

throughout so that the radiators are connected in parallel, resulting in the same water temperature in all radiators. With the one-pipe system part of the water flows through more than one radiator, so that the water temperature toward the end of the main is not as high as near the boiler. However, with the one-pipe system, by maintaining a rapid circulation and small difference in temperature between the water leaving and returning to the boiler or other heat generator, the variation in the radiator water temperature is reduced.

The two-pipe system for larger buildings should, if possible, be arranged for reversed return. The direct and reversed return systems are shown in Figs. 1 and 2. With the reversed return system, the length of the water circuit for any one radiator is the same as for any other radiator and, therefore, the friction and temperature losses to all radiators should be nearly the same.

In some cases the reversed return system involves no more piping than

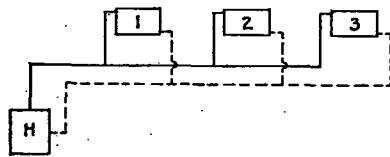


FIG. 1. A DIRECT RETURN SYSTEM

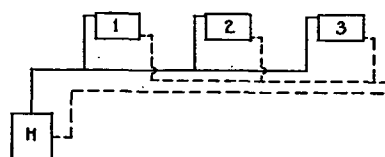


FIG. 2. A REVERSED RETURN SYSTEM

the direct return system. In the case of large buildings, it is often advisable to zone the piping.

Mechanical Circulators

Circulating pumps are usually of the centrifugal type. The capacity of the pump is figured from the Mbh (1000 Btu per hour) required for heating and the drop in temperature selected. For example, for 100 Mbh and 20 F drop a pump having a capacity of 5000 lb water per hour or 10 gpm should be used. The resistance head is based on the system as designed. In large systems the economical size of pump may be determined by comparing the cost of power for operation, with the annual charges on the capital cost of the piping system, as larger pipe sizes mean less pump power. Velocities through piping in excess of 4 fps are likely to cause disturbing noises in buildings other than factories. In large systems the pumps are run continuously while in small ones they are run either continuously or intermittently depending on the type of automatic temperature control selected. Small circulating pumps are usually driven by direct-connected electric motors. Under certain conditions a valved by-pass should be provided and the piping so designed that in case of breakdown of the pump or failure of electric current there will be sufficient gravity circulation to keep the building reasonably warm. In large buildings or groups of buildings, it is often advisable to have two pumps, each of about 70 per cent of the total capacity, to take care of breakdown service. During mild weather, variations in water temperature may be utilized to balance the required heat loss. In the larger

systems steam turbines are sometimes used to drive the pumps, the exhaust steam being used for heating the water, and in such buildings as hospitals this may be the most economical method.

As the average pump used for water circulation is not over 60 per cent efficient, the cost of power on a large installation should be computed and comparisons made between the savings in capital cost of piping and the annual cost of power.

FORCED CIRCULATION PIPE SIZES

The pressure heads available in forced circulation systems are much greater than those in gravity circulation systems, consequently, higher velocities may be used in designing the system, with the result that smaller pipes may be selected and the first cost of the installation reduced. As the pipe sizes of a heating system are reduced, the necessary increase in the velocity of the water increases the friction losses and thus the cost of operation and the initial cost of the circulating equipment. The increased velocity of a forced circulation system offers a number of advantages, such as a much shorter heating-up period and a more flexible control of hot water circulation. This improved performance merits the small increase in operating cost necessary to circulate the water mechanically. The velocities required should be determined by calculation for the particular system under consideration.

Since forced circulation velocities are higher than those in gravity systems, and since the friction heads in a heating system vary almost as the squares of the velocities, a given error in the calculation or assumption of a velocity is less important in a forced circulation system than in a gravity circulation system, and, consequently, it is easier to design a satisfactory forced circulation system than a satisfactory gravity circulation system.

In forced hot water systems, it is customary to use a temperature drop of 20 or 30 F between the water entering and leaving the boiler or other heater. The head against which the system is to operate must then be decided. This varies from 2 to 5 ft for small systems and may rise to 100 ft on large jobs with a group of buildings. For iron pipe, the sizes can be figured using Fig. 3 and Tables 1 and 3. For copper tubing Tables 2 and 3 are to be used. In systems designed with reversed returns, it will generally be found that very little adjustment is necessary to secure even distribution to all radiators. However, orifices may be used to control the flow and the capacities are given in Table 4. In large buildings provision should be made for quickly draining radiators in case of breakage, and it is often advisable to install a lock shield valve on one end of each radiator and a hand controlled valve on the other. In case of breakage the two valves can be closed and the radiator removed without affecting the rest of the system. The lock shield valve can also be used for balancing the water circulation.

GRAVITY CIRCULATION PIPE SIZES

In gravity hot water heating systems the difference in temperature (density) between the flow and return water produces the required