

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.

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 other considerations which make such a system desirable. In the first place, where a toxic refrigerant is undesirable or cannot be used because of fire or other risks, especially in densely populated areas, the brine can be cooled in an isolated room or building and can then be circulated through the air conditioning equipment. This arrangement eliminates any possibility of direct contact between the air and refrigerant.

REFRIGERANT PIPE SIZES

The selection of proper pipe sizes and frictional pressure losses varies with the installation and the capacity of the system. Generally the suction piping should be selected so that the pressure loss is between 2 and 3 lb per square inch. The pressure drop in liquid lines should be maintained so as to permit no vaporization in the pipes with limiting pressure drops not to exceed 5 lb per square inch. Hot or discharge gas lines should be limited to approximately 4 lb per square inch pressure drop. All pressure drops mentioned are total system losses and include not only the piping losses, but also the pressure losses in the valves, fittings and coils.

Pressure drops for discharge or hot gas lines may be determined from Table 7. Pressure losses in liquid refrigerant lines of various sizes and capacities are given in Table 8. Pressure drops of suction refrigerant pipe lines at varying capacities and refrigerant temperatures are given in Table 9. Oil circulating with the refrigerant appreciably increases the pressure losses in both suction and discharge lines from that given in these tables. All tables are for 100 ft of pipe, including an average number of fittings, and for other lengths the losses are proportionate. Losses through control and regulating valves must be added to the other pipe losses to determine the total drop. All copper pipe referred to in these tables is of type L wall thickness and is designated by outside diameter.

The effect of the sizes of refrigerant lines on the system may be studied by referring to the preceding discussion on Characteristics of Compression

Systems. It will be noted that any lowering of the suction pressure at the compressor lowers the capacity. Therefore, excessive pressure drop through the suction piping should be avoided. On the other hand, the suction line must not be made too large when using refrigerants which are soluble in oil, because under such circumstances the velocity of the returning refrigerant may become too low to carry back the entrained oil. Pressure drop in the discharge line also lowers the capacity of the system but not to the same extent as does the pressure drop in the suction line. The velocities of the refrigerant in either suction or discharge lines must not be excessive or noise will result. Velocities of 1000 to 2000 fpm are common in suction lines, and from 2000 to 3500 fpm are used in discharge lines. Velocities in the discharge lines as high as 5000 fpm can only be used where the fittings and bends are all stream-lined as noise will otherwise result.

The pressure drop in the liquid line affects the capacity of the expansion valve as the pressure drop across the valve is reduced by the amount of

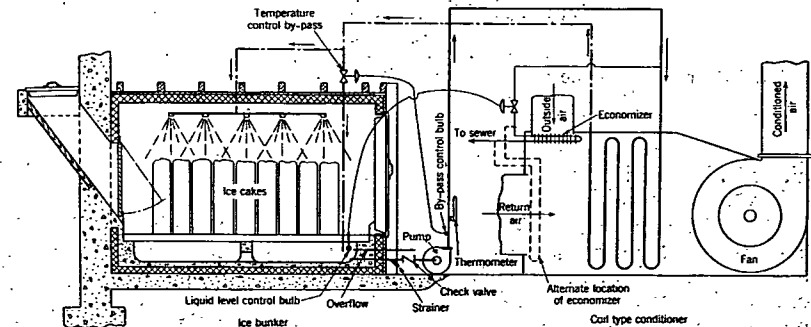


FIG. 9. TYPICAL ICE SYSTEM SHOWING BUNKER DETAILS

the pipe line drop. If the liquid line drop is sufficient to cause flashing (i.e. vaporizing) of some of the liquid refrigerant, a hissing noise in the lines and valves usually develops.

ICE SYSTEMS

Cold water systems using ice as the cooling agent have been installed in many theaters, restaurants, funeral homes, churches and other places where short hours of operation and high peaks of cooling demand make this type of system desirable. A comparatively small quantity of ice in the water cooling tank of such a system can release refrigeration at a relatively rapid rate. For instance, neighborhood theaters having a peak demand of 1,200,000 Btu per hour (100 tons refrigeration) have found 8 ton capacity ice bunkers satisfactory.

In operation, the water in the air conditioning system is circulated over ice placed in an insulated box and is cooled to the 38 or 40 F range or higher if desired. This cold water is pumped from the ice bunker to air cooling coils or spray type air washers. The blowers, coils, air washer or