

predetermined safe maximum. The type of limit control selected will depend on the type of the heating system. In a warm air furnace installation, a limit control would be used, reacting to the temperature of the heated air in the bonnet of the furnace; in a hot water system a control reacting to the temperature of the water in the boiler; and in a steam system a control reacting to the pressure of the steam in the boiler.

In addition to the normal control of the burner from the room thermostat and limit control, it is necessary that a combustion safety device be used to prevent operation of the burner under hazardous conditions. The oil fire is automatically ignited by means of gas, electric spark or incandescent element and the combustion safety control acting through a sequence device permits the burner operation only when the fire is properly established as the burner starts up. A further function of the combustion safety control is to react to any major disturbance in the flame during the running operation, shutting down the burner and preventing the discharge of unburned fuel if for any reason the flame is extinguished.

Gas Burner Controls

In the case of the domestic burner, full automatic operation is the normal requirement and the burner is started and stopped at the command of a room thermostat which, in turn, opens and closes a control valve in the gas supply line. Modulating controls and controls providing a high and low fire are also available for gas burners. For purposes of preventing abnormally high temperatures in the bonnet of gas-fired furnaces or in the temperature of the water in gas-fired hot water heating boilers or excessive pressures in gas-fired steam boilers, temperature and pressure limit controls are used. Ignition is normally secured through the use of a gas pilot flame and a safety device is provided, utilizing the heat of the pilot flame in such a manner that if the pilot light is extinguished for any reason, the main gas valve cannot be opened. For satisfactory and economical operation, all automatically-fired gas burners should be equipped with pressure regulators on the gas supply line.

Stoker Controls

Domestic stokers are normally placed under command of a room thermostat for primary operation subject also to the command of a limit control to prevent their operation when conditions in the boiler or furnace exceed predetermined safe maximums. Utilizing coal as fuel, automatic ignition is not provided and the stokers, once ignited, maintain their fire, merely changing the rate of combustion by changing the draft and the rate at which the coal is fed. Thus, at the command of the room thermostat the stoker motor is started, driving a forced draft fan and fuel feeding mechanism. The rate of combustion is thus increased and this operation continues until the thermostat has been satisfied when the motor is stopped and the fuel in the combustion chamber continues to burn at a slow rate with reduced draft.

Automatic controls may be used to operate the stoker sufficiently to maintain a fire in mild weather and also to prevent feeding of fuel if the fire is extinguished.

ZONE CONTROL

Zone control for winter heating of buildings, in which a single room thermostat will not provide satisfactory conditions and where the refinement of control from individual room thermostats is not a requisite, may be secured in various ways. According to its size, use and exposure, the

building may be divided into zones where the general requirements will be relatively constant. The number of zones is determined by (1) size of building, (2) number and character of exposures, (3) variation in occupancy and other inside conditions, and (4) cost of additional zones. For large buildings it is desirable to have at least one zone for each exposure and for high buildings, each exposure may be sub-divided into upper and lower zones in order to properly provide for the stack effect. In buildings of this type it is advisable to provide a separate main with local thermostats for the street floor heat sources, especially those adjacent to entrances and exits.

For small buildings or where cost or other conditions limit the number of zones, a frequent compromise is to combine the North and West exposures in one zone and the South and East exposures in a second zone.

For steam heating systems, the radiator output may be proportionately reduced as the outdoor temperature rises by several methods. Some of those in common use are:

1. Throttling steam pressure to allow flow through orifices in proportion to the needs for heating.
2. Turning steam on and off on time intervals proportioned to the needs for heating.
3. Varying the absolute pressure of steam in the system.

The usual zone controlling device is arranged to sense the effect of sun, wind, or rain, as well as the outdoor local zone temperature, and in some instances is fitted with additional elements sensing the indoor zone or zone radiator temperatures. It functions to regulate the rate of flow or the flow impulse as required to maintain the desired indoor zone temperature condition. A switch panel containing manual switches arranged to raise or lower the operating point of each zone controller is frequently mounted at a selected location. These panels may contain time switches for automatic cycling of day-night or other predetermined control programs. In buildings where some zones or all zones have no night occupancy, provisions may be made to index the control system to maintain predetermined low economy temperatures during the unoccupied periods and short morning warm-up period, and to obtain normal operation throughout the occupied period. Either manual operation or automatic cycling by time switch may be used. For hot water heating systems, the zone controller functions to regulate the water temperature in accordance with the prevailing outdoor temperature.

For discussion of zoning in air conditioned buildings see section on Zoning in Chapter 43.

CONTROL OF UNIT SYSTEMS

Because of the usual segregated location of unit equipment throughout a building and its consequent lack of competent supervision, complete automatic control is essential to its satisfactory operation.

Unit Heaters

In its simplest form, unit heater control consists of a room thermostat to start the unit heater motor when heat is required and shut it off when the demand is satisfied. With this limited control, it is possible in some instances that, with no steam available at the heater, the operation of the fan would cause objectionable drafts. To avoid this, limit controls are available which will prevent the operation of the fan at the command of the room thermostat except when steam is available, as determined by