The principal disadvantages to air cooled condensers are the power required to move the air and the reduction of capacity on hot days. This loss of capacity due to high condensing pressures on warm days requires that equipment of reduced capacity be selected to meet the peak load. Thus, at normal loads the equipment is oversized.

Water Cooled

Water cooled condensers are usually of the double pipe type or the shell and tube type. Double pipe condensers are arranged so that water passes through the inner of two concentric pipes, and refrigeration circulates through the annular space in the outer pipe. Where possible, there should be counter-flow of the refrigerant and the condensing water to maintain maximum temperature differences.

The amount and temperature of the condensing water determine the condensing temperature and pressure, and indirectly the power required for compression. It is, therefore, necessary to determine a balance so that the quantity of water insures economical compressor operation.

Because there is a decided tendency to conserve the water in city mains and because most large cities are restricting the use of water for air conditioning and refrigeration equipment, it is often necessary to install cooling towers or evaporative condensers. Cooling towers, unfortunately, produce the warmest condensing water at the time when the load on the system is greatest, so that the refrigeration equipment must be designed to meet not only the maximum load at normal conditions, but also the maximum load at abnormal condensing water temperatures. If properly designed, this makes little difference in the efficiency of operation throughout the year except at those times when the condensing water temperature is highest. As this occurs only for 5 per cent of the entire cooling period it can be disregarded as a factor in establishing yearly operating costs.

The cooling tower has a certain advantage over the use of water from the city mains in that the temperature of the condensing water varies directly with the outdoor temperature and, as pointed out, the refrigeration load also varies with this temperature. Certain economies are possible when a cooling tower is used which cannot be achieved by the use of condensing water from city mains, even where the city water temperature is extremely low. Normally, the lowest city water temperature met during the summer months is from 65 to 70 F. This temperature range takes place for the entire cooling period, regardless of the outdoor temperatures. With the cooling tower, the temperature of the condensing water may rise to 80 or 85 F under maximum conditions, but under less than maximum conditions the temperature of the water leaving the cooling tower drops considerably, and it has been established that 50 per cent of the time the outdoor wet-bulb temperature varies from 60 to 70 F and the cooling tower water, for the same periods, varies from 65 to 75 F. When the outdoor wet-bulb temperature drops below 60 F, which occurs approximately 30 per cent of the time, the condensing water temperature is still lower. The cost of water used for condensing is negligible, as the only water required is that used to make up the loss by evaporation in the cooling tower itself. Refer to the section on cooling towers in Chapter 25.

Evaporative

Due to the high cost of city water for condenser purposes and due to ordinances in some localities prohibiting the discharge of large quantities of such water into the sewage systems, there has been developed a condenser which uses a minimum amount of water on a finned surface, cooling it to approximately the wet-bulb temperature of the surrounding atmosphere.

A diagram of a typical small evaporative condenser is shown in Fig. 8 which includes a fan that forces the air over a finned tube condenser coil to the outside atmosphere through a connecting duct. A fine spray of water keeps the coil surface wetted. The hot refrigerant gases enter the top of the condenser coil and the liquid collects in the receiver below

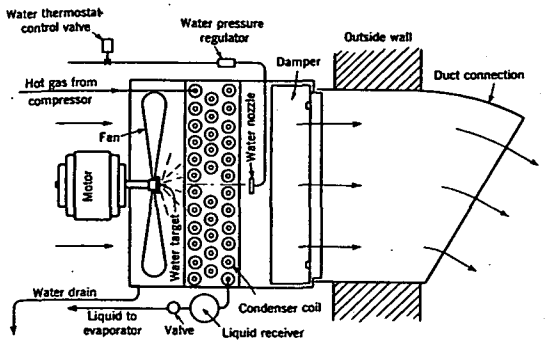

FIG. 8. DIAGRAM OF EVAPORATIVE CONDENSER

the condenser unit. A thermostatic control valve and pressure regulator are arranged on the condenser water supply for regulating and adjusting the water flow to the nozzle. It is desirable that a condenser of this type be located near the compressor.

Units of this design are available in sizes ranging from 2 tons of refrigeration up to about 6 tons. About 10 per cent as much water is required for this unit as is normally used in a shell and tube type condenser. For larger capacities evaporative condensers are usually equipped with a pump for recirculating the water. Such units are available in capacities ranging from 5 to 40 tons of refrigeration. They require no more water than a cooling tower, i.e., from 3 to 5 per cent as much water as required where all water is taken from the city main.

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