heated air before it is admitted to the areas to be heated. In the operation of such a plant it is important to have the heating coil under entirely separate control from the tempering coil. By *tempering coil* is meant the heater which receives the cold air and raises its temperature to above 32 F. This tempering coil should be either under hand control so that it is entirely *on* when the outside temperature is 35 F or less; or it should be under the control of a snap action thermostat set to come on at 35 F and to insure steam being on the coils at all times that the temperature is below this point. Any control for the heated areas involving steam regulation, should be accomplished by regulating the supply to the reheaters.

DESIGN OF CENTRAL FAN SYSTEMS

The design of a fan steam heating system is in many respects similar to that for a fan-furnace system. As in all problems involving the layout of a heating system, the first step is to calculate the heat losses of the building. If all or a part outside air is to be used, the heat required to warm this incoming air must be added to the heat losses of the building.

The general procedure for the design of all types of central fan systems, whether fan-furnace or fan steam, is as follows:

1. Calculate the heat loss for each room or space to be heated according to the procedure outlined in Chapter 2.
2. Determine volume of air for ventilation or air conditioning by reference to Chapters 24, 27, 28 and 29.
3. Determine temperature of air leaving register outlets or supply outlets. If the system is to function only as a heating system, that is, entirely as a recirculating one, the temperature of the air must be assumed and the values given in Table 1 may be used as a guide.
4. Estimate temperature of air leaving heater. This is the outlet temperature plus the loss in transit in the ducts. For ducts in outside walls or attics, or other exposed

TABLE 1. AIR VELOCITIES AND REGISTER TEMPERATURES

TYPE OF BUILDING	VELOCITIES IN FEET PER MINUTE							REGISTER TEMPERATURE
	Thru Free Area of Heaters	In Horisontal Supply Ducts	In Supply Risers	Into Room	In Vent Outlets	In Vent Risers	In Horisontal Vent Ducts and Recirculating Ducts	
Schools	800 to 1000	800 to 1000	500 to 600	300 to 400	300 to 400	500 to 600	600 to 800	90° to 120°
Churches	800 to 1000	700 to 900	400 to 600	300 to 500	300 to 500	400 to 600	500 to 700	80° to 120°
Auditoriums and Convention Halls	800 to 1000	800 to 1000	500 to 600	300 to 500	300 to 500	500 to 600	600 to 800	80° to 120°
Garages and Industrial Buildings	1000 to 1400	1000 to 1400	600 to 1000	400 to 1000	400 to 600	600 to 1000	800 to 1200	80° to 140°

places, allow 0.25 deg per linear foot of uninsulated duct, and less for ducts in interiors.

5. Calculate weight of air to be circulated.
6. Determine temperature of air entering heater.
7. Determine temperature increase through heater.
8. Calculate heat to be supplied.
9. Calculate fuel requirement and grate areas.
10. Select heater using manufacturers' data and performance curves.
11. Design duct system from data in Chapter 32.
12. Calculate total static pressure of system from data in Chapter 32, and manufacturers' tables. *The total static pressure is the sum of the static pressure requirements* of all the elements in series in the system.
13. Select fan, motor, and drive, from manufacturers' tables and also Chapter 34.

The foregoing procedure is necessary in any of the following cases which may arise in practice[1], the formulæ applying to either direct-fired or steam systems:

A. The heating of the building is done entirely by means of a central fan system, all of the air being drawn from the outside.

B. Similar to (*A*), except that all of the air is recirculated.

C. A portion of the air is recirculated, and the remainder is drawn in from the outside.

D. Air at the same temperature to be delivered to all the rooms. A constant relative humidity is maintained in the building and all of the air circulated is drawn from outside the building. (Not applicable to the heating of various rooms where individual control of each room is desired).

E. Arrangement similar to (*D*), except that a portion of the air is recirculated.

F. Arrangement of apparatus where individual control of the temperature for each room is required in conjunction with air washer equipment to maintain a constant relative humidity in the rooms. The air washer is provided with a water heater for the spray water, capable of fully saturating the air. It is impossible to maintain the same room temperature throughout the building with a uniform temperature of the air entering the rooms owing to the fact that the weight of air to be delivered to each room is determined and fixed by the ventilating requirements.

In analyzing these cases, the following symbols will be used:

H = heat loss of the room or building, Btu per hour.
H_1 = heat to be supplied to the heater, Btu per hour.
H_2 = heat supplied tempering coil, Btu per hour.
H_3 = heat supplied air washer, Btu per hour.
M = weight of air to be introduced into the room or building, pounds per hour.
M_r = weight of recirculated air, pounds per hour.
M_o = weight of air drawn in from outside, pounds per hour.
t_o = mean temperature of outside air, degrees Fahrenheit.
t = mean air temperature to be maintained in the room or building, degrees Fahrenheit.
t_1 = mean temperature of the air entering the heater.
t_2 = mean temperature of the air leaving the heater.
t_z = temperature loss in the duct system.
t_y = temperature of the air leaving the duct outlets.
0.24 = specific heat of air at constant pressure.
G = grate area, square feet.
C = combustion per hour (pounds of coal, gallons of oil, cubic feet of gas).

[1]See Mechanical Equipment of Buildings by Harding and Willard, Vol. I, revised edition, 1929.