fin and so compress them upon the tube. There are also types of construction where the fin is formed out of the material of the tube itself. In any case the successful performance of a fin surface depends upon the bond between fin and tube being secure and remaining so in service.

For heating coils the materials most generally used are copper, steel and aluminum. Sometimes aluminum or brass fins are used on copper tubes. Steel is uncommon except in special cases. Some types of heating coils are made of cast-iron. There are sufficient practical installations of each of these to demonstrate that they can all give good service. However for equal performances brass and aluminum fins must be of greater thickness than copper fins on account of their lower coefficients of conduction. The copper coils are frequently tin-dipped and steel coils galvanized to protect them from corrosion and to assure a bond between fin and tube.

Cooling coils for water or for volatile refrigerants are most frequently of copper, both fin and tube. Aluminum fins on copper tubes are also used. For brines such as sodium or calcium chloride and for ammonia, steel fins and tubes are common.

Although there are many variations for special cases, tube and fin sizes and spacings for air conditioning coils, both heating and cooling, fall within fairly narrow limits. The tubes are usually $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, or $\frac{3}{4}$ in. OD, and the fins spaced from 4 to 8 per inch, 6 per inch being a common design. The tube spacing generally varies from about $1\frac{1}{8}$ to 2 in. on centers. Small tube size and close fin spacing give large capacity with small space demand, but the resistance, both over the surface and through the tubes, is higher than with larger tubes and more widely spaced fins. Moreover, too close a fin spacing may result in trouble from dirt accumulation, especially on dehumidifying coils, and may also cause trouble from water *hold-up* between the fins, particularly with air flow vertically upward. This condition increases the air resistance and decreases the capacity of the coil. Water hold-up sometimes causes flooding trouble in vertical air flow units by accumulating too much water for the drain to handle all at once when the fan is stopped.

Steam Coils

For proper performance of steam heating coils, condensate and air must be continually eliminated and the steam must be evenly distributed to the individual tubes. This distribution is usually accomplished by individual orifices in the tubes, by distributing plates and orifice in the steam header, or by perforated internal steam-distributing pipes extending into the individual tubes. The latter arrangement has the advantage of distributing the steam throughout the length of each tube, and is conducive to uniform delivered air temperatures. The tendency for freezing of condensate at the bottom of the coil with cold entering air and light heating loads is also minimized. This is especially valuable for outside air preheaters. Methods of air and condensate elimination are discussed in detail in Chapters 14, 15 and 22.

Water Coils

The performance of water coils, for heating or cooling, depends on the elimination of air from the system and proper distribution of water. Air elimination is taken care of in the system piping as described in Chapter

16. To assure a pressure drop sufficient for adequate distribution but at the same time to provide against excessive pumping head where large water quantities are handled, water coils are provided with various water circuit arrangements. For instance, a typical coil 18 tubes high and 6 tubes deep in the direction of air flow can be arranged for 6, 9, 18 or 36 parallel water circuits as conditions may require. Orifices in individual tubes are occasionally employed but are usually unnecessary as the resistance of individual water circuits is generally sufficient to effect a satisfactory distribution. In cases such as well water precooling coils, where there may be considerable sand and other foreign matter in the water, provision for cleaning of individual tubes is of advantage. It is important to arrange water coils for drainage if located where they will be

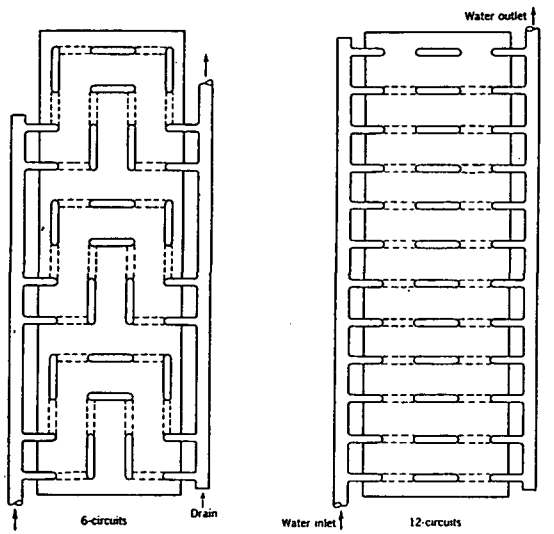

FIG. 2. VARIOUS WATER CIRCUIT ARRANGEMENTS

exposed to freezing. For this reason the circuits should be so laid out that there are no pockets to hold water. Fig. 2 shows such construction. The drains may be provided in the water piping although they are often arranged in the coil headers.

Direct-Expansion Coils

Coils for volatile refrigerants present more complex problems of fluid distribution than do water, brine or steam. It is desirable that the coil be effectively and uniformly cooled throughout, and necessary that the compressor be protected from entrained, unevaporated refrigerant. There are two types; namely, flooded systems, and thermal expansion valve systems, as shown in Figs. 3 and 4. With flooded control the coils are supplied with liquid by the same type of circulation that exists in a water tube boiler, while the level in the surge drum is maintained by the action