ceptionally high it may be necessary to supplement the warm floor by either adding some coils in the ceiling or forming heated panels in the side walls.

4. *By attaching separate heated metal plates or panels to the interior surfaces.* These plates or panels are placed either in an insulated recess so that the surface of the panel is flush with the surface of the walls or ceilings, or they may be secured to the face of the wall. They may be covered with wood veneers and decorated to harmonize with other parts of the room, or they may be cast into panels to imitate oak or other wood designs. With flat plate panels it is common practice to use a frame of plaster, wood, metal or composition to allow for expansion. These plates may be heated with either hot water or steam and connected as in an ordinary radiator system. See Figs. 5 and 6.

5. *By electric heated metal plates or panels.* These plates or panels are either placed in insulated recesses of walls or ceilings or fastened to the construction; as found desirable.

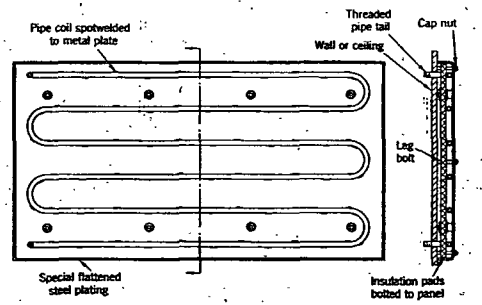

FIG. 5. PILLAR TYPE RADIANT HEAT PANEL

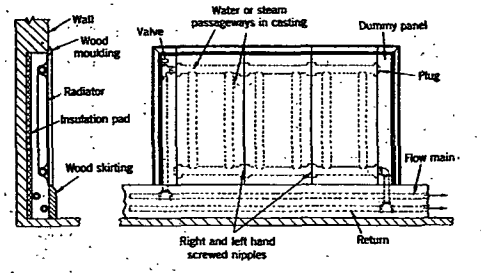

FIG. 6. FLAT TYPE PANEL INSTALLED IN WALL RECESS

They should not have a surface temperature much above 200 F. Some have a much higher surface temperature but a lower temperature gives a more comfortable condition and is more efficient.

6. *By electrically heated tapestry mounted on screens and on the wall.* For this purpose the screen is woven with an electric continuous conductor. Such screens are useful to plug in at any position for emergency local heating without taking care of a large room or office.

Note. If all of a heating panel is installed at one end of a large room there may be a marked difference between the equivalent temperature on the two sides of the body. It is usually desirable, therefore, that the heat be distributed at different parts of the walls and ceilings so that no uncomfortable effect will be felt from unequal heating.

CALCULATION PRINCIPLES

Part I—Panel Heating

The term *panel heating*, involving both radiation and convection, is applied in this chapter to a system in which the heat is transmitted from

panel surfaces to both air and surrounding surfaces, as is the case under indoor conditions.

Panel heating systems for buildings may be designed as illustrated and described in the following design of a panel heating system for the room shown in Fig. 7. The design is based on continuous heating. Panel heating systems should, in general, be operated continuously since the panels have large thermal capacities. Where panels are heated by high temperature radiation from a heat source directed toward them, this qualification does not apply.

1. *Assume the location and the approximate size of the heating panel.*

Heating panels may be located in ceilings or floors or walls. Ceiling panels have the advantage that their heat emission is not affected by tapestry or furniture and that they can be used, to a limited extent, as cooling panels during the summer months. If used in low rooms, however,

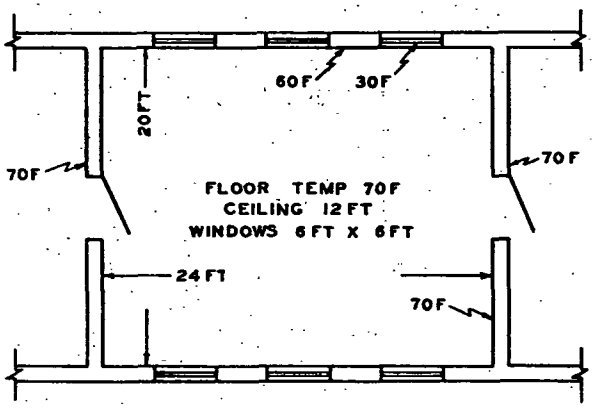

FIG. 7. ROOM PLAN USED FOR ILLUSTRATION OF METHOD OF DESIGNING A PANEL HEATING SYSTEM

they may produce an undesirable heating effect upon the head. Floor panels have the advantage that they can be easily installed and that much of the radiated heat is delivered to the lower portions of the walls; they have the disadvantage that their heat emission is rather uncertain, since it may be affected by rugs, carpets, furniture, machinery, etc.

It is best to make the panels as large as practicable; for example, if the floor or ceiling is used as the heating panel, it is best to use the entire floor or the entire ceiling, or both. Heating a room by means of panels is very similar to lighting a room. Heat radiation is exactly like light radiation, except that it has a longer wave length. If a room is lighted by means of a large number of small units distributed uniformly over the ceiling, the room is lighted more uniformly than if it is lighted by means of a single unit of equal capacity. Similarly, if the entire ceiling is the heating panel, the room is heated more uniformly than if only a fractional part of the ceiling is used as the heating panel.

In the following example, *the entire ceiling will be used as the heating panel.*

2. *Select the desired mean temperature of the air in the room.*

In a panel-heated room, the mean air temperature is a few degrees