3. *Controlling the length of time steam flows* into the radiators by admitting steam 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.

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, and settlement have taken place. Because of this depreciation of the system, operation becomes more costly, and parts of the building may 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.

HOT WATER HEATING SYSTEMS

Some of the more generally accepted methods of controlling hot water heating systems are

1. Controlling the flow of water supplied to the system while maintaining a constant water temperature in the boiler or converter storage tank by:
   a. Starting and stopping the circulating pump by means of a room thermostat.
   b. Maintaining a constant pump circulation and stopping the water circulation to a zone or several zones by the use of positive acting valves under the control of room thermosats.
2. Varying the temperature of the water supplied to the system in accordance with the variations of the outside weather conditions, while maintaining constant water circulation to the system, and
   a. Regulating the volume of water to each room or zone by gradual acting valves under the control of room thermostats.
   b. Stopping the flow of water to each room or zone by positive acting valves under the control of room thermostats.
   c. Arranging the piping and regulating valves, such as three-way valves, under the control of room thermostats to further modify the water temperature in accordance with the heating requirements of the room or zone.

Whatever the mechanical features of the regulator may be, its function is to dictate the flow impulse, or rate of flow, in such a way as to maintain the desired indoor temperature in a zone, regardless of the fluctuations in the outdoor temperature.

UNIT HEATERS

The standard method is to stop and start the fan by means of a two-position room thermostat. A limit control may be provided to prevent operation of the fan when no heat is being supplied by the connecting services. Sometimes a separate manual switch may be connected so as to permit operation of the fan for ventilating purposes at times when no heating is desired.

A proportioning room thermostat may control a modulating valve in the connecting service pipes, if continuous fan operation is maintained.

AIR SUPPLY VENTILATING UNITS

There are several different acceptable control cycles. The choice may be governed by compulsory ventilation codes. Usually there is a room thermostat that governs a heat supply valve, an air supply damper and a thermostat in the entering air stream for each unit. The room thermostat controls heat supply to such auxiliary heat transmitters as may be in the room.

In *Control cycle No. 1* a fixed minimum volume of air is drawn from out of doors at times when the room temperature is at the design level. When the room is too cool, the damper is closed to outdoor air and is open for recirculated air from the room, and the heat supply valve is open. As the room temperature approaches the desired degree, the damper moves to admit more air from out of doors and reduces the volume recirculated. A further increase in room temperature causes throttling of the heat supply valve. Ultimately if the heat supply valve closes completely, the outside air damper opens wide and recirculation of any part of the air ceases. During the complete cycle, the thermostat in the air stream prevents entry of air so cool as to promote chilling.

Control cycle No. 2 sometimes is employed and is the same as cycle No. 1 except that the outside intake damper opens a minimum amount or is closed without an intermediate position; the recirculating damper being adjusted accordingly. The minimum quantity may be adjusted as any desired percentage of the capacity of the device.

Control cycle No. 3 has a stream-line thermostat in the mixed air stream to adjust the dampers so that if the room air is too cool, the outside air damper is closed and the valve on the heat supply pipe is open. As the room air temperature approaches that desired, the room thermostat takes control of the valve and the stream-line thermostat opens the damper in the outside air intake while moving the recirculating damper to reduce the amount of recirculation.

Auxiliary heating devices in the rooms that have unit ventilating machines should be controlled in sequence with the control cycle employed for these machines.

Day-night thermostats often are used with unit ventilating machines to permit reduced night temperature, with corresponding economy. For the night setting, the fan-motors may be idle, while the heaters are circulating warm air by gravity.

It is also possible to provide intermittent operation of the fan motors while operating under control of the night or reduced-temperature thermostat.

In many large schools it is possible to arrange for separate control circuits rather than for separate steam mains so that offices and toilet rooms may be controlled at a temperature considerably warmer than that of other rooms.

UNIT COOLERS

Although most unit coolers can be adapted to any control cycle, continuous fan operation is recommended to avoid stratification and wide fluctuations in space temperature. Should the unit be completely self-contained, control of the direct expansion refrigeration unit may be obtained from the temperature of the recirculated air and from suction pressure. In the case of multiple unit systems supplied with refrigerant or chilled water from a central source, a valve in the supply to each cooling coil may be controlled thermostatically from space temperature.

REFRIGERATION AND DEHUMIDIFICATION EQUIPMENT

Typical control equipment and its functions are described in the following paragraphs.

Well Water. Where well water is used directly in air washers or cooling coils,