INSTALLATION & MAINTENANCE MANUAL FOR

PVI FIREPOWER^{Ò}

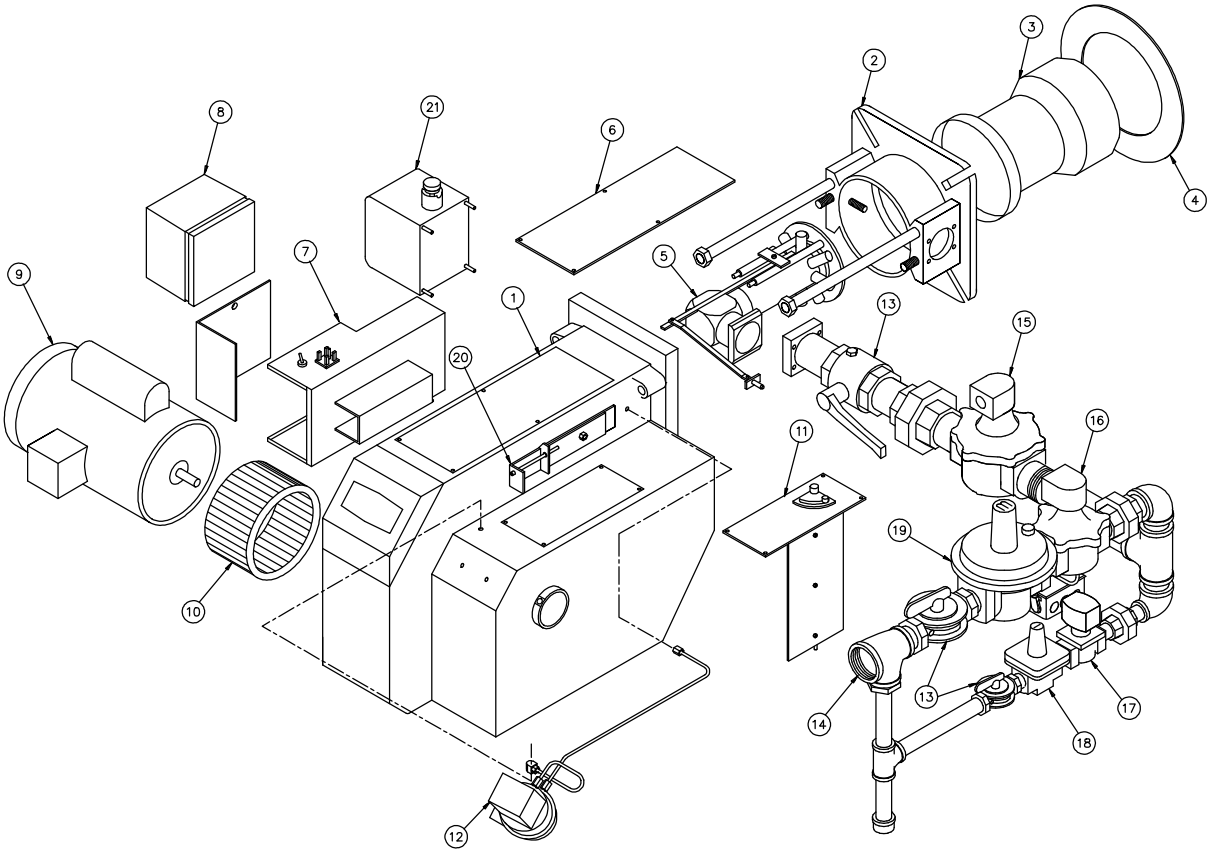
BG600 GAS BURNER

1,200,000 thru 2,400,000 Btu/h

CARBON MONOXIDE WARNING:

CAUTION: IMPROPER COMBUSTION MAY CAUSE SERIOUS INJURY.

PVI recommends a seasonal or annual combustion check-out be performed by a qualified service agency to ensure safe and efficient operation.



Typical Construction
Figure 21B-1

1. Burner housing
2. Mounting flange
3. Blast tube
4. Flange gasket
5. Gas nozzle assembly (Figure 21B-2)
6. Housing cover
7. Control enclosure
8. Flame safeguard
9. Fan motor
10. Fan wheel
11. Damper assembly
12. Air switch
13. Manual gas valve
14. Gas inlet
15. Common electric gas valve
16. Main electric gas valve
17. Pilot electric gas valve
18. Pilot regulator
19. Main regulator
20. Nozzle adjustment plate
21. Ignition transformer

**FOR YOUR SAFETY
WHAT TO DO WHEN
YOU SMELL GAS:**

- **DO NOT try to light any appliance**
- **DO NOT touch any electrical switch; DO NOT use any phone in your building.**
- **IMMEDIATELY call your gas supplier from a phone outside the building. Follow the gas supplier's instructions.**
- **If you cannot reach your gas supplier, CALL THE FIRE DEPARTMENT.**

FOR YOUR SAFETY

DO NOT store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

FOR YOUR SAFETY

WARNING: Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Refer to this manual for assistance, or consult a qualified installer

CAUTION: CONDUCT THE FOLLOWING GAS TRAIN LEAKAGE TEST BEFORE START-UP, AT ANNUAL INTERVALS AND PRIOR TO INVESTIGATING THE CAUSE OF ANY REPORTED OCCURRENCES OF DELAYED IGNITION.

1. Using an appropriate bubble detection solution, thoroughly coat all gas train pipe connections. If any bubbles are detected, the leaking connection must be tightened, recoated and rechecked to assure stoppage of the leak.

2. Attach a manometer, to measure gas pressure, at the manual gas shutoff valve located just upstream of the gas train. Adjust gas train inlet pressure to the specified value (e.g. 14 in. W.C.), and tightly close the gas train manual shutoff valve closest to burner.

3. Reattach the manometer to the gas train manual shutoff valve at the burner and record the measured gas pressure in inches of water column (in W.C.). Measure gas pressure again after 15 minutes. If gas pressure has increased 0.5" W.C. or more, the gas leak must be isolated to one or more of the operating gas valves, for example, a solenoid actuated gas shutoff valve. After any leaking valve is replaced, the reassembled gas train must be leak tested again before start-up is attempted. (NOTE: All gas valves removed because of suspected leakage must be returned to PVI Customer Service for disposition.)

ELECTRICAL

1. Wiring to the unit should conform to the National Electrical Code or the code legally authorized to your locality. A fused disconnect switch should be used for water heater control. Service wiring connections of 120V, 1 phase, 60 Hz. are located in the enclosure on water heater. (See Figure 21B-8, page 10.)

2. A proper earth ground for this unit must be provided. PVI recommends a single conductor ground wire be pulled from the distribution panel to the sub panel (or some similar type).

NOTE: Use only copper wire of proper sizing for incoming service. Damage resulting from use of aluminum wiring will be excluded from coverage under warranty of this unit.

PVI FIREPOWER®

BG600 GAS BURNER START-UP

(Refer to Figure 21B-1 to identify burner parts)

1. Remove the enclosure panel cover on the water heater or boiler to expose the control circuit. Located on the backside of this cover is a wiring diagram. This diagram will show the controls used in our circuitry.

2. Visually check that all components are intact and no damage has occurred during transit. Check all connections within the control cabinet. A loose connection could cause intermittent shutdowns.

3. The burner control system provides spark ignition and flame safeguard. On a call for heat, the burner motor circuit is energized. The air flow switch circuit closes. Following a short time delay (prepurge) the gas valve(s) opens and ignition occurs.

NOTE: Do not tamper with or readjust program dipswitch settings. This will cause the control to become inoperable. Damage resulting from tampering will be excluded from coverage under the warranty of this unit.

4. Remove flame safeguard control from its base. Check connections in control mounting base; loose connections can cause nuisance shutdowns. When applicable, check time card or programmer, for good connection. **NOTE: Always secure gas lines; tag "Out of Service" before servicing burner nozzle or electrodes.**

5. Pull nozzle assembly to check flame and ignition electrodes. See Figure 21B-8, page 8.

6. With electrodes exposed, check them for the proper settings as stated in Figure 21B-2, page 3. Check for any hairline cracks in the insulators. Should replacement of burner electrodes be required, certain procedures must be followed. In all cases, removal of the electrodes is accomplished by loosening the electrode mounting clamps. Draw the electrodes out of the nozzle assembly through holes in pressure plate.

7. Inspect electrodes for cracked ceramic or loose retaining studs that hold the wire within the ceramic. Select the proper pressure plate hole to place each electrode and insert electrode through the hole, retaining stud end first.

8. Tighten the electrode mounting clamp slightly until electrode ceramics are seated firmly and completely in the mounting bracket without gaps between ceramics and mounting bracket at the bearing faces.

9. Measure and set electrodes according to Figure 21B-2, pg. 3. After the gaps and setting are complete, fully tighten electrode mounting clamp. **Be careful not to overtighten or allow electrodes to impinge on pressure plate opening; insulation may crack.**

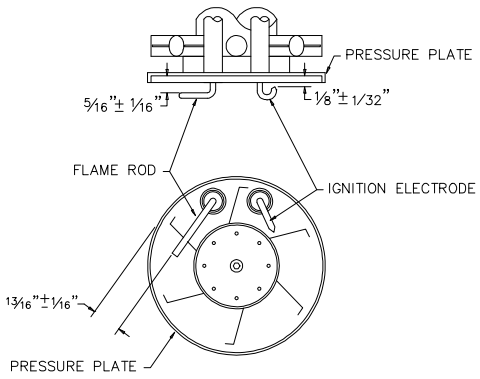


Figure 21B-2

10. Replace nozzle assembly; be sure to connect the flame and spark rod wires before installing nozzle assembly fully into blast tube. Check connections on the ends of the flame and spark rod wires for good contact. Look for properly stripped wire ends. Be sure connectors are firmly attached to flame and ignition rod ends. Insulating boots can give a false feeling of proper seating. **DO NOT MOVE ELECTRODES.** Be careful not to bump electrodes. Check fan wheel for free rotation.

11. Reinstall orifices in unions (if required). Reinstall gas nozzle assembly.

12. The following test equipment is required:
    a) Manometer or suitable gauge for measuring up to 28" W.C. for checking gas pressure.
    b) Draft gauge for determining draft in stack.
    c) Combustion analyzer which measures O_2 or CO_2, CO and stack temperature.
    d) AC/DC multimeter.
    e) Ammeter
    f) Potentiometer (modulating burners only)

13. Connect a test meter to the control for reading the flame response signal.

    NOTE: Some controls read the flame signal in micro amps and some in volts DC. The E110 provides measurement of relative flame strength on its LCD display module. A flame signal of 10 is the minimum acceptable; 20-80 is normal. The MC120 series control has two terminals marked for reading volts DC. A flame signal of 4.0 to 6.0 volts (for UV amplifiers) and 14-18 volts (for flame rectification amplifiers). The S89 control uses a micro amp signal for measuring flame strength. For this control, a meter must be hooked in series with the flame rod wire. Disconnect the leadwire at the S89 sensor terminal. Connect the positive lead of the meter to the quick-connect sensor terminal on the S89 and the negative lead to the free end of the sensor leadwire. Normal flame signal strength should be printed on the control case.

14. Be sure the tank is filled with water. Once the burner is reassembled, two devices to read pressure, preferably U-tube manometers, will be needed to read gas pressures. Connect one to read the inlet pressure of burner. This is the pressure measured before all components in the gas train. The manometer must stay connected throughout the testing, as the inlet pressure must be monitored during the firing of the burner. Record static pressure; it must not exceed the maximum inlet pressure of either regulator. This pressure will be recorded on each regulator. Pressures above this could cause damage to the diaphragm in the gas valve or pressure regulator.

15. Drill ¼" test hole in stack approximately 8" from vent connection (before the draft regulator).

16. Check terminal L1 and L2 in control cabinet to determine if proper control voltage has been supplied.

17. With fuel selector switch or burner power switch in off position, turn on main power switch, and reset low water cutoffs located in control cabinet.

18. Check to determine if correct voltage has been supplied to the blower motor.

19. For modulating burner: if no manual control is provided, it will be necessary to install a potentiometer in place of the modulating control devise for evaluation or adjustment of combustion.

20. Open manual gas valve.

21. Turn burner on to check blower motor rotation.

22. Place the high/low manual-auto switch in low fire position, if supplied. This will lock burner in low fire. *If the burner is supplied with a Landis & Gyr SQM5 modulation motor, refer to Figure 21B-3, below.*

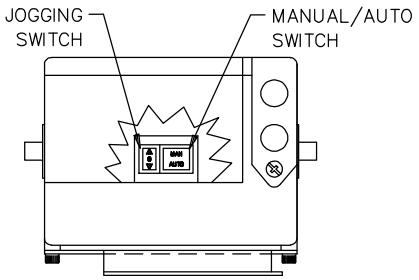


Figure 21B-3

23. When the blower motor starts, the air proving indicator (or 3 to P running interlock) on the MC120 or E110 control should be satisfied. This indicates a positive airflow condition. If the air proving indicator is not on, turn air proving switch adjustment screw counter-clockwise until the air proving light comes on, then turn screw one turn counter-clockwise. If the gas valves open and close intermittently during normal operation, turn screw one half counter-clockwise until this condition ceases. This procedure should be followed with every burner.

24. The burner control will go through a short prepurge. During that time the modulating motor should drive the air shutter to the full open position then back to low fire position before pilot ignition occurs.

25. The flame signal (a measure of the relative strength of the pilot or main flame) should be within the control manufacturers specified range. If the pilot fails to light during the initial period, check for air in the line. The control will lockout. Press the flame safeguard reset button to reset burner and begin the purge cycle again.

26. Once the pilot flame is established, set the pilot pressure (measure at the shutoff valve closest to the burner) at the pressure shown on the tag attached to the gas train.

27. Now open the main gas shutoff valve slowly. Allow burner to fire for at least 5 minutes or until the stored water temperature is at least 120°F. Premature testing can result in inaccurate combustion readings. **NOTE: Condensate coming from the tubes on a cold start is normal and does not indicate a leaking tube. This condensate will appear at the fitting in the lower part of the flue collector.**

28. The following pertains to flue gas analysis when supplied, for natural gas or LP **with fixed input control**. Refer to Figure 21B-4, page 7.

    a) Readings need to be taken from a hole in the vent several inches downstream of flue outlet connection but below the draft regulator.

    b) Insert draft gauge into the test opening in stack. Draft in the stack should read between -.02 to -.06" W.C. Adjust draft regulator to bring draft within this range.

    c) Check the manifold gas pressure. If set at the factory specified pressure in ("WC), proceed to paragraph (d). If the manifold gas pressure is too low, increase the gas pressure by adjusting the main gas regulator clockwise; decrease by turning counter-clockwise.

    d) Gradually close air damper to decrease O_2 reading or open air damper to increase O_2 reading until optimum O_2 % (4-6%) is reached. Refer to Figure 21B-6, page 8.

    e) CO should not exceed 100 ppm. A reading greater than 100 ppm indicates a lack of air or misadjusted gas nozzle assembly. Open air damper slightly or reduce firing rate, exceeding 6% O_2 if necessary; note any change in CO. If CO levels are still unacceptable or burner pulsates it may be necessary to adjust gas nozzle assembly. Refer to Figure 21B-6, page 8 for details.

    f) Once combustion is set, take note of the gross stack temperature; maximum gross stack is to be 400° F, minimum net stack is to be 300°F. (NOTE: Net temperature is the total stack temperature, less room temperature.) If an excessively high gross stack temperature is recorded, consult the factory.

29. **The following pertains to flue gas analysis, when supplied, for natural gas or LP with air/gas ratio controller**. (See Figure 21B-5, page 7.) For adjustment of the air/gas ratio controlling actuator, refer to Figure 21B-4, below. The high fire ratio and low fire bias adjustment screws are located on the top of the regulator under a sealed covered plate. The actual settings can be seen through a window on each side of the regulator.

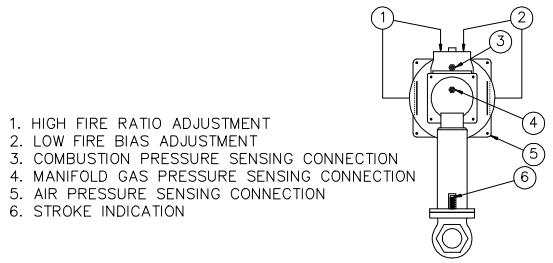


Figure 21B-4

NOTE: The burner firing rate is controlled by the movement of the air damper. The combustion quality (air/gas ratio) is controlled by the settings on the regulator (the + and – indications relate to the change in gas flow).

a) Combustion samples should be taken from a small hole in vent several inches from boiler vent connection but below draft regulator.

b) Insert draft gauge into the test opening in stack. Draft in the stack should read between -.02 to -.06" W.C. Adjust draft regulator to bring draft within this range.

c) Set the gas flow at low fire to achieve an O_2 content in the vent gas of 5 to 7% (low fire bias adjustment).

d) Switch to manual modulation and increase firing rate to approximately 90% of full capacity and set the gas flow to achieve an O_2 content in the vent gas of 4 to 6% (high fire ratio adjustment).

e) Return to low fire and measure O_2. If necessary, correct the setting by adjusting the low fire bias. Repeat these steps until optimum values are obtained.

f) CO should not exceed 100 ppm. A reading greater than 100 ppm indicates a lack of air or misadjusted gas nozzle assembly. Open air damper slightly slightly or reduce firing rate, exceeding 7% O_2 if necessary; note any change in CO. If CO levels are still unacceptable or burner pulsates it maybe necessary to adjust gas nozzle assembly. Refer to Figure 21B-7, page 8 for details.

g) Once low and high fire combustion has been set, take an O_2 and CO reading at 5 equally spaced inputs. These readings should met the criteria in steps (c) and (d).

h) Confirm that the manifold gas pressure at high fire is correct to achieve full rated input.

30. **The following pertains to flue gas analysis for natural gas or LP when supplied with metering valve**. (Refer to Figure 21B-5, pg. 7.)

a) Combustion samples should be taken from a small hole in the vent several inches from the burner vent connection but below draft regulator.

b) Insert draft gauge into the test opening in stack. Draft in the stack should be read between -.02 to -.06" W.C. Adjust draft regulator to bring draft within this range.

c) The percentage of O_2 in the vent gas at low fire, for modulating burners, should be between 5 and 7%. If O_2 does not fall within this range, adjust air and/or fuel pressure to achieve proper combustion.

d) The CO should not exceed 100 ppm. A reading greater than 100 ppm indicates a lack of air or misadjusted gas nozzle assembly. Open air damper slightly or reduce firing rate, exceeding 7% O_2 if necessary; note any change in CO. If CO levels are still unacceptable or burner pulsates it maybe necessary to adjust gas nozzle assembly. Refer to Figure 21B-6, page 7 for details.

e) Once combustion is set properly at low fire and the water temperature is at least 100°F, manually control burner to high fire, repeat steps (c) and (d), adjusting the O_2 range between 4 and 6%. This will apply to both fixed input and modulating burners. All adjustments on modulating burners should be made at low fire, so as to not to disturb previous low fire settings.

f) Confirm the manifold gas pressure is correct, so as to achieve full rated input.

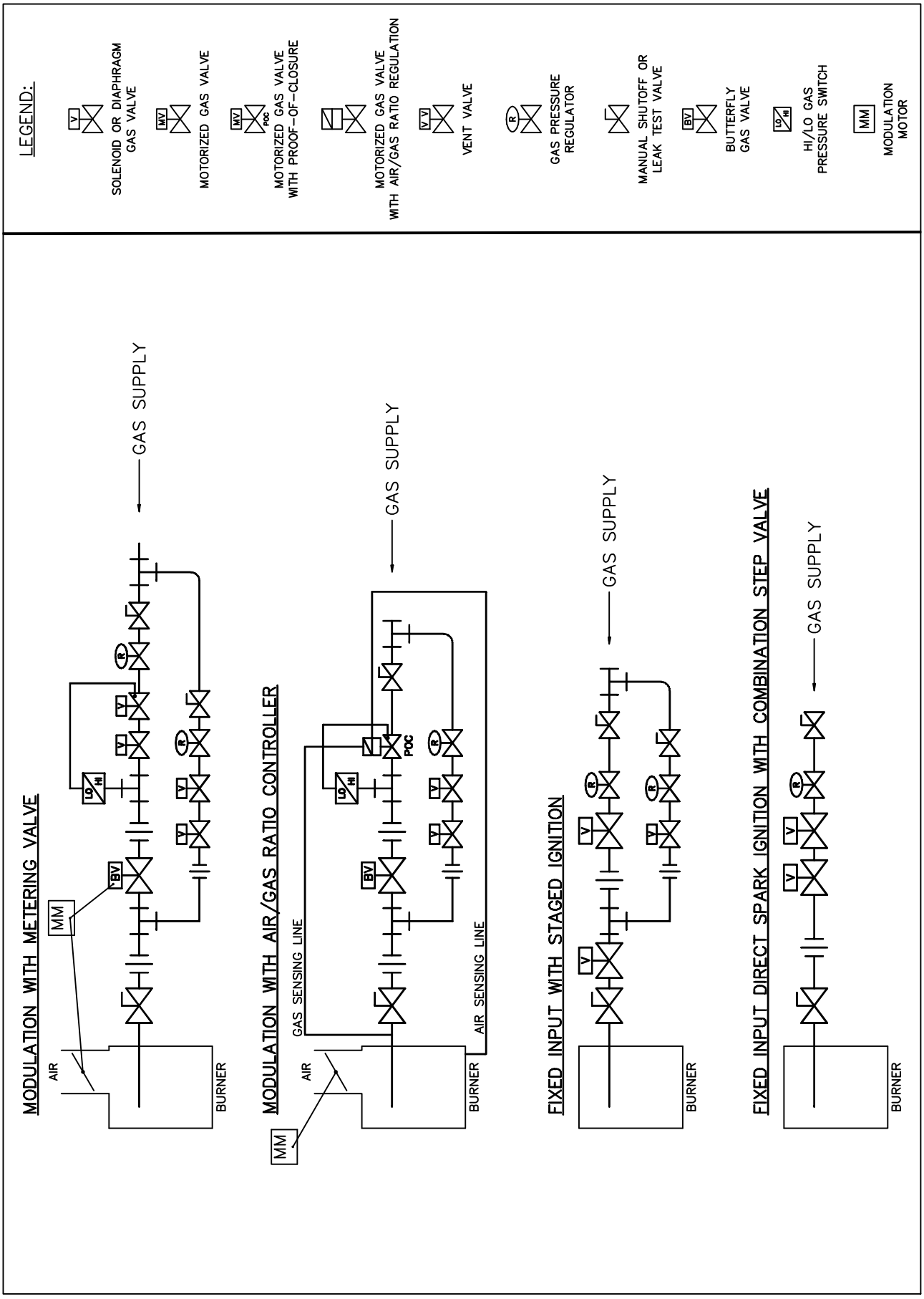
g) Once low and high fire combustion has been set, take an O_2 and CO reading at 5 equally spaced inputs. These readings should met the criteria in steps (c) and (d).

NOTE: Never change fuel or air adjustment without first consulting with PVI Customer Service or an authorized service company.

31. Make sure air shutter is locked securely in place. (Refer to Figure 21B-6, page 8.)

32. Check each operating and limit control to be sure they function properly by lowering and raising the temperature setting on each of the controls, causing the burner to cycle on and off.

33. Record the following information for future use:
    a) Air shutter position _____
    b) Manifold gas pressure_____" W.C.
    c) Stack draft _____" W.C.
    d) O_2 reading _____% (4-6%)
    e) CO_2 reading _____% (8-9%)
    f) CO reading _____% (less than .03%)
    g) Stack temperature:
       Gross _____°F.
       Less ambient _____°F.
       Net _____°F.
    h) Combustion efficiency _____



Gas Train
Figure 21B-5

AIR ADJUSTMENT

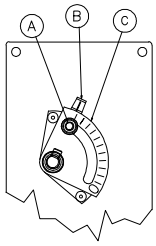


Figure 21B-6

Loosen the locking screw (A) and move the lever (B) along the scale (C) to the position wanted and tighten the screw. Check the air adjustment by making a flue gas analysis.

GAS NOZZLE ADJUSTMENT

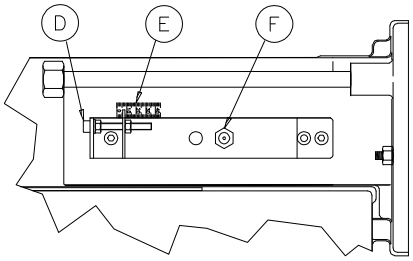


Figure 21B-7

High carbon monoxide can be caused by a misaligned gas nozzle assembly. Turning the adjustment screw (D) clockwise will retract the gas nozzle assembly, which can improve alignment.

Flame pulsation can be caused by poor flame retention. Turning the adjustment screw (D) clockwise will retract the gas nozzle assembly, which will increase flame retention.

Retracting the gas nozzle assembly will restrict air flow thereby reducing the input of the burner. Any adjustments should be gradual.

Adjustment of the gas nozzle assembly is done using a 5mm allen wrench. Record the position of the nozzle on the position indicating scale (E).

Removal of the gas nozzle assembly requires the removal of the nut (F) which secures the adjustment arm of the nozzle assembly.

GAS NOZZLE ASSEMBLY REMOVAL DETAIL

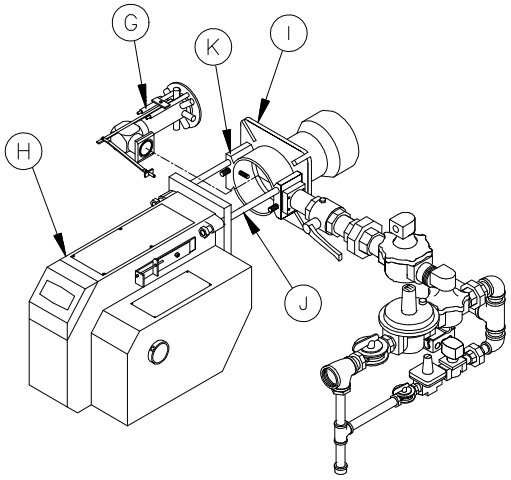


Figure 21B-8

To remove the gas nozzle assembly (G), unbolt burner housing (H) from mounting flange (I) and retract along support rods (J). Disconnect the electrode wires without stressing the electrodes; make note of their location. Now loosen the bolt (K) which presses the nozzle against the gas adapter. Be careful not to break the electrode while extracting the nozzle.

PVI FIREPOWER®

TROUBLESHOOTING SUGGESTIONS

BG600 GAS BURNER

1. BURNER FAILS TO START:

A. **Defective on/off switch.** Replace switch.

B. **Control circuit has open control contact.** Check limits, low water cutoff, and others as applicable.

C. **Bad fuse or switch open on incoming power source.** Correct as required.

D. **Flame safeguard control safety switch tripped out.** Reset and determine cause of apparent flame failure.

E. **Loose connections or faulty wiring.** Tighten all terminal screws and consult wiring diagram furnished with the heater.

F. **Flame safeguard control starting circuit blocked due to flame relay being energized.** Possible defective scanner or flame rod - replace. Possible defective amplifier - replace. Scanner actually sighting flame due to leaking fuel valve - correct unwanted flame cause. Defective flame safeguard control - replace.

G. **Defective blower motor.** Check for free rotation of fan wheel. Repair or replace.

H. **Air proving switch is not properly adjusted.** Adjust per instructions on pg. 4, paragraph 23.

I. **Direct short due to component failure or mis-wiring.** Isolate power from unit; **POWER OFF**. Disconnect neutral wire, (L2) from the power source. Using an ohmmeter, test from the grounding lug on the sub-base to the other terminals. At no time should the meter show continuity or read 0 ohms. Reconnect the neutral wire (L2) to the power source. Now test from the L2 terminal on the sub-base to the other terminals. It is normal to obtain a resistance at some terminals, but at no time should there be a 0-ohm reading.

2. OCCASIONAL LOCKOUTS FOR NO APPARENT REASON:

A. **Gas pilot ignition failure.** Check to see that ignition is instant and flame signal readings are stable and above minimum values. Use a manometer to make certain pressure is as recommended.

B. **Loose or broken wires.** Check all wire nut connections and tighten terminal screw connections in panel and elsewhere as appropriate.

C. **With flame safeguard controls that incorporate the air flow switch in the non-recycling circuit,** ensure that when main flame lights, the air flow switch is not so critically set as to allow occasional momentary opening of the air switch contacts.

D. **Occasional low supply voltage.** Contact local utility to correct. Make certain the burner control circuit transformer (if supplied) is correct for the voltage and power (VAC) being supplied.

E. **Occasional low gas supply pressure.** Contact local utility to correct.

F. **Improper grounding to control.** Provide proper earth ground and confirm proper bonding to control.

G. **Incorrect polarity.** Verify and change polarity to heater.

H. **Improper voltage to burner.** Insure proper voltage (plus 10% - minus 15%).

I. **Excessive amp draw on ignition and gas valve circuits.** Identify & replace defective component.

3. BURNER MOTOR RUNS, BUT PILOT DOES NOT LIGHT:

A. **Gas supply to burner shut off.** Make sure all manual gas supply valves are open. Automatic high pressure valve at meter such as "Sentry" type tripped shut due to high gas pressure. Reset valve and correct cause for trip out.

B. **Pilot solenoid valve not opening.** Listen and feel for valve actuation. **Solenoid valve not being powered.** Check electrical circuitry. Replace coil or entire valve if coil is burned out.

C. **Defective gas pilot regulator.** Replace.

D. **Gas pressure too high or too low at pilot orifice** (if supplied). Check orifice size in gas pilot assembly. Replace if incorrect. Readjust pressure as required.

E. **Defective ignition transformer.** Replace.

F. **Incorrect ignition electrode settings.** Readjust as required.

G. **Defective flame safeguard control or plug in purge timing card.** Replace as required.

H. **Air flow switch not making circuit.** Check out electrically. **Defective air flow switch**. Replace. **Air switch negative pressure sensing tube out of position.** Reposition as necessary.

4. BURNER MOTOR RUNS & PILOT LIGHTS, BUT MAIN GAS FLAME IS NOT ESTABLISHED:

A. **Main shutoff or test cock closed.** Check to make certain fully open.

B. **Pilot flame signal reading too low to pull in flame safeguard relay.** Readjust as required.

C. **Defective automatic main or auxiliary gas shutoff valves.** Check electrical circuitry to valves. Replace valves or correct circuitry as required.

D. **Main diaphragm shutoff valve opening too slowly.** Adjust bleed on valve.

E. **Defective flame safeguard control or plug on amplifier.** Check and replace as required.

F. **Main gas pressure regulator atmospheric vent line obstructed.** Correct.

G. **Defective main gas pressure regulator.** Replace. **Misadjusted main gas pressure regulator.** Readjust to meet required operational values.

H. **Polarity reversed on incoming power.** (S89 control only.)

5. CARBON MONOXIDE READINGS ON GAS FIRING:

A. **Flame impingement on "cold" heat transfer surfaces caused by excessive firing rate.** Reduce firing rate to correct input volume.

B. **Incorrect gas/air ratios.** Readjust burner to correct CO_2 / O_2 levels, eliminate all CO formation.

C. **Gas nozzle misadjusted.** Adjust nozzle per instruction in Figure 21B-7, page 8.

6. GAS HIGH FIRE INPUT CANNOT BE ACHIEVED:

A. **Gas company pressure regulator or meter operating incorrectly, not allowing required gas pressure at burner train inlet.** Contact gas company to correct.

B. **Gas cock upstream of train inlet not fully open.** Check and correct.

C. **Gas line obstructed.** Check and correct.

D. **Gas train main and/or lead test cocks not fully open.** Check and correct.

E. **Gas supply line between gas company regulator and burner inlet too small.** Check supply pressure at meter, determine pressure drop and increase line size as required, or raise supply pressure to compensate for small line. Do not raise pressure so high that under static (no flow) conditions the pressure exceeds the maximum allowable pressure to the gas train components on the burner.

F. **Gas nozzle misadjusted.** Adjust nozzle per instruction in Figure 21B-7, page 8.

G. **Automatic gas valve not opening fully due to defective operation.** Replace gas valve.

H. **Orifice (if supplied) too small.** Replace with correct size.

I. **Defective main gas pressure regulator.** Replace.

J. **Incorrect spring in main gas pressure regulator.** Replace as required.

K. **Main gas pressure regulator vent line obstructed.** Check and correct.

L. **Normally open vent valve (if supplied) not closing when automatic gas valves open.** Replace vent valve, if not closing fully.

Additional troubleshooting information can be found in the Flame Safeguard bulletin supplied with the burner.