non-ferrous heating coils and piping. It is recommended that a medium temperature solder of 95 percent tin—5 percent antimony, or capillary brazing alloys, be used. All piping is, generally, subjected to a hydrostatic test of at least three times the working pressure, but not less than 150 psig.

The more common forms of application of panel heating fall into the following general categories: (1) embedded piping for ceilings; (2) embedded piping for walls; (3) embedded piping for floors; (4) air heated ceilings, walls or floors; (5) electrically heated ceilings, walls or floors.

Embedded Piping for Ceilings

When piping is embedded in ceilings, the construction used is generally one of the following:

a. Pipe or tube is embedded in the lower portion of a concrete slab, generally very close to its lower surface. If plaster is to be applied to the concrete, the piping may be placed directly on the wood forms. If the slab is to be used without plaster finish, then the piping should be installed not less than ¾ in. above the undersurface of the slab. Fig. 1 shows this method of construction. The minimum coverage must be in compliance with the local building code requirements.

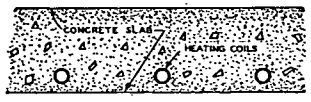
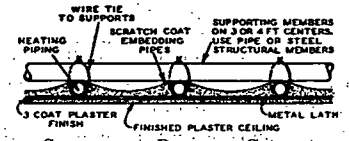


FIG. 1. COILS IN STRUCTURAL CONCRETE SLAB



SUSPENDED PLASTER CEILING

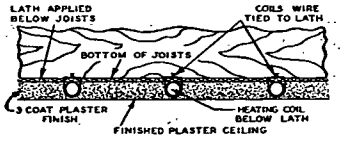
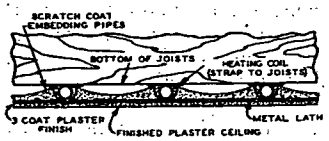


FIG. 3. COILS IN PLASTER BELOW LATH



Plaster Ceiling Below Joists

FIG. 2. COILS IN PLASTER ABOVE LATH

b. Pipe or tubing is embedded in a metal lath and plaster ceiling. If the lath is suspended to form a hung ceiling, both the lath and the heating coils are securely wired to the supporting members in such a way that the lath is below, but in good contact with the coils, as shown in Fig. 2. Plaster is then applied to the metal lath, care being taken to embed the coil, as shown in Fig. 2.

c. Copper tubes of the smaller diameters are attached to the underside of wire lath or gypsum lath. Plaster is then applied to the lath to embed the tube, as shown in Fig. 3.

d. Other forms of ceiling construction utilize prefabricated panels of metal, composition board, wood paneling, etc., having warm water piping, tube or channels built into the panel sections.

Coils are usually of the sinuous type, although some header or grid type coils have been used in ceilings. Coils may be of either ferrous or non-ferrous pipe or tube, with coil pipes spaced from 4½ to 9 in. on centers, depending on the required output, pipe or tube size, and other factors.

Where plastering is applied to pipe coils, a standard three-coat gypsum plastering specification[1] is followed, with a minimum of ⅜ in. of cover below the tubes when the tubes 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.

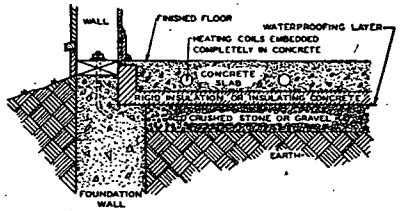


FIG. 4. COILS IN FLOOR SLAB ON GRADE

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 ar-

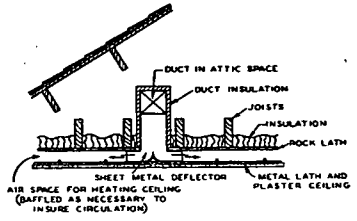


FIG. 5. WARM AIR PLASTER CEILING CONSTRUCTION