TABLE 8. MAXIMUM CAPACITIES OF RISERS[a] IN *Mbh*, 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 F THROUGH EACH RADIATOR

Pipe Size (Inches)		Equivalent Length of Pipe (Feet[c])	1st Floor[b]			2nd Floor	3rd and 4th Floors
Flow	Return		*Mbh*	Vel. (In. per Sec.[d]) Flow	Vel. (In. per Sec.[d]) Return	*Mbh*	*Mbh*
½	½	1.0				5	6.2
½	¾					6.4	8.0
¾	¾	1.5	9	2.3	2.3	10.1	14.0
¾	1		12	3.2	2.0	12.8	17.1
1	1	2.0	18	2.5	2.5	20	26.0
1	1¼		21	3.0	2.0	25.2	34
1¼	1¼	3.0	26	3.0	3.0	43	55
1¼	1½		34	4.0	2.5		
1½	1½	3.5	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]The riser branches, the piping which connects the risers to the mains, are to be one size larger than the risers.

[c]Approximate length of pipes in feet equivalent to one elbow in friction head. This value varies with the velocity.

[d]Velocities apply to the riser branches.

a 1 in. flow and a 1 in. return is 12.5 Mbh. The former is more nearly the correct size, but since it is difficult to secure a good flow through first floor radiators, the 1 in. flow and return connection is selected. For the two upper floors, the capacity of a ¾ in. flow and return connection is 10.5 Mbh, and that size is used.

As explained in the design of the forced circulation system of Fig. 5, the two-pipe direct return system of Fig. 8 will not function correctly unless its four sets of risers are balanced among themselves. This necessary balancing is accomplished by adding resistances to all risers, except the one farthest from the boiler, equal to the excess boiler pressure heads available for those risers above the boiler pressure head available for the farthest riser. For example, the first set of risers is 60 ft nearer the boiler than the last set. Since the flow and return mains are designed for a friction head of 3 milinches per foot (see Table 7, Column 8), the boiler pressure head available for the first set of risers is 360 milinches in excess

TABLE 9. MAXIMUM CAPACITIES OF RADIATOR CONNECTIONS IN *Mbh*, FOR ONE-PIPE AND FOR TWO-PIPE DIRECT RETURN GRAVITY CIRCULATION SYSTEMS WITH A TEMPERATURE DROP OF 35 F THROUGH EACH RADIATOR

Pipe Size		Equivalent Length of Pipe (Feet[a])	1st Floor	2nd, 3rd, and 4th Floors
Flow	Return		*Mbh*	*Mbh*
½	½	1.0	4.1	5.9
½	¾		5.2	7.5
¾	¾	1.5	7.0	10.5
¾	1		9.1	13.0
1	1	2.0	12.5	17.8
1	1¼		17.5	23.2
1¼	1¼	3.0	23.3	33.2

[a]Approximate length of pipe in feet equivalent to one elbow in friction head. This value varies with the velocity.

of that available for the fourth set. The velocity in the riser branch is 3 in. per second (see Table 8) and, therefore, according to Table 6, an 0.65 in. orifice in a 1¼ in. union should be used. This will provide a resistance of about 420 milinches. In the same manner it is found that for the second set of risers a resistance of 240 milinches is required and that an 0.70 in. orifice in a 1¼ in. union will provide a resistance of 285 milinches. For the third set of risers, a resistance of 120 milinches is required and an 0.60 in. orifice in a 1 in. union will provide sufficient resistance.

EXPANSION TANKS

When water at ordinary temperatures is heated or cooled, its volume is increased or decreased. This variation in the volume of the water in a heating system is generally provided for by means of an expansion tank

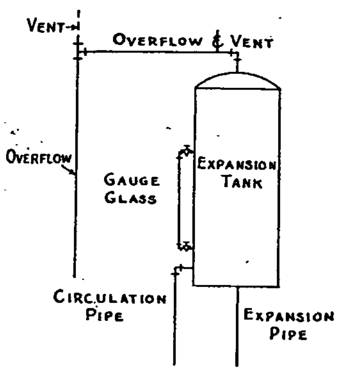

FIG. 9. AN OPEN EXPANSION TANK

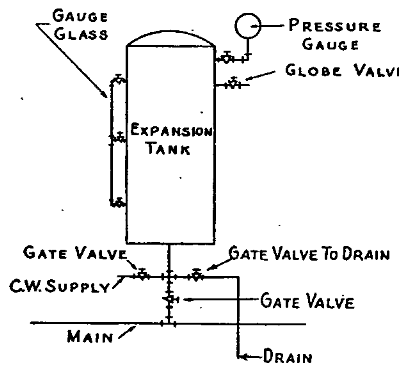

FIG. 10. A CLOSED EXPANSION TANK

into which the water can flow from the system during the heating-up periods and from which it can flow back into the system during the cooling-down periods.

The expansion tank may be open or closed. In an open expansion tank (Fig. 9), the water is subjected to atmospheric pressure and can expand freely without a material increase in pressure. In a closed expansion tank (Fig. 10), the water is subjected to the pressure of the compressed air within the tank, and as the water expands, the volume of the air in the tank is decreased and its pressure increased.

The open expansion tank must be placed at a sufficient elevation above the highest radiator to prevent boiling when the water in that radiator is at the highest temperature to which it is to be heated. For example, if the water is to be heated to 225 F on extremely cold days, the absolute pressure on the water in the highest radiator must be at least 19 lb per square inch. This pressure will be secured if the open expansion tank is located 15 ft above the highest radiator. If a closed expansion tank is used and is located 30 ft below the highest radiator, an absolute pressure