clogged openings in the motor frame may result in the loss of effective cooling. Check the motor windings with a megohmmeter annually. Also check and record the no-load amps.

- Check the condition and alignment of the blade arbor, according to manufacturer's recommendations and plant service history.
- Check all saw and frame connectors and foundation bolts and tighten as needed.
- Check all hydraulic and pneumatic cylinders for leaks or damaged packing, and repair or replace as needed.

### **Billet Transfer Conveyor (to Press)**

The conveyors which transport hot billets from the billet heater or log shear to the press are critical to press performance, because they often cause excessive downtime and require constant operator attention. Many of the older systems in use are difficult to maintain because the components are inaccessible. Billets don't stay aligned, so the operator must watch each billet, ready to grab a pry bar and help the billet into position; this keeps the operator tied to the press and prevents truly automatic operation. For these reasons, billet conveyors offer one of the best improvement opportunities for press maintenance.

Described below are some of the more common billet conveyor designs, listed in order from best to worst, with recommendations including a few maintenance pointers:

**Overhead billet conveyor:** This type picks up the billet in a clamp and transfers it over the press tie rods, lowering it into the billet loader during the press dead cycle. It offers the advantage of gentler billet handling (important for 2-piece billets), plus free access to the floor area between the press and log shear or billet furnace. Combined with a moveable-ram press it also helps to reduce the dead-cycle time. Maintenance items: hydraulic cylinders and drive motor; rack and pinion drive; linear bearings and guide rods; limit switches; and lubrication.

**Robot loader:** Today many new presses are equipped with robot-type billet loaders, designed to accommodate moveable-ram systems. Robot loaders offer precise positioning and easy access for maintenance. A telescoping device supports the billet, yet permits the robot to withdraw quickly so as not to adversely affect the dead-cycle. Maintenance items: hydraulic cylinders and drive motor; limit switches; and lubrication.

**Transveyor:** This device consists of a billet holder "tray" which travels on a fixed track from the billet furnace or log shear to the press loader, where the tray is mechanically tipped over to dump the billet into the loader. The transveyor is simple, elegant, reliable, accessible for maintenance, and easily adapted to most presses. ("Dumping" a 2-piece billet is not preferred, but reliability is still good.) By using an encoder and PLC control, the tray may be paused in intermediate positions for billet lubrication or 2-piece manipulation. It is available from most equipment suppliers. Maintenance items: drive chain and sprockets; hydraulic or gearmotor drive; V-casters or cam follower guides; limit switches; regular lubrication, and cleaning of the track.

**Pivot arms:** Often used with one of the other type devices below; a pivoting arm, or a series of arms, actuated by air cylinders, cradles the billet loosely within a “cage” while moving it horizontally and down to the next device. Pivot arms are rugged and reliable and easy to design and build. Because the billet rotates, pivot arms are less reliable for handling 2-piece billets. **2-piece loaders** have been retro-fitted on some presses in order to reduce dead-cycle time. However, the general experience has been that the extra maintenance downtime caused by increased mechanical complexity more than offsets any benefits in reduced dead-cycle. Maintenance items: air cylinders; pivot bushings (lubrication, check for wear); and limit switches.

**Elevator (cylinder or chain):** Common on older presses, a carrier is actuated by chain/sprocket or air cylinder, to lower the billet from the heater to a lateral conveyor. These devices are simple, crude, and fairly reliable. Maintenance items: air cylinders, guide bushings, and/or chains and sprockets; limit switches; and lubrication of guides.

**Gravity (rolling) tables:** Often used together with elevators or pivots to replace parallel chains (below); however, hot billets tend not to roll in a predictable manner. Two-piece billets can't be handled. With no moving parts, the only maintenance needed is occasional cleaning.

**Parallel chains (with lugs):** Always found with a set of pry bars used by the operators to straighten cocked billets. It is almost impossible to keep the different chains synchronized. Access for maintenance of chains, sprockets, and drives is extremely difficult. Maintenance items: chains, sprockets, hydraulic or gearmotor drive; limit switches; and lubrication.

#### **General Maintenance for All Types of Billet Conveyors:**

- Check all guards and safety devices weekly, as these tend to be left open or jumped out for access.
- Lubricate bearings (weekly) with high-temperature grease.
- Check all chains (where installed) monthly; lubricate and align as needed.
- Check belt drives weekly for wear, tension, or overheating (used on transveyor or overhead-type conveyor).
- Check and tighten pivot arms, check bushings for wear; lubricate; check air cylinders -- rod seals, flow and speed controls, cylinder mounting bushings.
- Check limit switches for loose mountings, loose wires, loose arms, proper tripping, etc. Check the position of proximity switches for proper actuation. The lenses of photoelectric switches require periodic cleaning with a soft dry cloth, and reflective devices used in conjunction with photoelectric switches also require periodic cleaning. Do not use solvents or cleaning agents on the lenses or reflectors. Replace any damaged lenses and reflectors.
- Check and tighten all bolts monthly, due to high impact loads.

## Billet Lubrication

**Billet and Dummy Block Lubricants.** To prevent the billet from sticking to the dummy block, the ends of pre-cut billets have traditionally been lubricated by painting with graphite dispersions, in a base of either kerosene or water. However, increasing use of fixed dummy blocks, combined with hot-sheared billets, has forced the development of alternatives which may be automatically applied, for example after the billet is sheared. At the present time there are three popular methods of applying lubricant to the surface between billet and dummy block:



Figure 7-23: "Sooter" or flame lubricator for billet end (Photo courtesy of OMAV)



Figure 7-24: Spinning nozzle lubricant applicator for dummy block (Photo courtesy of Amcol)

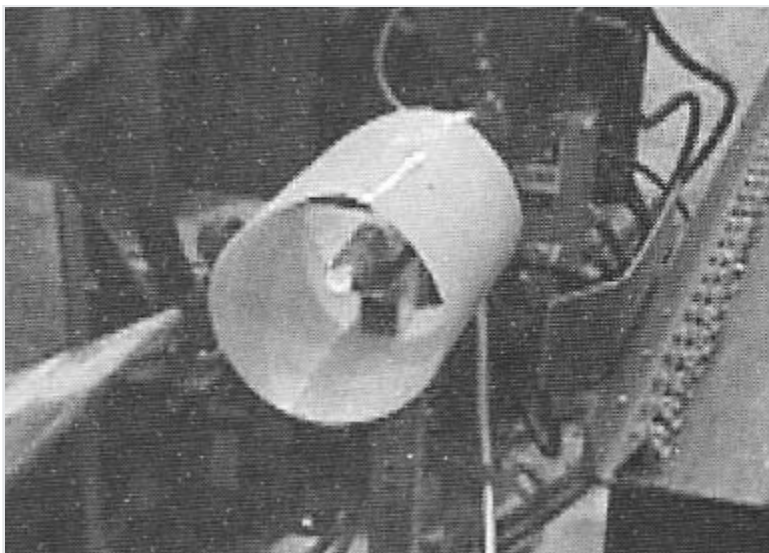


Figure 7-26: Applicator head for Boron Nitride powder. (Photo courtesy of Castool)

- **Flame application of carbon** (soot) to the billet face. The billet is paused at some point of its transfer to the press, while a carbon-rich flame applies a coating of “soot” or carbon to the end of the billet. An acetylene or Mapp-gas flame burns for 3 to 4 seconds with a visibly black smoke. (The air pollution aspect is a problem in some plants.) Typically, every billet is coated. Equipment source: most suppliers of hot billet shears offer an acetylene lubricator. Maintenance: Check the system weekly; clean the igniter and nozzle.
- **Automatic spraying of proprietary liquid parting compounds** to the dummy block. An automatic applicator descends from above by means of a pneumatic cylinder to align with the dummy block during the press dead cycle; then a rotating nozzle applies lubricant to the face and edges of the dummy block. PLC or relay controls determine the frequency and duration of application, followed by a short air purge. Typically, the block is sprayed every 5 to 10 billets. The fluids applied are specially developed to facilitate separation and prevent build-up of aluminum, without accumulation of chemicals on the die or tooling. Typical supplier: Amcol Corporation, (Telephone 248-414-5700).
- **Electrostatic application of Boron Nitride (BN) powder** to the billet and/or other tooling surfaces. BN powders are expensive and so must be applied carefully to minimize cost, so application is normally by electrostatic sprayer. Controls may be set to permit spraying intermittently – for example, every billets. Typical suppliers:
  - Castool, , [www.castool.com](http://www.castool.com), (Telephone 416.297.1521)
  - Amcol Corporation, , [www.amcolcorp.com](http://www.amcolcorp.com) (Telephone 248.414.5700).



Figure 7-25: Applicator system for Boron Nitride powder (Photo courtesy of Castool)