approximately 1.27 times the cubic feet of air admitted through the intake per hour on a zero day. For systems which recirculate all the air this value will be zero. For systems which have a fresh air intake, controlled by damper, this value might well be approximated, since this loss will probably be reduced to a minimum on a zero day. Assume for such cases, that the building loss is increased by 25 per cent, and that there is the usual 20 per cent loss between furnace and registers.

It is not always possible to obtain performance curves, and the following method is suggested as being a close check. An addition of 2 per cent of the furnace capacity is proposed for each unit that the heating surface-grate area ratio of the furnace exceeds 20. This addition

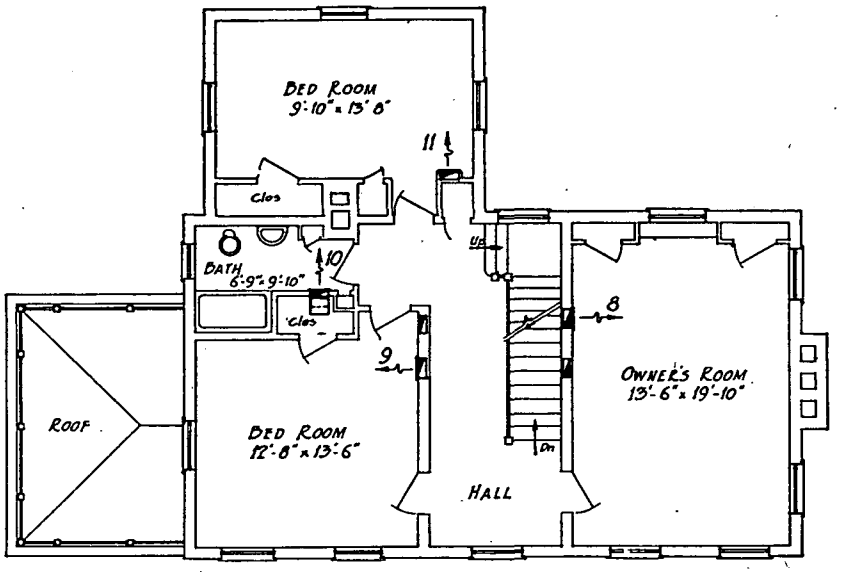

FIG. 10. SECOND-FLOOR PLAN, RESEARCH RESIDENCE

is based on tests of four types of furnaces having various ratios of heating surface to grate area, at the University of Illinois.

Let E = efficiency of the furnace.
f = fuel value of the coal, B.t.u. per pound.
p = pounds of coal burned per square foot grate per hour.
R = ratio of heating surface to grate area.
H = total heat requirements of the house.

$$\text{Grate area, square inches} = \frac{1.2 \times 144\ H}{Efp\ [1 + 0.02\ (R - 20)\ ]} \text{ for all inside air} \qquad (9)$$

For coal having a heat value of 12,000 B.t.u., a furnace having 60 per cent efficiency, and 6-lb. coal burned per square foot grate per hour, and 20 sq. ft. of heating surface for 1 sq. ft. of grate this becomes:

$$\text{Grate area, square inches} = \frac{1.2 \times 144\ H}{0.60 \times 12{,}000 \times 6} \text{ for all inside air} \qquad (10)$$

and for another furnace having 24 sq. ft. of heating surface for 1 sq. ft. of grate the expression is

$$\text{Grate area, square inches} = \frac{1.2 \times 144\ H}{0.60 \times 12{,}000 \times 6\ [1 + 0.02\ (24 - 20)]} \qquad (11)$$

The air temperatures at the registers corresponding to the conditions of equation (11) would be approximately 165 deg. fahr. and for 175 deg. fahr. and 12,000 B.t.u. the combustion rate would be about 7.5 lb. with an efficiency of 57 per cent, using the curves of Fig. 6 as a guide.

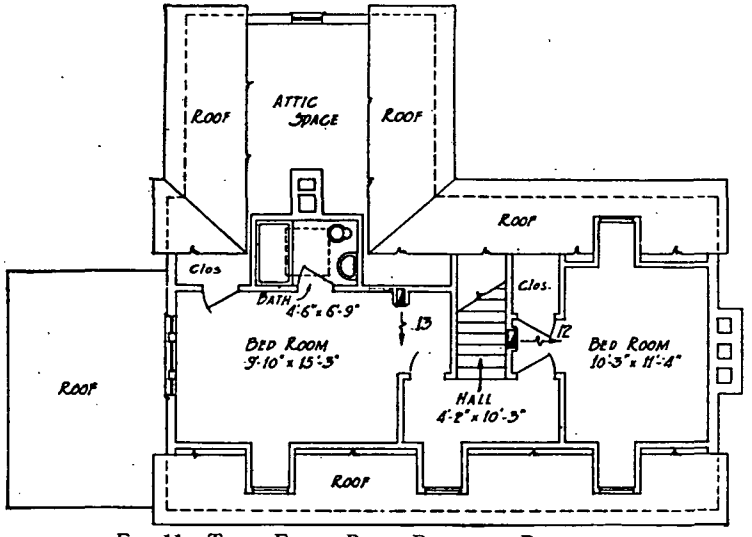

FIG. 11. THIRD-FLOOR PLAN, RESEARCH RESIDENCE

APPLICATION OF DATA

The application of the preceding data to an actual example may be of assistance to the designer. Figs. 7, 8, 9, 10 and 11,[2] represent the plans of the Warm Air Research Residence of the *National Warm Air Heating Association* erected at the University of Illinois.

Leaders, Stacks and Registers. (Direct Method)

Living Room, 1st floor:

17,250 ÷ 111 = 155 sq. in. leader area. See summary, Table 1; also Example under Standard Code, Art. 3, Basis of Working rules for pipes.

Leader diameter = 14 in.

Register size = 155 sq. in. net area. Gross area = say 1.6 × net area = 14 × 18 in.

Owner's Room, 2nd floor:

15,030 ÷ 167 = 90 sq. in. leader area. See Summary Table; also Example under Standard Code, Art. 3, Basis of working rules for pipes.

[2]Plans used with permission. Bath room on third floor not heated at present.