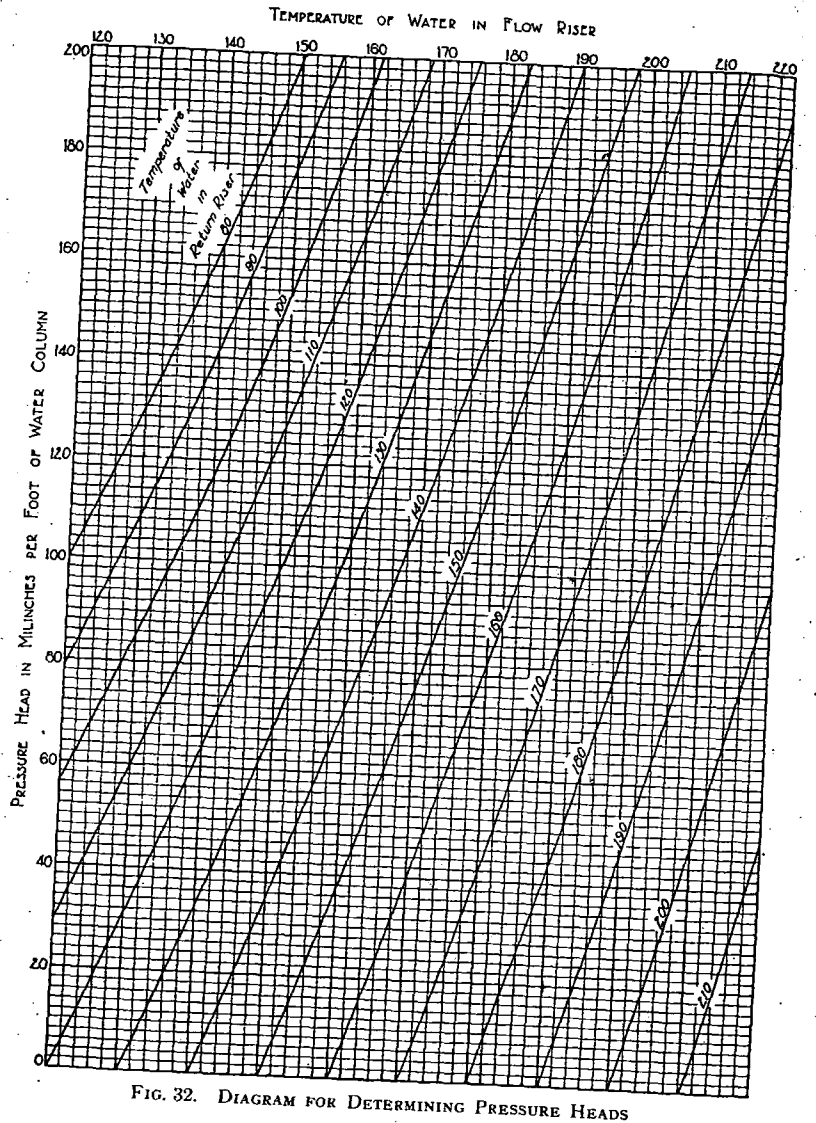

FIG. 32. DIAGRAM FOR DETERMINING PRESSURE HEADS

square of the velocity in both cases. Since more 90 deg. elbows are used in hot water heating systems than any other type of fitting or any valve, all fittings, valves, and other obstructions, found in radiator circuits, shall be expressed in terms of elbow equivalents, for the determination of their friction heads. For this purpose the following table of equivalents may be used:[1]

1 90 deg. elbow	1.0	1 Open globe valve	12.0
1 45 deg. elbow	0.9	1 Angle radiator valve	2.0
1 Open return bend	1.0	1 Radiator	3.0
1 Tee	2.2	1 Heater	3.0
1 Open gate valve	0.5		

To avoid friction head calculations by complicated formulae, the diagram of Fig. 33 may be used to find the friction head in one foot of pipe, as the diagram of Fig. 34 is used to find the friction head in one elbow.

GRAVITY SYSTEM

The pressure head for any radiator or group of radiators, in a gravity-flow system, shall be determined by calculating the maximum difference in the pressures caused by the water in the flow and return risers and dividing this difference by the density of water whose temperature is the mean of the temperatures of the water in the flow and return risers. To illustrate: If a radiator is located above the flow main so that its risers are 12 ft. high, and if the temperature of the water in the flow and return risers is, respectively, 180 and 160 deg., and if the density of water at 180, 170 and 160 deg. is, respectively, 60.58, 60.80, and 61.00 lb. per cu. ft., the maximum difference in the pressures caused by the water in the two risers is 12 (61.00 − 60.58) or 5.24 lb. per sq. ft.; the corresponding pressure head is 5.24/60.80, or 0.0829 ft., or 995 m.i. of 170 deg. water.

Instead of calculating the pressure head, it may be determined, with sufficient accuracy, from Fig. 32. To illustrate: For the example cited, find 180 on the upper margin of the diagram; from there traverse vertically downward to the intersection with the inclined 160 deg. line; from there, horizontally to the left margin and read 82 m.i. per foot of water column; multiply by 12, the height of the risers in feet, and find 984 m.i. of 170 deg. water, which differs only by about 1 per cent from the head calculated previously.

After the general arrangement of the pipe lines has been decided upon, the pipe sizes are determined so that, for any radiator or group of radiators, the friction head is equal to the pressure head when the system is operating at a uniform or constant rate.

The friction head for any radiator or group of radiators should be determined by calculating and adding together the friction heads in the heater, radiator, pipes, pipe fittings, and valves which constitute the circuit for that radiator or group of radiators.

[1]These values are based, with slight modifications suggested by later research, on experimental determinations by F. E. Giesecke and published in *Domestic Engineering*, November, 1912. A record of these tests is shown in Harding and Willard, *Heating and Ventilating*, p. 259 and in Marks, *Machine Design*, pp. 239–240.