size and flow. Assume 20 F drop for this system. One gallon of water per minute with a density of 7.99 at 215 F will deliver approximately 9600 Btu per hour with a 20 F drop.

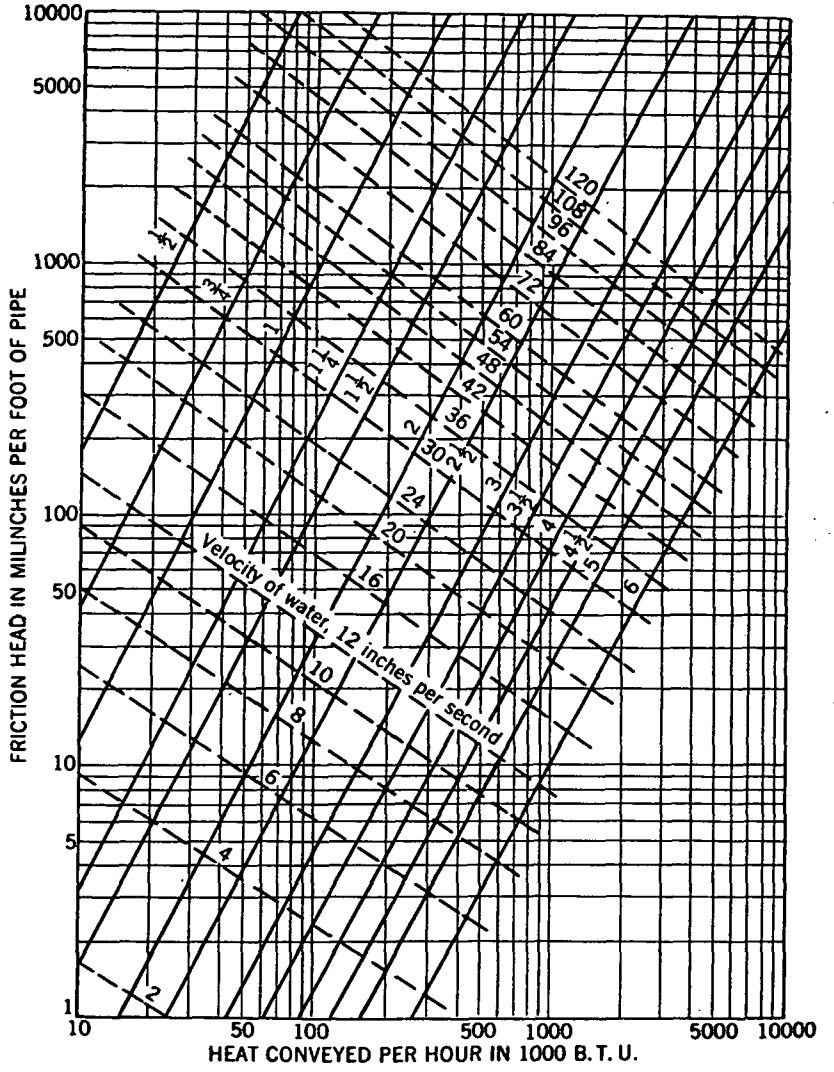

FIG. 3. FRICTION HEADS IN BLACK IRON PIPES FOR A 20 F TEMPERATURE DIFFERENCE OF THE WATER IN THE FLOW AND RETURN LINES

For other temperature drops the pipe capacities may be changed correspondingly. For example, with a temperature drop of 30 F, the capacities shown in this table are to be multiplied by 1.5.

The total radiation load is 98 Mbh, therefore the pump must deliver 10.2 gpm or 4900 lb of water per hour.

Knowing that the rate of flow is 10.2 gpm, the next step is to determine from the characteristics of available pumps, which one will produce a satisfactory velocity in the system. Assume that 4 pumps are available for this load which will produce 10.2 gpm at pressure heads of 2, 5, 10 and 18 ft. At these heads the pumps would produce a velocity high enough to make available a friction head per foot of pipe of 96, 240, 480 and 860 milinches per foot respectively. If 95 milinches per foot were used, the gravity head at 215 F average temperature in the mains would be 26 per cent of the total head and should be considered in sizing the system. At 240 milinches per foot the gravity effect is 10 per cent and as this is lower than the delivery variation from the pipe used, it can be neglected. At 480 and 860 milinches the gravity effect is still a smaller percentage of

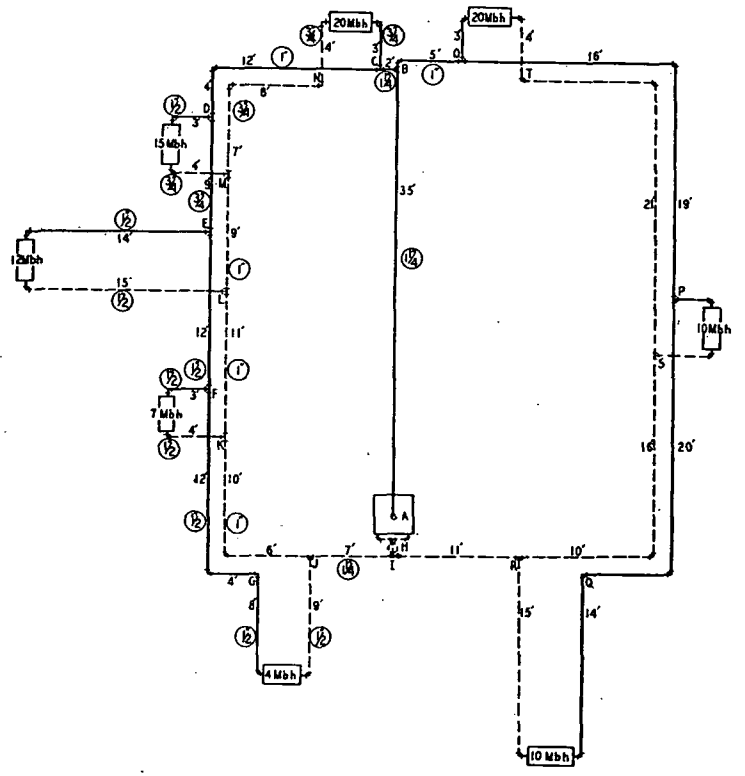

FIG. 4. A FORCED CIRCULATION REVERSED RETURN SYSTEM[a]

[a]Note that the numbers on the radiators indicate thousands of Btu per hour (Mbh) and not square feet.

the total, but at these losses in the average system the cost of pumping will more than offset the advantage gained in pipe sizes. Therefore, pipe size this system at 240 milinches per foot which is equivalent to a total loss of 60,000 milinches for the 250 ft equivalent length of pipe.

The pipe sizes may be selected from Fig. 3 or from Table 1 which has been derived from Fig. 3.

Size the supply main of the longest circuit first. Section AB carries 98 Mbh. From Fig. 3 it will be noted that at 240 milinches per foot, a 1¼-in. pipe carries 98 Mbh. Therefore, use 1¼-in. pipe in Section AB. Section BO carries 40 Mbh. A 1-in. pipe carries 48 Mbh at 240 milinches per foot. Use a 1-in. pipe. Section OP carries 20 Mbh