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

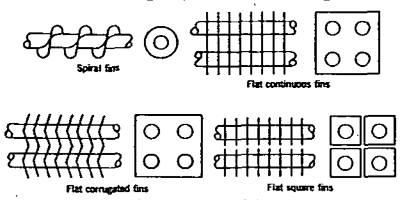

Fig. 1 . . . . Types of Fin-Coil Arrangement

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 continuation of 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 are then 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 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 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 aluminum fins and copper tubes, although copper 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 3/8, 1/2, 5/8, 3/4, and 1 in. outside diameter, and with fins spaced three per inch up to fourteen per inch. The tube spacing generally varies from about 1 to 2½ 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 possibility of lint accumulation and, especially in lower temperature 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 individual orifices in the tubes, by distributing plates and orifices 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 temperature of delivered air. The tendency of condensate to freeze at the bottom of the coil with cold entering air and light heating loads, is also minimized. This is especially valuable for outdoor air preheaters.

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 28. 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, 24, 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 precooling coils using well water, where there

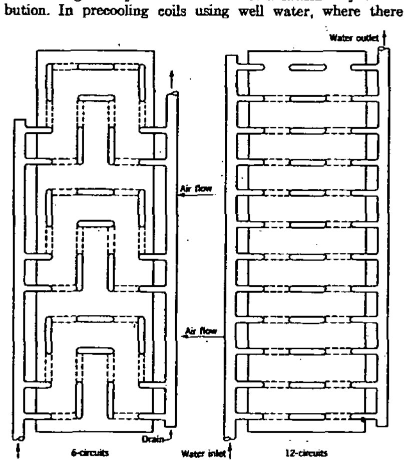

Fig. 2 . . . . Various Water Circuit Arrangements

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 complete drainage (see Fig. 2). The drains are usually provided in the water piping at the coil header.

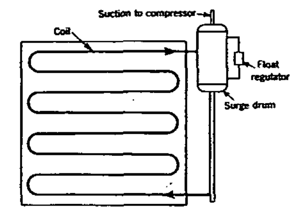

Fig. 3 . . . . Direct-Expansion Coil with Flooded System

Direct-Expansion Coils

Coils for volatile refrigerants present more complex problems of fluid distribution than water, brine, or steam coils. 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. In a flooded coil, the circulation is similar to that in a water tube boiler. The liquid is maintained at the proper level by the action of a float regulator as shown in Fig. 3. The thermal-expansion-valve system depends upon the thermal valve to feed automatically just as much liquid to the coils as is required to maintain the superheat at the coil-suction outlet within predetermined limits, which vary from about 6 to 15 deg. The thermal-valve arrangement is in common use for the type of coils covered by this chapter, while the flooded system is rarely used.

With the flooded system the refrigerant distribution through the tubes depends on properly selecting the length of the feeds, and the head of liquid imposed upon the liquid inlets. The flow of refrigerant from the liquid inlets must be horizontal and upward. The possibility of gas trapping must be avoided. No auxiliary distributing devices are required.

In the thermal-valve system, the path of each refrigerant feed from the distributor to the suction header is called a circuit. The length of each circuit should be chosen to provide good heat transfer and return of oil, as well as a reasonable pressure drop across the circuit. The external loading conditions, the tube size, and other factors, influence the practical length of a circuit. Because of the various factors involved, the practical length and the arrangement of the circuits is developed from laboratory tests and the design of coils for units produced in volume are usually verified by additional tests. It is general practice to obtain superheat by suitable design of the coil rather than by use of external heat exchangers or other auxiliary devices.

To insure reasonably uniform refrigerant distribution in multi-circuit coils, it is common practice to provide a distributing means, between valve and coil liquid inlets, to divide the refrigerant equally among the feeds. Such a distributor must be effective for distributing both liquid and vapor, because the entering refrigerant is a mixture of the two. Fig. 5 shows three typical types of distributors. In distributor A the liquid and gas mixture from the thermal valve is led tangentially into a chamber. The coil feed connections extend outward radially at the top of this chamber. In distributor B the refrigerant is discharged at a high velocity through a central jet against the end plate, forming a uniform mixture of gas and liquid within the distributor, from which individual connections are led as shown. In type C the refrigerant enters at high velocity from the thermal valve and is discharged against the end plug in which the individual liquid feeds are closely arranged. These distributors can be used in either vertical or horizontal position. There are also other types of headers such as the centrifugal and weir type. The individual liquid connections from the distributor to the coil inlet are commonly made of small diameter tubing, and are all of the same length and diameter in order to impose the same friction between the distributor and the coil. Since the thermal valves act in response to the superheat at the coil outlet, this superheat should be produced with the least possible sacrifice of active evaporating surface. Sometimes a single thermal valve is used per coil. In other cases, multiple valves are used, with the coil divided across the air flow or parallel to the air flow as shown in Fig. 6. The arrangement of Fig. 7 should be avoided, since it offers the disadvantage of unequal load on the two parallel circuits.

Control of Coils

Chapter 43 discusses methods of controlling air-heating and cooling coils to meet system or space requirements, and factors that should be considered in sizing automatic valves for steam and water coils.

Flow Arrangement

In all heat transfer processes, the relative directions of flow of the fluids influence the performance of the heat-transfer surface. In air-heating and cooling coils, the air usually flows at right angles to the tubes. In a coil having only one row in the direction of air flow, the relative directions of flow would all be at right angles. In coils having more than one row in the direction of air flow, the media in the tubes may be variously circuited as illustrated for

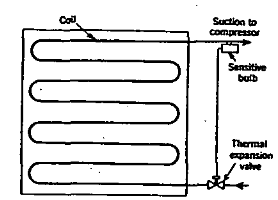

Fig. 4 . . . . Direct-Expansion Coil with Thermal Valve System

water or steam coils in Fig. 8. It is the usual practice to designate a coil that is circuited and employed as in Fig. 8A, as a *parallel-flow* coil. Figs. 8B and 8C show the general arrangements that are termed *counter-flow* and *cross-flow* respectively. Cross flow is common in steam