8 ● What is the approximate relation for heat losses?

Heat losses from the body when in a sedentary position are approximately as follows: radiation 49 per cent, convection 23 per cent, evaporation 15 per cent, respiration 11 per cent, and miscellaneous 2 per cent. Actually, it depends upon age, environment and other conditions.

9 ● What generally is the air temperature necessary to give equal comfort effect for sedentary conditions?

With radiant heating, 64 to 66 F. With convection heating, 70 to 72 F.

10 ● Why is there a saving in fuel consumption with radiant heating?

A saving is effected because the differential between inside and outside temperature is much less for radiant heating. Less ventilating air is necessary and this can be supplied at a much lower temperature.

11 ● Describe how to calculate the required amount of radiant heating surface.

a. Obtain the mean heat emission in Btu per square foot per hour for room surfaces X, using values in Table 1, and surface temperatures as shown in second column of Table 2.

b. Deduct X from 142 (142 being the emission per square foot given off by the human body at 83 F surface temperature) = Y in Btu per square foot per hour.

c. From (142-X) deduct 11.1 (11.1 being the average radiation which the human body should lose per square foot for comfort conditions) = (142-X-11.1) = Z.

d. Multiply total interior surface of room by Z and divide by the emission per square foot from radiant heater, giving the surface S of radiant heater in square feet.

12 ● Give a simple formula to calculate radiant heating surface required, and explain.

$$S = \frac{(142 - X - 11.1)\,A}{B}$$

where

S = surface of radiant heater, square feet.
142 = Heat emission, Btu per square foot per hour which the human body would give off at 83 F, with surroundings at absolute zero.
X = mean heat emission, Btu per square foot per hour from surfaces of room.
11.1 = heat emission, Btu per square foot per hour from human body.
A = total surface, square feet of walls, ceilings, windows, etc., in room.
B = heat emission per square foot from radiant heater surface.

13 ● What natural evidence have we that air temperature alone is no criterion of comfort and that radiant heat affects the body more quickly?

When standing in the sunshine on a cool spring day, a person feels perfectly comfortable, but when a cloud passes over the sun, he instantly feels much cooler as the shadow reaches him. A shielded thermometer recording the temperature of the air shows no reduction in air temperature in so short a period, so that the person actually feels a sensation of cold which an ordinary thermometer cannot register. This shows that light and heat rays are shut off simultaneously and travel at the same speed; it also proves that radiant rays affect the comfort of the body quicker than air temperature does.

Chapter 42

DISTRICT HEATING

Steam Distribution Piping, Selection of Pipe Sizes, Provision for Expansion, Capacity of Returns with Various Grades, Conduits for Piping, Pipe Tunnels, Inside Piping, Steam Requirements, Fluid Meters and Metering, Rates, Utilization, Automatic Temperature Control.

THOSE phases of district heating which frequently fall within the province of the heating engineer are outlined here with data and information for solving incidental problems in connection with institutions and factories. Some data are included to cover the piping peculiar to heating systems which are to be supplied with purchased steam. A complete district heating installation should not be attempted without a thorough study of the entire problem by men competent and experienced in that industry.

STEAM DISTRIBUTION PIPING

The methods used in district heating work for the distribution of steam are applicable to any problem involving the supply of steam to a group of buildings. The first step is to establish the route of the pipes, and in this matter the local conditions so fully control the layout that little can be said regarding it.

Having established the route of the pipes, the next step is to calculate the pipe sizes. In district heating work it is common practice to design the piping system on the basis of pressure drop. The initial pressure and the minimum permissible terminal pressure are specified and the pipe sizes are so chosen that the required amount of steam, with suitable allowances for future increases, will be transmitted without exceeding this pressure drop. The steam velocity is therefore almost disregarded and may reach a very high figure. Velocities of 35,000 fpm are not considered high. By the use of this method the pipe sizes are kept to a minimum with consequent savings in investment.

The steam flowing through any section of the piping can be computed from a study of the requirements of the several buildings served. In general a condensation rate of 0.25 lb per hour per square foot of equivalent heating surface is a safe figure. This allows for line condensation which, however, is a small part of the total at times of maximum load. Miscellaneous steam requirements such as laundry, cooking, or process should be individually calculated.

The steam requirements for water heating should be taken into account,