

entrained air, evaporated water, and impelling steam is discharged into a surface condenser at a pressure which permits the available condensing medium to condense it. The resulting condensate is removed from the condenser by a small pump, from which it can be discharged to the sewer

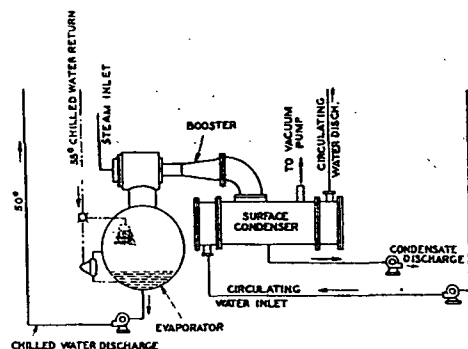


FIG. 4. STEAM EJECTOR COMPRESSION REFRIGERATION SYSTEM

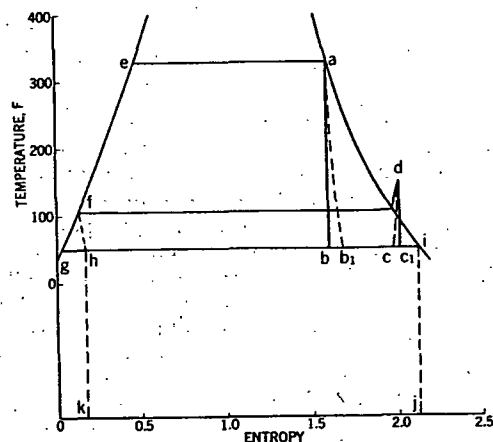


FIG. 5. STEAM EJECTOR TEMPERATURE-ENTROPY DIAGRAM

or returned to the system in the form of make-up water, or part of it may be returned to the boiler feed pump.

The slight amount of air which may be entrained in the cooled water is removed by a small secondary ejector which raises the pressure sufficiently so that the air can be discharged to the atmosphere. A small secondary condenser, of course, is necessary to condense the steam used in the secondary jet.

The performance of the steam ejector may be studied theoretically by the use of the temperature-entropy diagram, Fig. 5. Unlike its usual

application, however, the amount of working fluid is different for one portion of the cycle than for the other. Dry saturated steam under high pressure, for example 100 lb per square inch gage, at *a*, is expanded through the nozzle of the steam ejector. With 100 per cent efficiency, the expansion would occur along isentropic line *ab*. Actually, however, most nozzles are only about 90 per cent efficient, the real expansion being along the line *ab₁*. Since the exact path of the line *ab₁* is not known, the work area is normally assumed by using the isentropic giving a work area *abgea*. The velocity at the mouth of the nozzle may be determined in the usual manner using this area and the velocity coefficient of the nozzle.

At the evaporator pressure or slightly below, the vapor from the nozzle mixes with virtually dry saturated vapor from the evaporator. An impact loss also occurs at this point due to the mixture of vapors at different velocities. This results in bringing the state point of the mixture to *c*. Compression then occurs along the line *cd*, the work of compression per pound being *cdfgc*. In computing the work area, however, the point *c* is not actually known. Therefore, the work area *c₁dfgc₁* is used in expressing the efficiency of the ejector, the line *c₁d* being an isentropic. The losses are expressed by nozzle efficiency, impact loss and diffuser efficiency. The work of compression, however, is performed on the mass of the mixture. Thus, the available work is reduced in proportion to:

$$\frac{M_{\text{primary}}}{M_{\text{mixture}}}$$

The impact loss is commonly determined from the formula:

$$MV_{\text{primary}} + MV_{\text{secondary}} = MV_{\text{mixture}} \quad (8)$$

Common efficiencies for commercial ejectors are: nozzle efficiency 90 per cent, diffuser efficiency 60 to 70 per cent. Customary steam rates in pounds per ton are approximately as follows:

Evaporator temp. 50 F	Steam press. 100 lb per sq in.	Steam press. 12 lb per sq in.
Condenser temp. 105 F	Steam rate 30 lb per hour per ton	Steam rate 45 lb per hour per ton
Evaporator temp. 40 F	Steam press. 100 lb per sq in.	Steam press. 12 lb per sq in.
Condenser temp. 105 F	Steam rate 40 lb per hour per ton	Steam rate 70 lb per hour per ton

CENTRIFUGAL VAPOR VACUUM SYSTEMS

The centrifugal vapor vacuum system functions on the same general principle as the steam jet system, except that a centrifugal evacuator is used to produce the low absolute pressure instead of the velocity of the steam through a jet. Less condenser water is required and a vacuum pump is employed instead of a steam jet purge.

CHARACTERISTICS OF COMPRESSION SYSTEMS

The different types of compression systems have quite different characteristics of capacity and power with varying evaporator temperature and with varying condenser temperature, as will be seen from curves in Figs. 6 and 7.

The capacity of the reciprocating and rotary compressor varies slowly with a change of evaporator temperature, and the variance of power