TABLE 6. CAPACITIES OF MAINS IN *Mbh*, FOR ONE-PIPE AND FOR TWO-PIPE DIRECT RETURN GRAVITY CIRCULATION SYSTEMS WITH A TOTAL FRICTION HEAD OF 0.6 IN., A TEMPERATURE DROP OF 35 F, WHEN THE MAINS ARE 4 FT ABOVE THE CENTER OF THE BOILER

1	2	3	4	5	6	7	8	9	10	11
Pipe Size (Inches)	Equivalent Length of Pipe (Feet)[a]	Equivalent Total Length of Pipe in Feet in Longest Circuit								
		75	100	125	150	175	200	250	300	350
		Unit Friction Head, in Milinches								
		8.0	6.0	4.8	4.0	3.4	3.0	2.4	2.0	1.7
1½	3.0	43.0	37.5	33.0	30.0	27.0	25.0	22.2	20.2	18.7
2	4.0	83.0	72.0	63.0	57.0	51.0	48.0	42.0	38.0	35.0
2½	4.5	140.0	115.0	100.0	90.0	81.5	75.4	67.2	61.0	56.0
3	5.0	234.0	204.0	175.5	160.0	143.0	133.0	110.0	107.5	100.0
3½	5.5	347.0	300.0	260.0	236.0	214.0	200.0	177.0	160.0	146.0
4	6.0	490.0	422.0	370.0	334.0	297.0	278.0	248.0	223.0	205.0

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

are used, the capacity will be 8.0 Mbh; if both risers are ¾ in., the capacity will be 14.0 Mbh. The ¾-in. pipe is selected for both risers.

To design the radiator connections, use Table 8 and note that for the first floor radiator connections the capacity of a ¾-in. flow and 1-in. return is 9.1 Mbh, and that of 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.

TABLE 7. 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]		*Mbh*	*Mbh*
				Flow	Return		
½	½	1.0				5.0	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	20.0	26.0
1	1¼		21	3.0	2.0	25.2	34.0
1¼	1¼	3.0	26	3.0	3.0	43.0	55.0
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.

TABLE 8. 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		6.2	7.5
½	¾	1.5	7.0	10.5
¾	¾		9.1	13.0
¾	1	2.0	12.5	17.8
1	1		17.5	23.2
1	1¼	3.0	23.3	33.2
1¼	1¼			

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

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 6, Column 8), the boiler pressure head available for the first set of risers is 360 milinches in excess of that available for the fourth set. The velocity in the riser branch is 3 in. per second (see Table 7) and, therefore, according to Table 5, 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

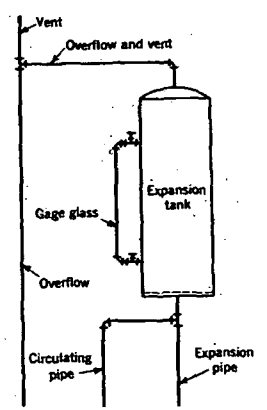

FIG. 9. AN OPEN EXPANSION TANK

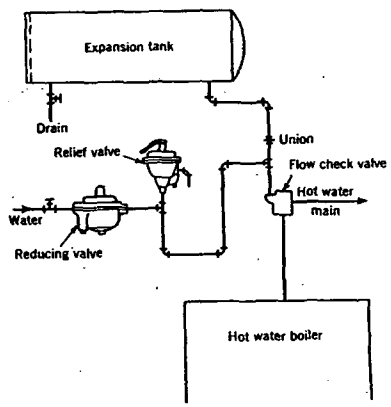

FIG. 10. A CLOSED EXPANSION TANK