

the oil piping is enclosed with steam lines in the same thermal insulation. The economy of the steam preheating method is also dependent on the availability of steam at the pressure and quantity required, and on the distance from boiler to storage tank.

The hot water preheating method utilizes equipment similar to that used for steam. Because of the possibility that oil may penetrate into the boiler through a faulty heat exchanger, some devices have been developed to prevent this condition. Double-transfer heaters and fuel-oil detectors are those most frequently used. Similarly, as with steam, continuity of burner operation, or cycling burner operation, is needed to maintain the temperature of the heating medium. Since oil heating is limited by the water temperature in the boiler, less transmission and transfer losses, such losses must be taken into account, particularly on installations having a considerable length of oil piping.

The indirect gas-fired preheating method is a package arrangement that uses gas as the primary energy source. It generates its own supply of low-pressure steam in a closed vapor-condensate cycle. The oil is pumped through the steam oil heater as required to compensate for radiation losses in the oil-circuit lines, whenever pumping action stops. During the layover period, the main boilers and oil burners are entirely inactive. If separate oil transfer pumps are not available, a small circulating oil pump is added to the package to provide circulation in the oil lines during the gas-firing periods.

The electrical preheating method involves use of immersion heaters, plus a special arrangement for heating the fuel oil piping. One special arrangement is a heating cable (soil cable or plastic covered wire), wrapped around the supply line or all oil piping, and a vertical-element immersion heater in the suction pipe inside the oil tank. The closeness and evenness of the spiral winding of the cable determine the heat input. The on-off periods are thermostatically controlled. For protection of the heating cable, the temperature of the oil piping has to be limited, and usually must not exceed 170 F. Where pipe and oil temperatures permit wrapping of all oil piping, constant oil circulation is not required. The efficiency of this preheating method is lower than for element-immersion or electric-impedance heating, because of transfer losses between the heating element and the pipe.

Oil burners designed for automatic operation on No. 5 or No. 6 oil are generally equipped with thermostatically controlled electric immersion heaters. In an emergency, the burner-immersion heater may be used alone to heat a modulated, very low quantity of oil for combustion. However, in a normal operation, it functions in conjunction with the primary preheating system.

Maintaining Piping and Tank Temperature

When using No. 5 and No. 6 oils, special arrangements must be made to keep the oil fluid in the piping at all times, and to keep a portion of the oil in the storage tank around the suction draw-off fluid.

The piping may be heated by one or more of the following methods:

1. Wrapping the supply line with electrically heated tape.
2. Passing a current through the supply line itself.
3. Enclosing the supply line with a steam or hot water line in the same envelope.
4. Insulating the supply line so as to decrease the thermal losses.
5. Setting up a dual system in which the primary preheaters

have a capacity greater than the burner requirement and returning the excess heated oil continually to the fuel oil tank.

All the oil in the tank, or a portion of it, may be heated by one of the following methods:

1. By steam coils in the bottom of the tank.
2. By hot water coils in the bottom of the tank.
3. By a suction-bell, which is provided with either steam or hot water coils, in the bottom of the tank.
4. By providing a hot-well that extends from the top to the bottom of the tank, and provides enough heated oil to supply the burner under a full load.
5. By submerging an electric preheater in the wall or bottom of the tank.

Pipe Sizes for Heavy Oil

Table 1 gives recommended good practice pipe sizes for handling No. 5 and No. 6 oils.

Oil Storage Tanks and Piping

Storage tanks, and the piping and pumping facilities for delivering the oil from the tank to the burner, are very important considerations in the design of an industrial oil-burning system. The construction and location of the tank and oil piping are usually subject to local regulations, which should always be consulted, and to the standards of the National Board of Fire Underwriters, such as *NBFU Pamphlet No. 31*.^a

The size of the storage tank is usually based on the rate at which oil is to be consumed; the space available; the method of oil delivery (truck or tank car); and the ease with which deliveries can be made under all weather conditions. A minimum capacity of at least the maximum weekly usage is desirable. If deliveries are to be made by tank car, the capacity should not be less than 15,000 gal.

Controls

The control of oil-fired equipment is discussed in the section Automatic Control of Fuel-Burning Equipment.

GAS-FIRED HEATING EQUIPMENT

A gas burner is defined by the American Gas Association as "a device for the final conveyance of the gas, or a mixture of gas and air, to the combustion zone." Burners used for domestic heating are of the atmospheric injection, luminous flame, or power burner types.

DOMESTIC

Domestic gas burners may be classified as either those types designed for central heating plants or those designed for unit application. Gas-designed units and conversion burners are available for the several kinds of central systems in which gravity and forced warm air furnaces or steam and hot water boilers are used; and for other applications where warm air floor furnaces and room heaters are installed in the space being heated.

Central Heating Systems

Gas-designed boilers for hot water or steam heating are available in cast-iron, steel, and non-ferrous metals (Fig. 9). The burners are located beneath the sections, and the flue gases pass upwards between the sections to the flue collector. Some boilers are designed to provide domestic hot water, using tankless or instantaneous heaters.

Table 1.... Recommended Minimum Suction and Return Pipe Sizes for Fuel Oil Lines^a
(For Nos. 5 and 6 Fuel Oil)^b

Equivalent Length of Suction Line Feet ^a	Pump Capacity, Gallons per Hour													
	50		100		150		200		300		600		900	
	Grade of Oil (Number)													
	5	6	5	6	5	6	5	6	5	6	5	6	5	6
	Diameter of Pipe, Inches													
10-50	1½	1½	1½	2	2	2	2	2	2	2	2½	3	3	4
60-100	1½	1½	2	2	2	2	2	2½	2½	2½	2½	3	3	4
110-150	1½	2	2	2	2	2	2½	2½	2½	2½	3	3	4	4

^a Pipe sizes shown are based on vertical suction lift not to exceed 10 ft from bottom of storage tank to oil pump.

^b A suction line length in excess of 100 linear feet is not recommended for systems using No. 5 or No. 6 oil. Where the length is greater a separate pump should be installed near the storage tank.

^c Equivalent length of pipe includes all horizontal and vertical measured piping plus proper allowance for valves and fittings as follows:
Elbow = Factor 3; Tee = Factor 4; Gate Valve = Factor 1 1/4; Globe Valve = Factor 8.

Warm air furnaces are of two types, gravity and forced air. Forced warm air furnaces utilize a motor-driven blower to circulate air over the heat exchanger and through the ducts. One common type is quite similar to Fig. 7, except that gas burners, pilots, controls, and the gas pressure regulator are substituted for the oil burner, its blower, ignition system, and controls. A draft hood is attached to the outlet of the furnace and replaces the barometric damper. Heat exchangers are available with upflow of air as shown, or with crossflow or downflow of air to be heated.

Some gas furnaces and boilers are available with sealed combustion chambers. These units have no draft hood. Combustion air is piped, usually through a side wall from outdoors, directly to the combustion chamber.

The air intake pipe terminates in the same location as the flue gas vent, sometimes as concentric pipes, with an appropriate terminal covering or cowl. No chimney or vertical flue is needed with such units.

The A.G.A. listed output at the boiler nozzle, or at the bonnet for forced air furnaces, is 80 percent of the approved input to the burners, as set by the American Standards Association (ASA) requirements. The corresponding output for gravity furnaces is 75 percent.

Conversion Burners

Conversion burners are complete burner and control units designed for installation in existing boilers and furnaces. A typical gas conversion burner is shown in Fig. 10. Atmospheric conversion burners may have drilled-port, slotted-port, or single-port burner heads.

Several power burners in domestic sizes are available. These are of gun-burner design and are particularly desirable for accommodating furnaces or boilers with restricted flue passages.

Conversion burners for domestic application are available in sizes ranging from 40,000 to 400,000 Btuh capacity. It should be noted that the American Standard Listing Requirements are limited at present to conversion burners having input capacities up to 400,000 Btuh. Burners of larger capacity, for use in large steel boilers, are usually engineered by a contractor specializing in this type of work, or by the local utility company. They are available in a large number of sizes and types. In some cases, the burner may be an assembly of

multiple burner heads filling the entire firebox. For conversion burner installation in boilers requiring more than 400,000 Btuh input, reference should be made to the current American Standard Requirements for Installation of Gas Equipment in Large Boilers, ASA Z21.33.

Domestic sizes of conversion burners should conform to current American Standard Listing Requirements for Domestic Gas Conversion Burners, ASA Z21.17. As the successful and safe performance of a gas conversion burner depends on numerous factors other than those incorporated in such equipment, installations of this kind must be made in strict accordance with current American Standard Requirements for Installation of Domestic Gas Conversion Burners, ASA Z21.8. Draft hoods conforming to current American Standard Listing Requirements for Draft Hoods, ASA Z21.12, should also be installed (in place of the dampers used with a solid fuel) on all boilers and furnaces converted to burn gas.

Floor Furnace

The floor furnace is used to supply central heating in mild climates, or for auxiliary heating or heating of single rooms in colder climates. It is used for heating first floors, or where heat is required in only one or two rooms. However, upper floor installations are possible. A number may be used to provide heat for the entire building where all rooms are on the ground floor, thus giving flexibility to the heating system.

In floor-furnace applications, the heating element, gas piping, and flue vent piping are suspended below the floor, and the only part visible in the room being heated is the circulating air register, which may be of the single type, installed in the floor, or of the dual type, installed in a partition and heating two rooms. The A.G.A. output rating of floor furnaces is based on an efficiency of 70 percent for the gravity-type and 75 percent for the fan-type unit.

Vented Wall Furnace

Another type of heating appliance is the vented, recessed heater, which is either a gravity or fan-type appliance designed for installation in or permanent attachment to a wall, floor, ceiling, or partition. Such heaters may have short stub ducts to conduct heated air to adjacent rooms. They are installed primarily in new homes, usually being plastered into the wall as a permanent part of the building. The A.G.A.