

with a constant register or delivery temperature maintained, *provided that the rate of fuel consumption can be increased to provide the necessary heat*. In other words, the capacity of a forced circulation system is limited by the ability of the chimney to produce a sufficient draft.

TABLE 1. SUMMARY OF DATA APPLIED TO WARM AIR RESEARCH RESIDENCE

Rooms	From Chapter 7 Estimating Heat Losses Btu Heat Losses H	Leader Area Sq. In.	Stack Area Sq. In. 0.7 × LA	Leader Diameter Inches	Stack Size Net	Register Size Gross
First Floor		= 0.009H				
Living.....	17250	155	---	14	-----	14 × 16
Dining.....	6810	61	---	9	-----	8 × 12
Breakfast.....	2300	21	---	8	-----	8 × 10
Kitchen.....	9210	83	---	11 or 12	-----	12 × 14
Sun.....	25710	230	---	Two 12	-----	Two 12 × 14
Hall and stair	12570	113	---	12	-----	12 × 14
Second Floor		= 0.006H				
Owner's.....	15030	90	63	11 or 12	5 × 12	12 × 14
S. W. Bed.....	9800	59	41	9	3½ × 12	8 × 12
Bath.....	2450	15	10	8	3 × 10	8 × 10
N. Bed.....	14800	89	62	11 or 12	5 × 12	12 × 14
Third Floor		= 0.005H				
E. Bed.....	8220	41	29	8	3 × 10	8 × 10
W. Bed.....	8220	41	29	8	3 × 10	8 × 10

BOOSTER FANS

Booster fans often may be arranged to operate when gas or oil burners are running and to stop automatically when the burners shut down. The booster equipment is most effective in increasing output at low operating temperatures. According to tests, efficiencies may be advanced from 60 per cent for gravity to 70 per cent with boosters at low operating temperatures, but at high operating temperatures gravity and booster efficiencies are almost identical⁶.

⁶See University of Illinois Eng. Exp. Sta. Bulletin No. 141, p. 79.

PROBLEMS IN PRACTICE

1 ● What may prohibit the use of a gravity warm air system in a large house having several exposed wings?

In a gravity warm air system, excessive vertical distances above the furnace cause little trouble in the design of the wall stacks, but excessive horizontal distances from the furnace should be carefully considered in the design of the leaders. To work effectively, a gravity warm air system should be balanced and leaders over 12 ft in length should be avoided if possible. Long leaders, if used, must be of ample size, well pitched, and well insulated. Large houses having exposed wings may require leaders much longer than 12 ft; infiltration may create severe back-drafts in the exposed wings; and the basement ceiling height may not be sufficient to allow the leaders to have a pitch of more than one inch per foot. These conditions may make the exposed wings very difficult to heat with a gravity system because of its low air head differentials.

- 2 ● A third-story bedroom has a calculated heat loss of 12,000 Btu per hour.
- What size leader pipe should be used for a 175 F register air temperature?
 - What size stack?
 - What size register?

a. Leader area = $\frac{12,000}{200} = 60$ sq in. Use leader with diameter of 9 in.
 b. Stack area = $0.7 \times 60 = 42$ sq in. Use stack 3½ in. by 12 in.
 c. Register gross area = $\frac{60}{0.7} = 85.7$ sq in. Use register 8 in. by 12 in.

- 3 ● The calculated heat loss of a house is 130,000 Btu per hour. Find the grate area required for the furnace under the following conditions:

Heating value of coal = 12,500 Btu per lb.

Furnace efficiency = 55 per cent.

Combustion rate = 7.5 lb per sq ft per hour.

Ratio of heating surface to grate area of furnace = 20 to 1.

Register temperature = 175 F.

Loss between furnace and registers = 20 per cent.

Grate area = $\frac{1.2 \times 144 \times 130,000}{0.60 \times 12,500 \times 7.5} = 399.5$ sq in.

Grate diameter = 22.6 in.

Use grate with diameter of 23 in.

- 4 ● If in Question 3 the conditions were the same except that the ratio of heating surface to grate area of furnace was 24 to 1, what size grate would be required for the furnace?

Grate area = $\frac{1.2 \times 144 \times 130,000}{0.60 \times 12,500 \times 7.5} \times \frac{1}{1 + 0.02(24 - 20)} = \frac{399.5}{1.08} = 370$ sq in.

Grate diameter = 21.7 sq in.

Select grate with diameter of 22 in.

- 5 ● Name the items involved in the design of a furnace heating system.

- Heat loss from each room, Btu.
- Area and dimensions of warm-air pipes in basement, inches.
- Area and dimensions of vertical pipes, inches.
- Free and gross area and dimensions of warm-air registers, inches.
- Area and dimensions of recirculating or outside air ducts, inches.
- Free and gross area and dimensions of recirculating registers, inches.
- Size of furnace necessary to supply the warm air to overcome the heat loss.
- Area and dimension of chimney and smoke pipe, inches.

- 6 ● Discuss the design features of recirculating ducts.

- Their area should be equal to or greater than that of the supply ducts.
- They should be streamlined, and have a minimum number of turns.
- All runs should be as short as possible.
- Account should be taken of all cold walls and window areas in determining sizes and positions of return air inlets.
- The return line should be pitched downward toward the furnace. It should be designed to minimize friction.
- The top of the shoe or boot should never be above the grate level.