None of the absorbent is carried off with the refrigerant from the generator and the performance ratio ranges as high as 75 percent. Both the refrigerant and the absorbent are non-toxic and non-explosive and the performance ratio does not vary greatly between 20 percent of capacity and full load. This increased efficiency places operating costs in competition with other forms of refrigeration in many high temperature applications such as air conditioning.

One form of lithium-bromide-water absorption system is shown schematically in Fig. 8 with the generator and condenser shown located in a high pressure shell and the evaporator and absorber in a low pressure shell. The water to be cooled flows through coil 1. Water from the evaporator

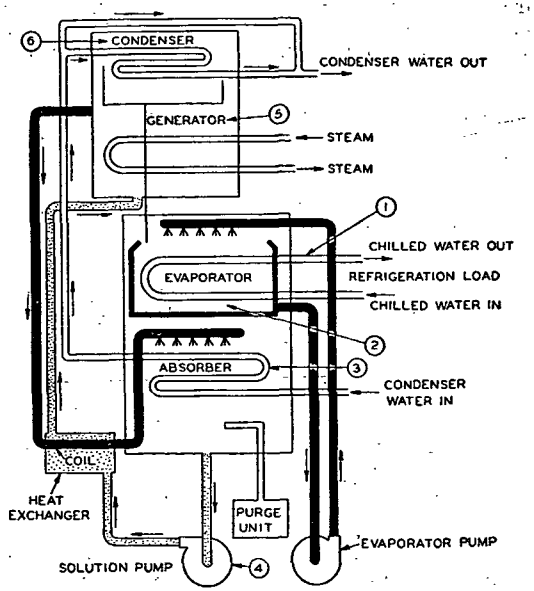

FIG. 8. DIAGRAM OF LITHIUM BROMIDE WATER ABSORPTION SYSTEM

tank 2 is sprayed over the coil. The evaporation and cooling effect of this spray on the surface of the coil chills the water inside of the coil. The pressure in the low side shell and, therefore, the temperature of the spray water is controlled by the temperature and concentration of the lithium bromide brine sprayed over absorber coil 3. The water vapor formed in the evaporator chamber is absorbed by the strong salt solution to form a weak solution which drains from the low pressure chamber and passes through solution pump 4. In the generator 5 heat is used to raise its temperature and boil off the excess water vapor. The reconcentrated salt solution is then returned to the absorber to continue the cycle. Water vapor boiled off from the weak salt solution in the generator is condensed and returned to the evaporator tank. A heat exchanger is added to the circuit to conserve heat in the cycle by using the hot concentrated salt solution from the generator to preheat the cooler weak solution from the absorber. Condensing water from a cooling tower or other available

source is circulated through coils in the absorber and the condenser to remove waste heat from the refrigeration cycle.

Fig. 9 illustrates the performance of a typical lithium bromide absorption machine with varying chilled water and condenser water temperature.

THE HEAT PUMP

Heat Pump is the name commonly applied to a year-round air conditioning system employing refrigeration equipment in such a manner that heat is removed from a *heat source* and given up to the conditioned space during the heating period and is removed from the conditioned space and given up to a *heat sink* during the cooling period. The heat-pump cycle is identical with the conventional refrigeration cycle, except that it is concerned with both the cooling effect produced at the evaporator and the

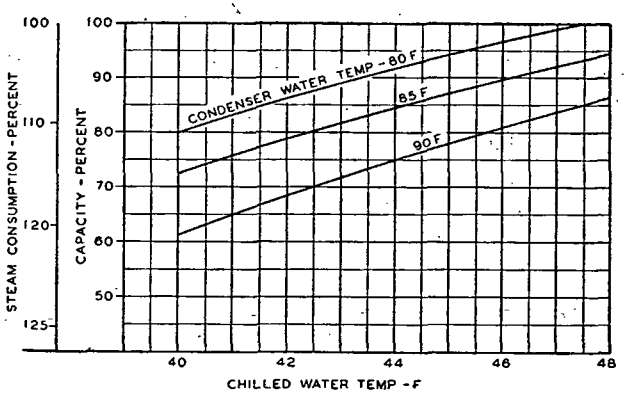

FIG. 9. PERFORMANCE CHARACTERISTICS OF A LITHIUM BROMIDE ABSORPTION REFRIGERATION MACHINE

heating effect produced at the condenser. The conventional refrigeration system is concerned mainly with the cooling effect produced. In some systems, both heating and cooling may be used simultaneously.

Operating Cycles

During the heating cycle, heat is taken from a heat source by one of the heat exchange surfaces, and is transferred, together with a portion of the work of compression, to a second surface and then released to the space. During the cooling cycle, the heat taken from the space is rejected, together with a portion of the work of compression, to the heat-sink medium. Flow diagrams of basic heat-pump cycles, which are readily adaptable to year-round air conditioning, are shown in Figs. 10, 11, 12 and 13.

The system illustrated in Fig. 10, using expansion valves to regulate the refrigerant flow, is frequently employed in the larger central-plant type of systems. The heating or cooling effect is obtained by using an automatically- or manually-operated valve to change the direction of the refrigerant flow. The refrigerant sub-cooling coil, when used, is usually located in the ventilation air intake to preheat this air and, at the same time, lower the temperature of the liquid refrigerant. In this way, the ventilation air can be preheated 40 to 50 F deg with a resulting increase of as much as