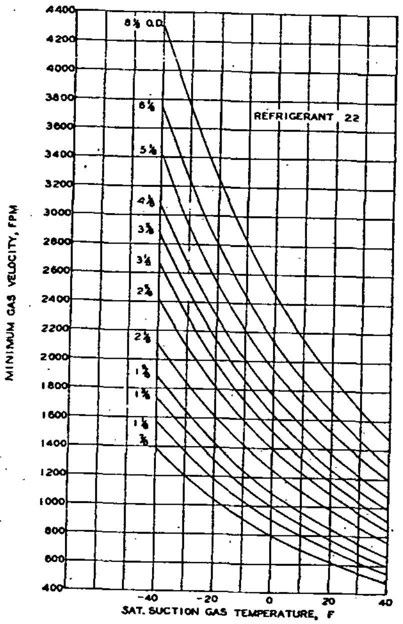

Fig. 3 .... Minimum Gas Velocity for Oil Entrainment in Copper Tube Suction Risers (Refrigerant 22)[2]

which will entrain oil at the minimum loading, using Refrigerant 12 with a 40 ton compressor having capacity reduction in steps of 25, 50, 75, and 100 percent. Assume that the minimum system loading is 10 tons at 40 F suction and 105 F condensing temperatures.

Solution: From Fig. 3 of Chapter 69, the refrigerant flow rate per ton is found to be 4.07 lb per min.

The minimum flow rate = 10 × 4.07 = 40.7 lb per min.

The specific volume of gas at 40 F (saturated) is found (from Table 3 of Chapter 19 in the 1961 Guide And Data Book) to be 0.7736 cu ft per lb.

The flow rate is 40.7 × 0.7736 = 31.5 cfm.

From Fig. 2, the minmum gas velocity for oil entrainment at 40 F suction in a 2⅝ in. OD copper tube is 930 fpm. Adding 25 percent for minimum recommended design, the minimum velocity is 930 × 1.25 = 1163 fpm.

The inside cross-section area of a 2⅝ in. OD copper tube is 4.77 sq in. (Table 2, Chapter 50 of the 1961 Guide And Data Book.) The gas velocity in 2⅝ in. OD tube at minimum loading is

$$\frac{31.5 \times 144}{4.77} = 950 \text{ fpm}$$

Since the actual gas velocity (950 fpm) at minimum loading is less than 1163 fpm, but more than 930 fpm, a riser of 2⅝ in. OD tube may return oil, but the next smaller size is the safest choice.

Therefore, the riser should not be greater than 2⅛ in. OD.

When vertical riser sizes are reduced in size to provide satisfactory minimum gas velocities, the pressure drop in them is increased considerably at full load and the horizontal lines should be sized to keep the total pressure drop within practical limits. As long as the horizontal lines are well pitched in the direction of the compressor it is not necessary to adhere to any specified minimum gas velocities for oil entrainment.

Because modern compressors have capacity reduction features, it often becomes difficult to maintain the gas velocities required to return oil upward through vertical suction risers. When the suction riser is sized to permit oil return at the minimum operating capacity of the system, pressure drop in this portion of the line may be too great when operating at full load.

If a correctly sized suction riser imposes too great a pressure drop at full load, it is possible to eliminate this problem by using a double suction riser.

Double Suction Risers

Fig. 4 shows two methods of double suction riser construction. Oil return is accomplished with this arrangement at minimum loads, while not imposing the penalty of excessive pressure drops at full load. The *sizing and operation of* a double suction riser is described as follows:

1. The small riser, indicated by *A* in the figure, is sized so that it will return oil at the minimum load which can occur.
2. The second riser *B*, which is usually larger but not necessarily so, is sized so that the pressure drop through both risers at full load is satisfactory. The usual method is to size the second riser *B* so that the combined cross-sectional area of *A* and *B* is equal to or slightly greater than the cross-sectional area of a single *pipe*, which *would be sized* for an acceptable pressure drop at full load without regard for oil return at minimum load. The combined cross-sectional area, however, should not be greater than the cross-sectional area of a single pipe which would return oil in an upward flow riser under maximum load conditions.
3. A trap is introduced between the two risers as shown in the figures. During partial load operation where the gas velocity is not sufficient to return oil through both risers, the trap will gradually fill up with oil until the second riser *B* is sealed off. The gas then travels up riser *A* only and now has enough velocity to carry oil along with it, back into the horizontal suction main.

As illustrated in the diagrams, precaution should be taken

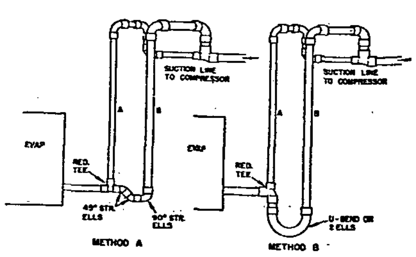

Fig. 4 .... Double Suction Riser Construction[2]

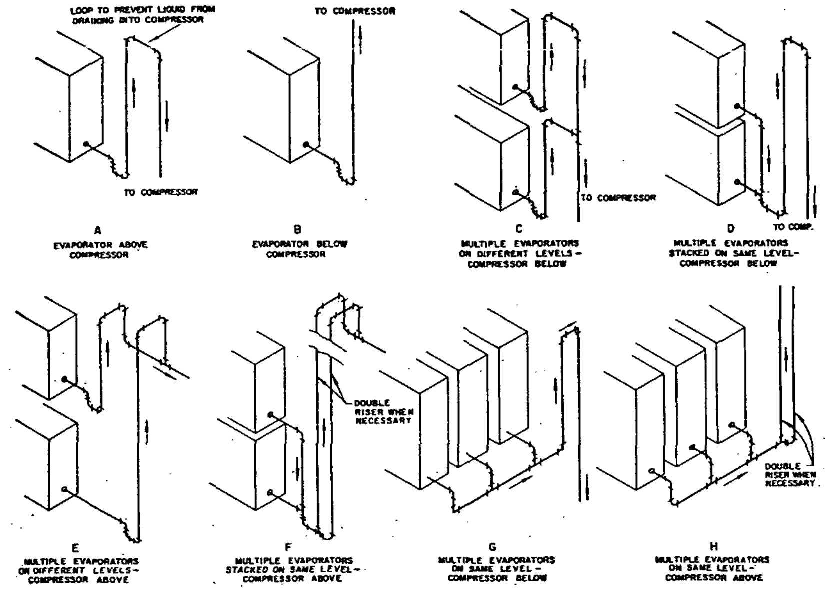

Fig. 5 .... Suction Line Piping at Evaporator Coils[2]

to close-couple the fittings at the bottom of the risers, so that the oil holding capacity of the trap will be limited to a minimum. If this is not done, the trap can accumulate enough oil on partial load operation to seriously lower the compressor crankcase oil level and also cause larger slug-backs of oil to the compressor when the trap clears out on resumption to increased load operation. Note in Fig. 4 that the large riser *B* forms an inverted loop and enters the horizontal suction line from the top. This is to prevent oil drainage into this riser, which may be idle, during partial load operation.

Double suction risers are frequently essential on low temperature systems where very little pressure drop can be tolerated with good economy.

For systems operating at higher suction temperatures, such as for comfort air conditioning, single suction risers may be sized for oil return at minimum load without serious penalty at design load, in the majority of cases. Where single compressors are used, employing capacity control, minimum capacity to be considered will be that corresponding to the compressor capacity at its minimum displacement. This minimum displacement usually bears a relationship of 3 or 4 to 1, to maximum displacement. With this low ratio, pressure drop in suction risers designed for oil return at minimum load, will rarely be serious at full load.

Where multiple compressors are interconnected and controlled so that one or more may shut down while another continues to operate, the ratio of minimum to maximum displacement becomes much larger. *In this case the double suction riser may be necessary for good operating economy at design load.*

The remaining portions of the suction line may be sized to permit a practical pressure drop between the evaporators and compressors, since oil will be carried along in horizontal lines at relatively low gas velocities. It is good practice to give a definite pitch to these lines toward the compressor. Traps should be avoided, but if unavoidable, risers from these traps must be treated in the same manner as those leading from the evaporators.

Suction Piping to Prevent Liquid Drainage into Compressors

Where the automatic compressor pump-down cycle is not used it is necessary to design the suction piping to prevent the drainage of liquid refrigerant into the compressor during compressor off cycles, since thermal expansion valves may not make a positive closure on the off cycles and slowly leak refrigerant into the coil. Certain standard piping practices have been developed to serve this purpose.

Diagram A of Fig. 5 represents the case where a single evaporator is above the compressor. A loop rising to the top