Example: Assume 70 deg. room temp.
42.3 deg. plus 70 deg. = 112.3 deg.

5. Determine final temperature of air leaving heater:

Final temperature equals register temperature plus allowance for loss in ducts:

Example: 112.3 deg. register + 10 deg.
Loss in ducts = 122.3 deg.

6. Determine temperature rise through heater:

Temperature rise equals final temperature minus initial temperature. Where part outside air and part recirculated air is used, initial temperature approximately equals $P_o T_o + P_r T_r$:

P_o = percentage outside air.
T_o = temperature.
P_r = percentage recirculated air.
T_r = temperature recirculated air.

Example: Temperature rise 122.3 deg. − 0 deg. = 122.3 deg. with all outside air.
or
Assume 50 per cent outside air 0 deg.
50 per cent recirculation 60 deg.
$P_o T_o + P_r T_r = 0.50 - 0 + 0.50 \times 60 = 30$ deg. initial temperature.
Temperature rise through heater = 122.3 deg. − 30 deg. = 92.3 deg.

7. Calculate required free area through heaters[2]:

Select velocity through heaters suitable to problem.

$$\text{Free area} = \frac{\text{Total cubic feet per minute}}{\text{Velocity in feet per minute}}$$

Example.—Assume total cubic feet per minute of all rooms = 21,000.
Assume 900 ft. per minute through heater. (See Table 1.)

$$\frac{21{,}000}{900} = 23.3 \text{ sq. ft. free area.}$$

8. Select size and number of heaters:

Take temperature rise from item 6;
Take free area from item 7;
Assume maximum allowable combustion rate for fuel to be burned and stack available;
Note resistance of heaters for air volume;
Select suitable heaters from ratings.

9. Design duct system:

Ducts may be designed according to standard practice. (See Chapters 5 and 27).

[2]Some heaters are rated on the basis of the volume of air that may be warmed over any given temperature range for all heater sizes and list the static resistance in each instance. In this case the free area need not be calculated, but the combustion rate should be investigated.

10. Calculate total static pressure for entire system.
11. Select fan. (See Chapter 26 and fan manufacturers tables).
12. Select motor.
13. Select the type of power transmission from the motor to the fan.

FAN-FURNACE SYSTEMS FOR LARGE BUILDINGS

The fan-furnace system is well adapted to public and industrial buildings, including schools, churches, theaters, auditoriums, convention halls, factories, garages, and in recent years, has been much used for aeroplane hangars. In each case the building plans largely determine the type of duct system that can most advantageously be used. So far as the design of the ducts is concerned, the engineer has only to follow his customary practice in ventilating work. He may calculate the duct sizes either on the velocity basis or on the pressure-loss basis, using the same velocities, data, temperature ranges, and methods he would use in planning any other system of forced air circulation for heating and ventilation. (See Chapter 27). The ratio of the amount of outside air to the amount of recirculated air varies with different types of buildings and with the purpose for which they are used. State laws, local codes, and customary practice will govern the engineers' decision. (See Chapters 3, 4 and 7).

Selection of Heaters

In selecting heaters for any particular work, the engineer should be governed by certain considerations that arise through the nature of the service for which the plant is intended. The volume of air to be passed over and through the heaters limits the free area required in the latter, once the velocity at this point is agreed on. It will be evident that more heater capacity is required to offset the heat losses of a building with outside air than with recirculated air. Consequently when designing a plant for operation with recirculated air, the volume of air per heater will be considerably larger than would be the case for outside air. If the velocity through the heater in this case is not investigated, it may prove to be excessive, thus increasing the static resistance of the system unduly and resulting in unnecessarily increased power consumption. The free area may be increased by using wider casings, thus reducing the resistance and power consumption. In practice, velocities through the free area of the heaters are used as follows:

1. Schools, Churches, Auditoriums, Theaters, etc., from 800 to 1,000 ft. per minute.
2. Industrial Buildings, Factories and Garages, from 1,000 to 1,400 ft. per minute.

The importance of power cost affects the decision as to what free area and static resistance are allowable.

The thermal efficiency of the various makes of heaters is a consideration deserving some thought in case the fuel to be burned is relatively high in cost.

First-cost and fuel-economy are items that bear also on the type of furnace casing to be employed.