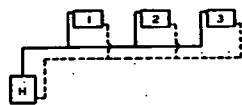
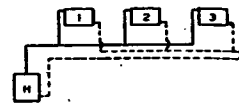


FIG. 4. ONE-PIPE SYSTEM

FIG. 5. A TWO-PIPE
DIRECT RETURN
SYSTEMFIG. 6. A TWO-PIPE
REVERSED RETURN
SYSTEM

spectively. These figures would also illustrate forced circulation if a pump or circulator were shown in the return line at the boiler.

One-pipe gravity systems require very precise design owing to the small circulating head available. Also, circulation in them is slow, and temperature drop is large toward the end of the main, and consequently these systems are usually considered impractical.

One-pipe forced systems compared with gravity systems provide more rapid circulation, with consequent smaller temperature drop in mains and more uniform water temperature in all radiators, and are therefore preferred. Special flow and return fittings are available for improving the circulation to risers.

Two-pipe systems have separate flow and return mains. If the return main is *direct* as shown in Fig. 5 the radiator at the end of the system has

TABLE 3. HEAT-CARRYING CAPACITY OF TYPE L COPPER TUBING
WITH TEMPERATURE DROP OF 20 DEG°

Nominal Tube Sizes $\frac{1}{8}$ in. to 4 in., and Friction 60 to 720 milinches per foot. (A = Capacity, Mbh. B = Velocity, inches per second) (One milinch equals 0.001 in.)

NOMINAL TUBE SIZE, IN.		MILINCH FRICTION LOSS PER FOOT OF TUBE											
		720	600	480	360	300	240	180	150	120	90	75	60
$\frac{1}{8}$	A	10	9	8	6.8	6.2	5.4	4.6	4	3.6	3	2.8	2.4
	B	27	24	21	18	16.5	14	13	11	10	8.5	8	7
$\frac{1}{4}$	A	20	18	16	13.5	12	10.8	9	8	7	6	5.4	4.7
	B	35	30	25	21	19	17	15	13	12	10	9	8
$\frac{3}{8}$	A	36	30	26	22.1	20	17.8	15	13.1	11.8	9.9	9	7.9
	B	37	34	30	24	21	19	17	15	13	11	10	9
$\frac{1}{2}$	A	61	46	40	34	31	28	23.2	20.5	18.1	15.3	13.9	12.1
	B	42	38	33	27	24	21	19	17	14	12	11.5	10
$\frac{3}{4}$	A	104	94	82	70	63	56	47	42	37	32	28	25
	B	48	43	39	34	30	25	22	19	17	14.5	13	12
1	A	185	169	149	125	112	100	84	75	66	56	50	44
	B	55	51	45	39	35	30	25	22	19	17	15	14
1 1/4	A	300	270	235	200	180	160	134	120	105	90	81	71
	B	62	57	51	43	39	35	30	25	22	19	17	15
2	A	625	560	495	420	375	335	280	250	207	188	170	150
	B	76	68	59	51	47	42	36	32	27	23	20	18
2 1/2	A	1130	1010	890	750	680	600	500	450	395	335	305	270
	B	90	80	69	58	52	47	42	37	33	28	23	21
3	A	1840	1650	1450	1210	1100	980	820	740	650	550	490	420
	B	98	88	76	66	59	52	47	42	36	30	27	23
3 1/2	A	2750	2480	2170	1840	1650	1450	1210	1100	980	820	740	650
	B	110	100	89	75	68	57	51	45	40	35	30	26
4	A	3900	3505	3100	2600	2350	2090	1760	1550	1390	1180	1050	950
	B	120	108	96	83	73	63	55	49	44	37	34	29

* For other temperature drops the pipe capacities may be changed correspondingly. For example, with temperature drop of 30 deg the capacities shown in this table are to be multiplied by 1.5.

TABLE 4. FRICTION (IN MILINCHES) OF CENTRAL CIRCULAR
DIAPHRAGM ORIFICES IN UNIONS

(One milinch equals 0.001 in.)

DIAMETER OF ORIFICES (INCHES)	VELOCITY OF WATER IN PIPE IN INCHES PER SECOND									
	2	3	4	6	8	10	12	18	24	36
<i>3/4-in. Pipe</i>										
0.25	1300	2900	5000	11,300	20,800	32,000	45,000	57,000		
0.30	650	1450	2500	5700	10,400	16,000	23,000	26,000	47,000	
0.35	330	740	1300	2900	5200	8000	12,000	13,000	24,000	53,000
0.40	170	380	660	1500	2600	4000	6800	2900	12,000	27,000
0.45		185	330	740	1300	2000	2900	3200	5700	13,000
0.50			155	350	620	970	1400	1600	2800	6400
0.55			75	170	300	480	700			
<i>1-in. Pipe</i>										
0.35	900	2000	3500	7800	14,000	22,000	32,000	37,000	65,000	
0.40	460	1000	1800	4000	7200	12,000	17,000	21,000	37,000	
0.45	270	570	1000	2300	4100	6400	9300	10,000	18,000	40,000
0.50	160	330	580	1400	2300	3700	5400	12,000	22,000	50,000
0.55		190	330	750	1300	2200	3000	7000	13,000	28,000
0.60			200	440	800	1300	1800	4200	7400	17,000
0.65			120	260	460	720	1100	2400	4300	10,000
<i>1 1/4-in. Pipe</i>										
0.45	1000	2250	4000	8900	16,000	25,000	36,000	53,000		
0.50	660	1450	2600	5800	10,400	16,400	23,000	34,000	60,000	
0.55	430	950	1700	3800	6800	10,500	15,000	22,000	40,000	
0.60	280	630	1100	2500	4400	6900	10,000	15,000	27,000	60,000
0.65	190	420	750	1700	3000	4700	6700	10,000	18,000	40,000
0.70		285	510	1150	2000	3100	4500	10,000	18,000	40,000
0.75		190	330	750	1300	2100	3000	6700	12,000	26,000
<i>1 1/2-in. Pipe</i>										
0.55	850	1900	3300	7400	13,000	21,000	30,000	50,000		
0.60	600	1300	2300	5400	8600	16,800	21,000	30,000	39,000	
0.65	400	850	1500	3600	7200	10,400	14,000	21,000	39,000	
0.70	260	600	1100	2600	4400	7000	10,000	21,000	39,000	
0.75	180	400	760	1800	3000	5000	7000	14,000	28,000	
0.80		300	540	1200	2200	3200	5000	10,200	19,000	45,000
0.85		200	380	860	1600	2300	3000	7800	13,000	30,000
<i>2-in. Pipe</i>										
0.70	890	1850	3500	7400	14,000	22,300	33,000	37,000		
0.80	470	975	1800	3900	7400	11,700	17,000	20,500	38,000	
0.90	255	560	1000	2200	4200	6500	9500	12,500	23,000	49,000
1.00	160	340	610	1320	2520	4000	5800	7900	14,000	30,000
1.10		214	375	850	1600	2500	3700	5000	8100	16,800
1.20			195	460	950	1360	1910	4200	8100	16,800
1.30				275	525	980	1375	3100	4400	8850

Note.—The losses of head for the orifices in the 1 1/4-in. and 2-in. pipe were calculated from those in the smaller pipes, the calculations being based on the assumption that, for any given velocity, the loss of head is a function of the ratio of the diameter of the pipe to that of the orifice. This had been found to be practically true in the tests to determine the losses of head in orifices in 1/4-in., 1-in., and 1 1/4-in. pipe, conducted by the Texas Engineering Experiment Station, and also in the tests to determine the losses of head in orifices in 4-in., 6-in., and 12-in. pipe, conducted by the Engineering Experiment Station of the University of Illinois, (Bulletin 109, Table 6, p. 38, Davis and Jordan).