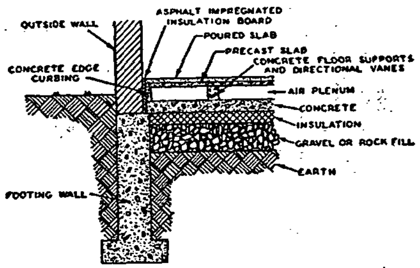

FIG. 6. WARM AIR FLOOR PANEL CONSTRUCTION

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 $1\frac{1}{2}$ to 4 in. of cover above 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.

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 20.)

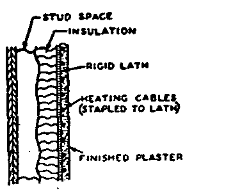

FIG. 7. ELECTRIC HEATING CABLES IN PLASTER

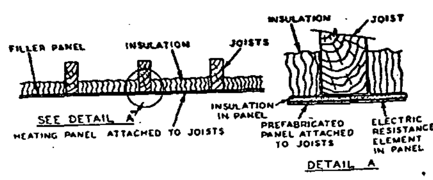

FIG. 8. PREFABRICATED ELECTRIC PANEL

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 42, Electric Heating.

OUTPUT FROM PANEL SURFACES

The heat transfer from a panel is accomplished by radiation and convection, which are considered in following paragraphs.

Radiation Transfer

The radiation transfer can be evaluated by means of the relationship set up by Stefan and Boltzmann:

$$q_r = 0.173\, F_a F_e \left[\left(\frac{T_s}{100}\right)^4 - \left(\frac{T_w}{100}\right)^4\right] \tag{1}$$

where

q_r = heat transfer by radiation, Btu per (square foot) (hour).
T_s = absolute temperature of panel heated surface, Fahrenheit.
T_w = absolute mean radiant temperature of all unheated surfaces, Fahrenheit.
F_a = the configuration factor (dimensionless).
F_e = the emissivity factor (dimensionless).

For large parallel planes or large enclosed surfaces as ordinarily encountered in panel heating practice:

$$F_e = 1 \Big/ \left(\frac{1}{e_1} + \frac{1}{e_2} - 1\right) \tag{2}$$

where

e_1 and e_2 = emissivities of the respective surfaces.

In heating practice e_1 and e_2 are usually equal to 0.9 and F_e to 0.82. Also, the configuration factor F_a is equal to 1 for large parallel planes, long concentric cylinders, or smaller bodies in large enclosures. Therefore, for ordinary rooms with parallel walls, regular floors and ceilings, with an emissivity factor of 0.82, Equation 1 can be simplified to:

$$q_r = 0.142 \left[\left(\frac{T_s}{100}\right)^4 - \left(\frac{T_w}{100}\right)^4\right] \tag{3}$$

Irregularities in room surfaces and materials may introduce some error