Unless the resistance of the unit is to be increased the spray chamber must be increased to allow for the space occupied by the coil in the air path. If much refrigeration is being used it will be found that the horizontal projected area of the coil is considerable.

Only a small fraction of the water sprayed hits or comes in contact with the coil surface. Some of the water is therefore not cooled during each cycle and to maintain a certain average water temperature some of the water must be cooled considerably lower. As it is not advisable to operate too close to the freezing point, either brine must be sprayed or a low temperature cannot be carried without submerged coil surface as well as extra coils in the spray chamber.

When the sprayed water hits the cooling coil it does not have a tendency to stick to the coil. The result is that a lower total volume of water will be flowing over the total coil surface and less total cooling will be secured per foot of surface used.

If the cost of a larger spray chamber, extra coil surface in the spray chamber, and the submerged coils required and the other factors are favorable, the coils may be used in the upper spray chamber with satisfactory results in some installations.

For some duties a return bend arrangement may be used passing the air through the upper chamber and then down and back through the lower coil chamber. The coils are covered by a film of running water at a lower temperature than the air and as some air will come in contact with the cold water and other cooled surfaces a limited amount of extra cooling may be secured.

There is one important point which is a problem for the refrigerating engineer, but which has sometimes been overlooked. This is the matter of control of the refrigeration. Almost all air conditioning installations, whether with automatic or hand control, give a varying refrigerating load. Systems have been operated using many tons of refrigeration and this load has suddenly been removed owing to changing requirements. Meanwhile the ammonia compressor may be operating, and freezing of the system with accompanying damages results if carried far enough. Ammonia lines in a plant cannot be tapped and valves turned on and off quite as readily as in a steam line. The refrigerating engineer should be fully advised regarding the varying of the air conditioning refrigerating load.

With the accompanying charts no one should have difficulty in checking a layout or making preliminary approximate estimates of the part of an air conditioning unit using refrigeration. It is impossible to give here all the factors governing the use of refrigeration and the allowance to make for different conditions such as coils that are dirty or oily on the inside, coils with poor outside surfaces, the element of time in changing conditions of air treatment, structural considerations and particularly the action of the water when it is sprayed in the coil chamber in contact with the air. It is not suggested by the author that those unfamiliar with the details of such work use these charts except as a source of general information as to the factors governing the design of such equipment.

Estimates as shown by the dotted lines on the charts are made as follows:

1. Total heat load—4,000 B.t.u. per minute
   20 tons refrigeration
2. Design and conditions allow 6 deg. rise in water temperature
3. Average water temperature 44 deg.
4. Average ammonia temperature 10 deg.
5. Difference ammonia and water 34 deg.
6. Gallons handled per ft. of trough 1¼
7. Standard unit available allows 8 ft. long troughs

Fig. 78 shows that 80 gallons water per minute are required.

Fig. 79 shows that 140 square feet of cooling coil surface are required when working at the rate of 50 B.t.u. per hour per square foot per degree difference.

Fig. 80 shows 64 lineal feet trough required.

Also shows 8 troughs and coils wide and space required as follows:

6 in. coil centers require space 54 in. wide
8 in. coil centers require space 68 in. wide
10 in. coil centers require space 82 in. wide
12 in. coil centers require space 96 in. wide

From Figs. 79 and 80 it was found that 140 sq. ft. of surface and 64 lineal feet of troughs were required. Fig. 81 shows the following:

Pipe diameter	1½ in.	1¼ in.	1 in.
Lineal Feet	225	283	404
Pipes High	5	6	7

Pipes High have been increased to eliminate fractions and in designing a unit the lineal feet of coil required would have to be increased in proportion. Allowance must be made for dirty coils, uneven water distribution, quick control of temperatures and other factors, all of which might double the coil surface shown mathematically by the charts.

The heat transfer which may be obtained in the upper chamber and the maximum rise in the water temperature, and therefore the use of Fig. 78, will vary with each change in nozzle, pump pressure, time element, pounds of water used per pound of air, water to air temperature differences, and other such factors as might be expected, but once the volume of water and the temperature through which it must be cooled are determined, the design of that part of the apparatus using refrigeration will be a comparatively simple problem to those familiar with such work.

In this work the problems are many and varied for cooling is used in many industries as well as for the conditioning of air in hotel dining-rooms, theater auditoriums and many other rooms where it is desirable to maintain a temperature under that prevailing out of doors.

With modern refrigerating and dehumidifying apparatus properly designed and applied it is possible to obtain most any percentage of ventilation perfection outlined in Chapter XV. Unless artificial cooling is resorted to it is hardly possible to obtain better than 75 per cent perfection as outlined in Chapters XV and XVI in hot sultry summer