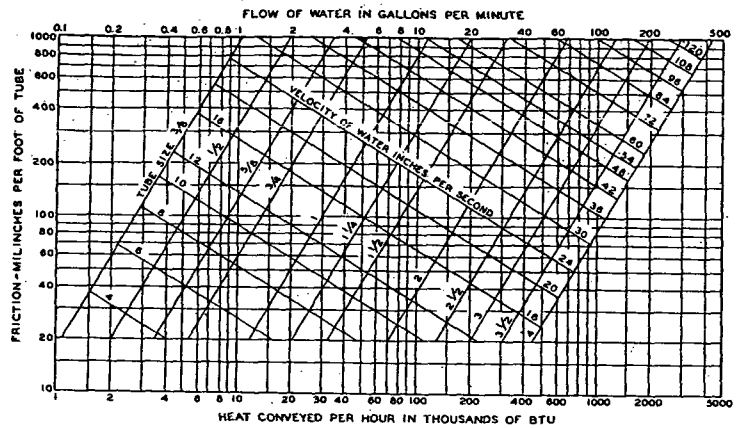


Lower scale of chart is based on 20-deg temperature difference between flow and return risers. To find friction when temperature drop is other than 20 deg, multiply the actual heat conveyed by (20 ÷ actual temp. drop) and read the corresponding friction.

Conversion Ft/100 Ft) to Millinches/Ft

Ft per 100 ft	0.5	1	2	3	4	5
Millinches per ft	60	120	240	360	480	600

Fig. 6.... Friction Loss due to Flow of Water in Type L Copper Tube

Table 2.... Iron and Copper Elbow Equivalents[a, 8, 9, 10]

Fitting	Iron Pipe	Copper Tubing
Elbow, 90-deg	1.0	1.0
Elbow, 45-deg	0.7	0.7
Elbow, 90-deg long turn	0.5	0.5
Elbow, welded, 90-deg	0.5	0.5
Reduced coupling	0.4	0.4
Open return bend	1.0	1.0
Angle radiator valve	2.0	3.0
Radiator or convector	3.0	4.0
Boiler or heater	3.0	4.0
Open gate valve	0.5	0.7
Open globe valve	12.0	17.0

[a] See Table 3 for equivalent length of one elbow.

should be calculated. The friction loss at design flow for all individual sections of pipe and for all fittings in the longest piping circuit should then be summarized.

Table 2 shows the number of elbow equivalents for various fittings. These equivalents can be converted to equivalent feet of pipe by use of Table 3. Fig. 7 shows the elbow equivalents for determining friction loss in tees. If the pipe size calculation indicates a required pump head different from that of a standard pump, pipe sizes in the system may be changed to establish a closer relationship between the two. The relationship between systems and pump heads is discussed in the section Circulating Pumps.

If there are more circuits than one in a system, the friction loss for the longest circuit should be used to determine

Table 3.... Equivalent Length of Pipe for 90-Deg Elbows

Vel. Fps	Pipe Size														
	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6	8	10	12
1	1.2	1.7	2.2	3.0	3.5	4.5	5.4	6.7	7.7	8.6	10.5	12.2	15.4	18.7	22.2
2	1.4	1.9	2.5	3.3	3.9	5.1	6.0	7.5	8.6	9.5	11.7	13.7	17.3	20.8	24.8
3	1.5	2.0	2.7	3.6	4.2	5.4	6.4	8.0	9.2	10.2	12.5	14.6	18.4	22.3	26.5
4	1.5	2.1	2.8	3.7	4.4	5.6	6.7	8.3	9.6	10.6	13.1	15.2	19.2	23.2	27.6
5	1.6	2.2	2.9	3.9	4.5	5.9	7.0	8.7	10.0	11.1	13.6	15.8	19.8	24.2	28.8
6	1.7	2.3	3.0	4.0	4.7	6.0	7.2	8.9	10.3	11.4	14.0	16.3	20.5	24.9	29.6
7	1.7	2.3	3.0	4.1	4.8	6.2	7.4	9.1	10.5	11.7	14.3	16.7	21.0	25.5	30.3
8	1.7	2.4	3.1	4.2	4.9	6.3	7.5	9.3	10.8	11.9	14.6	17.1	21.5	26.1	31.0
9	1.8	2.4	3.2	4.3	5.0	6.4	7.7	9.5	11.0	12.2	14.9	17.4	21.9	26.6	31.6
10	1.8	2.5	3.2	4.3	5.1	6.5	7.8	9.7	11.2	12.4	15.2	17.7	22.2	27.0	32.0

the pump head requirement. Piping in the other circuits should be sized to obtain the same total friction loss.

Effects of Antifreeze Fluids. Antifreeze solutions are sometimes used in heating systems when the danger of freezing exists. They should not be used in direct-fired boiler application. Corrections must be made in flow rates, pipe size, and pump capacity relative to water when antifreeze solutions are used. See Chapter 76, Snow Melting.

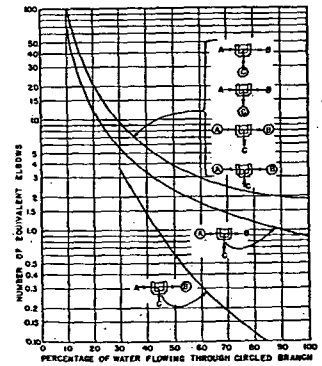
SELECTION OF PIPING ARRANGEMENT

The type of distribution system selected for any particular building will depend primarily on the structural and architectural characteristics of the building, the need for separate control of different zones, the pressure head due to the height of the building, the space available for piping, and the relative cost of different arrangements of piping. Consequently, mains may be run in basement, separate floors, or in space above highest heating units.

There are four distinct arrangements of main piping: (1) the two-pipe reversed-return system, (2) the one-pipe system, (3) the series-loop system, and (4) the two-pipe direct-return system. The last is not recommended unless elaborate pipe sizing technique and provision for adjustment are employed.

Two-Pipe Reversed-Return System—Description and Design

The two-pipe reversed-return main system, Fig. 8, has two mains, one supplying water to the heating units or to risers



Notes: 1. The chart is based on straight tees, that is, branches A, B, and C are the same size.

2. Head loss in desired circuit is obtained by selecting proper curve according to illustrations, determining the flow at the circled branch, and multiplying the head loss for the same size elbow at the flow rate in the circled branch by the equivalent elbows indicated.

3. When the size of an outlet is reduced the equivalent elbows shown in the chart do not apply. The maximum loss for any circuit for any flow will not exceed 2 elbow equivalents at the maximum flow (gpm) occurring in any branch of the tee.

4. The top curve of the chart is the average of 4 curves, one for each of the tee circuits illustrated.

Fig. 7.... Elbow Equivalents of Tees at Various Flow Conditions[9, 11]

to heating units, and one collecting water returned from these units. The piping is arranged in such a manner that the sum of the equivalent length of supply and return piping to any unit is approximately equal to that of any other unit.

Compared with a one-pipe system, the two-pipe system may:

1. Have a smaller average pipe size. While two mains are required, the sizes of the mains vary as water passes from one main through the heating unit to the other. The maximum size of either main is no larger than the size of a one-pipe main.
2. Be more flexible in its application because larger friction loss may be used in the heat-transfer unit circuits.
3. Require a minimum pumping head because the heating unit resistances are in parallel.
4. Permit adjustment of flow through individual units of radiation over wider limits.

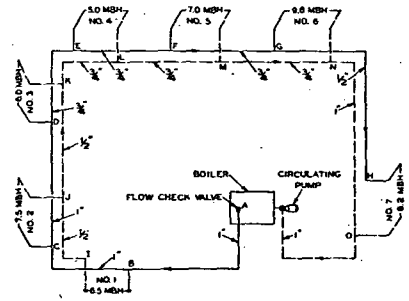


Fig. 8.... A Two-Pipe Reversed-Return System

Continuing the comparison, some disadvantages are:

1. Two mains may require more pipe fitting labor than a single main.
2. Some additional pipe may be required to achieve a reversed return.
3. A two-pipe system will be slightly more expensive for small systems.
4. The piping for two mains may be unsightly in occupied spaces.

Important considerations in the design of a two-pipe reversed-return distribution system are:

1. The head which the pump must generate is equivalent to the friction drop through the circuit having the highest resistance. At design flow, the resistance through the distribution system to any one heating unit should be the same as that through any other unit. Where the length of pipe required to obtain distribution to a particular section must be shorter than to other sections, it is desirable to design that section with a higher friction loss.
2. A reversed return, as indicated in the section Adjustment of Flow and Capacity, will reduce the need for adjustments necessary to obtain equal total head through each heating unit circuit.
3. Fan-type air-heating units with extended-surface coils can be used with a higher water temperature drop than that recommended for direct radiation. It is necessary to avoid a difference in air temperature across the face of the coil in such units. One method of minimizing this difference is to install a minimum of two serpentine coils in each unit, one in front of the other. Coil