formula (Equation 8, Chapter 4) with values of the density and viscosity of water chosen for 300 F. When corrections are desirable Fig. 24 may be used to correct the friction loss as found in Fig. 23.

The friction loss in fittings expressed in equivalent feet of pipe is given in Table 5.

Circuits

High temperature water is used directly in unit heaters, air heating coils, steel heating panels, and process equipment. Evaporators or steam generators are used for generating steam where required for steam heating systems and equipment. Converters or heat exchangers are also used for building heating and domestic hot water service systems.

Smaller district heating systems pressurized at 12 to 15 psig with distribution at 250 F are in common use. In such installations the water is

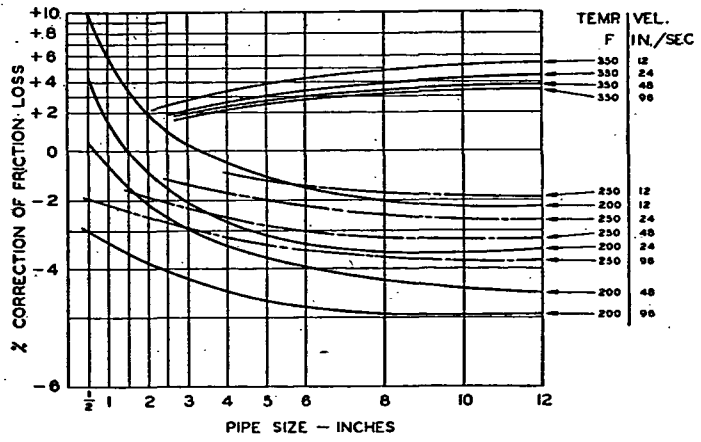

FIG. 24. CORRECTION OF 300 F FRICTION LOSS FOR OTHER WATER TEMPERATURES

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drawn into the individual building systems and recirculated by means of a conventional circulator. Temperature is controlled in each system by a control valve at the high temperature line. The control is usually of the *indoor-outdoor* type, but many variations are used. Sufficient pressure head is usually available to permit circulation of the high temperature water through domestic water heaters for individual supply in each building.

Pumps for High Temperature Systems

Circulating pumps form one of the most important components of the system, and are installed in the flow main to increase the static pressure in the main and thereby maintain a satisfactory temperature-pressure relationship and keep the pressure in the system at all times above the evaporation temperature of the water.

It is common practice to use single-inlet single-stage centrifugal pumps operating at 1750 rpm and having water-cooled bearings and glands (al-

TABLE 5. HEAD LOSS IN FITTINGS[a]
(For turbulent flow)

Fittings \ Pipe Size Inches	Feet of Same Size Pipe Having Equal Loss[e]												
	10	8	6	5	4	3	2½	2	1½	1¼	1	¾	½
Globe Valve	340	270	200	170	135	105	83	70	55	45	36	28	21
Gate Valve	7	5.75	4.5	3.5	3	2.2	1.7	1.5	1.2	1	0.8	0.6	0.5
90° Welding Elbow	11	8.5	6.5	5.5	4.5	3.5	2.6	2.2	1.8	1.5	1.2	0.9	0.7
45° Welding Elbow	7	6	4.5	3.6	3	2.4	1.7	1.5	1.2	1	0.8	0.6	0.5
22½° Welding Elbow	5	4	3	2.5	2	1.6	1.3	1.1	0.9	0.7	0.6	0.5	0.3
Lateral[b]	26	20	16	13	11	8	6.5	5.5	4	3.5	2.8	2.2	1.6
Lateral[c]	17	14	10	8.5	7	5	4	3.5	2.8	2.5	1.8	1.5	1.1
Welding Tee[c]	13	10	8	7	5.5	4	3.2	2.6	2	1.7	1.4	1.2	0.8

Concentric Reducers: From \ to	10	8	6	5	4	3	2½	2	1½	1¼	1	¾	½
10		1	2.5	3	2.8								
8	3.5		1.2	2	2.2	2.2			CONTRACTING				
6	10	3.5		0.5	1.3	1.8	1.7						
5	12	7.5	1.5		0.5	1.2	1.4	1.5					
4	12	9.5	4.5	1.5		0.6	1.2	1.4	1.5				
3		10	7	5	1.8		0	0.8	1	1			
2½			7.5	6	3.8	0.7		0	0.7	0.8	0.75		
2				6	5	2.5	0.8		0	0.6	0.6	0.6	
1½					5	3.8	2.8	9		0	0.5	0.5	0.5
1¼						4	3	2	0.3		0	0	0.3
1		ENLARGING					3	2.5	1.25	0.5		0	0.3
¾								2.5	2	1.3	0.5		0
½									2	1.8	1.5	0.8	

[a] Compiled from data published by *Tube Turns*, Inc., a Division of the National Cylinder Gas Co. Used by permission.
[b] Water deflected through branch.
[c] Water flowing straight through fitting.
[d] For eccentric reducers, the values read for concentric reducers must be increased by 33⅓%.
[e] Equivalent length of pipe having a Fanning friction coefficient of 0.006.

though mechanical seals are coming into use). With pumps of this type the total differential head should not exceed 150 ft.

Pumps for high temperature must be specially designed and constructed to withstand the higher pressure and temperature, at which they will operate, and the higher stresses involved. For space heating loads where the flow varies greatly, it is common practice to use two or more pumps, although care should be taken in motor sizing to avoid overloading when one or more pumps may not be in operation. By use of multiple pumps light loads during off peak periods can be handled economically.