This resistance can be supplied by a calibrated and adjusted modulating valve or by an orifice resistor in a union. If the orifice resistor is to be used, its size may be selected from Table 6.

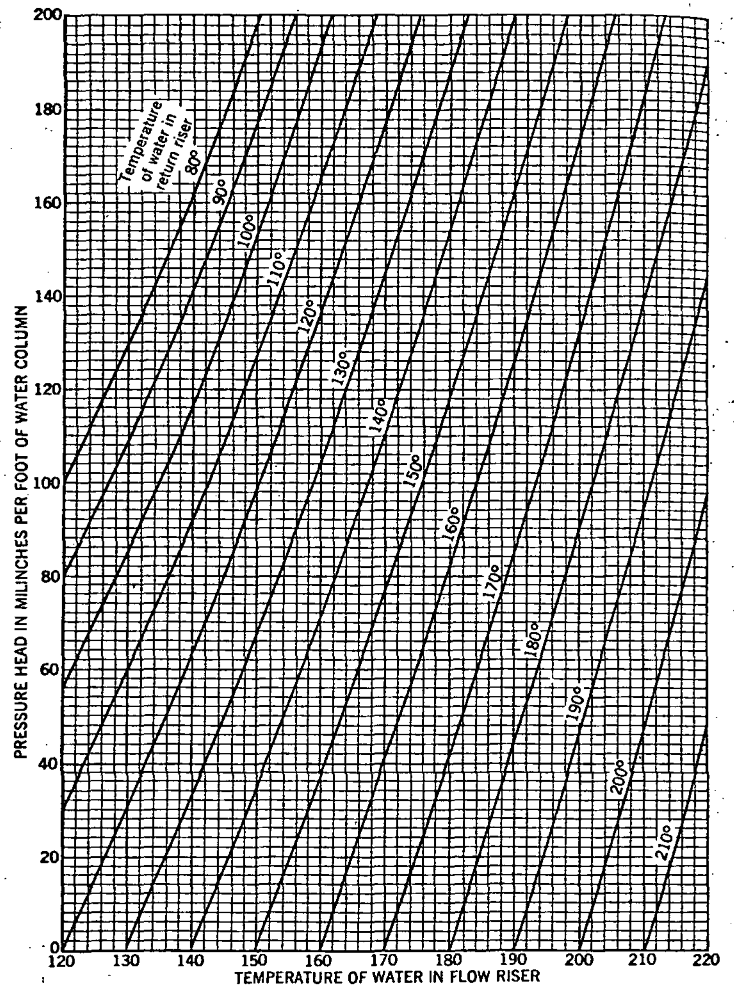

FIG. 6. GRAVITY PRESSURE HEADS FOR VARIOUS TEMPERATURE DIFFERENCES

Since the first section of riser No. 1 is ¾ in. pipe and supplies 28.8 Mbh, it may be noted from Table 2 that a corresponding velocity is approximately 22 in. per second.

From Table 6 a ¾ in. pipe with a velocity of 24 in. per second, used with a 0.35 orifice will produce a loss of 47,000 milinches. For a velocity of 22 in. per second the loss of

head will be less, probably about 41,700 milinches, which is approximately 10 per cent more than the required resistance. This is permissible and the 0.35 in. orifice is selected.

The sizes of the orifice resistors for the second, third and fourth risers are selected in a similar manner and found to be 0.38, 0.42 and 0.50 in. respectively.

GRAVITY CIRCULATION

In a gravity system the motive force to supply circulation is the difference in the weight of the water in the supply and the return and is proportional to the height of the risers. In this system, two distinct heads are available, the head provided in the mains by their elevation above the boiler and the head produced by the elevation of the risers above the mains. From Fig. 6 it is possible to determine the head produced per foot of height by the temperature difference to be used in designing the system. A chart such as Table 1 can be arranged using Fig. 4 for black iron.

To affect a balanced circulation in a gravity hot water heating system careful consideration must be given in sizing the pipes against the amounts of water to be carried, and the head available. The larger the temperature drop, the greater the motive force available.

It is generally customary to use a heat emission of 150 Btu per square foot of radiation, which normally requires an average water temperature of 170 F in the radiator. This can be accomplished by using a 35 F drop with the water entering the radiation at 187 F and leaving at 153 F. Raising the water temperature leaving the boiler will increase the average radiator temperature and alter the heat emission of the radiator.

Assuming that the height of mains above the boiler is 4 ft and that a 35 F drop is desirable, it will be noted that from Fig. 6, a maximum temperature of 200 F and return temperature of 165 F with a pressure head of 150 milinches per foot of height will be produced. A total head of 600 milinches or 0.6 in. is thus produced in the mains. Assuming that the average height of first floor radiators to be 3 ft above the main and second floor radiators to be 12 ft, third floor radiators 21 ft and fourth floor radiators 30 ft, the circulating head will be respectively, 450, 1800, 3150 and 4500 milinches.

The data given in Fig. 4 are based on a 20 F temperature drop which may be converted for capacities of 35 F drop by multiplying the capacity by 1.75. From these data, Tables 7 and 8 may be constructed.

The most common piping layouts used in gravity design are the one-pipe system of Fig. 7 and the two-pipe system of Fig. 8. The same objections are to be found with direct return design in gravity as in forced circulation and the reverse return system of Fig. 2 is to be preferred.

Example 3. 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 7 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 7 may be used to determine the size of the mains. Note from Column 3, 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