The one-pipe system would not be suitable for this installation because the sizes of the radiators, in the buildings receiving the cooler water, would be excessive.

Either of the two-pipe systems shown in Figs. 11 and 12 could be used.

To determine the pipe sizes it is necessary to assume some unit velocity or some unit friction head for the system. The higher the velocity, for

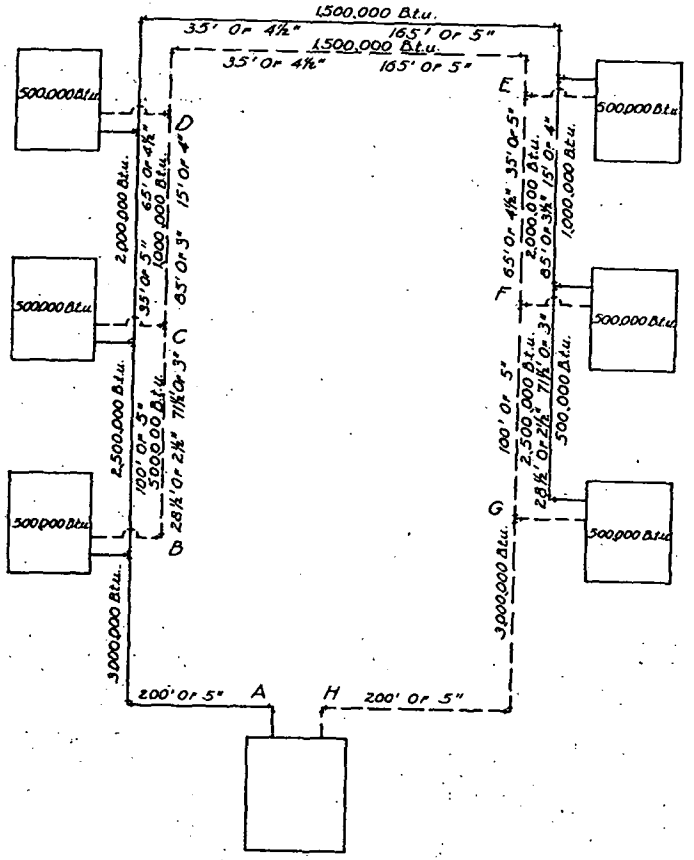

FIG. 11. TWO-PIPE, WITH REVERSED RETURN, FORCED CIRCULATION SYSTEM FOR SIX BUILDINGS

which the system is designed, the smaller will be the pipe and its cost, and the larger will be the cost of the pump and of its operation. For every case there will be an optimum velocity for which the total cost is a minimum. This velocity must be calculated for every case.

For the system of Fig. 11, assume that the temperature drop through each building is to be 20 deg., and that the velocity of the water in the

largest pipe of the main is to be approximately 5 ft. per second and in the smaller generally less, but adjusted so that the friction will be practically the same throughout the system for any one of the six possible paths. Divide the system into seven sections as shown in Fig. 11 and in Table 4.

TABLE 4. TABULATION OF FRICTION HEAD CALCULATIONS FOR THE FORCED CIRCULATION SYSTEM SHOWN IN FIG. 11

SECTION	HEAT 1,000 B.T.U.	PIPE LENGTH, FEET	ELBOWS	PIPE DIAMETER	VELOCITY	UNIT FRICTION, MIL-INCHES		TOTAL FRICTION, MIL-INCHES
						Pipe	Elbows	
A–B	3,000	200	10	5 in.	58	180	2,700	63,000
B–C	2,500	100		5 in.	48	130		13,000
C–D	2,000	100		35 ft. 5 in. 65 ft. 4½ in.	40 45	84 155		13,015
D–E	1,500	200	2	35 ft. 4½ in. 165 ft. 5 in.	36 29	85 50	1,100 690	13,015
E–F	1,000	100		15 ft. 4 in. 85 ft. 3½ in.	32 39	75 140		13,025
F–G	500	100		71.5 ft. 3 in. 28.5 ft. 2½ in.	27 41	82 250		12,988
G–H	3,000	200	10	5 in.	58	180	2,700	63,000
TOTAL Friction Head..... Mil-Inches								191,043

It is evident from Fig. 11 and Table 4 that the water may flow from the central plant through any one of the six buildings and back to the central plant with a loss of head of 15.9 ft. of water, plus the losses of head in the building, and in the central plant. If the six buildings are piped so that the loss of head is the same in each of the six buildings, the water will flow uniformly through the buildings.

If the buildings are piped so that the loss of head is not the same in all, the losses can be made equal by adjusting the valves at the several buildings. For this purpose every building must be supplied with gate valves in the flow and return lines at the building connections and with thermometers in the pipe lines near the valves which should be adjusted so that the calculated temperature drop (20 deg. in this particular problem) is obtained in each building.

Using the prices shown in Table 5, the cost of the 1,600 ft. of mains

TABLE 5. APPROXIMATE COST OF COVERED PIPE INSTALLED IN TUNNEL

SIZES—INCHES	2	2½	3	3½	4	4½	5	6	8	10
Cost per Foot....	$0.75	$1.00	$1.25	$1.50	$1.75	$2.00	$2.25	$2.75	$4.50	$6.25