## *RATING*

This class of equipment usually is rated in one of three ways, as follows:

1. The temperature rise of the air is listed over a certain range of velocities through the free area of the heater for varying combustion rates, for a certain heating value of the fuel.
2. The volume of air in cubic feet per minute is listed over several temperature rises with the necessary fuel consumption, taking coal of some known heating value as a standard.
3. The B.t.u. imparted to the air is listed for varying combustion rates.

Either of the first two methods is preferable to the third because of the inaccuracies that are apt to creep into the latter, due to the fact that for the same combustion rate on any given heater, the B.t.u. imparted to the air will not remain constant, but will vary with the volume of air passed over the heater.

The capacities of heaters for large commercial and industrial buildings range from 400,000 to 1,500,000 B.t.u per hour per unit. The capacities of heaters for residences and other small buildings range from 90,000 to 400,000 B.t.u. per hour per unit.

### *Efficiency of Heating Surface*

The emission of heat from the heating surface of these furnaces will vary from 2,000 to 3,000 B.t.u. per square foot per hour. The average is about 2,500 B.t.u.

### *Ratio of Heating Surface to Grate*

In commercial sizes the ratio of the heating surface to the grate surface will vary from 30 to 1 to 50 to 1.

### *Free Area and Resistance*

The free area through the heaters and resistance to the flow of air at varying velocities are characteristics depending upon the heater in question.

## *FAN FURNACES FOR VARIOUS FUELS*

The proper design of the heater hinges largely on the kind of fuel to be burned. Accordingly, various manufacturers are making special units for coal, oil and gas. Each class of fuel requires a distinct type of heater for the highest efficiency and economy obtainable. Briefly the characteristics of a heater to obtain the best efficiency and economy for each of the fuels are as follows:

1. COAL BURNING:
   a. *Bituminous*—Large, open combustion spaces, and self-cleaning heating surfaces.
   b. *Anthracite*—Large firebox capacity.
2. OIL BURNING:
   a. Long tortuous fire travel.
   b. Extensive heating surface.
3. GAS BURNING:
   a. Extensive heating surface.
   b. Numerous small flue passages.





Anthracite, semi-anthracite, semi-bituminous and bituminous coals are suitable when selected in the proper sizes. The fan-furnace system lends itself to the burning of buckwheat coal by using forced draft from a fan with grates having small air spaces. For burning small-sized bituminous coal, a stoker or a Dutch oven easily can be added.

Where oil fuel is used care must be exercised in selecting the proper size and type of burner for the particular type of heater used.

It is desirable to provide the following controls with any type of oil burner in addition to the usual house-temperature regulation:

1. A temperature limit control in the warm-air plenum space for burner cut-off in case of overheating.
2. An automatic fan-motor starter, governed by a thermostatic switch in the warm-air plenum chamber so that the fan cannot be started until after the heater is sufficiently warmed and which will cause the fan to start as soon as the heater becomes warm. It is advisable in the burning of heavy fuel oil to install an electric oil preheater unless steam is available for warming the oil in the storage tank.

A gas-burning installation should be fitted with safety devices, such as safety pilot burners and temperature limit controls in the warm-air plenum space operating in conjunction with automatic snap valves in the gas supply lines. These will function to shut off all gas to the burners in the event the pilot burners should be extinguished or if the temperature in the warm-air plenum chamber exceeds any set degree.

## *PROCEDURE FOR DESIGN OF FAN-FURNACE SYSTEMS*

The following general procedure is recommended for the design of fan-furnace systems:

1. Calculate heat loss of each room in building: (See Chapter 2).

   *Example:* Assume schoolroom with cubic content 6,550.
   Heat loss = 45,269 B.t.u.

2. Determine volume of air per minute, based on number of occupants and number of air changes:

   *Example:* Assuming 33 occupants; 30 cu. ft. per minute per occupant.
   $33 \times 30 = 990$ cu. ft. per minute.
   $\frac{6,550}{990}$ contents = 6½ min. per air change or approximately 9 changes per hour.

3. Figure diffusion temperature of air for each room[1]:

   *Example:* Diffusion Temperature $= \frac{56 \times h}{60 \times v} = \frac{56 \times 45,269}{60 \times 990} = 42.3$ deg.

4. Determine required register temperature:

   Register temperature equals room temperature plus diffusion temperature:

[1]The diffusion temperature may be defined as the number of degrees the volume of air as determined under Item 2 must be *in excess* of the room temperature, in order to offset the heat loss by cooling over that range. In other words it is the number of degrees representing the difference between the necessary supply register temperature and the room temperature for the conditions under which the heat losses are calculated in Item 1. It is readily calculated by using the following formula:

Diffusion temperature $= \frac{56\ h}{60\ v}$ where $h$ is the heat loss in B.t.u. per hour. $v$ is the volume of air in cubic feet per minute measured at 70 deg. fahr. for the room in question.