

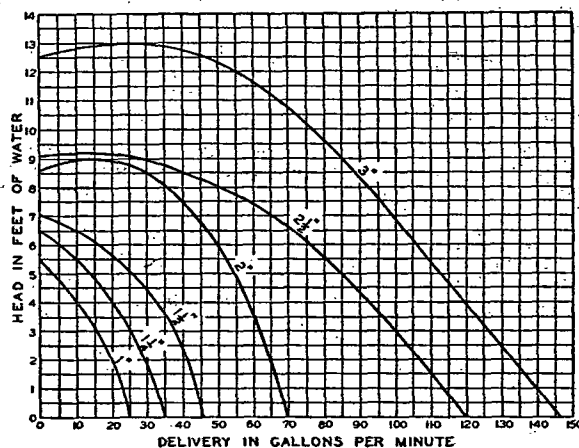


FIG. 12. PERFORMANCE CHART FOR CIRCULATING PUMP

In determining sizes for the piping from the main to any radiator, the resistance in the radiator circuit such as B-C (which has a load of 9 Mbh) is made equal to the resistance in the main from B to C which, if there are 3 ft of main between connections, is $3 \times 320 = 960$ milinches. If the total equivalent length of the radiator circuit determined by use of Table 1 is 32 ft, the radiator circuit B-C will be sized for a friction loss of $960 \div 32 = 30$ milinches per foot, for which in Table 2 a $\frac{3}{4}$ in. pipe is found to supply 8550 Btu per hour and will be considered ample.

Other radiator circuits such as D-E, F-G etc. can be sized in a similar manner.

Two-Pipe Gravity System (with Reversed Return)

Example 5. Select pipe sizes for the two-pipe gravity system shown in Fig. 13. The center plane of the highest radiator is 8 ft above the center plane of the boiler. Assume a 180 F flow temperature and a 150 F return temperature.

Solution. The piping should be sized so that the frictional resistance at the desired rate of flow is equal to the available circulating head.

From Fig. 1 at 180 F flow and 150 F return temperature the available head is 118 milinches per foot of height or $8 \times 118 = 944$ milinches total for the highest radiator. The longest circuit from boiler to radiator and back to boiler must therefore have a resistance of 944 milinches. The longest circuit (see Fig. 13) is A-D + D-H + H-N containing 38 ft of pipe and, if 50 per cent is added for equivalent length of fittings, the equivalent length is 57 ft.

The circuit should then be designed for a friction loss of $944 \div 57 = 16$ milinches per foot (approximately).

The pipe size may be found from Table 2 at 16 milinches per foot as follows:

SECTION	LOAD MBH	SIZE OF PIPE FOR 16 MILINCHES PER FOOT	SECTION	LOAD MBH	SIZE OF PIPE FOR 16 MILINCHES PER FOOT
A-B	58	2	G-H	11	1
B-C	31	1 $\frac{1}{2}$	H-K	19	1 $\frac{1}{4}$
C-D	20	1 $\frac{1}{4}$	K-L	25	1 $\frac{1}{4}$
D-E	16	1 $\frac{1}{4}$	L-M	31	1 $\frac{1}{4}$
E-F	6	$\frac{3}{4}$	M-N	58	2

Pipe sizes to the radiators may be sized for the same resistance per foot. From Table 2 at 16 milinch per foot the sizes will be selected as follows:

Radiator	#1	#2	#3	#4	#5	#6
Load, Mbh	11	8	6	6	24	3
Pipe size, In.	1	1	$\frac{3}{4}$	$\frac{3}{4}$	1 $\frac{1}{4}$	$\frac{3}{4}$

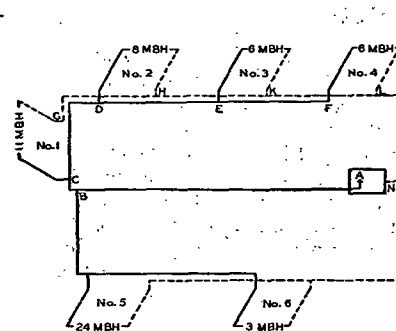


FIG. 13. TWO-PIPE REVERSED RETURN GRAVITY SYSTEM (EXAMPLE 5)

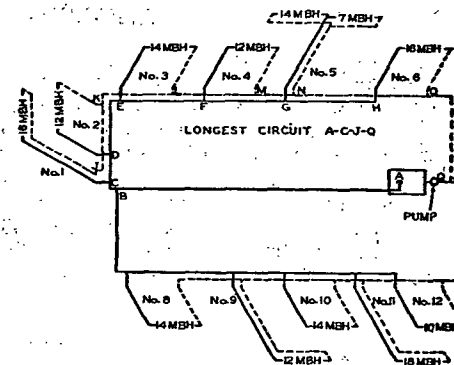


FIG. 14. FORCED CIRCULATION TWO-PIPE REVERSED RETURN SYSTEM

A hot water heating system will adjust its rate of flow until the friction loss balances the available head. It is therefore self-correcting in regard to small errors made in selection of pipe sizes.

Two-Pipe Forced Circulation System

Example 6. Select pipe sizes for the two-pipe forced circulation reversed return system having a total load of 159 Mbh shown in Fig. 14. Assume a difference of 20 deg in supply and return water temperature. The total equivalent length of the longest circuit is 180 ft. The gravity circulating head due to difference in temperature may be disregarded in design.

Solution. The water to be circulated is $159,000 \div 20 = 79,500$ lb per hour or $\frac{7950}{60 \times 8} = 16.5$ gpm. From a pump performance chart such as Fig. 12 it is found that 16.5 gpm will be delivered by a 1 in. pump against a 3 ft head (36,000 milinches) or a $1\frac{1}{4}$ in. pump against a 4.5 head (54,000 milinches).

The longest circuit including the supply and return main and the longest radiator circuit is 120 ft and, if 50 per cent is added for friction loss in fittings, the equivalent length is 180 ft. If the 1 in. pump is used, the piping will be sized for $36,000/180 = 200$ milinches per foot, resulting in selection from Table 2 of a 2 in. main for the Section A-B which supplies 159 Mbh. The large difference in pump and main size, as well as the low velocity resulting from the 200 milinch per foot friction loss, indicates that the $1\frac{1}{4}$ in. pump should be considered. The design friction loss, if the $1\frac{1}{4}$ in. pump is used, can be $54,000/180 = 300$ milinches per foot and at this friction loss Table 2 will indicate the pipe sizes for the various sections in Fig. 14 as follows:

SUPPLY			RETURN		
Section	Mbh	Pipe Size, In.	Section	Mbh	Pipe Size, In.
A-B	159	1 $\frac{1}{2}$	J-K	16	$\frac{3}{4}$
B-C	91	1 $\frac{1}{4}$	K-L	28	$\frac{3}{4}$
C-D	75	1 $\frac{1}{4}$	L-M	42	1
D-E	63	1 $\frac{1}{4}$	M-N	54	1
E-F	49	1	N-O	75	1 $\frac{1}{4}$
F-G	37	1	O-P	91	1 $\frac{1}{4}$
G-H	16	$\frac{3}{4}$	P-Q	159	1 $\frac{1}{2}$

The radiator circuits may also be sized for the same friction loss, 300 milinches per foot, using Table 2 as follows:

Radiator	#1	#2	#3	#4	#5 and #6	#7
Load, Mbh	16	12	14	12	21	16
Pipe size, In.	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$

^aWhere circuit divides, use $\frac{3}{4}$ in. branch to #5 and $\frac{1}{2}$ in. to #6 radiator.