TABLE 6. MAINS, CAPACITIES OF MAINS IN EQUIVALENT SQUARE FEET OF HEATING SURFACE[a], *and in 1000 Btu*, FOR ONE-PIPE AND FOR TWO-PIPE DIRECT RETURN GRAVITY CIRCULATION SYSTEMS WITH A TOTAL FRICTION HEAD OF 0.6 IN., A TEMPERATURE DROP OF 35 DEG, AND WHEN THE MAINS ARE 4 FT ABOVE THE CENTER OF THE BOILER

1	2	3	4	5	6	7	8	9	10	11
Pipe Size (Inches)	Equivalent Length of Pipe (Feet[b])	Equivalent Total Length of Pipe in Feet in Longest Circuit								
		75	100	125	150	175	200	250	300	350
		Unit Friction Head, in Milinches								
		8.0	6.0	4.8	4.0	3.4	3.0	2.4	2.0	1.7
1½	3.0	179 *43.0*	156 *37.5*	137 *33.0*	125 *30.0*	112 *27.0*	104 *25.0*	92 *22.2*	84 *20.2*	78 *18.7*
2	4.0	356 *83.0*	300 *72.0*	263 *63.0*	237 *57.0*	212 *51.0*	200 *48.0*	175 *42.0*	158 *38.0*	146 *35.0*
2½	4.5	583 *140.0*	480 *115.0*	417 *100.0*	375 *90.0*	338 *81.5*	314 *75.4*	280 *67.2*	254 *61.0*	233 *56.0*
3	5.0	975 *234.0*	850 *204.0*	730 *175.5*	667 *160.0*	576 *143.0*	555 *133.0*	458 *110.0*	446 *107.5*	417 *100.0*
3½	5.5	1446 *347.0*	1250 *300.0*	1080 *260.0*	985 *236.0*	890 *214.0*	834 *200.0*	738 *177.0*	667 *160.0*	608 *146.0*
4	6.0	2040 *490.0*	1760 *422.0*	1540 *370.0*	1390 *334.0*	1240 *297.0*	1160 *278.0*	1040 *248.0*	930 *223.0*	853 *205.0*

[a]Based on 240 Btu per square foot.
[b]Approximate length of pipe in feet equivalent to one elbow in friction head. This value varies with the velocity.

TABLE 7. RISERS[a], MAXIMUM CAPACITIES OF RISERS IN EQUIVALENT SQUARE FEET OF HEATING SURFACE[b], *and in 1000 Btu*, **and Velocities of Water in Pipes in Inches Per Second** FOR ONE-PIPE AND FOR TWO-PIPE DIRECT RETURN GRAVITY CIRCULATION SYSTEMS WITH A DROP OF 35 DEG THROUGH EACH RADIATOR

Pipe Size (Inches)		Equivalent Length of Pipe (Feet[d])	Sq Ft	1st Floor[c]			2nd Floor		3rd and 4th Floors	
				1000 Btu	Vel. (Ft per Sec.)[e]		Sq Ft	1000 Btu	Sq Ft	1000 Btu
Flow	Return				Flow	Return				
½	½	1.0					21	*5*	26	*6.2*
½	¾						27	*6.4*	33	*8.0*
¾	¾	1.5	37	*9*	**2.3**	**2.3**	42	*10.1*	58	*14.0*
¾	1		50	*12*	**3.2**	**2.0**	53	*12.8*	71	*17.1*
1	1	2.0	75	*18*	**2.5**	**2.5**	83	*20*	108	*26.0*
1	1¼		88	*21*	**3.0**	**2.0**	105	*25.2*	142	*34*
1¼	1¼	3.0	109	*26*	**3.0**	**3.0**	179	*43*	229	*55*
1¼	1½		142	*34*	**4.0**	**2.5**				
1½	1½	3.5	200	*48*	**3.0**	**3.0**				

[a]This table is based on pressure heads of 450, 1800, 3150 and 4500 respectively, for the first, second, third, and fourth floor radiators, and on friction heads of 200 milinches for the first floor radiators and connections, and 700 milinches for all other radiators and their connections.
[b]Based on 240 Btu per square foot.
[c]The riser branches, the piping which connects the risers to the mains, are to be one size larger than the risers.
[d]Approximate length of pipes in feet equivalent to one elbow in friction head. This value varies with the velocity.
[e]Velocities apply to the riser branches.

TABLE 8. RADIATOR CONNECTIONS, MAXIMUM CAPACITIES OF RADIATOR CONNECTIONS IN EQUIVALENT SQUARE FEET OF HEATING SURFACE[a], *and in 1000 Btu*, FOR ONE-PIPE AND FOR TWO-PIPE DIRECT RETURN GRAVITY CIRCULATION SYSTEMS WITH A TEMPERATURE DROP OF 35 DEG THROUGH EACH RADIATOR

Pipe Size		Equivalent Length of Pipe (Feet[b])	1st Floor		2nd, 3rd and 4th Floors	
Flow	Return		Sq Ft	1000 Btu	Sq Ft	1000 Btu
½	½	1.0	17	*4.1*	25	*5.9*
½	¾		22	*5.2*	31	*7.5*
¾	¾	1.5	29	*7.0*	43	*10.5*
¾	1		38	*9.1*	54	*13.0*
1	1	2.0	52	*12.5*	74	*17.8*
1	1¼		73	*17.5*	97	*23.2*
1¼	1¼	3.0	97	*23.3*	138	*33.2*

[a]Based on 240 Btu per square foot.
[b]Approximate length of pipe in feet equivalent to one elbow in friction head. This value varies with the velocity.

To develop a rule for determining radiator sizes, assume a system similar to that of Fig. 6, in which the total temperature drop is to be 35 deg and which is equipped with 7 radiators, all radiators dissipating equal quantities of heat. The mean temperature of the water in the radiators will be reduced 5 deg for each successive radiator. If the mean temperature of the water in the first radiator is 200 F, the mean temperature of the water in the seventh radiator will be 170 F, and, according to Table 3, Chapter 6, the heat dissipation of these two radiators will be to each other as 868 is to 617, or as 140 is to 100, and therefore if the last radiator is to dissipate as much heat as the first, its size must be 40 per cent larger. The following rule may therefore be formulated for determining radiator sizes for one-pipe hot water heating systems having two-pipe risers and a total temperature drop of 35 deg:

Determine the radiator sizes in the usual manner. If the mean temperature of the water in the radiator is 215 F, select the same size radiator that would be selected for steam at this temperature. If the mean temperature of the water is to be less than 215 F, increase the amount of heating surface above that required for steam, as explained in Chapter 6. Use the calculated sizes for the radiators on the first set of risers; increase the sizes of the radiators on the last set of risers 40 per cent; those on the middle set of risers, 20 per cent, and those on the remaining risers proportionally.

Applying this rule to the five radiators of the system shown in Fig. 6, the actual sizes will be found to be 50, 55, 90, 65 and 70 sq ft of equivalent heating surface, instead of the nominal sizes of 50, 50, 75, 50 and 50 sq ft.

Example 4. Design a two-pipe, direct return, gravity circulation system for the layout shown in Fig. 7. Assume that the main circuit from the boiler to the farthest flow riser and from the farthest return riser back to the boiler consists of 160 ft of pipe, 6 elbows, and 1 boiler.

Solution. Replacing the boiler by 3 elbow equivalents and assuming that the largest size of the main will be about 3 in., the total equivalent length of the main will be 160 plus 45, or 205 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 will be 35 deg for the system, the pressure head caused by the difference in weight between the water in the