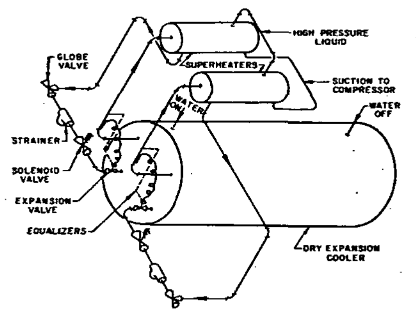

Fig. 25 .... Two-Circuit Dry Expansion Cooler Hookup[3]

flow is through a solenoid valve which is operated by a low pressure float switch responsive to the liquid level in the evaporator.

The *pilot operated low pressure float* control (Fig. 24) is widely used for flooded systems using Refrigerants 12, 22 and 500. Direct acting low pressure float valves are impractical for these refrigerants except for very small tonnages.

The *high pressure float valve is so named* because the float chamber is connected to the high pressure side of the system. It is actually a float trap, whose function is to pass all liquid refrigerant and no gas. Liquid is fed to the evaporator as fast as it is condensed. High-side float valves are usually practical only in systems having one evaporator because of distribution problems if multiple evaporators are used. It is necessary to charge the system carefully to provide a liquid level that will flood the evaporator, and yet not cause slop-over at full load.

Float chambers should be located as near the liquid connection on the cooler as possible since a long length of liquid line, even though insulated, can pick up room heat and give an artificial liquid level in the float chamber. Equalizer lines must be amply sized to minimize the effect of heat transmission toward creating false liquid levels in the chamber. The float chamber and its equalizing lines must be insulated.

Some sources indicate that a *discharge line oil separator* must be used on each flooded cooler system to keep the oil concentration low in the evaporator. In spite of the hazards accompanying the use of oil separators, this appears to be good practice. The use of this device minimizes the amount of bleed-off that must be taken to keep the oil concentration down in the cooler and the lower oil concentration insures maximum cooler efficiency. Oil separators are not 100 percent efficient. Therefore, it is still necessary to design for oil return from the cooler whether a seprator is used or not.

Direct Expansion Fluid Chillers

The dry expansion chiller has the refrigerant flow through the tubes while the water, or liquid to be cooled, flows transversely over the outside of the tubes and is guided by vertical baffles. These coolers may be single circuit or multi-circuit with each circuit fed by a thermal expansion valve or pilot operated thermal expansion valve. Multi-circuit coolers are usually used on systems where the compressor capacity can be reduced below 50 percent since oil cannot be properly returned and good thermal valve control may not be expected below this minimum loading per circuit. In addition, at light loadings the liquid distribution may become poor, resulting in unequal feeding of the tubes because of separation in the cooler heads of flash gas from the liquid. The high gas velocity through the cooler coupled with the thermal valve control enables this type of evaporator to return oil to the compressors when due regard is given to the minimum loading per circuit and the design of the suction line. A discharge line oil separator is generally not required since the oil return from the low side will normally be in balance with the oil coming from the high side.

It is usually recommended that the minimum capacity on a single circuit should not be less than 50 percent of its full capacity. For example, on a system containing a compressor which can be reduced to 25 percent capacity, a two circuit cooler is often used so that when the compressor reduces in capacity below 50 percent, the refrigerant solenoid valve feeding one of the circuits closes.

Liquid-suction interchangers (superheaters) are sometimes used with these coolers to prevent slop-over to the compressor with any cycling of the thermal valve, although they are usually not necessary.

Fig. 25 shows typical piping connections for a multi-circuit dry expansion chiller. Each circuit contains its own thermal valve and solenoid valve. One of the solenoid valves should be wired to close at reduced system capacity. The thermal valve bulbs should be located between the cooler and the liquid-suction interchangers, if used. Locating the bulb downstream from the interchanger will cause bad cycling of the thermal

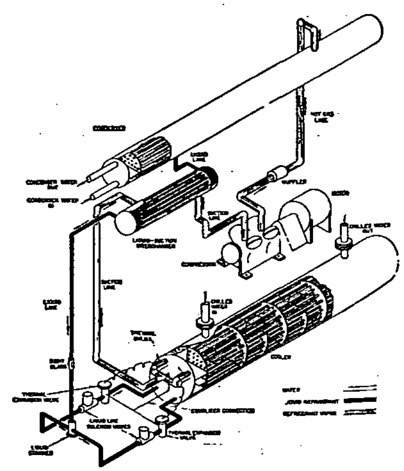

Fig. 26 .... Typical Piping Arrangement in Liquid Chilling Package Using Direct Expansion Chiller[3]

valve since the high pressure liquid flow through the interchanger ceases when the thermal valve closes; consequently, no source of heat is available from the high pressure liquid and the cooler must starve itself to obtain the necessary superheat to open the valve. Then when the valve does open, excessive superheat will cause it to overfeed until the bulb senses liquid downstream from the interchanger. Therefore, the remote bulb should always be located between the cooler and the interchanger.

Fig. 26 shows a typical piping arrangement that has been used successfully in packaged water chillers having direct expansion chillers.

Any suction risers must be sized to return oil at minimum possible loading in that riser. Care must be given in designing a system to prevent any oil traps in the suction gas passage of an L-S interchanger, if used. When the suction gas flows around the annular space through an interchanger, the suction connection going to the compressor should be made at the bottom to avoid a trap in the interchanger where the oil may accumulate.

Note in Figs. 25 and 27, that the water or liquid to be cooled enters the cooler on the suction gas leaving end. This is desirable to obtain the maximum superheat on the suction gas leaving the chiller.

On larger systems it may become necessary, due to the limited size of thermal valves, to use a pilot operated liquid valve controlled by a small thermal expansion valve. Fig. 27 shows the proper arrangement. The small thermal valve pilots the main liquid control valve. The equalizing connection and the thermal bulb of the pilot thermal valve should be treated in the same manner as that of a direct acting thermal expansion valve. A large liquid line solenoid valve is not required to shut off the high side from the low during shutdown as a small solenoid valve in the pilot line will serve this purpose.

Semi-Flooded Evaporators

A typical example of this type of evaporator is the floor mounted, forced circulation, air cooler, with a prime surface (no fins) type coil, used for product refrigeration.

These evaporators are usually primarily designed for flooded operation, and are therefore built with the maximum amount of circuits for the minimum possible pressure drop. For instance, a type commonly used has large horizontal headers at top and bottom, with individual serpentine pipe coils 6 to 10 rows high in direction of air flow connecting the two headers.

If refrigerant is fed to the top header of these coils with

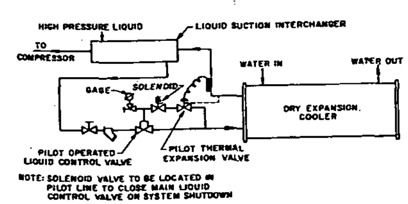

Fig. 27 .... Dry Expansion Cooler with Pilot Operated Control Valve[3]

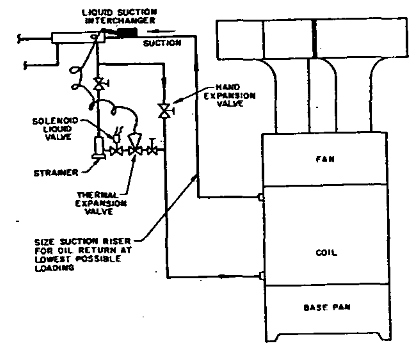

Fig. 28 .... Forced Circulation Air Cooler with Direct Expansion Feed of Flooded Type Coil[3]

thermal expansion valves, very poor liquid distribution would result in the large header. This would seriously reduce the unit capacity. Therefore, best results are obtained by bottom-feeding the coil. This will result in a semi-flooded condition which tends to more evenly feed all circuits (Fig. 28).

Because of the large volume and number of circuits in prime surface coils designed for flooded operation, the suction gas velocity up through the coil is not sufficient to entrain oil when bottom-feeding the coil from an expansion valve. Thus the coil can form a trap for any lubricating oil which is in circulation through the system. If this is allowed to happen the concentration of oil in the refrigerant-oil mixture, which constitutes the coil operating charge, can become so great as to impair the heat transfer performance of the coil and cause lubrication failure of the compressor.

To keep the oil concentration in the coil at a minimum, it is actually necessary to overflow this liquid refrigerant-oil mixture from the top of the coil in sufficient quantity to continuously return to the suction line the same amount of oil that enters the coil. Once this oil-rich liquid refrigerant enters the suction line, proper design of this line will carry the oil back to the compressor.

The oil-rich liquid refrigerant slopped over from the top of the prime surface coil must be rectified by means of a liquid-suction heat interchanger which will evaporate the refrigerant and permit the oil only to be returned in liquid form, by entrainment or gravity, to the compressor.

To realize this slop-over of oil-rich refrigerant from the top of the coil, the valve should operate at a low superheat setting and the thermal bulb should be located at a point where the necessary superheat can be obtained to operate the valve while the required slop-over is taking place.

Direct Expansion Air Coils

Direct expansion air coils are usually composed of a finned-tube bundle into which refrigerant is fed by means of an expansion valve, usually the thermostatic type, and over which air is passed by forced convection means. This type of evap-