discharge it outdoors. This system has been used in evenly-balanced climates where the heating requirements in winter are about the same as the cooling requirements in summer.

AUXILIARY ELECTRIC HEATING

In conjunction with heating systems of other types, an auxiliary electrical heating arrangement is a convenient means of caring for mild days in the spring and fall which require little heat to make a house or building comfortable. Likewise, such electrical heating might be used on abnormally cold days to help out the main heating system and by this means reduce the necessary size of the system.

Because of the feeling of comfort that a radiant type heater gives, bathrooms may be heated electrically with this type of heater while the rest of the house is cared for by some other system. Offices and rooms which require heat at periods when the main heating plant is shut down are conveniently cared for electrically.

CONTROL

Because the efficiency of electric heat production is the same for large or small units, it is possible to reduce heat waste to a minimum by applying local heating, locally controlled. Wherever radiant heaters are used, thermostats are not an effective means of control and manual operation or control by eupatheoscope is necessary. For all convection and fan circulation heaters thermostatic control is useful. For small heaters having ratings up to about 1500 watts, there are direct-acting thermostats which are satisfactory, but for larger heaters it is advisable to use relays or contactors, which should break all of the power lines. All heaters having fan circulation should have the heat circuit interlocked with the motor circuit so that the fan will be running when the heat is on. A thermal fuse or trip should be located in the heat chamber to throw off the heat in case any interruption of air flow should occur; otherwise undue temperature rise would result. In all large heaters the heating elements should be arranged in groups and control provided to vary the heat input to correspond approximately to the heat demand. If this is not done, and all the heat is kept available, the thermostat will continue throwing it on and off at short intervals. Except for central fan systems, the heat stages can be operated by manual switches, but automatic modulation of the heat load is usually preferred.

CALCULATING CAPACITIES

The methods of calculating heat losses outlined in Chapters 6, 7, and 8 may be used for electric heating exactly as for fuel heating. The total heat requirements in Btu per hour may then be converted into the electrical rating of an equivalent heating system by using the equation:

$$\frac{\text{Total Btu per hour}}{3415} = \text{kw rating of required electric heating} \qquad (1)$$

The following empirical rules for estimating electric heater require-

ments may be used in territories where the heating load is never greater than 1500 degree days:

Capacity of heater required for average room in home............2 watts per cubic foot.
Capacity of heater required for average office occupied in the daytime only..........1.2 watts per cubic foot.

POWER PROBLEMS

The first point to determine is the cost of the power which is available for electric heating. Unlike fuels, there is no uniform cost for electric power because of the unequal cost of distribution to large and small users. The fact that electricity cannot be economically stored, but must be used as fast as it is generated, makes it impossible to operate power plants at uniform loads; hence, even the time of use may affect the cost of power.

Homes are almost universally supplied with lighting current of 115 volts, which cannot be used economically for any but the smallest heaters. Usually the service lines will not permit more than plug-in devices. The underwriters permit heaters of 1250 watts to be used from approved baseboard receptacles. Where homes have 230 volt service for cooking and water heating, and rates are favorable, larger heaters can be installed. For industrial purposes, heaters should be designed to use polyphase power, which is usually supplied at 230, 460 or 575 volts. All polyphase heaters should be balanced between phases.

ELECTRIC HEATING DATA

Electric heater capacity is rated in kilowatts (kw). Electric energy is measured in kilowatt-hours (kwhr). Cost of operation = kw rating × hours used × cost per kwhr.

One boiler horsepower (bhp) = 33,471.9 Btu per hour.
One kilowatt-hour (kwhr) = 3,415 Btu.

One boiler horsepower $= \frac{33{,}471.9}{3{,}415} = 9.80$ kwhr.

One boiler horsepower will evaporate 34.5 lb water per hour *from and at* 212 F.

One kilowatt-hour $= \frac{34.5}{9.80} = 3.52$ lb of water per hour at 212 F.

Additional conversion factors are given in Chapter 41.

PROBLEMS IN PRACTICE

1 ● Why is electrical energy economically feasible to use for certain heating applications?

a. Because heat from the radiant type of electrical heater is effective in producing comfort for the occupant almost as soon as it is turned on, the heater may be turned off when the room in unoccupied.

b. There is nothing to freeze in an electrical heater.