The magnitude of this pressure is determined by the temperature of the suction gas leaving the evaporator, as the control bulb is attached to the suction line at this point and is at approximately the same temperature. The suction pressure in the evaporator is transmitted through the equalizer tube and exerts an opposing force on the other side of the diaphragm in the direction to close the valve. This pressure corresponds to the temperature of the boiling refrigerant. The resulting force on the diaphragm is determined by the differential between the temperature of the suction gas and the boiling point of the refrigerant, which is the amount of superheat in the gas. If this temperature differential becomes greater (superheat increases), the resultant force on the diaphragm opens the valve and admits more refrigerant. The reverse is true if the superheat decreases, and the valve partly closes, thus admitting less refrigerant. The spring keeps the valve closed until the resultant force on the diaphragm corresponds to the desired superheat. The adjustment of the spring will change the amount of superheat to be maintained in the suction gas.

The selection of the expansion valve is, of course, determined by the capacity of the valve. The capacity of a valve with a given orifice is determined by the refrigerant used, the differential of pressure across the valve, and the amount the liquid is sub-cooled as it enters the valve. The expansion valves are usually rated at zero sub-cooling of the liquid, or 100 per cent liquid. Frequently special devices are used to properly distribute the refrigerant among the parallel paths of the evaporator. These distributing devices usually have considerable pressure drop. Where they are used, the pressure drop across the expansion valve is not the difference between suction and discharge pressures, as allowance must be made for the pressure drop across the distributing device. An equalizer connection from the evaporator suction line must be made to the underside of the diaphragm (see Fig. 10) whenever the valve outlet is not at the evaporator pressure so as to insure suction pressure at this point. When distributing devices are used, this equalizer connection is essential for proper operation of the valve. Another pressure drop allowance must be made for the liquid line, particularly when the liquid line has an appreciable vertical rise.

Whenever possible, expansion valves should be installed in a manner which will permit placing thermometer wells in the suction connection and allow sufficient room for free adjustment of the valve.

Evaporators and Coolers

The types of coolers used in connection with air conditioning work fall into three general groups. The *first*, is the direct cooling of water; the *second*, direct cooling of air; and the *third*, cooling of brine for circulation in a closed system, which can cool either water or air. One method of the direct cooling of water is to install direct expansion coils in the spray chamber so that the water sprayed into the air comes in direct contact with the cooling coils. Another common and efficient method of cooling spray water is to use a Baudelot type of heat absorber where the water flows over direct expansion coils at a rate sufficiently high to give efficient heat transfer from water to refrigerant.

Another type of spray water cooler is the shell and tube heat exchanger in which the refrigerant is expanded into a shell enclosing the tubes through which the water flows. The velocity of the water in the tubes affects the rate of heat transfer, and as the refrigerant is in the shell completely surrounding the tubes at all times, good contact and a high rate of heat transfer are insured. The disadvantage of such a system is that with the falling off of load on the compressor the suction temperature or the temperature in the evaporator drops and there is a possibility of freezing the water in the tubes, which, of course, might split the tubes and allow the refrigerant to escape into the water passage. This danger can be eliminated by automatic safety devices.

Another system of cooling spray water is to submerge coils in the spray collecting tank, or in a separate tank used for storage. The heat transmission through the walls of the coils, however, is low and a great deal more surface is required than for any other type of cooler. However, with large storage tanks this type of cooling can be utilized to advantage.

TABLE 11. BASIS OF EQUIPMENT SELECTION

CAPACITY TONS	MAJORITY USED	SOME USED	FEW USED
0 to 5	Unit systems in conditioned space.	Unit central systems using duct distribution.	Built up central systems.
5 to 25	Built up central systems using reciprocating compressors.	Unit central systems using duct distribution.	Unit systems in conditioned space. Built up systems using absorption and adsorption systems.
25 to 50	Built up central systems using reciprocating compressors.	Built up central systems using centrifugal compressors.	Central systems using adsorption systems.
50 to 400	Built up central systems using reciprocating compressors.	Built up central systems using steam jet and centrifugal compressors.	
400 and Over	Built up central systems using centrifugal compressors.	Built up central systems using steam jet.	

When direct cooling of air is employed, the refrigerant is inside the coil and the air passes over it. Cooling depends upon convection and conduction for removing the heat from the air. The type of coil used can be either smooth or finned, the finned coil being more economical in space requirement than the smooth coil. The fins, however, must be far enough apart so as not to retain the moisture which condenses out of the air.

The indirect cooler, where brine is cooled by the refrigerant and the resulting cold brine is used to cool either air or water, introduces several other considerations. It is not the most economical from a power consumption standpoint, as it is necessary to cool the brine to a temperature sufficiently low so that there is an appreciable difference between the average brine temperature and that of the substance being cooled. This requires that the temperature of the refrigerant must be still lower, and consequently the amount of power required to produce a given amount of refrigeration increases due to the higher compression ratio. There are