distribution of the return water over the boiler heating surfaces. The velocity of flow through the outlets of low pressure steam heating boilers should not exceed 15 ft. per second if entrainment of moisture is to be prevented, as with higher velocity the steam leaving the boiler may carry water with it.

Blow-off or drain connections should be made near the boiler and so arranged that the entire system may be drained of water by opening the drain cock. In the case of two or more boilers separate blow-off connections must be provided for each boiler on the boiler side of the stop valve on the main return connection.

Water service connections must be provided for both steam and water boilers, for refilling and for the addition of make up water to boilers. This connection is usually of galvanized iron pipe, and is made to the return main near the boiler or boilers. The heating contractor is required to run this line to the nearest water service main, in which the plumber has left a plugged tee.

For further data on pipe connections for steam and hot-water heating systems, see Chapters 20 and 21.

BOILER TROUBLES

A complaint regarding boiler operation generally will be found to be due to one of the following:

1. *The boiler fails to deliver enough heat.* The cause of this condition may be: (*a*) poor draft; (*b*) poor fuel; (*c*) inferior attention or firing; (*d*) boiler too small; (*e*) improper piping; (*f*) improper arrangement of sections; (*g*) heating surfaces may be covered with soot and (*h*) insufficient radiation installed.

2. *The water line is unsteady.* The cause of this condition may be: (*a*) grease and dirt in boiler; (*b*) water column connected to a very active section and, therefore, may not be showing actual water level in boiler, (*c*) boiler operating at excessive output.

3. *Water disappears from gage glass.* This may be caused by: (*a*) priming due to grease and dirt in boiler; (*b*) too great pressure difference between supply and return piping causing water to back into return; (*c*) valve closed in return line; (*d*) connection of bottom of water column into a very active section or thin waterway; (*e*) improper connections between boilers in battery permitting boiler with excess pressure to push water into boiler with lower pressure.

4. *Water is carried over into steam main.* This may be caused by: (*a*) grease and dirt in boiler; (*b*) insufficient steam dome or too small steam liberating area; (*c*) outlet connections of too small area; (*d*) excessive rate of output; (*e*) water level carried higher than specified.

5. *Boiler is slow in response to operation of dampers.* This may be due to: (*a*) poor draft due to air leaks into chimney or breeching; (*b*) inferior fuel; (*c*) inferior attention; (*d*) accumulation of clinker on grate; (*e*) boiler too small for the load.

6. *Boiler requires too frequent cleaning of flues.* This may be due to: (*a*) poor draft; (*b*) smoky combustion; (*c*) too low a rate of combustion; (*d*) too much excess air in firebox causing chilling of gases.

7. *Boiler smokes through fire door.* This may be due to: (*a*) defective draft in chimney or incorrect setting of dampers; (*b*) air leaks into boiler or breeching; (*c*) gas outlet from firebox plugged with fuel; (*d*) dirty or clogged flues; (*e*) improper reduction in breeching size.

If boiler trouble is attributed to oil and dirt in boiler one of the following tests will determine whether cleaning of boiler is necessary:

1. Draw off a small quantity of water from the try-cock near the water line. Boil this water in a pan and at the same time boil an equal quantity of water such as fed

to boiler in another pan (of same size if available). A marked difference in liberation of steam from the surface will indicate that the boiler should be cleaned.

2. After building a pressure in the boiler of 2 to 5 lb. open safety valve by means of a wire attached to lifting lever. Keep valve open for one minute. If water is discharged with the steam after the first rush of steam and water, it can safely be assumed that the boiler should be cleaned.

HOT WATER SUPPLY BOILERS

Boilers for hot water supply are classified as direct, if the water heated passes through the boiler, and as indirect, if the water heated does not come in contact with the water or steam in the boiler.

Direct heaters are built to operate at the pressures found in city supply mains and are tested at pressures from 200 to 300 lb. per square inch. The life of direct heaters depends almost entirely on the scale-making properties of the water supplied. If water temperatures are maintained below 140 deg. the life of the heater will be much longer than if higher temperatures are used, owing to decreased scale formation and minimized corrosion below 140 deg. Direct water heaters in some cases are designed to burn refuse and garbage.

Indirect heaters generally consist of steam boilers in connection with heat exchangers of coil or tube heaters which transmit the heat from the steam to the water. This type of installation costs more than a direct system, but has the following advantages:

1. The boiler operates at low pressure. Water hammer and cold water shocks are not transmitted to the boiler.

2. The boiler is protected from scale and corrosion.

3. The scale is formed in the heat exchanger in which the parts to which the scale is attached can be cleaned or replaced. The accumulation of scale does not effect efficiency although it will effect the capacity of the heat exchanger.

4. Water hammer due to formation of steam is minimized especially if the steam supply to the heater is under automatic control.

5. Discoloration of water may be prevented if the water supply comes in contact only with non-ferrous metal.

SELECTION OF HOT WATER SUPPLY BOILERS

The size of hot-water supply boiler selected is based upon the quantity of water used in 24 hours, the temperature rise, the peak load, the duration of peak load, and the size of storage tank used. A boiler capable of delivering per hour 1/24 of the 24-hour demand, operating continuously, would be sufficiently large, but it is good practice to provide at least 20 per cent reserve capacity in the boiler by selecting a boiler which can deliver per hour 1/20 of the 24-hour demand. The storage tank should be of such size that the water stored during off-peak hours, plus the hourly output of the heater will equal the demand during the period of peak load.

If the storage tank is already installed and is too small, a larger boiler must be used; the boiler having such capacity that the stored water plus the hourly heat output of the boiler equals the demand during the peak period.

Control of the water temperature by means of thermostats is discussed in Chapter 17 on Automatic Heat Control.