of the inefficient work and is commonly termed the superheat loss. The refrigerating effect per pound is the same for the practical as for the theoretical cycle, working with the same sub-cooling of liquid and superheating of vapor, that is, area $e_1a_1g_1f_1e_1$.

Sources of loss which are usually recognized as reflected by the overall efficiency referring particularly to reciprocating and rotary systems, are as follows:

1. The superheat loss.
2. A pressure loss to and from the cylinder of the compressor. (The line pressure drop between the compressor and the evaporator and condenser, respectively, is usually taken into account separately in the design of the refrigeration system.)
3. Leakage loss through valves and past pistons is quite small in most compressors.
4. With an oil soluble refrigerant, there may be an absorption loss due to absorption and re-evaporation of refrigerant in the oil of the cylinder.
5. Mechanical losses are always present and are usually a large part of the total.

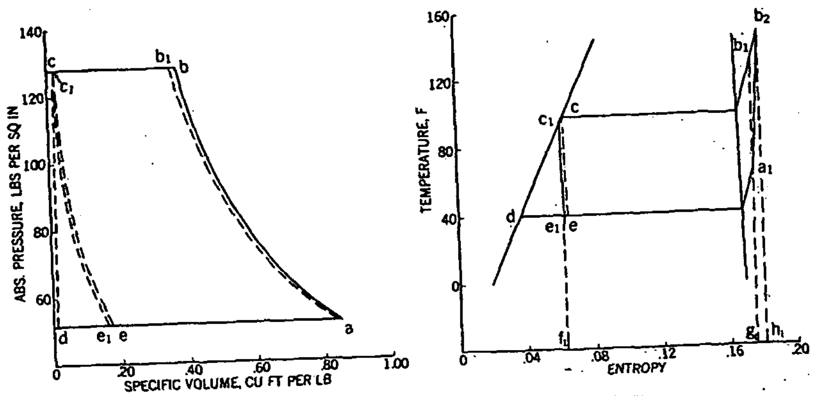

FIG. 3. PRACTICAL DICHLORODIFLUOROMETHANE (F_{12}) CYCLES

Reciprocating and rotary compressors always take in less vapor than that which corresponds to the displacement. The overall volumetric efficiency is the ratio of the suction vapor volume to the piston displacement. On reciprocating compressors part of the loss is the re-expanded volume, at suction pressure, of the vapor which was in the clearance volume. This is expressed by the following equation:

$$\text{Volumetric Efficiency} = 1 - \frac{v_c}{v_d} \times \left[\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right] \qquad (6)$$

where

v_c = clearance volume.
v_d = cylinder displacement volume.

The balance of the overall volumetric efficiency is known as the superheat volumetric efficiency even though it includes some other sources of capacity loss.

The mechanical efficiency of a reciprocating and rotary compressor must be multiplied by the superheat volumetric efficiency to give the overall efficiency of the compressor.

$$\text{Eff.}_{\text{overall}} = \frac{\text{Vol. Eff.}_{\text{overall}}}{\text{Vol. Eff.}_{\text{reexp.}}} \times \text{Mech. Eff.} = \text{Super. Vol. Eff.} \times \text{Mech. Eff.} \qquad (7)$$

Normally, the volumetric efficiency of a compressor varies with the ratio of compression, while the mechanical efficiency remains virtually fixed. Good standard practices for dichlorodifluoromethane compressors are:

	Low comp. ratio = 2.5 to 1	High comp. ratio = 5 to 1
Vol. Eff.$_{\text{reexp.}}$	94 to 96 per cent	88 to 92 per cent
Vol. Eff.$_{\text{super.}}$	75 to 85 per cent	73 to 77 per cent
Vol. Eff.$_{\text{overall}}$	70 to 81 per cent	64 to 71 per cent
Mech. Eff.	75 to 85 per cent	75 to 85 per cent

These values are for one ton or larger compressors. Part of the difference expresses the change with capacity. With other refrigerants and other types of compressors there will be some further variation.

STEAM JET SYSTEM

The steam jet type of compressor, under certain circumstances, is desirable for use in air conditioning. The power used for compressing the refrigerant is steam, taken directly from the boiler, thus eliminating the mechanical losses of manufacturing electric current. As the compression ratio between the evaporator and condenser under normal circumstances is large, the mechanical efficiencies of the equipment are somewhat lower than those of the positive mechanical type of compressor; also the condensing water requirements are considerably greater, as both the refrigerant and the impelling steam must be condensed.

The steam jet system functions on the principle that water under high vacuum will vaporize at low temperatures, and steam ejectors of the type commonly used in power plants for various processes will produce the necessary low absolute pressure to cause evaporation of the water.

A diagrammatic representation of a typical steam ejector water cooling system is shown in Fig. 4. The water to be cooled enters the evaporator and is cooled to a temperature corresponding to the vacuum maintained. Because of the high vacuum, a small amount of the water introduced in the evaporator is flashed into steam, and as this requires heat and the only source of heat is the rest of the water in the evaporator tank, this other water is almost instantly cooled to a temperature corresponding to the boiling point, determined by the vacuum maintained. The amount of water flashed into steam is a small percentage of the total water circulated through the evaporator, amounting to approximately 11 lb per hour per ton of refrigeration developed. The remainder of the water at the desired low temperature is pumped out of the evaporator and used at the point where it is required.

The ejector compresses the vapor which has been flashed in the evaporator, plus any entrained air taken out of the water circulated, to a somewhat higher absolute pressure, and the vapor and air mix with the impelling steam on the discharge side of the jet. The total mixture of