Mechanical Circulators

Circulating pumps are usually of the centrifugal type. The required capacity of the pump is calculated as shown by Equation 1. For example, for 100 Mbh and 20 deg 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

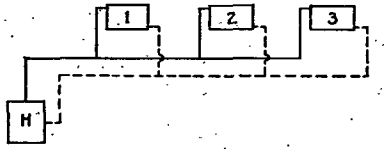

FIG. 1. A DIRECT RETURN SYSTEM

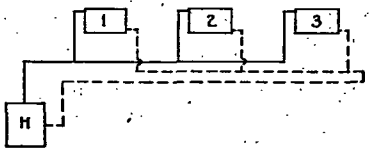

FIG. 2. A REVERSED RETURN SYSTEM

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 heads available to cause circulation are much greater in forced circulation systems than 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. As forced circulation velocities

are higher than those in gravity systems, and as the friction in a heating system varies almost as the square of the velocity, 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 circulation systems, it is common practice to use a temperature drop of 20 to 30 deg across the boiler or heater. Next, the allowable friction in the water circuit must be decided. The allowable friction is

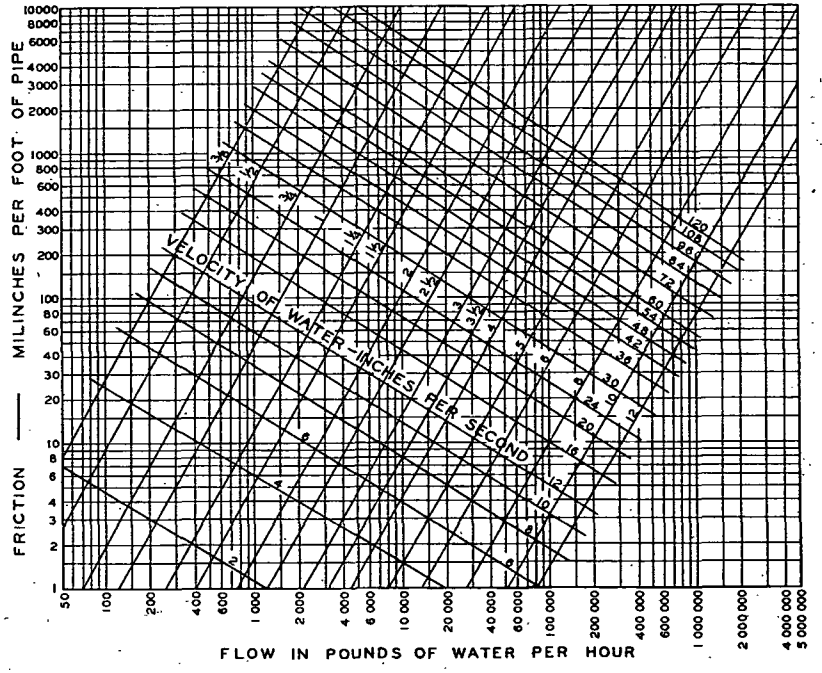

FIG. 3. FRICTION IN BLACK IRON PIPES BASED ON FLOW IN POUNDS PER HOUR

controlled partly by the characteristics of the pumps available for this service. The heads developed by these pumps range from 2 to 5 ft for residential systems up to 100 ft for institutional heating plants.

The problem in sizing of pipe is one of selecting sizes which will cause a circuit resistance approximately equal to the head available to produce circulation when the desired quantity of water is flowing.

The friction loss in black iron pipes for a determined weight of water may be obtained from Fig. 3. For the frequently used temperature drop of 20 deg the friction loss may be determined directly from the heat requirement by means of Table 1 or Fig. 4 for black iron pipes, or by means of Table 2 for copper tubing.

The resistance of various types of fittings expressed in equivalent elbow resistance is shown in Table 3.