top or sides near the top of the furnace casing, is distributed to the various rooms of the building through sheet metal warm-air pipes. The warm-air pipes in the basement are known as leaders, and the vertical warm-air pipes which are run in the inside partitions of the building are called stacks. The heated air is finally discharged into the rooms through

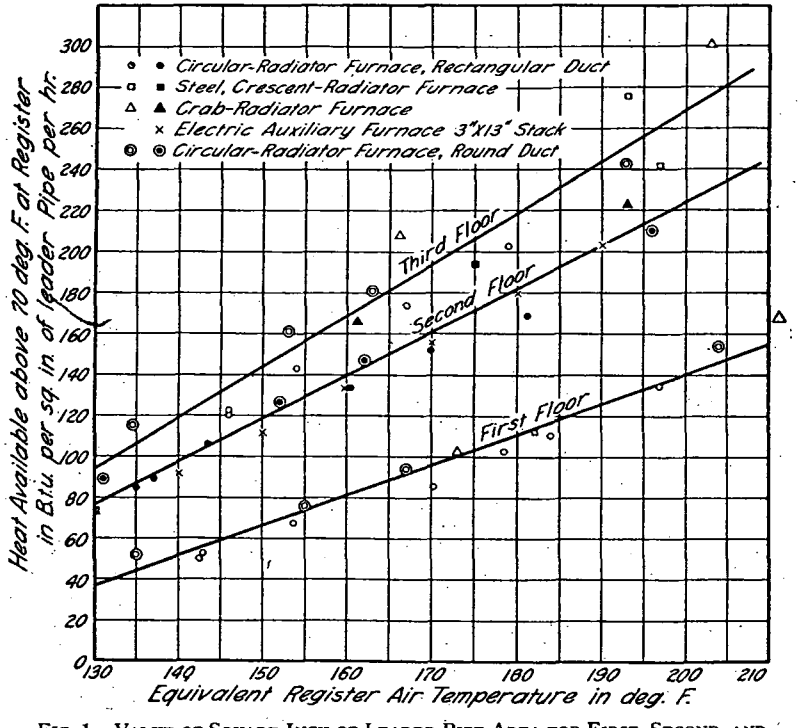

FIG. 1. VALUE OF SQUARE INCH OF LEADER PIPE AREA FOR FIRST, SECOND, AND THIRD FLOORS

registers which are set in register boxes placed either in the floor or in the side wall, usually at or near the baseboard.

The air supply to the furnace may be taken (1) entirely from inside the building through one or more recirculating ducts, (2) entirely from outside the building, in which case no air is recirculated, or (3) through a combination of the inside and outside air supply system is employed.

Furnace heating plants may be (1) of the gravity circulating type in which the motive head producing flow depends upon the difference in weight between the heated air leaving the casing and pipes and the cooler air entering the bottom of the casing, or (2) of the fan circulating type in which a fan may supply all or part of the motive head producing flow. In most house installations, the former type of system is in general use.

DESIGNING A FURNACE HEATING SYSTEM

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).

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 (1) recirculating or (2) outside air supply ducts in inches. There may be one or more of each.

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 lining and smoke pipe. If an unlined chimney is to be used, that fact should be made clear.

HEAT LOSSES FROM BUILDING

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 I, Heat Losses from Buildings.

LEADER 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:

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

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

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