C_1 = combustion rate for coal, pounds of coal per square foot of grate per hour.
E = heater efficiency factor.
F = fuel value per unit of the fuel, Btu.

Case A. (Fig. 2 or 11) All of the air circulated to be drawn from outside the building, in which case $(t_1 - t_o)$.

$$M = \frac{H}{0.24\,(t_y - t)} \tag{1}$$

$$H_1 = 0.24\,(t_2 - t_1)\,M \tag{2}$$

$$C = \frac{H_1}{F \times E} \tag{3}$$

$$G = \frac{C}{C_1} = \frac{H_1}{F \times E \times C_1} \tag{4}$$

Example. The heat loss H for a certain factory building is 700,000 Btu per hour. The mean inside temperature t to be maintained is 65 F. The assumed outside air temperature t_o is 0 deg; $t_1 = 0$ and $t_y = t_2$ and is assumed to be 140 F. Required, M and H_1.

$$M = \frac{700{,}000}{0.24\,(140 - 65)} = 38{,}889 \text{ lb per hour}$$

$$H_1 = 0.24\,(140 - 0)\;38{,}889 = 1{,}305{,}000 \text{ Btu per hour}$$

If a fan furnace is to be employed with gaseous fuel having a calorific value of 530 Btu per cubic foot and if the manufacturers performance efficiency is 0.85:

$$C = \frac{1{,}305{,}000}{530 \times 0.85} = 2880 \text{ cu ft gas per hour}$$

or if coal at 12,000 Btu per pound is used in a furnace that has a performance efficiency of 0.60 at a combustion rate of 7 lb per square foot of grate per hour:

$$G = \frac{1{,}305{,}000}{12{,}000 \times 0.60 \times 7} = 26 \text{ sq ft}$$

Case B. (Fig. 12) All of the air is to be recirculated, in which case $t_1 = t$.

Using the data from the preceding example, $M = 38{,}889$ and from Formula 2

$$H_1 = 0.24\,(140 - 65) \times 38{,}889 = 700{,}000 \text{ Btu per hour}$$

This example illustrates the saving in fuel consumption by the recirculation of the air. The heat to be supplied the apparatus is the same as that required for a direct system of heating and is equal to the heat loss of the building ($H_1 = H$), in the example (700,000 Btu per hour) as compared with 1,305,000 for *Case A*.

Case C. (Fig. 3 or 13) A portion of the air circulated is recirculated air and the remainder, as may be required for ventilating purposes, is drawn in from the outside.

$$M = M_o + M_r = \frac{H}{0.24\,(t_y - t)} \tag{5}$$

The temperature of the resulting mixture of outside and recirculated air entering the heater is:

$$t_1 = \frac{M_o(t_o + 460) + M_r(t + 460)}{M_o + M_r} - 460 \tag{6}$$

Example. Assuming that a positive supply of outside air is required for ventilation at the rate of 1800 cu ft per hour per employee, and assuming 50 employees in the

preceding example, then $M_o = 0.075 \times 50 \times 1800 = 6750$ lb per hour is required, measured at 65 F.

$$M_r = M - M_o = 38{,}889 - 6750 = 32{,}139 \text{ lb.}$$

$$t_1 = \frac{6750\,(460) + 32{,}139\,(65 + 460)}{38{,}889} - 460 = 54 \text{ F.}$$

$$H_1 = 38{,}889 \times 0.24\,(140 - 54) = 802{,}669 \text{ Btu.}$$

The three preceding cases refer to installations in which conditioning the air to maintain certain relative humidity requirements does not enter

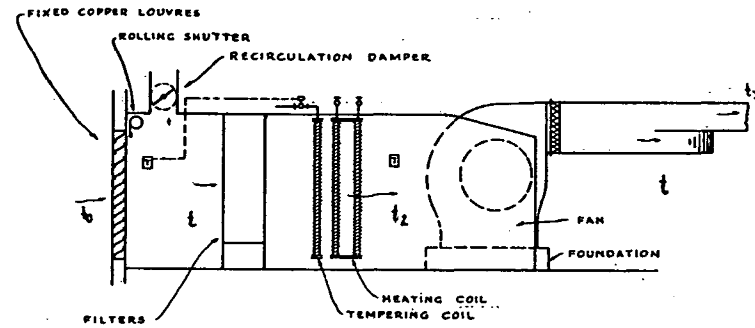

FIG. 11. HEATER AND FAN ARRANGED FOR OUTSIDE AIR CIRCULATION (CASE A)

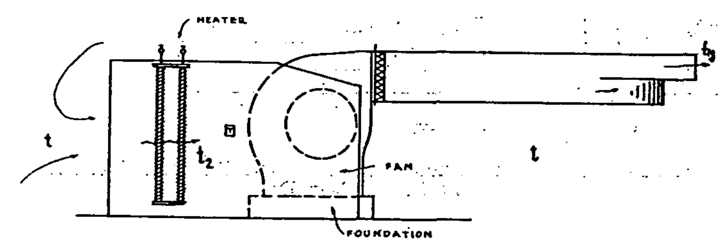

FIG. 12. ARRANGEMENT FOR RECIRCULATION (CASE B)

into the problem, as for example, certain types of industrial installations. In practically all modern public buildings, theaters, schools, and in many industrial installations the ventilating requirements include the provision for air washing and humidifying the air delivered to the various rooms of the structure.

In the following cases it is assumed that in addition to maintaining a mean room temperature t, the heating and ventilating apparatus is required to maintain a constant relative humidity in the rooms.

Case D. (Fig. 4 or 14) The maximum relative humidity that may be maintained within the building without the precipitation of moisture on single glazed sash when the outside temperature is 30 F is approximately 35 per cent. If the inside temperature t is 70 F, 35 per cent relative humidity corresponds to a dew-point temperature of 41 F. (See psychrometric chart, Chapter 27):

The installation shown in Fig. 14 contemplates the use of a tempering coil, air washer provided with a water heater, and a hot-blast heater. The tempering coil, one section