7. There should be a uniform drop in pressure between the source of steam supply and the farthest radiator on every riser. With a boiler pressure of 16 oz. and a maximum total pressure drop of 8 oz., the steam pressure at the supply valve of the farthest radiator on each riser should be 8 oz. The riser whose farthest radiator is 100 ft. from the main would be sized on a drop of 8 oz. per 100 ft. minus the drop in the main to this riser connection; while one, 200 ft. from the main would be sized on a drop per 100 ft. —one-half of the difference between the drop of 8 oz. and the drop in the main to the riser connection.

The total drop, minus the drop in the main to the point of connection to any riser, divided by the equivalent length of the riser from the main to the farthest radiator in hundreds of feet, gives the drop per 100 ft. in the riser. For a total drop 6 oz., with the farthest radiator on riser No. 4, 200 ft. equivalent from the main and this riser

TABLE 33. FLOW OF STEAM IN PIPES

P = Loss in pressure in lb.
d = Inside diameter of pipe in inches
L = Length of pipe in feet
D = Weight of 1 cu. ft. steam
W = Lb. of steam per min.

$$W = 87.0\sqrt{\frac{P\,D\,d^5}{\left(1+\frac{3.6}{d}\right)L}}$$

$$P = 0.000132\left(1+\frac{3.6}{d}\right)\frac{W^2 L}{D\,d^5}$$

Pressure Loss in Oz.	Col. 1 $87.0\sqrt{\frac{P}{100}}$	Inside Dia. Pipe	Col. 2 $\sqrt{\frac{d^5}{1+\frac{3.6}{d}}}$	Steam Pressure By Gage	Col. 3 $\sqrt{D}$	Length Pipe in Feet	Col. 4 $\sqrt{\frac{100}{L}}$
1	2.175	1	0.522	0.0	0.193	20	2.240
2	3.076	1¼	1.177	0.3	0.195	40	1.580
3	3.767	1½	1.828	1.3	0.201	60	1.290
4	4.350	2	3.709	2.3	0.207	80	1.120
5	4.863	2½	6.109	5.3	0.223	100	1.000
6	5.328	3	11.183	10.3	0.248	120	0.912
7	5.754	3½	16.705	15.3	0.270	140	0.841
8	6.152	4	23.630	20.3	0.290	160	0.793
10	6.878	4½	32.098	30.3	0.326	180	0.741
12	7.532	5	43.719	40.3	0.358	200	0.710
14	8.138	6	69.718	50.3	0.388	250	0.632
16	8.700	7	105.35	60.3	0.415	300	0.578
20	9.727	8	150.33	75.3	0.452	350	0.538
24	10.655	9	205.37	100.3	0.507	400	0.500
28	11.509	10	271.16	125.3	0.557	450	0.477
32	12.290	12	437.51	150.3	0.603	500	0.447
40	13.756	14	733.90	175.3	0.645	600	0.407
48	15.069	16	925.19	200.3	0.685	700	0.378
80	19.454	.....	.....	.....	.....	800	0.354
160	27.512	.....	.....	.....	.....	900	0.333
320	38.863	.....	.....	.....	.....	1000	0.316
480	47.652	.....	.....	.....	.....	1400	0.267

Column 1 × 2 × 3 × 4 = lb. steam per min. will flow through a straight pipe for a given condition.

Example.—1 oz. drop — 2-in. pipe — 1.3 lb. press. — 100 ft. long. — 2.175 × 3.709 × 0.201 × 1 = 1.615 lb. per min., then 1.615 × 60 — 20 per cent = 77.28 lb. per hr.

Preceding table does not allow for entrained water in low-pressure steam, condensation in covered pipe and roughness in commercial pipe, therefore reduce calculated capacities approximately 20 per cent.

connection 100 ft. from the source of supply, this riser would be sized on a basis of $\frac{6-1}{2}$ or 2½ oz. drop per 100 ft. of riser.

In using this method experience indicates that no pipe carries a velocity above the critical value of 20 ft. per second where steam and condensate flow in opposite directions, or above 50 ft. per second elsewhere on account of noise and entrainment difficulties.

8. In order to get uniform distribution of steam throughout the entire system, it is necessary to control the flow by reducing the riser sizes nearer the boiler. The nearer the riser is to the boiler, the greater will be its drop in pressure per 100 ft., since the total drop at the top of all risers should be practically the same.

9. Pipe sizes are figured on a pressure drop basis for undirectional flow or on a critical velocity basis for counterflow, depending upon whether the steam and water flow in the same or in opposite directions.

10. Due to the high rate of condensation in heating up a cold system the critical velocity should be figured at not over 20 ft. per second which will give velocities considerably below the critical velocity once the system is heated.

PIPE SIZES

Table 33 gives the numerical value of the four factors of the Babcock formula for various sizes and lengths of pipe and various initial pressures and pressure drops. By multiplying together the four factors for any set of conditions the pounds of steam per minute which will flow through the pipe may be found, as illustrated in the example below the table.

Table 34 is a basic table giving the theoretical capacities of pipe in square feet of direct cast iron radiation (based on ¼ lb. steam per hour per square foot) for various pressure drops in ounces per 100 ft. length of pipe or equivalent length and with an initial steam pressure of 1 lb. gage. This table does not allow a factor of safety for variation in pipe size, condensation in the pipe or other variables and should not be used without taking these factors into consideration.

Table 35 is the same as Table 34 except that it allows a 20 per cent factor of safety to take care of condensation within the pipe itself, variation in size and roughness in the pipe due to blisters, scaled corrosion and other factors. This table is recommended for general use.

In determining the length of pipe used in any system, the actual length must be increased for the various fittings, and values in determining the equivalent length before applying any of the tables given. Table 36 gives the length in feet to be added to the actual length of pipe for various fittings and values in determining the equivalent length. If it is desired to determine the capacity of a pipe for any other length than 100 ft. or for any initial pressure other than 1 lb. such capacity may be found from either Table 34 or 35, by multiplying the capacities found in those tables by constants given in Table 37.

Example.—What is the capacity of a 150 ft. 4 in. pipe with an initial pressure of 1 lb. and pressure drop of 2 oz. in the 150 ft.?

Solution.—From Table 35 it is found that the capacity of a 100 ft. 4 in. pipe with 1 lb. initial pressure and 2 oz. pressure drop, is 2780 sq. ft. Multiplying this value by 0.817 the constant for a 150 ft. length as given in Table 37 gives 2271 the capacity for the given conditions.

Example.—What is the capacity of a 100 ft. 4 in. pipe with 2 lb. initial pressure and pressure drop of 1 oz.?

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