Gravity hot water heating systems may be designed for even circulation at any range of water temperature difference between flow and return, within practical limits. Small differences in temperature result in large pipe sizes, uneconomical both in cost of installation and operation, and slowness to respond to outside temperature changes. Large differences in temperature result in undesirable small piping and difficulty in balancing for circulation. While gravity systems have been designed and installed on as low as 10 deg. and as high as 60 deg. difference, best results are obtained for difference between 20 and 30 deg. with 20 deg. difference applicable to most conditions.

The calculations of pipe sizes to the radiator most unfavorably situated on the basis of one or more different temperature differences will usually make the best practical temperature difference evident. The criterion which determines whether one radiator is more unfavorably or favorably situated than another is the value of the quotient when the height of the center of the radiator above the center of the boiler in feet is divided by the total travel of the water through the radiator in question.

In selecting approximate pipe sizes the following Table 47 may be used:

TABLE 47. APPROXIMATE PIPE SIZES FOR GRAVITY CIRCULATION FOR A TEMPERATURE DROP OF 20 DEG. AND FOR VELOCITIES RANGING FROM 2 TO 6 IN PER SECOND

Pipe Size	Capacity in 1000 B.t.u.
½"	1.5 to 4.6
¾"	2.7 " 8.1
1"	4.4 " 13.1
1¼"	7.6 " 22.7
1½"	10.3 " 30.9
2"	16.9 " 50.8
2½"	24.2 " 72.5
3"	37.3 " 111.8
3½"	49.9 " 149.6
4"	64.3 " 192.9
4½"	80.7 " 242.0
5"	102.0 " 306.0
6"	146.0 " 438.0

The capacities shown in the table vary directly with the temperature drop and the velocity. Since the velocity depends on the pressure head and on the friction head it cannot be predicted or estimated accurately before the system is designed and, consequently, Table 47 must be used only for very approximate determinations of pipe sizes.

A much better approximate determination of pipe sizes may be made by the following method:

1. Determine the equivalent length of the circuit by adding the length of the pipe in the circuit to the equivalent length of the elbow equivalents, placing each elbow equivalent equal to a pipe whose length is equal to 24 diameters.

2. Determine from Fig. 32 the pressure head for the circuit and divide it by the equivalent length of the circuit to find the average friction head of the circuit in millinches per foot of pipe.

3. Determine from Fig. 33 which pipe size has that particular unit friction head when the given quantity of heat is being conveyed.

To illustrate the application to practice, let it be required to determine the sizes of a few of the pipes for the hot-water heating system shown in Fig. 35.

This system is intended for a three-story building in which all rooms are to be heated to 70 deg. The first floor radiator is to dissipate 10,000 B.t.u., the second floor radiator, 8000 B.t.u., and the third floor radiator, 12,000 B.t.u., per hour.

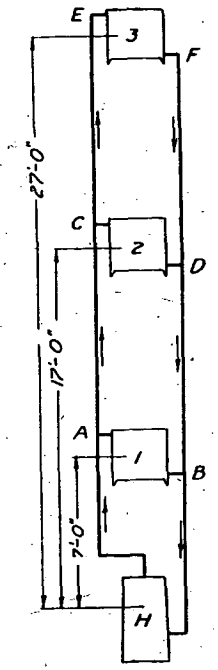

FIG. 35. GENERAL ARRANGEMENTS OF HEATING SYSTEM

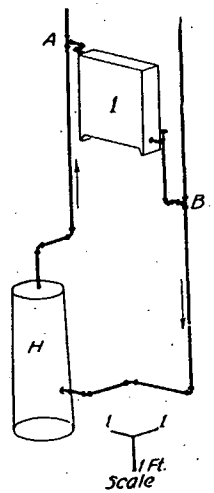

FIG. 36. DIAGRAM FOR SIZING PIPES

The system is piped so that water, leaving the heater, may take any one of three paths, through Radiator, 1, 2 or 3. The correct solution of the problem requires that the three paths be so proportioned that the proper quantity of water will flow through each of the three radiators.

Proceed with the design as follows:

1. Divide the three circuits of the system into sections so that every section will contain only one pipe size and only one rate of flow of heat. For example, the circuit of Radiator I should be divided into four sections; the first section extending from H to A; the second from A to 1; the third from 1 to B; and the fourth from B to H. The point A must be the