4. When electrical defrost is used, and several display cases are being operated on the same electrical circuit it is advisable to stagger the defrost periods of the cases an hour or more apart to avoid overloading the electrical circuits, unless the wiring has been installed with the total defrost load in mind.

Thermostatic expansion valves for liquid refrigerant control are most widely used in cases being made today. The size of valve to be used is determined by the refrigerant used, Btu per hour load, and operating refrigerant temperature. Most cases are supplied with expansion valves installed at the factory. On low temperature cases it may be necessary to use pressure limiting thermostatic expansion valves. The high pressure created by the heating of the coil for defrost can overload the condensing unit during the pull down period after defrost, where units selected for low temperature application have been used. As an alternate, a crankcase pressure limiting valve may be used. Some self-contained display case models are being equipped with capillary tubes for liquid refrigerant control.

Condensing units are supplied by many manufacturers for their self-contained fixtures. Selection of the proper condensing unit for remote installations is based on the display case manufacturer's load and other operating conditions.

WALK-IN COOLERS

Walk-in coolers are required for the storage of meat, produce, dairy products, frozen food and ice cream, etc. Their number and size depends on the size of the store.

In medium and larger stores, it is desirable to have a separate produce cooler as well as a separate dairy cooler. Meat coolers are used in all food stores with storage conditions being 34 to 36 F. Moisture conditions must be confined to a relatively narrow range, because if too high, bacterial growth, mold, and sliming will be encouraged. If too low, excessive dehydration will occur. Air circulation must be maintained at all times to prevent stagnation, but not so rapid as to cause drying out or *burning*. Forced air blasts must not be permitted

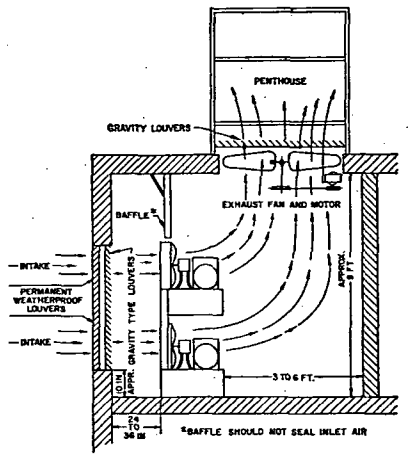

Fig. 2 .... Typical Machine Room Layout

Table 2 .... Minimum Net Liquid Receiver Volume

Hp	Volume Cu In.	Weight—Lb Refrigerant 12	Refrigerant 22
½	150	6.8	6.2
¾	225	10.3	9.3
1	300	13.7	12.4
1½	450	20.5	18.6
2	600	27.4	24.8
3	750	35	32
5	900	41	37
7½	1500	70	64

to strike products. For this reason gravity type coils may be preferred.

All modern markets today require low temperature storage. Some prefer a low temperature walk-in, which is used for all low-temperature storage; others prefer batteries of low temperature reach-ins, individually located, to store frozen foods, frozen meats, ice cream, etc. See Chapter 51, 1961 Guide And Data Book for design, construction and performance data. For the regular frozen food department, low temperature storage capacity equivalent to the cubic feet of low temperature display equipment in the store has been found to be satisfactory. Forced air type coils are generally used for these coolers because humidity tolerance is not critical. Off-cycle defrosts are normally used for produce and dairy coolers. Straight-time or time-initiated pressure terminated defrosts are generally used for meat coolers. For low-temperature coolers both electric heat defrosts and reverse cycle defrosts are being successfully used.

MECHANICAL REFRIGERATION MACHINES

Air-cooled, water-cooled, and evaporative condenser types of refrigeration machines are used for food store application. Due to the ever increasing water shortage, more and more air-cooled condensers are being used. Usually a machine room or *rooms* (Fig. 2) are provided to contain condensing units, electrical controls and sometimes the cooling tower. These rooms should be well ventilated for both water- and air-cooled units. It is suggested that 100 cfm per total horsepower of condensing units should be allowed for proper ventilation of a water-cooled unit machine room.

Liquid Receivers

Because of the long runs of refrigeration lines frequently found in food stores, and the larger than average refrigerant requirements of multiple display cases, it is necessary that the condensing units be equipped with adequately large liquid receivers. Net volumes for liquid receivers as shown in Table 2 have been found to be practical minimums.

Sizing of refrigeration lines, both liquid and suction, are more critical than in the average refrigeration installation because of the typically long horizontal runs and the frequent use of vertical risers. Recommended refrigerant line sizes to assure a full feed of liquid to the expansion valve, and proper suction line oil return to the compressor without excessive pressure drop, are shown in Table 3. Suction lines should be insulated for 50 ft from the display case, unless provision is made to run these lines in an area where sweating will not be objectionable.

Water Cooling Towers

Approximately 30 percent of the supermarkets being installed today are using water-cooled condensing units, although the trend is toward air cooling. Nearly all of these water-cooled condensing units are installed with a water saving cooling tower due to the shortage or cost of water as well inadequate sewage capacity.

Table 3 .... Recommended Copper Refrigerant Line Sizes (Inches)

Hp	Refrigerant 12								Refrigerant 22			
	Normal Temp				Low Temp				Low Temp			
	Liquid		Suction*		Liquid		Suction*		Liquid		Suction*	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
½	⅜	⅜	⅞	⅝								
¾	⅜	⅜	⅞	⅝	⅜	⅜	⅞	⅝				
1	⅜	⅜	1⅛	⅞	⅜	⅜	1⅛	⅞	⅜	⅜	⅞	⅝
1½	⅜	⅜	1⅛	⅞	⅜	⅜	1⅛	⅞	⅜	⅜	⅞	⅝
2	½	⅜	1⅜	1⅛	½	⅜	1⅜	1⅛	⅜	⅜	1⅛	⅞
3	½	⅜	1⅜	1⅜	½	⅜	1⅜	1⅛	½	⅜	1⅛	⅞
5	⅝	½	1⅜	1⅜	⅝	½	1⅝	1⅜	½	½	1⅜	1⅛
7½	⅝	½	2⅛	1⅝	⅝	½	1⅝	1⅜	⅝	½	1⅜	1⅛

* For vertical risers a trap should be provided at the bottom of the riser and minimum line size recommendation followed. Long radius fittings should be used wherever possible to minimize pressure drop.

The application of water cooling towers in conjunction with air conditioning is an entirely different engineering problem from applying towers in conjunction with food store refrigeration, because:

1. Air conditioning is rarely used during the winter months, whereas food store units are used the year around. The special problems of winter operation of food store refrigeration are to maintain discharge or condensing pressure high enough to fully feed the evaporators, and to prevent freezing of the cooling water.
2. In air conditioning applications, the units operate nearly constantly at nearly constant load. Refrigeration units applied to food stores, however, cycle frequently and operate under widely differing cooling water requirements from the beginning to the end of the running cycle. The water requirement just after starting is normally at least four times the requirement just before stopping. The problem of maintaining proper water flow for changing seasonal and continually changing load conditions is far more complex for food store refrigeration than for air conditioning.

The basic purpose of the cooling water is, of course, to control the condensing or head pressure of the refrigeration unit. In order to obtain lowest operation costs, it is desirable to operate at as low a head pressure as is possible. However, if the head pressure is maintained so low that the liquid refrigerant leaving the condenser is cooler than the temperature of the air surrounding the receiver tank or the liquid line, then re-evaporation or *flash gas* will occur. When flash gas occurs, the refrigeration capacity begins to drop, the expansion valve capacity is vastly reduced, and its operation becomes erratic. Erratic valve operation resulting in starved evaporators causes the evaporator to retain oil. Field experience has shown that this has caused many compressor failures. It is of vital importance that no matter what system of controlling condensing water is used, some means must be provided to prevent the head pressure from falling below the refrigerant pressure corresponding to the maximum expected ambient temperature.

Recommended practice is to provide year-around control of condensing pressure through the use of a thermostatic control of the cooling tower fan (the control being set to turn the fan off when the water temperature drops to 70 F) and a properly set condensing pressure-actuated water regulating valve.

Valve Settings

The water valves should be set to maintain the discharge pressures above the saturation pressure of the refrigerant corresponding to summer machine room temperatures. As an example, if the summer machine room temperature is 100 F, Refrigerant 12 units should have their water valves set for 117 psig or higher; Refrigerant 22 units should have their valves set for 200 psig.

The use of properly sized water regulating valves will not cause excessive pressure drop and reduced water flow. Experience shows that the normal water valve pressure drop should be below 3 psi. The water regulating valve will automatically vary the amount of water required to provide the desired condensing pressure under all load and under all seasonal conditions, thereby giving maximum year-around economy of operation.

Cooling water problems may be classified in the order of their severity as scaling, corrosion, cooling tower wood deterioration, and fouling by growths of algae and slimes. Numerous treatments have been devised, but often a treatment for a specific condition may aggravate or even create another of the unfavorable conditions noted. For example, cooling water softened by cation exchange usually solves the scaling problem, but then gives rise to wood deterioration as a result of the highly alkaline water produced. On the other hand, if sulfuric acid is used to prevent scaling and to avoid high alkalinities, the corrosion problem may become severe. Proper bleed-off and regular water treatment is required to insure the satisfactory performance and full life of the cooling towers, condensers, water pumps and piping. Specialists in this field of water treatment should be consulted, because each locality has different water and atmospheric conditions.

Air-Cooled Condensers

Air-cooled condenser type condensing units are gaining popularity for food store refrigeration as well as for air conditioning. Their relative freedom from continuous, regular maintenance is one factor in their increasing popularity. This type of unit is used in two major variations:

1. *Remote air-cooled condenser type.* This type of system usually has the air-cooled condensers outdoors, while the compressors and controls for the condensing units are located indoors in a machine room.
2. *Complete air-cooled condensing units.* This type of system