consists of complete factory-assembled air-cooled condensing units, located in a well-ventilated machine room.

The trend seems to be toward indoor location of the complete condensing units in ventilated machine rooms, due to less complex and lower cost installation. With either of these systems, proper control of condensing pressure must be maintained for winter as well as for summer operation. With outdoor air-cooled condensers, special precautions must be taken to insure satisfactory operation of the refrigeration systems during both summer and winter.

During winter operation, the condensing temperature will be reduced to the point that special precautions are required as follows:

1. When the condensing temperature falls below 90 F, there is insufficient liquid pressure to achieve proper expansion valve operation. Poor expansion valve operation will result in unsatisfactory refrigeration temperature, and possible compressor damage. The recommendations of the manufacturer of the outdoor condensers should be followed.
2. When the compressor operation is controlled by a low-pressure control, during winter operation the suction pressure may not rise to the cut-in point even though the refrigerator requires cooling. This is caused by migration of the refrigerant to the cold condenser during the off-cycle. Here again, the manufacturer's recommendations should be followed to prevent this condition.
3. Sufficiently large liquid receivers should be provided to accommodate the larger than normal refrigerant requirements of outdoor air-cooled condenser systems. The manufacturer of the air-cooled condensers should be consulted for the design refrigerant requirements.

With the complete air-cooled condensing unit located indoors, the main consideration is ample, well-distributed ventilation. For winter operation, the exhaust fans are termostatically controlled. Ventilation requirements will vary depending on maximum summer conditions, but experience has shown that 750 to 1000 cfm per total condensing unit horsepower has given proper results. Exhaust fans should be spaced as evenly as possible for an even distribution of air, allowing one exhaust fan for every 6 to 10 ft of condensing units.

Intake louvers should be of sufficient size to allow an even distribution of air and low air pressure drop. Experience has shown that 1½–2½ sq ft of intake louver area per condensing unit horsepower obtains excellent results.

The machine room air entering the condensers should be maintained as close as possible to 80 F operating temperature during the cooler months. This is necessary to maintain adequate head pressures in winter. In order to accomplish this, thermostatic control of the exhaust fans is required. Gravity operated louvers have been used very successfully, but motor driven louvers are required for colder climates with temperatures below 10 F.

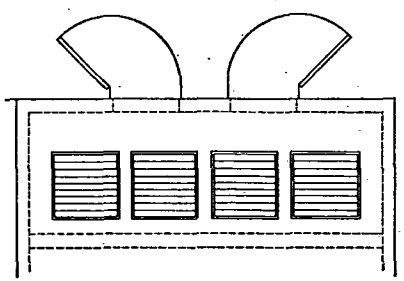


Fig. 3 .... Roof-Top Installation for Exhaust Air

An air baffle should be provided to prevent intake air from being short circuited to the exhaust fans. *The intake air should not be completely baffled to flow only through the condensers because difficulty with both proper winter control and proper summer condenser fan operation will result.*

Ventilation Fans

Ventilation fans will not normally have a capacity equal to the total of all the individual condenser fans. Therefore, if the air is baffled to flow only through the condenser, during maximum ambient temperature the condensers will not receive their full free air volume when all or nearly all the condensing units are in operation. Also, during winter operation, tight baffling of the air-cooled condenser would prevent or complicate the necessary recirculation of condenser air, which is essential to maintaining sufficiently high room temperature and condensing temperature for proper refrigeration system performance.

In Fig. 3 a roof exhaust is used for comparatively low ceilings, and space is provided for future addition of units. Condensing units should usually be placed 24 to 36 in. from the intake opening, with air-cooled condensers facing the louvers or wall opening so they can be easily cleaned. This 24 to 36 in. space also allows the proper distribution of outdoor air to all condensing units during summer operation and an even distribution of recirculated air for winter operation.

The machine room shown in Fig. 2 requires a control system for the louvers and fan.

The louvers are opened and closed gradually, by means of a motor, controlled by a thermostat located in the upper portion of the machine room behind the condensing units. The thermostat is set to start opening the louvers at 70 F and have them completely open at 80 F. As shown, there are two exhaust fans. Each fan is operated by a separate thermostat, located reasonably close to the thermostat controlling the louvers. One fan can be set to turn on at 80 F; the other at 85 F.

For the sequence of control operation during extremely cold winter weather, assume that the outdoor air temperature is 0 F or below, and that the desired machine room temperature is 65 F. As the condensing units cycle, heat is added to the room and the temperature rises. When the temperature reaches 70 F, the thermostat controlling the louvers opens them slowly. Outdoor air will come through the louvers and cool the room without permitting room temperature to rise high enough to start the exhaust fans. During cold weather the louvers will modulate, allowing just enough cold air leakage in the room to maintain the temperature between 70 and 80 F.

The type of control system described is only one of many that can be devised. This control system is planned primarily for climates that have winter temperatures low enough to cause low head pressures. Simpler control systems can be used in areas where low temperatures occur only briefly, or not at all.

Some food stores have utilized the machine room heat for supplementary heating of the storage area. This can be accomplished by a thermostatically controlled louver and exhaust fan, where the louvers close when the machine room temperature falls to 70 F, but open with the fan in operation when the machine room reaches 75 to 78 F. The economics of this heat utilization is questionable since the available heat is at a minimum when it is most needed.

CHAPTER 60

GENERAL COMMERCIAL REFRIGERATION

Application of Commercial Refrigeration; Reach-In Refrigerator Characteristics; Walk-In Coolers: Characteristics, Insulation, Refrigerating Methods; Special Purpose Refrigerators: Florist, Biological, Formula, Blood and Bone Banks, Mortuary; Retail Bakery: Retarders and Freezers, Display Cases; Miscellaneous Applications: Beverage, Candy, Ice Cream and Milk Cooling; Vending Machines; Military Refrigerators

THIS chapter describes a variety of applications of a specialized nature for commercial type of refrigerators and coolers. The two preceding chapters have shown how commercial refrigeration is used in Food Service and Retail Food Store applications.

REACH-IN REFRIGERATORS

The reach-in is considered the most flexible of the commercial refrigerator line. Its high degree of utility has led to a wide variety of applications, and new needs are constantly being developed. When the reach-in has been adapted to a particular function outside the food store or food service operation, it usually is given the appropriate functional designation such as dough retarder, biological refrigerator, etc. It is, however, a member of the reach-in family, with closely similar or even identical characteristics of basic design, material, construction, installation, and operational and servicing needs.

Design Characteristics

When intended for sale to a grocer or other food merchant, the reach-in is usually supplied with glazed display service doors. If for use in an eating establishment, the doors are usually solid; always so when the cabinet is exposed to the direct radiated heat from cooking equipment. An ice cube freezing unit may be part of the interior equipment. If intended for meat storage, the box may be equipped with meat rails and hooks in one compartment; a full-length door; and shelves and racks in the remaining compartments to accommodate butter, eggs, milk, or other perishables. Small food stores may depend entirely on a reach-in unit for refrigerated storage. In larger stores it often supplements the display case.

Reach-in units are made in a wide range of capacities, from 16 to 100 cu ft or more. They are available for unit or remote condensing unit installations.

Wood, aluminum, and steel are used in various combinations. Exteriors are finished in wood, aluminum, and porcelain-on-steel. Interiors of wood, enameled or galvanized sheet steel, aluminum or porcelain are all used. Wall thickness, where wood exterior and interior are used, averages four inches with two inches of insulation, although some cabinets have five-inch walls with three inches of insulation. Some boxes are also supplied with exterior and interior surfaces of stainless steel with frameworks of either metal or wood. All-metal cabinets predominate.

WALK-IN COOLERS

This type of commercial refrigerator as treated here is only the factory-made prefabricated sectional version of the large capacity cooling room. It ranks next to the reach-in type in meeting a wide variety of applications, of which only a few can be indicated here. In general, it may be said that wherever the requirement is one of providing low-cost storage with capacities greater than that of the reach-in refrigerator, this type of commercial refrigerator will be employed.

Design Characteristics

The factory-made walk-in cooler is comprised of standard top, bottom, wall-door and corner sections that are shipped to the user and erected on the job. Each section consists of a rigid, low-heat conductivity frame usually made of odor-free wood coated with a vapor-sealing compound. The frames are filled with insulation and are covered on the inside and outside with metal or odorless wood. The edges of these frames are usually of tongue and groove construction and are fitted with a gasket material to assure a tight vapor seal when assembled. These sections are assembled on the job with either lag screws or hooks operated from the inside of the cooler. The present trend is to manufacture walk-in coolers with coated metal interiors and exteriors, and eliminating floor racks, in order to obtain easier cleaning and lower production costs.

Sectional walk-in coolers are made with three types of bottoms. One is a standard floor, shipped as a section, and usually covered with a non-skid material or floor rack. The second is to use an existing building floor, with or without insulation underneath the building floor. In this case a base sleeper is shipped with the refrigerator. This is fastened to the floor and the walls are then attached to this sleeper. The third type of bottom requires that a pit be provided by the user. The walk-in cooler base sleeper is then applied in the pit, the pit filled with insulation which is covered with concrete. The second and third types of bottom provide a flush sill-less type of fixture which is advantageous when the products to be stored are wheeled in and out of the cooler.

Among the advantages the sectional cooler enjoys over the built-in type is that it is easily erected, easily moved, and, by adding standard sections, can be readily altered to meet changing requirements, uses, or layouts. Also the sectional walk-in cooler can be erected outside a building, providing more refrigerated storage with no expensive building costs