Warm Air System

The warm air system makes use of extended heating surface and a plenum chamber assembly (*i.e.*, a central fan system) which is usually installed in the basement alongside the storage tank. The warm air supply ducts are run in the usual manner from the top of the plenum chamber to the registers in the rooms. The return air is brought back through cold air ducts to the inlet side of the fan or blower depending on the size of the installation. Temperature regulation is obtained by thermostatic control of the blower and the valve admitting hot water to the heating units.

With forced air circulation, it is possible to use small ducts and such shapes as will accommodate themselves architecturally to the structure of the house which, of course, cannot usually be done with warm air where the circulation is obtained by natural convection alone. Improved temperature regulation and more uniform air temperature from floor to ceiling can be obtained in this manner. Air cleaning and humidifying apparatus is readily incorporated in the system.

Off-Peak Systems for Industrial Buildings

For substations and certain types of industrial buildings, the electric storage heater is used to supply hot water to unit heaters placed in various parts of the building. Certain sections of the building, such as offices and rooms which are partitioned off from the larger areas, may be heated by ducts leading from indirect heating units supplied with hot water in parallel with the unit heaters.

Still another application is the use of waste heat in conjunction with electric storage heat. In this application, heating units are installed in the waste heat ducts, which supply waste heat from the losses of synchronous condensers and other apparatus. When the waste heat does not provide sufficient heating, the air temperature is boosted by supplying the proper amount of hot water from the storage tank to the heating units. Controls are provided, which not only make the entire operation automatic, but insure the maximum amount of heating from the waste heat source.

Seasonal Power Consumption

There are a number of inherent characteristics of off-peak electric heating which give economies in heat consumption. With the storage tank and basement piping properly insulated, very little heat is given off in the basement. Rapid heating-up in the morning is obtained from storage with no reduction in efficiency of the heater. Further savings are obtained due to constant room temperature and elimination of periods of overheating.

Electric Water Heating

Electric water heating is made quite generally applicable by the use of the off-peak storage method. The low off-peak energy rates introduced by power companies make the cost of electric water heating comparable to manufactured gas in many districts. Automatic storage type electric water heaters, operated off-peak, are not limited in size. Domestic hot

water demands, ranging from 30 to 200 gal per day, can be met as well as applications requiring several thousand gallons per day.

COST COMPARISONS

Cost comparisons between various fuels and electricity for house heating should be made on a heat unit basis, giving due consideration in each case to efficiency. A rate of 1 cent per kilowatt-hour is equivalent to a cost of about $3.00 per 1,000,000 Btu, assuming a transmission loss through the wiring system of 2 per cent. A comparison between the cost of heating with electricity and the cost of heating with coal, oil or gas may be made by referring to Chapter 16.

INSULATION REQUIRED

The importance of insulation, weatherstripping, double windows or storm sash for electrically heated houses cannot be over-emphasized. If electrical energy had no value, there would be no object in reducing the heat losses of a building, at least from the standpoint of heat economy. On the other hand, the more costly the heat, whether produced from electrical energy or fuel combustion, the greater the thickness of insulation required. It is therefore important that the walls and roof of a building to be heated with electrical energy be well insulated, and that the windows be equipped with storm sash and weatherstrips.

The thickness of insulation for buildings heated with electricity (Y_e) for any assumed over-all investment return, may be estimated from the following formula (heating efficiency assumed 100 per cent):

$$Y_e = \frac{eUN\,(t - t_a)}{34.15 \times r \times z} - \frac{k}{U} \qquad (1)$$

where

e = cost of electrical energy, cents per kilowatt hour.
U = coefficient of transmission of uninsulated wall or roof, Btu per hour per square foot per degree Fahrenheit.
N = number of hours during heating season.
t = inside temperature.
t_a = average outside temperature during heating season of N hours.
r = return on investment.
z = installed cost of insulation, cents per square foot per inch thickness.
34.15 = a constant derived from the heat equivalent of electricity.

Example. The electrical energy (e) for a building to be heated by electricity costs 1¢ per kilowatt hour. The coefficient of transmission of the uninsulated wall (U) is 0.25. If the minimum acceptable return on the investment (r) is 20 per cent and the installed cost of the insulation is 9¢, how much insulation will be required? The building is located in Philadelphia, Pa. Assume N = 5040, t = 70, and k = 0.30.

Solution. The average outside temperature during the heating season (t_a) in Philadelphia is 41.9 F. Substituting the proper values in equation 1:

$$Y_e = \frac{1 \times 0.25 \times 5040 \times (70 - 41.9)}{34.15 \times 20 \times 9} - \frac{0.30}{0.25} = 4.5 \text{ in.}$$

For an efficiency lower than 100 per cent, the thickness required would be correspondingly greater.