water in the direct return system among the several risers, it is necessary to introduce resistances to balance the circuit.

The first riser is 80 ft nearer the boiler than the fifth riser. In order that the two may be balanced, that is, operated under equal pressure heads, resistance must be added to

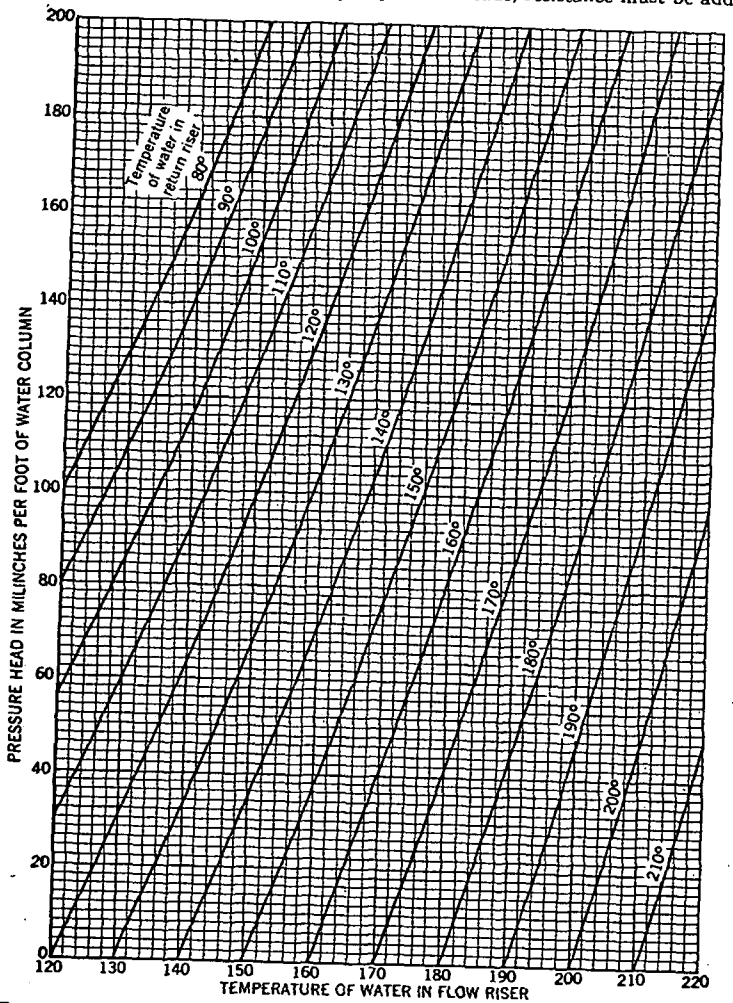


FIG. 6. GRAVITY PRESSURE HEADS FOR VARIOUS TEMPERATURE DIFFERENCES

the first riser equal to the friction head in the 80 ft of supply main B to F plus the 80 ft of return main G to K for a total of 160 ft of pipe.

Having designed the piping system on a 240 milinch basis, the total friction head in the supply and return mains between the first and fifth risers is therefore 160 × 240 = 38,400 milinches, or 3.2 ft which must be supplied by additional resistance in the first riser. This resistance can be supplied by an adjusting valve or by an orifice of size selected from Table 5.

GRAVITY CIRCULATION PIPE SIZES

In gravity hot water heating systems the difference in temperature (density) between the flow and return produces the circulation of the water. The temperature difference is usually made from 25 to 35 F. Having determined the temperature difference and the temperature of flow, Fig. 6 can be used to obtain the pressure head, and from this point the calculations are the same as for forced hot water. Heat emission rates from 150 to 170 Btu per square foot are commonly used so that flow temperatures range from 180 to 200 F or higher. Assuming a flow temperature of 200 F and 35 F drop and the mains 4 ft above the boiler, a circulating pressure head of 600 milinches results. Assuming first floor radiators 3 ft above the mains and second floor radiators 12 ft above mains, third floor 21 ft and fourth floor 30 ft, the circulating pressure heads are 450, 1800, 3150 and 4500 milinches respectively.

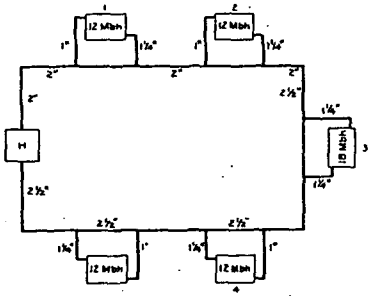


FIG. 7. A ONE-PIPE GRAVITY CIRCULATION SYSTEM

The following examples will illustrate the method to be followed in designing a gravity hot water system:

Example 8. Design a one-pipe gravity circulation system for the layout shown in Fig. 7. Assume that the main circuit consists of 150 ft of pipe, 7 elbows, and one boiler.

Solution. Replace the boiler by 3 elbow equivalents and assume that the size of the main will be about 2 in. According to Table 6, Column 2, a 2-in. elbow is equivalent to 4 ft of pipe, and the total equivalent length of the main will be about 150 plus 40, or 190 ft. Assuming that the center of the boiler will be about 4 ft lower than the horizontal portion of the main and that the temperature drop in the system is to be 35 F, Table 6 may be used to determine the size of the mains. Note from Column 8, for a 200 ft length, that a 2-in. main will supply 48 Mbh and a 2½-in. main, 75.4 Mbh. Since the system to be designed is to supply 66 Mbh, a 2-in. pipe is too small and a 2½-in. pipe too large. The solution is to use some 2 in. and some 2½ in. pipe. Since the 2½ in. is nearer the correct size than the 2 in., select 2-in. pipe for the first 50 or 60 ft from the boiler and 2½ in. for the remaining pipe back to the boiler.

Tables 7 and 8 may be used to design the radiator risers and connections. According to Table 7, for 12 Mbh the flow riser should be ¾ in. and the return riser 1 in., and the riser branches should be 1 in. and 1¼ in., respectively. Note that according to Table 8, both radiator tappings should be 1 in. To simplify the construction, select 1-in. flow risers with 1-in. riser branches and 1-in. radiator tappings. Also select 1¼-in. return risers with 1¼-in. riser branches, and 1¼-in. radiator tappings. Similarly, for 18 Mbh, select 1¼-in. flow and return risers and riser branches, and 1¼-in. radiator tappings.

To develop a rule for determining radiator sizes, assume a system similar to that of Fig. 7, in which the total temperature drop is to be 35 F