element operates at a relatively high temperature, and the heat transfer is principally by radiation.

b. Convection Type. For continuous heating. The heating element operates at a relatively low temperature and the heat transfer is mainly by air currents.

c. Contact Type. Electric strip heaters placed in direct contact by clamping to objects to be heated. They may be used to prevent freezing of pipes and tanks.

2. INDIRECT HEATERS

a. Hot Water or Steam Radiators. Electric immersion units (1) to heat water in radiators, or (2) to generate steam. Each radiator is a separate unit connected to the electric wiring system.

b. Central Heating Plant Using Instantaneous Heating. (1) Air heated by passing directly over electric heating elements, and then circulated by a duct system to the spaces to be heated. (2) Steam generated in electric boiler at times and in quantities required by the heating demand. (3) Water heated to the temperatures and in quantities required for the heating demand.

c. Central Heating Plant Using Thermal Storage. This is described in the following paragraphs and is applicable to warm air, hot water and steam heating.

OFF-PEAK ELECTRIC THERMAL STORAGE SYSTEMS

With electrical heating systems which take electrical energy coincidentally with the building heating demands, the load may come on during the power company's peaks and, therefore, such a load must be served at a rate carrying peak load investment costs. A system of electrical heating utilizing a thermal storage principle permits taking energy from the power system at off-peak periods when the energy can be sold at the lowest price. On this basis, rates of 1¢ and less per kilowatt-hour can be established, thus making electrical heating using thermal storage compare favorably in many cases with manufactured gas, and also with other fuels in certain localities when the service rendered is evaluated.

The off-peak load is not only favorable to the customer, but it is attractive to the power company. It increases many fold the potential sale of electrical energy to domestic customers. In addition, this type of load is corrective for the power company's load and power factors. A widespread appreciation of these facts has taken place in the past two years, as evidenced by the large number of rates being filed for the sale of off-peak energy. These rates vary from 1.5¢ per kilowatt-hour to less than 1¢ per kilowatt-hour. The early installations of off-peak storage heaters in this country were more or less custom built with consequent high cost. However, with increased use and improvements in design and erection of this equipment, standardized units are now available.

In the off-peak storage system, the water in an insulated storage tank

is heated during hours designated by the power company, and the stored heat is used under thermostatic control as required by the building. During the charging period, the storage tank absorbs heat and also smooths out the peak demands of the building, so that a lower connected load is required than for a non-storage system. Charging periods ranging from 12 to 20 hours are being used depending upon the characteristics of the utility's load curve.

Types of Off-Peak Systems

The following types of off-peak heating systems are in use:

1. Hot water with gravity circulation.
2. Hot water with forced circulation.
3. Warm air utilizing forced circulation.
4. Unit heaters utilizing hot water as the heating medium.
5. Warm air utilizing stored heat in connection with waste heat.

The essential parts of all types of off-peak storage systems are:

1. Heavily insulated storage tank.
2. Immersion heating elements.
3. Automatic charging control.
4. Heat distributing system.
5. Automatic room temperature control.

The insulated storage tank, the heating elements and the charging control are practically identical for all types of off-peak systems. Only the heat distributing system and the room temperature control differ to any extent.

The size of the storage tank is based upon the heat losses of the building, the heating schedule, the hours of heating from storage, and allowance for heating-up. The space required for the tank is usually less than that allowed for coal storage with a coal-fired system. In new buildings and where openings permit, factory fabricated tanks are used. Otherwise, the tanks are welded electrically at the final location.

The immersion heating elements are inserted directly into the tank. Automatic charging control is obtained by the use of a synchronous time switch and a tank thermostat, which open and close the main magnetic switch supplying current to the heating elements.

Hot Water Systems

In hot water systems, the storage tank supplies hot water to standard heating units (radiators or convectors) installed in the building. The water in the storage tank is heated to approximately 250 F. In the system using gravity circulation, the temperature of the hot water supplied to the heating units is varied by the action of a mixing valve under control of the room thermostat. In larger installations, the circulation is obtained by means of a pump under thermostatic control. In this case, the temperature of the water supplied to the heating units is regulated by mixing the proper amount of return water with the 250 F water from the storage tank through a suitable by-pass.