TABLE 2. IRON AND COPPER ELBOW EQUIVALENTS[a, 8, 9, 10]

FITTING	IRON PIPE	COPPER TUBING	FITTING	IRON PIPE	COPPER TUBING
Elbow, 90-deg	1.0	1.0	Angle radiator valve	2.0	3.0
Elbow, 45-deg	0.7	0.7	Radiator or convector	3.0	4.0
Elbow, 90-deg long turn	0.5	0.5	Boiler or heater	3.0	4.0
Elbow, welded, 90-deg	0.5	0.5	Open gate valve	0.5	0.7
Reduced coupling	0.4	0.4	Open globe valve	12.0	17.0
Open return bend	1.0	1.0			

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

TABLE 3. EQUIVALENT LENGTH OF PIPE FOR 90 DEG ELBOWS

VEL	PIPE SIZE														
fps	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

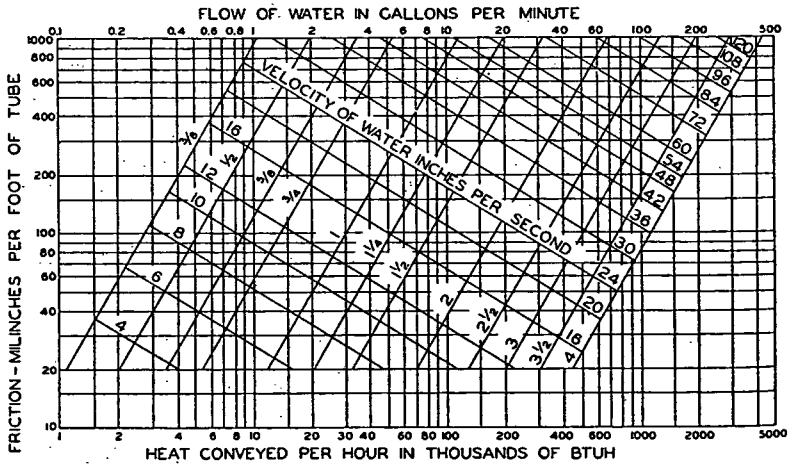

FIG. 6. FRICTION LOSS DUE TO FLOW OF WATER IN TYPE L COPPER TUBE

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 $\left(\frac{20}{\text{actual temp. drop}}\right)$ and read the corresponding friction.

Conversion Ft/(100 Ft) to Milinches/Ft

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

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 risers to heating units, and one collecting water returned from these units. The piping is arranged in such a

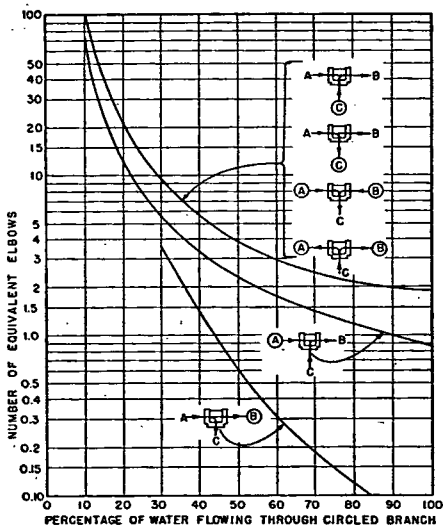

FIG. 7. ELBOW EQUIVALENTS OF TEES AT VARIOUS FLOW CONDITIONS[9, 11]

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 circuled 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.

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.

Continuing the comparison, some disadvantages are:

1. Two mains may require more pipe fitting than a single main.
2. Some additional pipe may be required to achieve a reversed return.