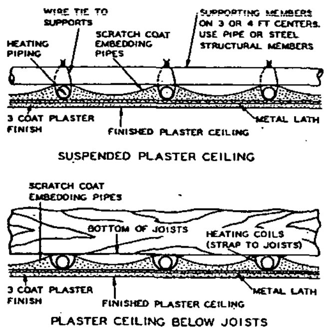

Fig. 2 . . . . Coils in Plaster Above Lath

are installed below the lath. Generally, the surface temperature of plaster panels should not exceed 120 F, and this is usually met by limiting the water temperature in the pipes or tubes in contact with the plaster to a maximum temperature of 140 F. Insulation should be placed above the coils to reduce the *reverse loss* which is the difference between the heat supplied to the coil and the net useful output to the heated room.

In order to protect the plaster installation and to assure proper air drying of the plaster, it is recommended that no heat be applied to the panels for two weeks after all plastering work has been completed. When the system is started for the first time, the water supplied to the panels should be at a temperature not more than 20 deg above the prevailing room temperature at that time (but not in excess of 90 F). Water should be circulated at this temperature for about two days. Then the water temperature should be increased at a rate of approximately 5 deg increase per day to 140 F.

During the air-drying and preliminary warming-up periods, adequate ventilation should be provided to carry off moisture from the panels. No paint or paper should be applied to the panels until these periods have been completed. No paint or paper should be applied while the panels are being operated. After paint and paper have been applied, a further shorter warm-up period, similar to that for the first time starting, is also recommended.

Embedded Piping for Walls

Although not so universally used as ceiling panels, wall panels may be constructed by any of the methods outlined for ceilings.

Embedded Piping for Floors

The construction for piping embedded in floors will depend upon whether (*a*) the floor is laid on grade, or (*b*) the floor is above grade.

a. Both ferrous and non-ferrous pipe and tube are used in floor slabs which rest on grade. The coils are constructed as either sinuous-continuous pipe coils, or arranged as header coils with the pipes spaced from 6 to 18 in. on centers. The coils are generally installed with 1½ to 4 in. of cover above

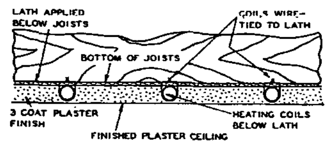

Fig. 3 . . . . Coils in Plaster Below Lath

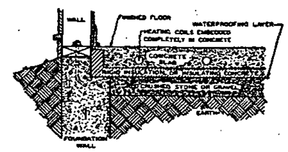

Fig. 4 . . . . Coils in Floor Slab on Grade

the coils. It is recommended that insulation be used to reduce the perimeter and reverse losses. Fig. 4 shows the application of pipe coils in slabs resting on grade. Coils should be embedded completely and should not rest on an interface. Any supports used for positioning the heating coils should be non-absorbent and inorganic. It is suggested that reinforcing steel, angle iron, pieces of pipe, or stone concrete mounds be used. No wood, brick, concrete block, or similar materials should be used for support of coils. Generally, a waterproofing layer is desirable to protect insulation and piping.

b. Where the coils are embedded in structural load supporting slabs above grade, construction codes may affect their position. Otherwise, the coil piping is installed in the same manner as described for slabs resting on grade.

c. A warm-up and start-up period for concrete panels should be similar to that outlined for plaster panels.

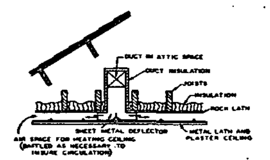

Fig. 5 . . . . Warm Air Plaster Ceiling Construction

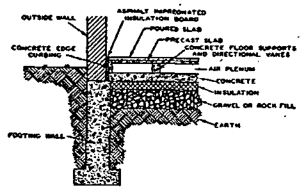

Fig. 6 . . . . Warm Air Floor Panel Construction

Air-Heated Ceilings, Walls, and Floors

Several methods have been devised to warm the interior room surfaces by circulating heated air through passages behind these surfaces. In some cases, the heated air is recirculated in a closed system. In others, all or a part of the air is passed through the room on its way back to the furnace to provide supplementary heating and ventilation.[2] Figs. 5 and 6 indicate two common types of construction. Care must be exercised to assure compliance with any building codes that might apply. (See also section on Warm Air Ceiling Panel Systems in Chapter 18.)

Electrically Heated Ceilings, Walls, or Floors

Several different forms of electric resistance units are available for heating the interior room surfaces. These include: (1) resistance cables that may be embedded in a manner similar to hot water piping in concrete or plaster; (2) prefabricated electric heating panels to be attached to room surfaces; and (3) electrically heated fabrics or other materials for application to, or incorporation into, finished room surfaces. Figs. 7 and 8 indicate two methods of installation. The constructions of electric panels for ceilings, walls, and floors are described in greater detail in Chapter 17, Electric Heating.

HEAT OUTPUT FROM PANEL SURFACES

A heated panel transfers heat to a room by convection and radiation. In the following paragraphs, the two transfer mechanisms are first considered separately and then combined to facilitate design calculations.

Radiation Transfer

The radiation transfer can be evaluated by means of the Stefan and Boltzmann equation:

$$q_r = 0.173 F_a F_e \left[\left(\frac{T_p}{100}\right)^4 - \left(\frac{T_r}{100}\right)^4 \right] \qquad (1)$$

where

q_r = heat transfer by radiation, Btu per (hour) (square foot).
T_p = temperature of panel heated surface, Fahrenheit, absolute.

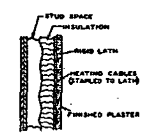

Fig. 7 . . . . Electric Heating Cables in Plaster

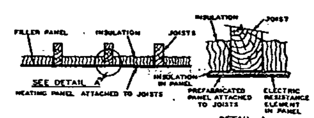

Fig. 8 . . . . Prefabricated Electric Panel

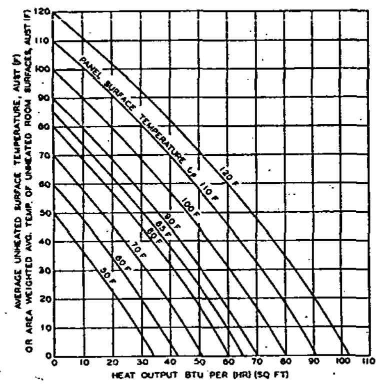

Fig. 9 . . . . Heat Output by Radiation

T_r = mean radiant temperature of all unheated surfaces, Fahrenheit, absolute.
F_a = the configuration factor (dimensionless).
F_e = the emissivity factor (dimensionless).

A combined configuration and emissivity factor for a simple, box-like room in which there is a *uniformly* heated ceiling, floor, or wall, all other surfaces are at another temperature, and all surfaces are perfectly diffusing is given by Hottel[3] as:

$$F_e = F_a F_e = \frac{1}{\frac{1}{F_{1-2}} + \left(\frac{1}{e_1} - 1\right) + \frac{A_1}{A_2}\left(\frac{1}{e_2} - 1\right)} \qquad (2)$$

where

F_e = combined configuration and emissivity factor.
F_{1-2} = view factor = 1.0.
e_1 and e_2 = emissivities of the surfaces.
A_1 and A_2 = areas of the surfaces.

In practice the emissivity of conventional, non-metallic, non-reflecting surfaces will be found to be about 0.9. When this emissivity is used in Equation 2, the combined factor will be found to be about 0.87 for most rooms. Substituting this value in Equation 1, the constant becomes about 0.15 and the equation can be rewritten:

$$q_r = 0.15 \left[\left(\frac{t_p + 460}{100}\right)^4 - \left(\frac{AUST + 460}{100}\right)^4 \right] \qquad (3)$$

where

t_p = temperature of panel surface, Fahrenheit.
AUST = area-weighted average temperature of unheated surfaces in room, Fahrenheit.

The actual radiation transfer in a room may be somewhat different from that given by Equation 3 because of non-uniform temperatures, irregular room surfaces, variations in