EIGHT DESIGN RULES

The design of a furnace heating system involves the determination of the following items:

a. Heat loss in B.t.u. from each room in the building.

b. Area and diameter in inches of warm-air pipes in basement (known as leaders).

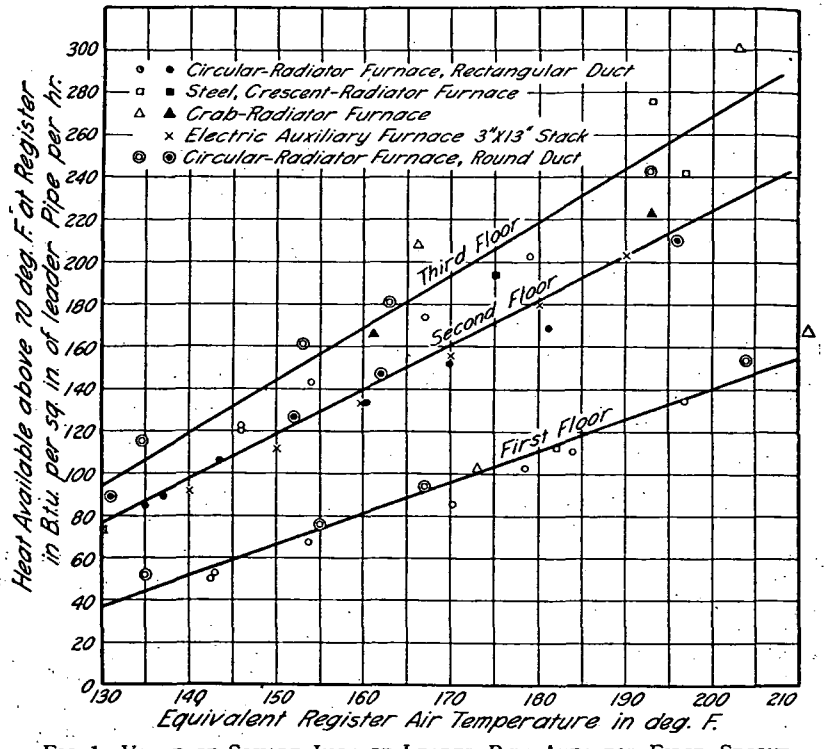

FIG. 1. VALUE OF SQUARE INCH OF LEADER PIPE AREA FOR FIRST, SECOND, AND THIRD FLOORS FOR SIMPLE SYSTEM HAVING LEADERS 8 FT IN LENGTH

c. Area and dimensions in inches of vertical pipes (known as wall stacks).

d. Free and gross area and dimensions in inches of warm-air registers.

e. Area and dimensions of recirculating or outside air ducts in inches.

f. Free and gross area and dimensions in inches of recirculating registers.

g. Size of furnace necessary to supply the warm air required to overcome the heat loss from the building. This "size" should include square inches of leader pipe area which furnace must supply. It is also desirable to call for a minimum bottom fire-pot diameter in inches, which is the nominal grate diameter.

h. Area and dimensions in inches of chimney and smoke pipe. If an unlined chimney is to be used, that fact should be made clear.

CALCULATING HEAT LOSSES

The heat which will be required for each room in the building depends on (1) the heat transmission losses through walls and glass as well as

through floors and ceilings when the latter two are next to unheated spaces, and (2) the infiltration of cold air through the cracks around outside windows and doors. Calculations for the heat required in B.t.u. per hour should be made as indicated in Chapter 5, Heat Loss Calculations.

LEADER PIPE SIZES

In a gravity circulating warm-air furnace system the size of the leader to a given room depends on the temperature of the warm air entering the room at the register. A reasonable air temperature at the registers must, therefore, be agreed upon before the system can be designed. The *National Warm Air Heating Association* has approved an air temperature of 175 deg. fahr. at the registers as satisfactory. At this temperature, the heat-carrying capacity (heat available above 70 deg. fahr.) per square inch of leader pipe per hour for first, second or third floors is shown by Fig. 1 at 175 deg. fahr. to be 105, 170 and 208 B.t.u. respectively. For average calculations, the values 111, 166 and 200 will simplify the work and may be satisfactorily substituted for these heat-carrying capacities. If H represents the total heat to be supplied any room, the resulting equations are:

$$\text{Leader areas for first floor, square inches} = \frac{H}{111} = \text{approximately } 0.009H \quad (1)$$

$$\text{Leader areas for second floor, square inches} = \frac{H}{166} = \text{approximately } 0.006H \quad (2)$$

$$\text{Leader areas for third floor, square inches} = \frac{H}{200} = \text{approximately } 0.005H \quad (3)$$

In designing for a lower warm-air register temperature, say 160 deg. fahr., the factors 111, 166 and 200 become 80, 140 and 166 (Fig. 1 at 160 deg. fahr.), and the resulting equations are:

$$\text{Leader areas for first floor, square inches} = \frac{H}{80} = \text{approximately } 0.012H \quad (4)$$

$$\text{Leader areas for second floor, square inches} = \frac{H}{140} = \text{approximately } 0.007H \quad (5)$$

$$\text{Leader areas for third floor, square inches} = \frac{H}{166} = \text{approximately } 0.006H \quad (6)$$

These equations are applicable to straight leaders from 6 to 8 ft. in length. Longer leaders must be very thoroughly covered or else the vertical stacks must be increased in area as discussed under wall stacks. If some provision is not made for these longer leaders, the air temperature may be much lower than anticipated and the room will not be properly heated.

While Fig. 1 takes care of the drop in temperature in straight leaders up to 8 ft. in length connected to stacks having about 75 per cent the area of the leader, the designer must make allowances for all other conditions. The temperature drop in leaders of various lengths at three different register temperatures is shown in Fig. 2.