tures, etc., to perform the same duty with either. In a few cases both sprays and coils are used. The coils may then be installed within the spray chamber, either in series with the sprays or below them. In making the selection between spray and surface dehumidifiers, certain advantages of each should be considered. The fact that a spray dehumidifier is usually designed to deliver nearly saturated air, tends to simplify the control problem. In this case the dry-bulb temperature is also the dew-point, and hence, a dew-point control can be arranged by using a simple duct thermostat. Spray dehumidifiers have an advantage over unwetted coils of obtaining some air cleaning and odor absorption. On the other hand, coils make possible a closed and balanced cooling water circuit, obviating the unbalanced pumping head, the complication of water level control, and danger from possible floods incidental to multiple spray dehumidifiers, especially if located on different levels. The use of coils often makes it possible for the same surface to serve for summer cooling and winter heating by circulating cold water in the one season and hot water in the other, with consequent saving in apparatus and piping. Another advantage is that where the surface coil system can be used with direct expansion of refrigerant, it is comparatively low in initial and operating costs. The safety of the occupant must be kept in mind in comfort conditioning applications. Some localities have refrigeration codes which restrict the use of direct-expansion coils in the air stream, and hence, local codes should be consulted by the engineer before a system employing direct expansion methods is designed. The choice between spray dehumidifiers and coils depends upon the necessities and the economic aspects of each case, and no general rule can be given. There are many installations in which either may be used.

COIL CONSTRUCTION AND ARRANGEMENT

Coils are basically of two types, those consisting of plain tubes or pipe, and those having *extended* surfaces. The former are little used for the applications covered by this chapter, but are often employed where conditions cause frost accumulation, and for cooling within spray dehumidifiers.

The heat transmission from air passing over a tube to a fluid flowing within it is impeded by three resistances. The first is that from the air to the surface of the tube and is usually called the outside surface resistance or air-film resistance. The second is the resistance to the conduction of heat through the metal itself. Finally there is another surface or film resistance to the flow of heat between the inside surface of the metal and the fluid in the tube. For the applications under consideration both the resistance of the metal wall to heat conduction, and the inside surface or film resistance are usually low as compared with the air-side surface resistance. Economy in space, weight and cost makes it advantageous to decrease the external surface resistance, where it is proportionately large, to approach that of the tube wall, and that from the tube to refrigerant. This may be accomplished by increasing the external surface by means of fins. Sometimes water spray is applied to the same type surface as would have been used without it. The overall heat transfer is not necessarily increased much, but the water spray may serve other purposes than to increase the flow of heat, such as air and coil cleaning.

In fin or *extended* surface coils the external surface of the tubes is known as *primary*, and the fin surface is called *secondary*. The primary surface consists generally of round tubes or pipes which may be staggered, or in some cases placed in line with respect to the air flow. The staggered arrangement is usually preferred because it obtains a somewhat higher heat transfer

value. Numerous types of fin arrangement are used, the most common of which are spiral, flat and flat-crinkled or corrugated, all as shown in Fig. 1. While the spiral fin surrounds each tube individually in all cases, the flat types may be continuous (including several rows of tubes), or they may be round or square, with individual fins for each tube. All of these, as well as other less common types, are in use, the selection for a particular installation being based on economic considerations, space requirements and resistances of individual designs of coils. A most important factor in the performance of extended surface coils is the bond between the fin and the tube. An intimate contact between the tube and the fin must be maintained permanently in order to assure a continuing rated performance after the heating units have been in service for a period of time. In some coils, fins are wound on the tubes under pressure, in order to upset the metal slightly at the fin root, and then are given a coating of solder while the fin and tube are still revolving, for the purpose of assuring a uniform coating of solder. In other types, the spiral fin may be knurled into a shallow groove on the exterior of the tube. The tube may be expanded after the fins are

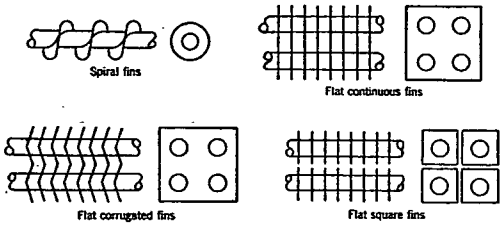


FIG. 1. TYPES OF FIN COIL ARRANGEMENT

assembled, or the tube hole flanges of a flat or corrugated fin may be made to override those in the preceding 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.

For *heating coils*, materials most generally used are copper and aluminum. Steel is occasionally used where sodium or calcium chloride brine is circulated in the tubes. Aluminum fins on copper tubes are a common construction. Generally speaking, brass does not serve as a satisfactory fin material because of corrosion difficulties. *Cooling coils* for water or for volatile refrigerants most frequently have copper fins and tubes, although aluminum fins on copper tubes are also used. There are many makes of heating and cooling coils of the light weight extended surface type for both heating and cooling with tubes commonly $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, and 1 in. outside diameter, and with fins spaced three per inch up to eight per inch. The tube spacing generally varies from about $1\frac{1}{8}$ to $2\frac{1}{2}$ in. on centers, depending upon the width of individual fins and on other considerations of performance. Fin spacing should be chosen for the duty to be performed, with special attention being paid to lint accumulation and, especially in dehumidifying, the consideration of frost accumulation.

Steam Coils

For proper performance of steam heating coils, condensate and air must be continuously eliminated and the steam must be evenly distributed to the individual tubes. This distribution is usually accomplished by indi-