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

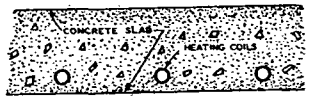
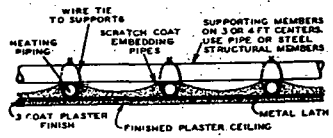



FIG. 1. COILS IN STRUCTURAL CONCRETE SLAB




Suspended Plaster Ceiling

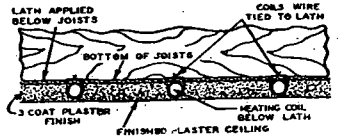
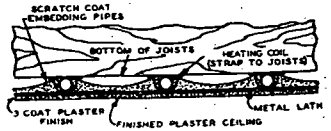



FIG. 3. COILS IN PLASTER BELOW LATH




Plaster Ceiling Below Joists

FIG. 2. COILS IN PLASTER ABOVE LATH

may be placed directly on the wood forms. If the slab is to be used without plaster finish, then the piping is installed about ½ in. above the undersurface of the slab. Fig. 1 shows this method of construction. It is important that any local construction codes which may affect the position of the piping be consulted.

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.



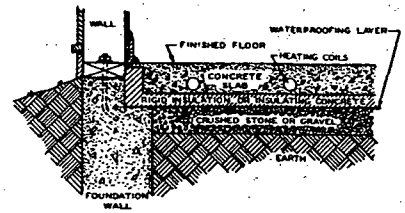



FIG. 4. COILS IN FLOOR SLAB ON GRADE

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.

## 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 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. 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.

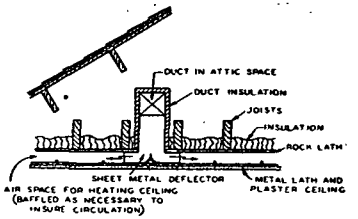



FIG. 5. WARM AIR PLASTER CEILING CONSTRUCTION