3. A two-pipe system will be slightly more expensive for small systems.
4. The piping for two mains may be unsightly in occupied spaces.

Important considerations in the design of a two-pipe reversed-return distribution system are:

1. The head which the pump must generate is equivalent to the friction drop through the circuit having the highest resistance. At design flow, the resistance through the distribution system to any one heating unit should be the same as that through any other unit. Where the length of pipe required to obtain distribution to a particular section must be shorter than to other sections, it is desirable to design that section with a higher friction loss.

2. A reversed return, as indicated in the section Adjustment of Flow and Capacity, will reduce the need for adjustments necessary to obtain equal total head through each radiation circuit.

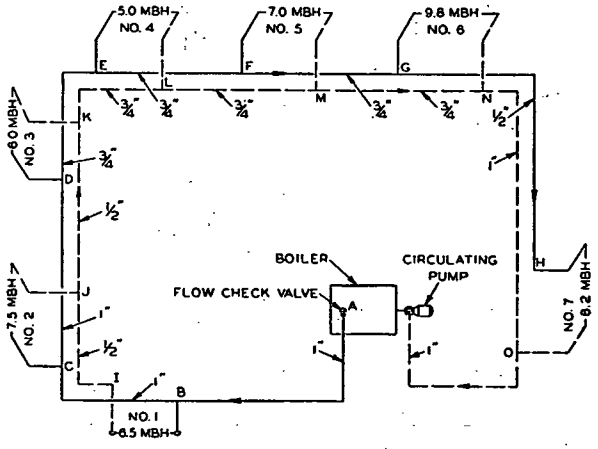

FIG. 8. A TWO-PIPE REVERSED RETURN SYSTEM

3. Fan-type air-heating units with extended surface coils can be used with a higher water temperature drop than that recommended for direct radiation. It is necessary to avoid a difference in air temperature across the face of the coil in such units. One method of minimizing this problem is the installation of a minimum of two serpentine coils in each unit, one in front of the other. Coil connections are made so that water travels from top to bottom in one coil and from bottom to top in the other.

The design of a two-pipe reversed return system will be illustrated by *Example 1.*

Example 1: Design a two-pipe reversed-return hot water heating system for a 37 x 29 ft one story residence with basement having a heat loss of 50 Mbh (50,000 Btu per hr). The heating units are to be convectors operating with a supply water temperature of 210 F and a 20 deg temperature drop. The piping layout and location of convectors are shown in Fig. 8.

Solution: A 50 Mbh load with a 20 deg drop requires a water circulation of 5 gpm. The length of the reversed return circuit is determined as 138 ft of pipe, by following the supply from the boiler to point G Fig. 8 and the return from point N back to the boiler. The estimated total equivalent length is 138 × 1.5 = 207 ft. This, plus an allowance of the equivalent of 25 ft of pipe for one convector circuit results in a total equivalent length of pipe of 232 ft. Fig. 9 shows that a 1-inch pump has a capacity of 5 gpm at 4.7 ft available head. The preliminary average design friction loss is then; $\frac{4.7 \times 100}{232}$ or 2 ft per 100 ft of pipe (240 milinches per ft). This value can also

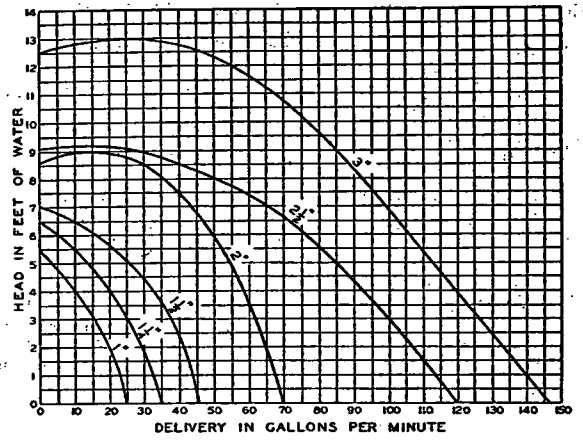

FIG. 9. PERFORMANCE CHART FOR CIRCULATING PUMP

be determined by reference to Table 1, where, using the vertical column under 5 ft, the next larger equivalent length to 232 ft is 250 ft. To the right in this line read the average design friction loss as 2 ft per 100 ft or 240 milinches per foot.

The piping may be sized initially from Table 1 as follows: In the friction loss column find the value 2 ft per 100 ft. Proceed to right in the same line to the nearest gpm value and then read the pipe size at the top of the column.

The pipe sizes found by this method for the various sections of Fig. 8 are shown in the following table:

Supply				Return			
Section	MBH	GPM	Pipe Size Inches	Section	MBH	GPM	Pipe Size Inches
A-B	50	5.0	1	I-J	6.5	0.65	½
B-C	43.5	4.35	1	J-K	14	1.4	½
C-D	36	3.6	¾	K-L	20	2.0	¾
D-E	30	3.0	¾	L-M	25	2.5	¾
E-F	25	2.5	¾	M-N	32	3.2	¾
F-G	18	1.8	¾	N-O	41.8	4.18	1
G-H	8.2	0.82	½	O-A	50	5.0	1

The risers to the convectors may also be sized for the same average friction loss, 2 ft/100 ft or 240 milinches per foot, as follows:

Convector No.	1	2	3	4	5	6	7
Load Mbh	6.5	7.5	6.0	5.0	7.0	9.8	8.2
Gpm	0.65	0.75	0.60	0.5	0.7	0.98	0.82
Pipe Size	½	½	½	½	½	½	½

After the initial pipe sizes have been selected the friction loss in the system should be recalculated as indicated in the following table. The highest pressure drop circuit should be marked off into sections; each of a different flow rate. The total equivalent length of each section should then be determined by adding its elbow equivalent length (see Tables 2, and 3 and Fig. 7) to its actual measured length. Total friction loss is established from charts or tables for each section by multiplying