lator is frequently installed and controlled from an immersion thermostat (in the return line) set to start and stop the pump over approximately a 20 F deg temperature range.

CONTROL OF SERVICE WATER TEMPERATURE

Coal-fired boilers are usually controlled by an immersion thermostat (located in the heated water) which opens or closes draft dampers at the boiler to adjust the rate of fuel combustion. With oil or gas-fired boilers the immersion thermostat controls the oil burner or the automatic gas valve. The gas pilot flame usually burns continuously. With electric heaters the immersion thermostat operates a switch on the source of energy.

When steam or hot water is the medium for heating the water in the tank, an immersion thermostat is used to control a valve in the steam or hot water supply line. In small residence installations, using water as the carrier, a combined immersion thermostat and butterfly valve in one simple fitting may be installed in the transmitting circuit to prevent over-heating of the service water.

In residences heated by pump circulated hot water, the house temperature is controlled by operating the circulating pump intermittently, while domestic hot water is warmed by transfer from the house boiler, independent of the pump operation. The domestic water is heated from the heating boiler the year 'round. Under such an arrangement, to prevent overheating the house by thermal circulation when the pump is not running, it is usual to insert a weighted check-valve in the house heating main, so that no circulation to the house heating system can occur unless the pump operates. In summer the fire may be controlled to maintain a boiler water temperature lower than when heating, and generally about 20 F warmer than that desired in the domestic hot water system.

In buildings which have restaurants, it is generally desirable to install two separate service hot water systems so that water at 140 F maximum may be available for lavatory and bath purposes, while an adequate volume of water at 180 F will be available for the sanitary rinse of tableware. Most commercial dishwashing machines employ water at 180 F. Spontaneous drying, which is a further requisite to proper sanitation, is made possible with water at 180 F or higher.[4] Frequently, instead of installing a two-pipe system, it may be preferable to use a booster heater to assure hot water for the dish room.

The immersion thermostat in a hot water storage tank should be located no higher than the center of the tank, and possibly should be even closer to the bottom since water in a tank stratifies proportionally to the temperature. When hot water is removed, the cold water entering to replace it quickly reduces the temperature in the lower parts of the tank.

SAFETY DEVICES FOR HOT WATER SUPPLY SYSTEMS

There are still numerous plumbing codes which do not have regulations for the prevention of hot water storage tank explosions.

An ordinary storage tank is under certain water pressure, depending on the static pressure in the system. When the water in the tank is heated by circulation through an external heater, or by heating units in the tank, it gradually expands. For instance, if the entire contents of a 30-gal storage tank are heated from 70 F to 160 F, there will be an increase in volume of about one-half gallon. If the tank is connected to some supply without any intervening check valve, the increase in volume

causes part of the water to be pushed back into the supply line. If the hot water reaches the water meter, it may ruin the composition discs.

If back-flow cannot occur, as for example, due to the use of a check-valve or a pressure-reduction valve in the line, or because of temporary shut-off of the cold-water line, the pressure in the tank rises as heating continues. Such a pressure rise, if the heating continues for any length of time, may result in rupturing of the tank.

If the tank water is not confined, continued heating would, of course, cause no increase in pressure beyond ordinary line pressure. However, the temperature would continue to increase. If this should happen at elevated temperatures, the flashing of the water into steam might cause a serious tank explosion.

In order to guard against the development of excessive pressure inside a hot water storage tank (owing to the thermal expansion of the water) it is customary to install a spring-loaded pressure-relief valve which is set to open at a pressure about 20 lb higher than the normal line pressure.

The amount of water discharged by any pressure-relief device is usually quite small, since it takes only a small quantity of water to relieve any pressure rise due to the thermal expansion of the water. The rate of discharge should be such as to limit the pressure rise for any given heat input to 10 per cent of the pressure at which the valve is set to open. For any given installation, the discharging capacity should be in excess of the water to be discharged by the heater. The heater discharge Q_m in gallons per minute may be computed by Equation 2:

$$Q_m = 0.00005b \qquad (2)$$

where b is the heat input of heater in Btu per minute.

To prevent danger of overheating, temperature-relief devices should be used. One type of such a device has a fusible plug of metal which melts at about 212 F. The hot water then runs from the opening until the deviced is serviced. A better type of relief device is one which incorporates a bellows or bimetallic disc, which opens at a temperature of 210 F and closes when the temperature drops to approximately 160 F.

Another type of safety device is a fuel cutoff switch or valve in which a fusible plug is melted by excessive water temperature. The fuel supply is cut off until the fusible plug is replaced.

The capacity of temperature relief devices may be calculated by Equation 3:

$$Q_m = 0.0008b \qquad (3)$$

where Q_m and b denote the same quantities as in Equation 2.

Pressure relief valves should be installed in the cold water line near the tank out of contact with the hot water in order to prevent excessive corrosion and lime deposit on the valve seat. *Temperature relief* valves, in general, must be installed at the point of maximum water temperature.

SOLAR WATER HEATERS

Solar heaters utilize the energy of the sun for heating hot water. The successful operation of such heaters requires the availability of sunshine practically every day in the year, which has limited their use to Florida and the southern portions of California. When supplemented with some other means of gas, coal, or oil water heating, solar heaters may be used in climates where sunshine may be more or less intermittent. They have