BURNER REMOVAL and CLEANING

a. Turn off main power to boiler.

b. Turn off main manual gas shutoff to boiler.

c. Remove the front outer jacket panels.

d. Disconnect manifold from gas train using union(s) just below each gas valve(s).

e. Remove mounting screws from manifold mounting brackets. Pull the manifold/orifice assembly away from burners. Repeat for each manifold assembly.

f. Remove three mounting screws from burner and slide burner out toward front of boiler. Use caution to prevent damage to burners, burner gaskets, refractory, hot surface ignitor or wiring.

g. Remove soot from burners with a stiff bristle brush. Dirt may be removed from burner ports by rinsing the burner thoroughly with water. Drain and dry burners before reinstalling. Damaged burners must be replaced.

A unit installed in a dust or dirt contaminated atmosphere will require cleaning of the burners on a 3 to 6 month schedule or more often, based on severity of contamination. Contaminants can be drawn in with the combustion air. Noncombustible particulate matter such as dust, dirt, concrete dust or dry wall dust can block burner ports and cause non-warrantable failure. Use extreme care when operating a boiler for temporary heat during new construction. The burners will probably require a thorough cleaning before the boiler is placed in service.

HEAT EXCHANGER CLEANING

h. While burners are removed, check the heat exchanger surface for sooting. If soot is present, heat exchanger must be cleaned and problem corrected. Proceed as follows.

i. Remove gas manifold(s)/orifice assemblies as described in steps a. through e. in Burner Removal.

j. Disconnect wiring from hot surface ignitor and hose from burner pressure tap.

k. Remove inner jacket panel mounting screws and slide burner/door assembly out toward front of the boiler. Use caution to prevent damage to the refractory and hot surface ignitor.

l. Check "V" baffles on top of heat exchanger. Remove and clean if necessary.

m. Remove soot from heat exchanger with a stiff bristle brush. Use a vacuum to remove loose soot from surfaces and inner chamber.

n. The heat exchanger can be removed by disconnecting all water piping and sliding towards the front of the boiler. Once the heat exchanger is removed from the boiler, a garden hose can be used to wash the tubes to insure that all soot is removed from the heat exchanger surfaces. **NOTE: Do not wet the boiler s refractory.**

o. Insure that all burner ports are cleaned to remove any soot. See Burner Cleaning Procedure.

p. Carefully reinstall the heat exchanger and "V" baffles if removed from the boiler.

q. Carefully reinstall inner jacket panels, burners, manifolds, wires and hoses. Use new gasket material to insure a proper air seal.

r. Reassemble all gas and water piping. Test for gas leaks.

s. Reassemble outer jacket panels.

t. Cycle unit and check for proper operation.

4. Combustion Air Fan: The combustion air fan should be checked every 6 months. Clean fan as required when installed in a dust or dirt contaminated location.

5. Water Circulating Pump: Inspect pump every 6 months and oil as necessary. Use SAE 30 non-detergent oil or lubricant specified by pump manufacturer.

6. Keep boiler area clear and free from combustible materials, gasoline and other flammable vapors and liquids.

7. Check frequently to be sure the flow of combustion and ventilation air to the boiler is not obstructed.

8. This boiler uses a transformer to supply a low voltage control circuit. The voltage on the secondary side should be 24 to 28 VAC when measured with a volt meter.

9. Combustion Air Adjustment: This boiler uses a fan assisted combustion process. All models have a two speed fan to supply combustion air to the burner stages. The same combustion air fan is used on the 399,999 thru 750,000 Btu/hr models and a larger combustion air fan is used on 650,000 and 750,000 Btu/hr models. The boiler s fan is factory preset and should not need adjustment in most cases. The fan is located in the top chamber. Follow the steps below to adjust fan if a continuous Low Air Light condition is observed:

   a. Check for proper installation and draft in venting system. Correct as required.

   b. Turn the power switch to the "OFF" position.

   c. Remove upper front jacket access doors.

   d. Turn the gas valve knob(s) to the "OFF" position.

Combustion Air Fan Adjustment

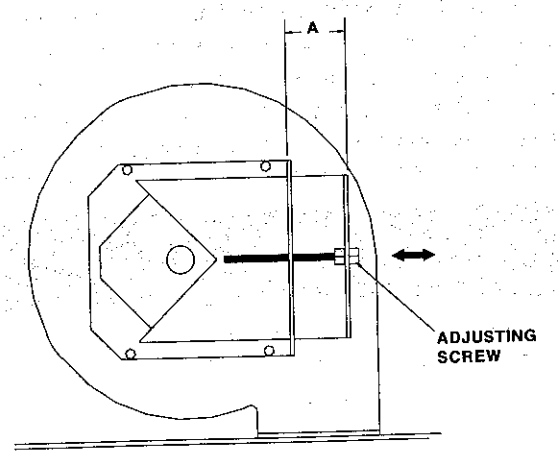


FIG. 39

   e. Use a rule to measure the distance between the outside surface of the fixed flange and the outside surface of the movable flange on the on the fan s air shutter. This distance is set by turning the adjusting screw on the air shutter assembly. See FIG. 39. Compare this distance to the specified A dimension for the boiler .

TABLE Q
AIR SHUTTER ADJUSTMENT OPENING

Model	A Dimension Opening
399,999	2 1/8"
500,000	1 3/4"
650,000	1 1/2"
750,000	1 3/8"

   f. If adjustment is necessary, follow these steps. If no adjustment is necessary, go to I .

   1. Turn air shutter adjustment screw clockwise to open the shutter and counter clockwise to close the shutter.

   2. Adjust the air shutter to the specified A dimension between the flanges and check with a rule. See Table Q.

   3. Proceed to step n to check appliance for proper operation.

   g. If the boiler does not function properly after manually setting the air shutter, use a Manometer magnahelic or slope gauge to set the air shutter based on differential air pressure.

Combustion Air Adjustment with a Manometer to set Differential Pressure

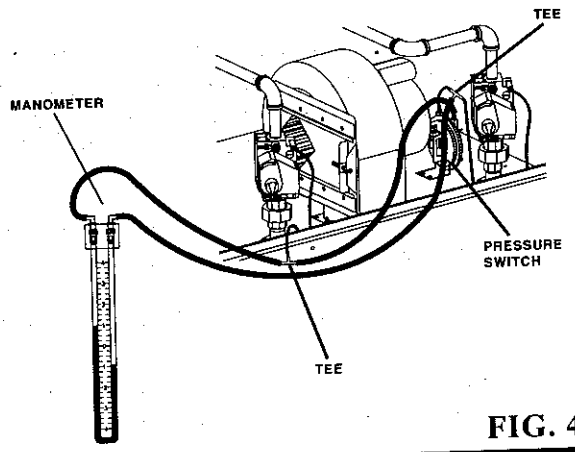


FIG. 40

   h. Install a tee in each of the hoses connecting the chamber pressure and burner venturi pressure to the low air pressure switch. Install a connecting hose from the branch of each tee to a magnahelic or slope gauge, legible in 0.1" increments up to 3" w.c. Connect **chamber**

pressure to the positive pressure side of the gauge "⊕" and burner venturi pressure to the negative side "⊖" of the gauge.

i. Turn the power switch to the "ON" position. Combustion air fan should start. Leave the gas valve "OFF".

TABLE R	
Models	Differential Pressure
399,999	1.8 - 2.2 w.c.
500,000	1.8 - 2.2 w.c.
650,000	1.8 - 2.2 w.c.
750,000	1.8 - 2.2 w.c.

j. With the combustion air fan running, the gauge will read a system differential pressure. The proper differential pressure should be in the following range, depending upon length of vent pipe used:

k. If adjustment is necessary, follow these steps. If no adjustment is necessary, go to step "L".

1. Turn air shutter adjustment screw clockwise to open the shutter and counter clockwise to close the shutter. See FIG. 37.

2. If differential pressure needs increasing, open the air shutter gradually and evenly. Close the air shutter to decrease differential pressure.

3. If the differential pressure cannot be obtained, shut the appliance down and inspect the vent system (both air and flue gas passageways) for obstructions or leaks.

4. Check the differential air pressure setting on the magnahelic or slope gauge.

L. Turn the power switch to the "OFF" position.

m. Remove gauge and tee connections, insuring connections are made at the pressure switch correctly; the chamber pressure to the "⊕" connection and the burner venturi pressure to the "⊖" connection.

n. Replace upper front access doors.

o. Turn the gas valve knob to the "ON" position.

p. Push the reset button for the ignition control and turn the power switch to the "ON" position.

q. When the main burner lights, observe the burner flame through observation port. Flames should be light blue in color with slight yellow tips; flames should be settled on burner head with no lifting.

r. The appliance is now ready to operate.

GAS TRAIN and CONTROLS

Gas Train Drawing
399,999—750,000 Btu Models

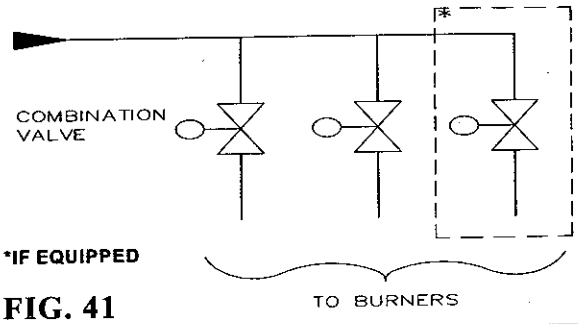


FIG. 41

NOTE: **The gas train and controls assembly provided on this unit have been tested under the applicable American National Standard to meet minimum safety and performance criteria such as safe lighting, combustion and safety shutdown operation.**

PIPING OF THE BOILER SYSTEM

The drawings in this section show typical boiler piping installations. Before beginning the installation, consult local codes for specific plumbing requirements. The installation should provide unions and valves at the inlet and outlet of the boiler so it can be isolated for service. An air separation device must be supplied in the installation piping to eliminate trapped air in the system. Locate a system air vent at the highest point in the system. The system must also have a properly sized expansion tank installed. Typically, an air charged diaphragm-type compression tank is used. The expansion tank must be installed close to the boiler and on the suction side of the system pump to insure proper operation. **Caution: this boiler system should**

not be operated at less than 12 PSIG. Hot water piping must be supported by suitable hangers or floor stands, NOT by the boiler. Copper pipe systems will be subject to considerable expansion and contraction. Rigid pipe hangers could allow the pipe to slide in the hanger resulting in noise transmitted into the system. Padding is recommended on rigid hangers installed with a copper system. The boiler pressure relief valve must be piped to suitable floor drain. See the relief valve section in the Installation and Service Manual.

CAUTION !!

A leak in a boiler system will cause the system to intake fr esh water constantly, which will cause the tubes to accumulate a lime/scale build up. This will cause a NON-WARRANTABLE FAILURE.

WATER CONNECTIONS HEATING BOILERS ONLY

Boilers with inputs of 399,999-750,000 Btu/hr have 2" NPT inlet and outlet connections. Caution, field installed reducing bushings may decrease flow resulting in boiler noise or flashing to steam.

CIRCULATOR PUMP REQUIREMENTS

This is a low mass, high efficiency hot water boiler which must have adequate flow for quiet, efficient operation. Pump selection is critical to achieve proper operation. A pump should be selected to achieve proper system design water temperature rise. A heat exchanger pressure drop chart (FIG. 42) is provided to assist in proper pump selection. Also provided is a System Temperature Rise Chart (Table S). This table provides GPM and boiler head-loss at various temperature rises for each boiler based on Btu/hr input. Temperature rise is the difference in boiler inlet temperature and boiler outlet temperature while the boiler is firing. Example: The boiler inlet temperature is 160°F and the boiler outlet temperature is 180° F, this means that there is a 20° F temperature rise across the boiler

HEAT EXCHANGER PRESSURE DROP CHART

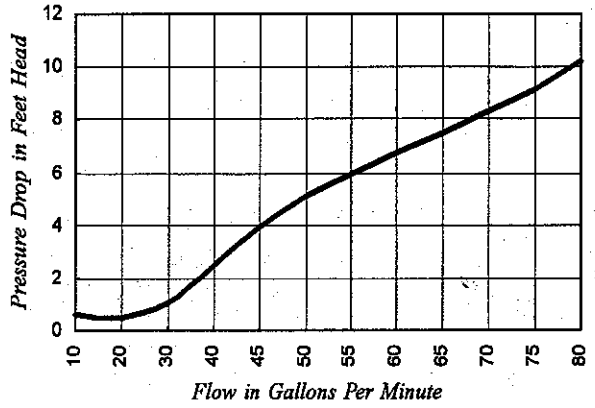


FIG. 42

CIRCULATOR PUMP SPECIFICATIONS

1. Maximum operating pressure for pump must exceed system operating pressure.
2. Maximum water temperature should not exceed nameplate rating.
3. Cast iron circulators may be used for closed loop systems.
4. A properly sized expansion tank must be installed near the boiler and on the suction side of the pump.

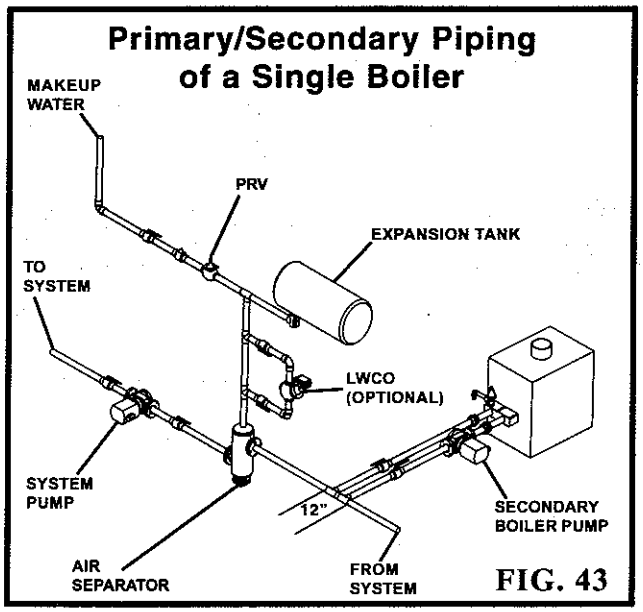
CIRCULATOR PUMP OPERATION (Heating Boilers Only)

The boiler pump should run continuously unless the boiler is provided with the optional intermittent pump or pump delay control system. These optional pump control systems are available as factory installed options. These pump control systems consist of a relay and a time delay wired into the control circuit of each heating boiler. External wire leads are furnished with this option to allow the power supply for the pump to be switched across the normally open contacts of the relay, allowing the control relay to cycle the pump on each call for heat. The field installed boiler pump using the optional factory supplied pump control system must not exceed 10 AMPS at 120VAC. As shipped from the

factory, the optional control systems are set to cycle the boiler pump on at each call for heat before the burners fire and run the pump for a 30 second period after the thermostat is satisfied. This will remove any residual heat from the combustion chamber before turning the pump off. See wiring diagram shipped with the unit.

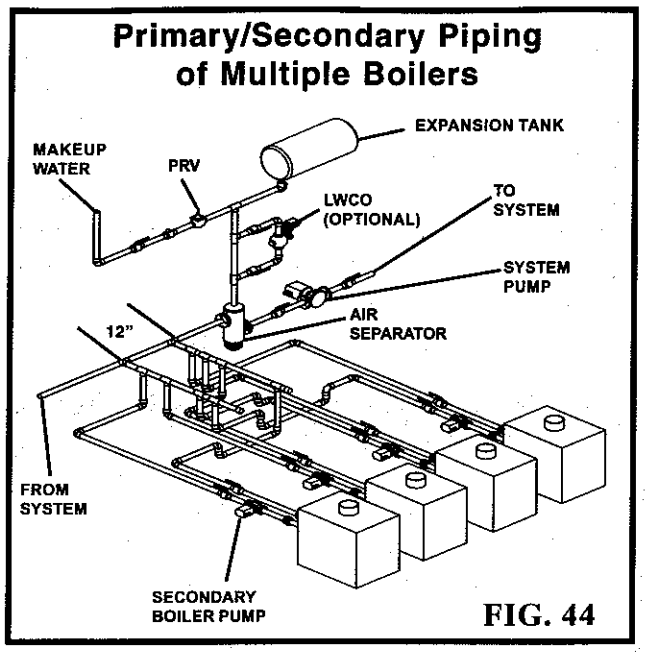
PUMP INSTALLATION AND MAINTENANCE: For installation and maintenance information on the circulator pump, refer to pump manufacturers instructions included in the instruction package.

PRIMARY/SECONDARY BOILER PIPING



PRIMARY/SECONDARY BOILER PIPING

Boiler installations with a primary/secondary piping system as shown in FIG. 43 are recommended. This type of system uses a dedicated pump to supply flow to the boiler only. This secondary pump is sized based on desired boiler flow rate, boiler head loss and head loss in the secondary system piping only. A properly sized system pump provides adequate flow to carry the heated boiler water to radiation, air over coils, etc. The points of connection to the primary system should be a maximum of 12" (or 4 pipe diameters) apart to insure connection at a point of zero pressure drop in the primary system. Multiple boilers may also be installed with a primary/secondary manifold system as shown in FIG. 44. The multiple boilers are connected to the manifold in reverse return to assist in balancing flow to multiple boilers.

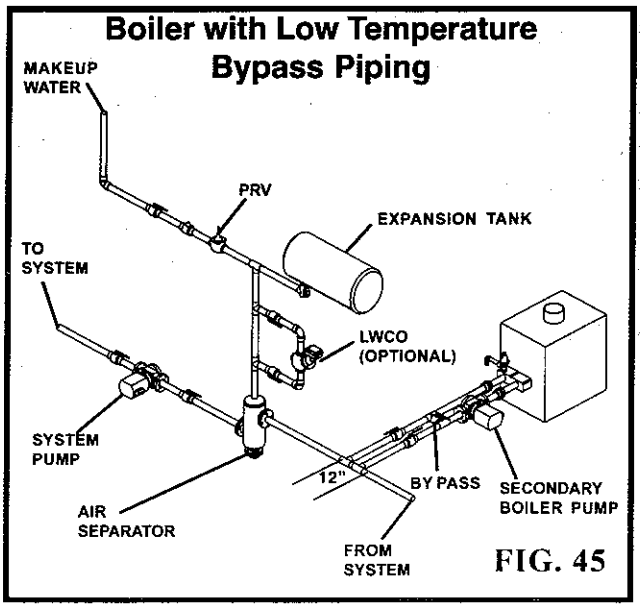


The installer must insure that the boiler has adequate flow without excessive temperature rise. Low system flow can result in overheating of the boiler water which can cause short burner on cycles, system noise and in extreme cases, a knocking flash to steam. These conditions indicate the need to increase boiler flow by installation of a larger circulator pump or the installation of a system bypass. System noise may also indicate an oversized boiler.

CAUTION !!

At no time should the system pressure be less than 12 PSIG.

LOW TEMPERATURE BYPASS REQUIREMENTS



A boiler operated with an inlet temperature of less than 140° F (60° C) must have a bypass to prevent problems with condensation. A bypass as shown in FIG. 45 must be piped into the system at the time of installation. This piping is like a primary/secondary boiler installation with a bypass in the secondary boiler piping. Inlet water temperatures below 140° F (60° C) can excessively cool the products of combustion resulting in condensation on the heat exchanger and in the flue. Condensation can cause operational problems, bad combustion, sooting, flue gas spillage and reduced service life of the vent system and related components. The bypass allows part of the boiler discharge water to be mixed with the cooler boiler return water to increase the boiler inlet temperature above 140° F (60° C). This should prevent the products of combustion from condensing in most installations. The bypass should be fully sized with a balancing valve to allow for proper adjustment. A valve must also be provided on the boiler discharge, after the bypass. Closing this discharge valve forces water through the bypass. Start boiler adjustment with the bypass valve in the full open position and the boiler discharge valve half open. A small amount of the higher temperature boiler discharge water is mixed with the system water to maintain the desired lower system temperature. A remote low temperature range operator is recommended to control the boiler operation based on the lower system temperature. This remote operator should be wired across the N and A terminals (See Thermostat Connection and Terminal Strip instructions).

THREE WAY VALVES

Boiler Piping with a 3-Way Valve

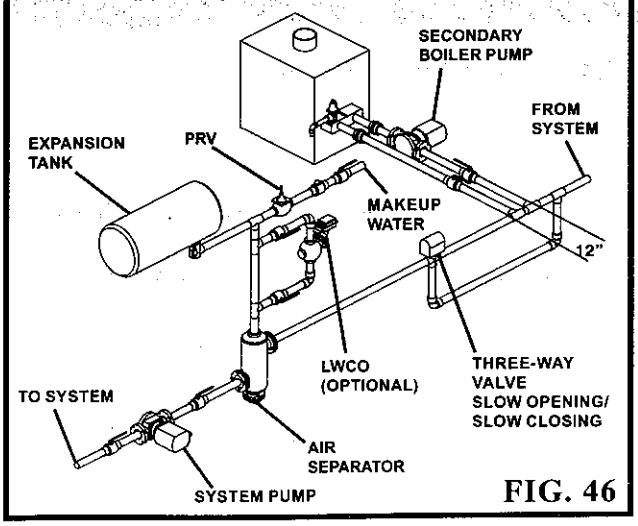


FIG. 46

The installation of a three way valve on this boiler is not generally recommended because most piping methods allow the three way valve to vary flow to the boiler. This boiler is a low mass, high efficiency boiler which requires a constant water flow rate for proper operation. Low flow rates can result in overheating of the boiler water which can cause short burner on cycles, system noise and in extreme cases, a knocking flash to steam. These conditions can cause operational problems and non-warrantable failures of the boiler. If a three way valve must be installed, please pipe in a primary/ secondary system as shown in FIG. 46. Based on boiler sizing and system flow requirements, this piping may still result in boiler short cycling.

MAXIMUM REQUIRED FLOW FOR HEATING BOILER

CAUTION !!

The maximum flow rate through the boiler with a copper heat exchanger must not exceed the following:

Input-Btu/hr	Maximum Flow
399,999 through 750,000	60 GPM

If higher flow rates are required through the boiler, an optional Cupro-Nickel heat exchanger is available. Consult the factory for specific application requirements.

The heat exchanger is generally capable of operating within the design flow rates of the building heating system. Should the flow rate exceed the maximum allowable flow rate through the boiler an external bypass must be installed. The bypass should be fully sized with a balancing valve to allow for proper adjustment of flow. Flow rate can be determined by measuring the temperature rise through the boiler.

TABLE — S
SYSTEM TEMPERATURE RISE CHART
Based on Btu Input

		10° ΔT		20° ΔT		30° ΔT		40° ΔT		50° ΔT		60° ΔT	
Input	Output	GPM	FT.HD	GPM	FT.HD	GPM	FT.HD	GPM	FT.HD	GPM	FT.HD	GPM	FT.HD
399,999	336,000	68	7.4	34	2.4	23	1.1	17	0.6	14	0.6	11	0.6
500,000	420,000	85+	*	42	4.1	28	1.6	21	0.7	17	0.6	14	0.6
650,000	546,000	110+	*	55	5.2	37	3.0	28	1.6	22	0.8	18	0.6
750,000	630,000	127+	*	64+	*	42	4.1	32	2.3	25	1.2	21	0.7

+These flow rates exceed recommended flow rates of boiler. If these system temperature rises are used, an external piping bypass must be installed.
*These foot head calculations exceed the maximum allowable flow rate of the boiler.

BOILER BYPASS REQUIREMENTS

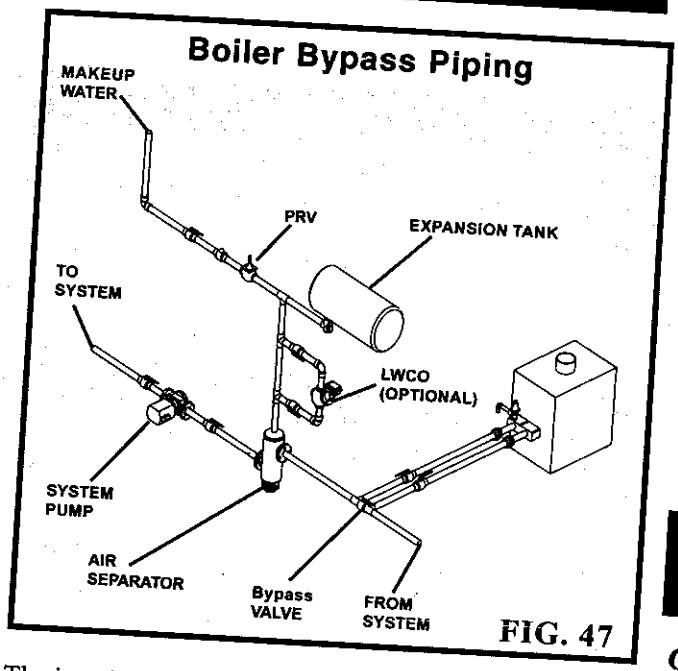


FIG. 47

The installer must insure that the boiler is supplied with adequate flow without excessive temperature rise. It is recommended that this boiler be installed with a bypass in the piping if the maximum recommended flow rate is exceeded. The bypass will help to insure that the boiler can be supplied with adequate water flow. Flow rates exceeding the maximum recommended flow will result in erosion of the boiler tubes. A typical bypass with a valve is shown in FIG. 47 will allow control of boiler flow.

TEMPERATURE / PRESSURE GAUGE

This boiler is equipped with a dial type temperature/ pressure gauge. This gauge is factory installed in the outlet side of the heat exchanger. The gauge has one scale to read system pressure and a separate scale to read water temperature in ¡F. The temperature/pressure gauge can be used to determine temperature rise by first recording the temperature of the boiler water with the boiler off. Record the temperature of the boiler water as the boiler fires and the discharge temperature stabilizes. Subtract the boiler water temperature with the boiler off from the stable outlet water temperature with the boiler firing. This temperature difference is the temperature rise.

TYPICAL HEATING BOILER INSTALLATIONS

General Plumbing Rules

1. Check all local codes.
2. For serviceability of boiler, always install unions.
3. Always pipe pressure relief valve to an open drain.
4. Locate system air vents at highest point of system.
5. Expansion tank must be installed near the boiler and on the suction side of the pump.
6. Support all water piping.

PLACING THE BOILER IN OPERATION

Filling the System: All air must be purged from the system for proper operation. An air scoop and air vent must be located close to the boiler outlet and there should be a minimum distance between the cold water feed and the system purge valve.

1. Close all drain cocks and air vents.

2. Open the makeup water valve and slowly fill the system.

3. If a makeup water pump is employed, adjust the pressure to provide a minimum of 12 psi at the highest point in the system. If a pressure regulator is also installed in the line, it should be adjusted to the same pressure.

4. Close all valves. Purge one circuit at a time as follows:

   A. Open one circuit drain valve and let the water drain for at least five minutes. Ensure that there are no air bubbles visible in the water stream before closing the drain valve.

   B. Repeat this procedure for each circuit.

5. Open all valves after all circuits have been purged. Make sure there are no system leaks.

NOTE: **Do not use petroleum based stop leak products. All system leaks must be repaired. The constant addition of makeup water can cause damage to the boiler heat exchanger due to scale accumulation. Scale reduces flow and heat transfer, causing overheating of the heat exchanger.**

6. Run the system circulating pump for a minimum of 30 minutes with the boiler turned off.

7. Open all strainers in the system and check for debris.

8. Recheck all air vents as described in step 4 above.

9. Inspect the liquid level in the expansion tank. The system must be full and under normal operating pressure to insure proper water level in the expansion tank. Ensure that diaphragm type expansion tanks are properly charged and not water logged.

10. Start the boiler according to the Start-Up Instructions in the Installation and Service Manual. Operate the system, including the pump, boilers and radiation units, for one hour.

11. Recheck the water level in the expansion tank. If it exceeds half the tank volume, open the tank to reduce the water level. Recheck pressure charge on diaphragm type tanks.

12. Shut down the entire system and vent all radiation units and high points in the system.

13. Close the water makeup valve and check the strainer and pressure reducing valve for sediment or debris. Reopen the water makeup valve.

14. Verify system pressure with the boiler pressure gauge before beginning regular operation.

15. Within three days of startup, recheck and bleed all air vents and the expansion tank using these instructions.

INSTALLATION WITH A CHILLED WATER SYSTEM

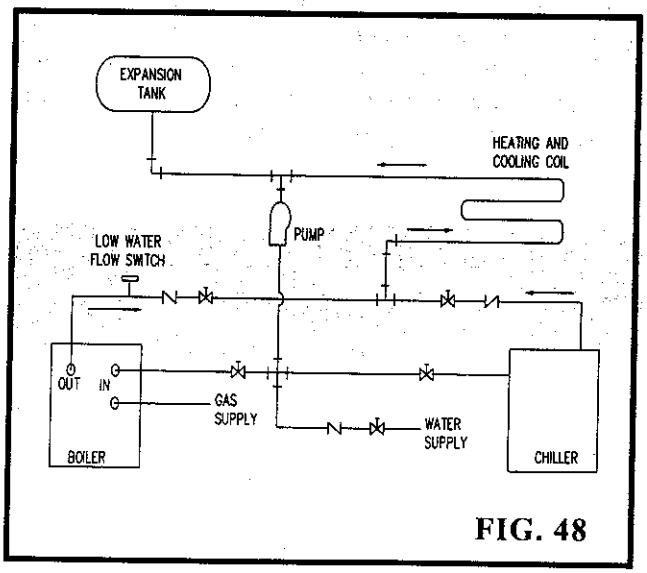


FIG. 48

Pipe refrigeration systems in parallel. Install duct coil downstream at cooling coil. Where the hot water heating boiler is connected to a heating coil located in the air handling boilers which may be exposed to refrigeration.air circulation, the boiler piping system must be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle. The coil must be vented at the high point and hot water from the boiler must enter the coil at this point. Due to the fast heating capacity of the boiler, it is not necessary to provide a ductstat to delay circulator operation. Also, omit thermostat flow checks as the boiler is cold when heating thermostat is satisfied. This provides greater economy over maintaining standby heat. (See FIG. 48)

BOILER OPERATING TEMPERATURE CONTROL

The electronic operating temperature control is located in the front control panel, behind the front access door. The sensing element for the operator is placed in a bulb well installed in the inlet side of the heat exchanger front header. Carefully observe the discharge water temperature on the initial boiler on cycles. The location of the temperature sensor will generally require a lower temperature set point on the operating control to achieve the desired discharge water temperature from the boiler. This sensing element location allows a boiler operating with a low to moderate flow rate to sustain longer burner on cycles, preventing short boiler "ON" cycles based on high discharge water temperatures. For example, a boiler operating with a 180° F discharge and a 20° F temperature rise would require approximately a 160° F to 165° F set point with the temperature sensor installed on the inlet side of the heat exchanger. The exact temperature set point is based on your system s requirements. Set the control set point(s) to the desired operating water temperature. Observe the boiler discharge temperature after each set point adjustment to insure proper operation.

EMS or REMOTE THERMOSTAT CONNECTION TO TERMINAL STRIP

An EMS, remote thermostat or other remote temperature control may be connected to the boiler. Follow the manufacturers instructions supplied with the remote thermostat for proper installation and adjustment. The boiler is equipped with a terminal strip to allow easy connection of a remote switching devices or additional field installed safety controls. The terminal strip on a 399,999 through 750,000 Btu/hr boiler is located in the electrical junction box, below the main gas connection. Connection of a set of dry switching contacts or a remote thermostat to cycle the boiler ON and OFF from a remote source should be made to the N and A terminals. The N and A terminals may also be used to connect any control that routinely cycles or a field installed safety control that you do not want to operate an optional alarm function. Remove the jumper between the N and A terminals before making a connection to these terminals. A control connected to the N and A terminals will interrupt the 24 VAC control circuit to shut off the boiler.

Additional safety controls are added to the boiler s 24 VAC control circuit by connecting them to terminals X and B on the boiler terminal strip. Remove the jumper between the X and B terminals before making a connection to these terminals. A control with contacts that routinely cycle on normal operation should not be connected to these terminals. A control connected to the X and B terminals will interrupt the 24 VAC control circuit to shut off the boiler. A boiler equipped with an optional function to provide alarm contacts or an audible alarm on any control sensed malfunction will also provide the specified optional alarm function based on the operation of a field installed safety control wired across the X and B terminals.

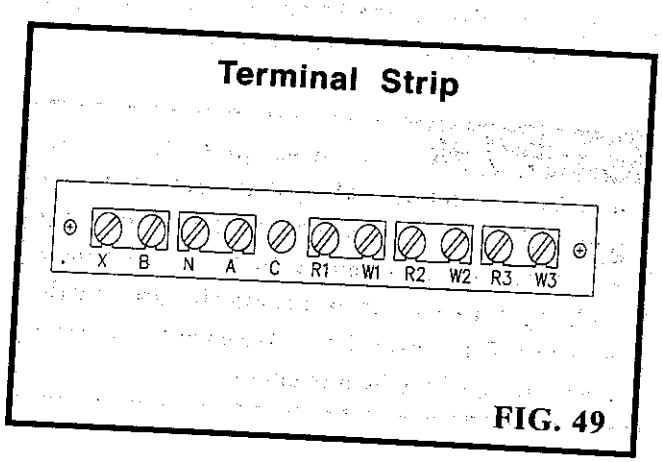


FIG. 49

Remove the brass jumper between the terminals to be used. Refer to the chart in this section to determine maximum allowable wire length and gauge recommended to connect the switching contacts of the remote thermostat or control to the appropriate terminals on the terminal strip.

TABLE T	
Wire Gauge	Maximum Allowable Length
12 GA	100 ft
14 GA	75 ft
16 GA	50 ft
18 GA	30 ft

External Energy Management System Connection to Terminal Strip for Control of Stage Firing of Burners on 399,999 through 750,000 Btu/hr Models

399,999 through 750,000 Btu/hr models are equipped with a factory installed terminal strip for connection of a energy management system (EMS) to the burner stages. The EMS terminal strip is located in the boiler s junction box. The terminal strip has up to three pairs of terminal connections, one pair for each stage of burner operation. These terminals are labeled; R_1 and W_1 for stage 1; R_2 and W_2 for stage 2 and R_3 and W_3 for stage 3. Connection to these terminals requires a set of dry switching contacts to be used for each stage of burner operation. The jumper installed between the terminals of each stage **MUST** be removed when making connection to the EMS dry switching contacts for each stage. The connection to the stages on the terminal strip must always sequence on the stages in increasing order (1,2,3) and sequence off in reverse order (3,2,1). Insure that all wiring used for connection to this terminal strip is properly sized per the recommendations in Table T. When connecting an EMS to this terminal strip to sequence on each stage of burner operation, the unit s internal electronic temperature control should have all stages set as an additional high limit control. This will prevent problems between the set points of the EMS and the boiler s internal controller.

DOMESTIC HOT WATER SUPPLY BOILERS

399,999 - 750,000 Btu/hr MODELS

This section applies only to those boilers used to supply domestic hot water, in conjunction with a storage tank. The use of a properly sized pump and the control of water velocity, as explained below, are important for correct operation of your hot water supply boiler.

This section contains specific instructions for those boilers used to supply domestic hot water. All warnings, cautions, notes and instructions in the general installation and service sections apply to these instructions. Hot water supply boilers are designed for installation with a storage tank. The use of a properly sized pump and the control of water velocity, as explained below, is important for correct operation of your water heater or hot water supply boiler.

WATER VELOCITY CONTROL

IMPORTANT: **To insure proper velocity through the heat exchanger, it is necessary to regulate the temperature rise across the heat exchanger from inlet to outlet. This must be done on initial installation and periodically rechecked. With the correct temperature rise across the heat exchanger, you may be assured of the proper velocity in the tubes. This will yield long life and economical operation from your hot water supply boiler. Excessive lime build-up in the tube is a result of too little velocity in the tubes. Excessive pitting or erosion in the tube is caused by too much velocity through the tubes. Care should be taken to measure temperature rise and maintain a velocity as follows:**

1. The pump must run continuously unless equipped with a factory supplied optional intermittent pump control or pump delay system.

2. With the pump running and the water heater or hot water supply boiler off, the inlet and outlet thermometers should read the same temperatures. If they do not, an adjustment must be made to your final calculation.

3. Turn the water heater or hot water supply boiler on and allow time for the temperature to stabilize. Record the difference between the inlet and outlet temperatures. This difference will be the temperature rise.

4. Compare the temperature rise on the heater with the required temperature rise in Table U. Should adjustment be needed, proceed as follows:

If the temperature rise is too high, the water velocity is too low. Check the following:

1. Check for restrictions in the outlet of the water heater or hot water supply boiler.

2. Be sure all valves are open between the water heater or hot water supply boiler and the tank.

3. Check the pump to be sure it is running properly and that the pump motor is running in the proper direction.

4. Be sure the circulation pipes between the water heater or hot water supply boiler and storage tank are not less than 2" diameter for a single 399,999 through 750,000 Btu/hr boiler installation.

5. Common manifold piping for multiple boiler installations will require larger minimum pipe sizes and tank circulating tappings to insure proper flow. See Table V.

If the temperature rise is too low, the water velocity is too high. Adjust as follows:

1. Slowly throttle the valve on the outlet side of the water heater or hot water supply boiler until the temperature rise is steady at the required temperature rise as noted in Table U.

2. Sustained high water velocity and low temperature rise may result in pitting or erosion of the copper tubes in the heat exchanger. This is a non-warrantable failure. Temperature rise must be properly adjusted to achieve the specified flow rate.

REQUIRED TEMPERATURE RISE

Based on heating potable water with a hardness of 5 to 25 grains per gallon and total dissolved solids not exceeding 350 ppm. See Water Chemistry.

Water Heater Temperature Rise
TABLE U

Btu Input	Temperature Rise °F
399,000	12°F
500,000	15°F
650,000	20°F
750,000	23°F

WATER CHEMISTRY

manufacturer when heating potable water exceeding these specifications. Heating of high hardness and/or high total dissolved solids water will require a larger circulating pump, an optional cupro-nickel heat exchanger and a revised temperature rise specification based on the water chemistry of the water to be heated. Water with a hardness of less than 5 grains per gallon will usually have a low pH which can be aggressive and corrosive causing non-warrantable damage to the heater, pump and associated piping. Corrosion due to water chemistry generally shows up first in the hot water system because heated water increases the rate of corrosive chemical reactions.

Typical Water Heater Piping with Storage Tank

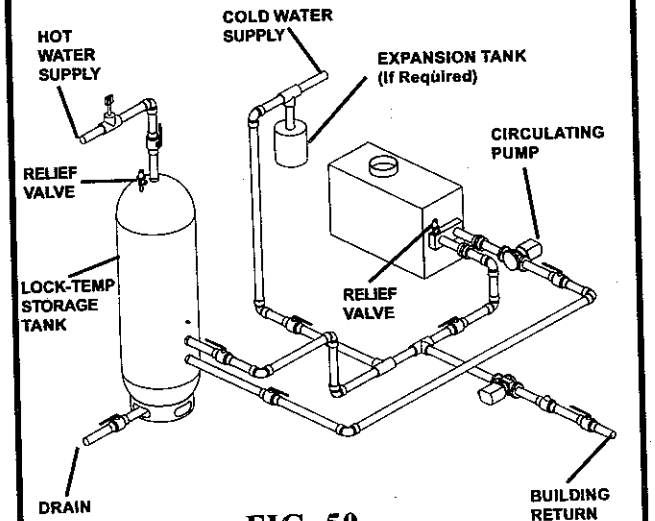


FIG. 50

COMMON WATER MANIFOLD SIZE FOR MULTIPLE HOT WATER SUPPLY BOILER INSTALLATIONS

Pipe sizing chart provides minimum pipe size for common manifold piping to insure adequate flow

Common Manifold Size
TABLE V

Number of Units 399,999 - 750,000	Common Manifold Size (Min)
1	2"
2	3"

PUMP OPERATION

1. The water heater or hot water supply boiler must be connected to a properly sized pump that circulates water between the heater and storage tank.

2. Pump is sized to heater input and water hardness. Care should be taken to size pump correctly. See Water Chemistry.

3. The pump must run continuously unless the water heater or hot water supply boiler is equipped with a factory supplied optional intermittent pump control or pump delay system.

4. Lubricate pump to manufacturers recommendations. Pump damage due to inadequate lubrication is non-warrantable.

5. Standard water heaters or hot water supply boilers are furnished with the following circulating pump to be mounted on the boiler's inlet water connection.

399,999 - 750,000 Btu/hr Models
1/4HP, 120 VAC, 5.8 Amp

This pump is sized based on installation of a single storage tank and heater in close proximity. If the number of fittings and straight pipe exceeds the quantities shown in this section, a larger pump will be required.

The standard pump selection is based on the following pipe and fittings from the boiler to the storage tank:

6 - 90° elbows	**2 - ball valves**
2 - unions	**1 - cold water tee**

Not more than 45 feet of straight pipe.

For every elbow and tee in excess of those shown above, **DEDUCT 5 FEET** from maximum allowable straight pipe in heater to tank circulating loop.

MINIMUM PUMP PERFORMANCE

Based on heating potable water with a hardness of 5 to 25 grains per gallon and total dissolved solids not exceeding 350 ppm. See Water Chemistry.

BTU INPUT	GPM	Ft. Hd.
399,999 - 750,000	55	10

HEAT EXCHANGER

This is a highly sophisticated heat exchanger, designed to carry water in such a way that it generates a scouring action which keeps all interior surfaces free from buildup of impurities. The straight-line, two pass design of the tubes sends water into the headers at a properly rated velocity. The configuration of the headers, in turn, creates a high degree of turbulence which is sufficient to keep all contaminants in suspension. This scouring action provides greater cost savings for owners. Tubes are always able to transfer heat at peak efficiency. Every surface within this water containing section is of a nonferrous material, providing clear, clean, rust-free hot water. Straight copper tubes-finned on the outside for maximum heat transfer-coated cast iron one piece cored headers make up an entirely rustproof boiler. On all models, header inspection plugs can be removed for field inspection and cleaning of copper tubes. The entire heat exchanger may be easily removed from the boiler.

TEMPERATURE CONTROL SETTINGS FOR POTABLE HOT WATER

This high efficiency hot water supply boiler should be operated at a temperature setting high enough to prevent condensing of the products of combustion on the boiler s heat exchanger or in the attached venting system. Use extreme caution when storing water at elevated temperatures. A water temperature setting maintained above the dew point of the products of gas combustion should prevent condensate formation and insure proper performance of the venting system. The manufacturer recommends the use of a properly sized thermostatic mixing valve to supply domestic hot water at temperatures less than 140°F. Storing water at a higher temperature and thermostatically mixing the water will increase the available quantity of mixed hot water, greatly reduce the possibility of condensate formation on the heat exchanger or in the venting system and help prevent the prevent the growth of water born bacteria. Adequate care **MUST** be taken to prevent a potential scald injury when storing water at elevated temperatures for domestic use.

1. This unit is equipped with an electronic operating temperature control.

2. The electronic control set points are pre-programmed to a low test setting when shipped from the factory.

3. Reprogram the temperature set points to the lowest settings which will satisfy hot water demands, eliminate a possible condensate problem and prevent a risk of scald injury.

4. The temperature set points for all stages should be set at the same temperature when supplying potable hot water for domestic use.

5. Stage firing is achieved by setting the differentials at approximately 3° F, 5° F and 8° F for stages 1, 2 and 3. Stage firing of a potable water heater should only be used to replace system standby heat loss.

6. All stages of burner operation should fire when there is a major draw from the potable hot water storage system. This prevents possible condensate problems and insures a rapid recovery of the hot water used.

When water is stored at temperatures above 130°F, a thermostatic mixing valve **MUST** be installed on the hot water outlet from the tank to supply lower temperature water and prevent the risk of a scald injury when supplying hot water for domestic use.

CAUTION!!

DOMESTIC HOT WATER TEMPERATURES

This boiler has an adjustable electronic temperature control to maintain the desired water temperature set point. See temperature adjustment procedure in the general section of the manual for instructions to program the control. The electronic control is factory preset at approximately 125°F or less. Households with small children or invalids may require 120° F or lower temperature hot water to reduce risk of scald injury. Some states may require a lower water temperature setting for specific applications. Check with local codes or your gas supplier for local specifications governing the temperature requirements for domestic hot water. Remember, no water heating system will provide exact temperature at all times. Allow a few days of operation at the settings you have programmed into the control to determine the correct temperature setting consistent with your needs.

NOTE: **(1) This water heater, when set at a lower temperature setting, is not capable of producing hot water of sufficient temperature for sanitizing purposes.**
(2) Higher stored water temperature increases the ability of the water heater to supply desired quantities of hot water, however remember

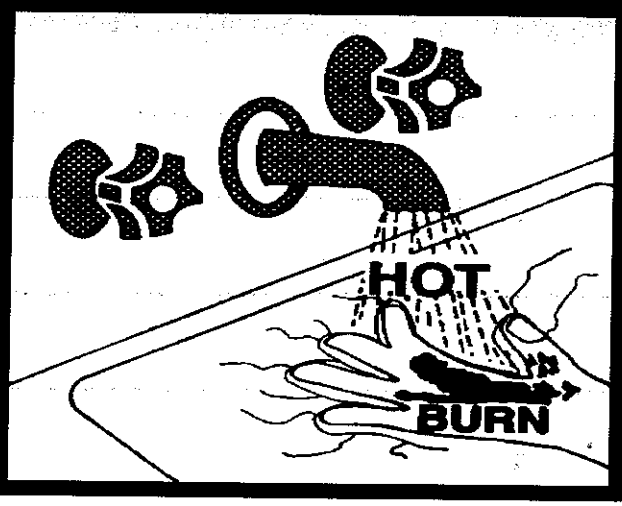
CAUTION !!

Hotter water increases the risk of scald injury.

Location of Cold Water Supply Piping Connections

Incorrect piping of the cold water supply to the system may result in excessive low temperature operation causing condensate formation on the heat exchanger and operational problems. The cold water supply piping must be installed in the discharge piping from the boiler to the storage tank. This allows the cold water to be tempered in the storage tank before entering the heater. See typical installation drawings provided with the

⚠ DANGER



Water temperature over 125°F can cause severe burns instantly or death from scalds.

Children, disabled and elderly are at highest risk of being scalded.

See instruction manual before setting temperature at heating appliance.

Feel water before bathing or showering.

If this appliance is used to produce water that could scald if too hot, such as domestic hot water use, adjust the outlet control (limit) or use temperature limiting valves to obtain a maximum water temperature of 125°F. See manual.

WARNING: ⚠

Should overheating occur or the gas fail to shut off, turn off or disconnect the electrical supply to the pump. Instead, shut off the gas supply at a location external to the appliance.

HIGH WATER TEMPERATURE LIMIT CONTROL

The unit is equipped with a fixed setting, auto-reset high water temperature limit control. The hot water supply boiler temperature limit control has a fixed limit setting of 200° F (93° C). If water temperature exceeds the set point, the limit will break the control circuit and shut down the boiler. The limit control will only be reset after the water temperature has cooled below the set point of the limit. The high water temperature limit control is mounted in the outlet side of the front header. A manual reset high water temperature limit control is available as an optional control.

OPTIONAL RELIEF VALVE

This water heater or hot water supply boiler is normally supplied with a temperature and pressure relief valve(s) sized in accordance with applicable codes. Boilers may be supplied with an optional pressure only relief valve(s). When a water heater or hot water or hot water supply boiler equipped with this optional relief valve is piped to a separate storage vessel, the storage vessel must have a properly installed temperature and pressure relief valve which complies with local codes.

THERMAL EXPANSION

A relief valve which discharges periodically may be due to thermal expansion in a closed system. A hot water supply boiler installed in a closed system, such as one with a backflow preventer or check valve installed in the cold water supply, shall be provided with means to control expansion. Contact the water supplier or local plumbing inspector on how to correct this situation. **DO NOT PLUG OR CAP THE RELIEF VALVE DISCHARGE!**

CATHODIC PROTECTION

Hydrogen gas can be produced in a hot water system that has not been used for a long period of time (generally two weeks or more). **Hydrogen gas is extremely flammable.** To prevent the possibility of injury under these conditions, we recommend the hot water faucet be open for several minutes at the kitchen sink before you use any electrical appliance which is connected to the hot water system. If hydrogen is present, there will be an unusual sound such as air escaping through the pipe as the hot water begins to flow. There should be no smoking or open flames near the faucet at the time it is open.

NOTES

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