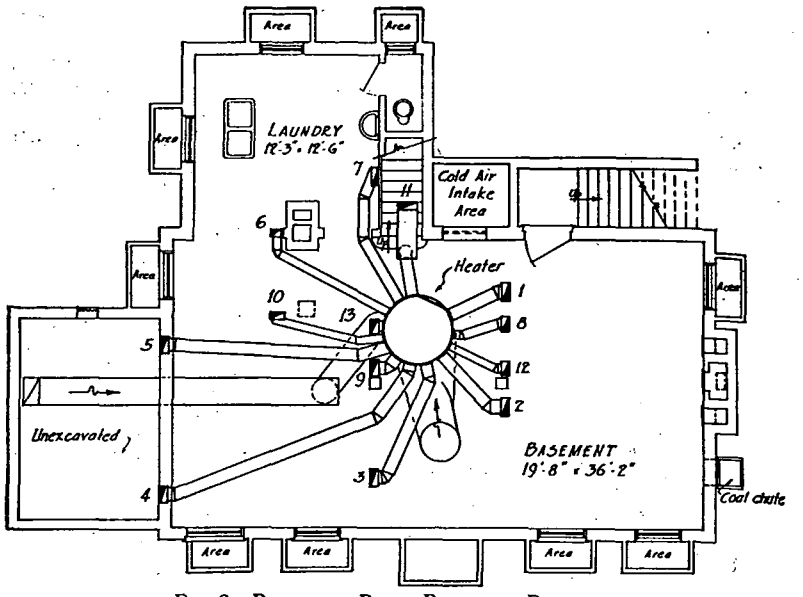

FIG. 8. BASEMENT PLAN, RESEARCH RESIDENCE

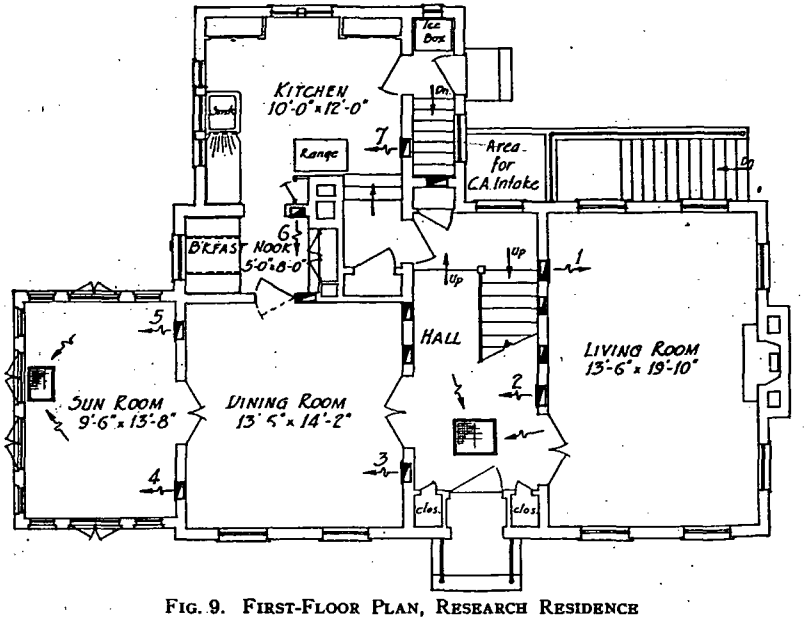

FIG. 9. FIRST-FLOOR PLAN, RESEARCH RESIDENCE

plant requirement (allowing 20 per cent heat loss between furnace and registers) will be:

$$\text{Grate area (175 F register temperature), square inches} = \frac{1.2\,H}{356} = 0.0034H \quad (7)$$

$$\text{Grate area (160 F), square inches} = \frac{1.2\,H}{300} = 0.0040H \quad (8)$$

Here H = Btu heat loss from the entire house per hour = summation of all room losses $H_1 + H_2 +$ etc. + the Btu necessary to heat the fresh air, if any, at intake. This fresh air loss in Btu per hour will be 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 to grate area ratio of the furnace exceeds 20. This addition is based on tests made at the University of Illinois, of four types of furnaces having various ratios of heating surface to grate area.

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

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

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

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

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

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

The air temperatures at the registers corresponding to the conditions of Equation 11 would be approximately 165 F, and for 175 F and 12,000 Btu the combustion rate would be about 7.5 lb with an efficiency of 57 per cent, using the curves of Fig. 7 as a guide.

TYPICAL DESIGN

The application of the preceding data to an actual example may be of assistance to the designer. Figs. 8, 9, 10 and 11 represent the plans of