6. *Arrange the heating system to obtain from it the highest possible efficiency.*
   a. Locate all valves and controls so as to be convenient and accessible. It is only human nature to delay or avoid doing that which is unnecessarily inconvenient.
   b. Investigate every complaint of "No Heat;" find the cause and correct it. Do not overheat an entire building to correct a local condition.
   c. Extract the heat in the condensate for heating water or for some other useful purpose.
7. *Make a study of the heating system and heating requirements.*
   a. Provide thermometers and recording pressure gages so that the heating system may be operated with full knowledge of what is being accomplished.
   b. Keep daily consumption records and check against the theoretical requirements.
   c. Study the system and understand its functions and its operations.

AUTOMATIC TEMPERATURE CONTROL

As stated in Chapter 33, Automatic Control, properly applied to heating, ventilating and air conditioning systems, makes possible the maintenance of desired conditions with maximum operating economy. The use of adequate temperature control provides more healthful, comfortable, and efficient working conditions in buildings.

There are three general means of obtaining centralized control of heat output of radiators.

1. *Controlling the rate of steam flow* into the radiators. This is accomplished by equipping the radiator inlets with orifices and controlling the flow of steam through them into the radiator by controlling the difference in absolute pressure between the supply and return.

2. *Controlling the temperature of steam* in the radiators by varying its pressure. This involves the use of high vacuums to obtain low steam temperatures. This must be supplemented by some other type of control for low heat output.

3. *Controlling the length of time steam flows* into the radiators by admitting steam to a heating system intermittently and varying the length of the *on* and *off* periods. Two types of controls are used. (1) A clock control providing *on* and *off* settings of various lengths, which can be changed in accordance with outside temperatures. In most cases these changes are made automatically by means of a thermostatic bulb, placed outdoors. (2) A control, having an outdoor bulb and a bulb attached to the radiator, which varies the length and frequency of the *on* intervals in such a way that the radiator temperature is varied according to the outside temperature. In some cases heat supply is controlled by combinations of the three methods described.

Before installing any type of modern temperature control equipment, it is necessary to see that the heating system is put in good operating condition. In general, the heating system in a building is not given the attention that other mechanical equipment is given because it will continue to function, after a fashion, even though changes in piping, location of radiation, settlement of piping, and the normal wear and tear or other changes have taken place. Because of this depreciation of the system, operation becomes more and more costly and parts of the building have to be greatly overheated in order to prevent underheating in other parts. Vents, traps, vacuum pumps, and valves should be given a careful inspection and replaced or repaired if required. The piping should be of adequate size and graded properly. The return piping should be inspected, and any pockets or lifts removed and properly vented. These inspections and repairs are not costly and may prevent a much greater outlay in future years. In most cities district heating companies will be willing to make a survey of heating systems and offer recommendations in regard to operation and changes in piping layout.

The selection of control equipment depends upon the type and size of building and the degree of saving which may be obtainable.

CHAPTER 44

Electric Heating

Resistors, Heating Elements, Electric Heaters, Unit Heaters, Central Fan Heating, Electric Boilers, Electric Hot Water Heating, Heating Domestic Water Supply, Radiant Drying, Reversed Cycle Refrigeration, Auxiliary Electric Heating, Induction and Electrostatic Heating, Control, Calculating Capacities, Power Problems

ELECTRIC heating is steadily assuming a more important place in heating, ventilating and air conditioning installations because it is flexible, clean, safe, convenient and easy to control. It has many basic principles in common with fuel heating, but there are also important differences. When heat is delivered by wire, no combustion process is necessary, either at a central plant or at the individual room units. The output of an electric heater is a fixed constant, unaffected by the temperature of the surrounding air and it follows that the total load on an electric heating system is the total wattage of connected electric heaters, regardless of weather conditions. The main obstacle to the more general adoption of electric heating for buildings is the cost of the electricity itself.

All heat is a form of energy. Fuels hold stored chemical energy which is released into heat by combustion. Electrical power is a form of energy which can be released into heat by passing it through a resisting material. Both fuel and electric heating have two divisions: *first*, the conversion of energy into heat; *second*, the distribution and practical use of the heat after it is produced.

In converting the chemical energy of fuels into heat by combustion, there is necessarily a considerable variation in thermal efficiency. This is not true, however, when converting electric power into heat, as 100 per cent of the energy applied to the resistor is always transformed into heat. In electric heating practice no concern need be given to efficiencies of heat production, but rather to efficiencies of heat utilization. The problem is to distribute the electrically produced heat units in such manner as to obtain conditions of maximum comfort with the minimum consumption of electricity.

DEFINITIONS

Definitions of general terms used in fuel heating are given in Chapter 47. Terms which apply particularly to electric heating are as follows:

Electric Resistor: A material used to produce heat by passing an electric current through it.

Electric Heating Element: A unit assembly consisting of a resistor, insulated supports, and terminals for connecting the resistor to electric power.

Electric Heater: A complete assembly of heating elements with their enclosure, ready for installation in service.

RESISTORS AND HEATING ELEMENTS

Solids, liquids, and gases may be used as resistors, but most commercial electric heating elements have solid resistors, such as metal alloys, and non-metallic compounds containing carbon. In some types of electric boilers, water forms the resistor which is heated by an alternating current of electricity passing through it. One of the more common