changes in piping layout. The selection of control equipment depends upon the type and size of building, and the degree of saving which may be obtainable.

PANEL HEATING CONTROL

Automatic controls for radiant and convective heating differ somewhat due to the thermal inertia characteristics of the panel heating surface, and the increase in the mean radiant temperature within the space under increasing loads for panel heating.

Effect of Inertia of Panel

If a panel has considerable heat storage capacity (as compared with a convector or conventional radiator) it will continue to emit heat for some time after the room thermostat has become satisfied and has shut off the

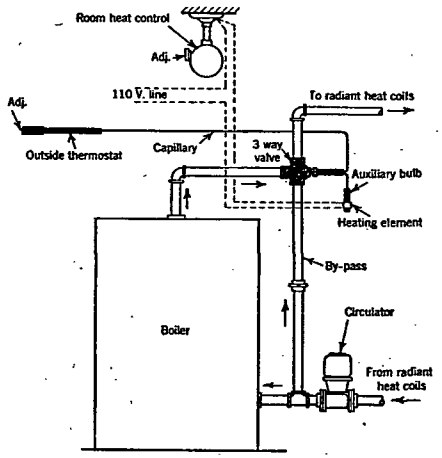

FIG. 3. PANEL HEATING CONTROL SYSTEM

supply of heating medium. This will cause uncomfortably warm conditions to exist in a space. Also, there will be a considerable delay between the time the thermostat calls for heat and the time heat is actually delivered to the space (because of the large part of the heat that must first be stored in the thermally *heavy* radiant surface). Whenever inertia exists in the source of heat supply, uncomfortable cycling of space conditions will result unless means of anticipating load changes *before* they occur in the space, or means of setting the basic energy supply rate from load conditions, are provided.

If a thermally heavy radiant surface is used, the primary control should be actuated by outdoor temperature (load) to determine the basic temperature of the heating medium supplied to the radiant surface. To allow for variations in internal load, an inside thermostat should be used as a high limit to reduce further the heat input, if necessary. If a thermally *light* radiant surface is used, controls may be applied in the same manner as for typical convection heating.

The terms *thermally heavy* and *thermally light*, referring to capacity for heat storage, are comparative and descriptive rather than exact. For example, a concrete floor panel in a frame structure without insulation

would represent a *heavy* panel in a *light* structure. A frame type (metal lath and plaster) panel in a concrete structure would represent a *light* panel in a *heavy* structure. As indicated previously, a *heavy* panel in a *heavy* structure provides comfortable conditions if outside controls are used in addition to the inside thermostat. But if a *heavy* panel is used in a *light* structure, rapid changes in outdoor conditions may cause discomfort in spite of outdoor controls, because the structure reacts so much more rapidly than the radiant heating surface.

Since thermally *heavy* radiant surfaces introduce considerable lag in the heating system, it is desirable that a control system be capable of maintaining the lag at a minimum. One method of reducing the lag in heat output is to utilize design water temperature in the panel, thus causing maximum rate of heat flow from the water in the pipe coils through the concrete slab to the surface of the panel, and into the space when heat is needed. Satisfactory control can be obtained only if the control system

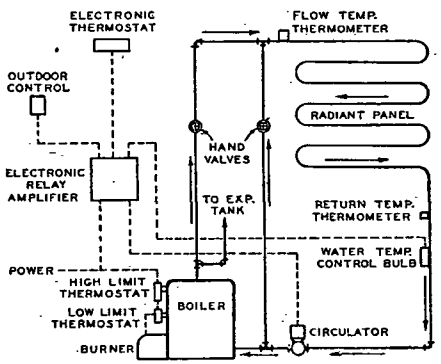

FIG. 4. ELECTRONIC CONTROL SYSTEM FOR PANEL HEATING

is sensitive enough to regulate the heat output of the panels with sufficient precision to prevent over-heating, and to anticipate heat demand as affected by outside weather conditions.

Two of the many methods used to achieve satisfactory control are shown in Figs. 3 and 4.

Fig. 3 shows a control system operated by an outside thermostat in conjunction with a room heat control instrument. The outside thermostat modulates the temperature of the circulating water in the coils by mixing some of the hot water leaving the boiler with a proportionate amount of return water which is diverted to the three-way valve.

One type of room instrument consists of a blackened copper sphere of 6 or 8 in. in diameter, in which a cylindrical sump contains a volatile liquid. A small electric heating coil creates in the sphere a vapor pressure which remains constant as long as the total heat loss from the sphere is at the desired rate. If the Operative Temperature becomes too high for comfort, a greater vapor pressure results from the smaller heat loss from the sphere. This acts on a diaphragm and reduces the supply of heat to the room. With too low an Operative Temperature, the reverse action occurs. A similar instrument, which has an electric heating element for warming the air inside