tive vapor seal on the warm side, and the cold side should be protected more for air permeation than vapor permeation for proper protection of the insulation. The insulating material is filled into the slots formed by the curtain wall and the partition wall erected at the edge of the floor slab between the floor and ceiling. This partition wall is generally constructed of brick and plastered with cement mortar on the room side. The loose insulating material must be carefully rammed down to prevent excessive settling, creating voids.

The inner face of the curtain wall should be water-proofed to avoid infiltration of moisture, as far as possible. The chief objection to this type of structure is the large space taken up by the partition walls and the loose insulating material. For equal heat leakage, the thickness of loose material used must be somewhat greater than the thickness of, for instance, sheet cork insulation.

In buildings of more than about six stories in height, vertical expansion joints must be provided to allow for the unequal expansion and contraction. Moreover, fire walls and cut-offs are required between the various sections of the building, and also between the shipping floor and the cold storage space, to reduce fire hazard.

Insulated warehouse construction is shown in Fig. 4. The building design used is that of the usual fireproof warehouse, insulated as well as possible. A comparison of the designs outlined leaves no doubt that the curtain wall construction lends itself best for an economical application of the insulating materials, and offers fewer weak points in the insulation against the inflow of heat and moisture.

A disadvantage of the insulated warehouse type of construction is that where the wall insulation meets a floor, it must be carried out over the floor in a sealing strip, and a wearing surface put above it. This requires a heavier structure for an equal live load and wastes space, as the floor thickness is increased by at least 7 in. However, even in a curtain wall type of a multi-story building, it is usually necessary to divide the building vertically into several sections by means of floor insulation in order to meet varying temperature requirements, so that the above objections do not apply exclusively to the conventional warehouse type of structure.

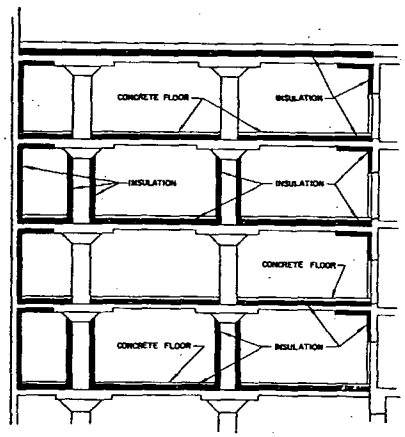

Fig. 4 .... Cold Storage Warehouse Construction

In buildings of the curtain wall type, unbroken layers of insulating material may be found on walls from 50 to 100 ft or more high. Such height of unsupported insulation will give trouble unless it is braced at every floor, either by corbeling out the curtain wall, or, where this is not feasible, by providing a horizontal wooden or steel rail against the wall side of the insulation, securing this rail to the curtain walls by anchors or bolts.

Comparing the structures of Figs. 3 and 4 for a cold storage of 1,000,000 net cu ft, the gross volume is 1,250,000 cu ft for the curtain wall types; and 1,312,500 cu ft for the warehouse type, or an increase of 5 percent. On a basis of one-half freezer and one-half cooler space, proper insulation requires about 535,000 board feet with curtain wall construction and about 840,000 board feet with the warehouse construction. Including the concrete wearing surface on top of the insulation in warehouse type, the cost of insulating is approximately twice as great as for the curtain wall type. However, since a certain amount of insulation is usually required between various floors even in a curtain wall type of building, the difference in insulation cost is probably not as great as it might first appear.

ROOF CONSTRUCTION

An effective *flashing* for roofing against parapet walls must be provided. It is necessary to make the lap of the flashing at least 9 to 12 in. deep. For added safety, one should waterproof all the interior and exterior exposed surfaces of the parapet walls. In any cold storage building, leakage at this point will cause serious damage to the insulation. In large rooms, contraction and expansion of the building structure make this point of joining wall and ceiling insulation a critical one. Where local building codes allow, it is better to omit parapet walls and carry roofing over the side to be flashed to gutters hung on the building wall.

The roofing, when applied directly on the insulation, has introduced problems of maintenance because of the possibility of entrapped moisture. It is advisable to consider the roofing material as the only vapor barrier and provide venting through the insulation and supporting roof deck so that any moisture under the roofing can vent downward into the refrigerated space below.

FLOOR CONSTRUCTION

Many buildings have been constructed without the use of floor insulation and some appear to be operating without difficulty. However, the possibilities of failure are so great that the practice cannot be generally recommended.

A properly designed pipe grid system, in which a nonfreeze fluid is recirculated in the pipes, has been proven economical and practicable. Because of the nonfreeze protection, the floor insulation can be reduced to 4 in. This saving in insulation is greater than the initial cost of the floor grid system. The under-floor system will retain the soil or fill at a temperature not lower than 32 F. The earth provides an upward flow of heat of about 1.3 Btu per hour. The heat flow through the insulated floor varies with the thickness of the insulation which can be calculated. This is usually greater than the upward flow from the soil so the difference is provided by the pipe grid system with circulation of a nonfreeze solution which obtains heat from an exchanger in the refrigeration cycle or an exchanger warmed by condenser water.

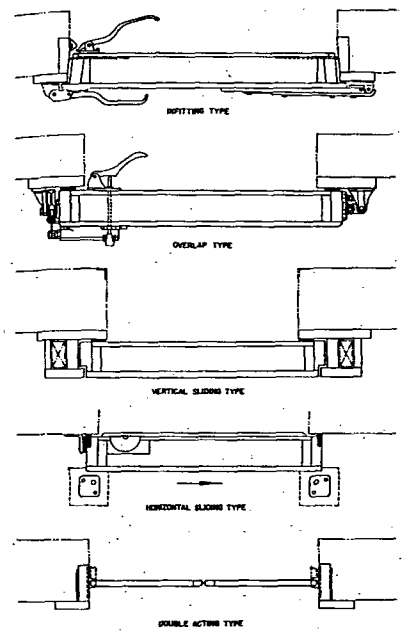

Fig. 5 .... Cold Storage Doors

Air flues running through the fill have also been used for warming the under-floor soil. The dependable protection of this system is debatable unless positive air circulation is induced in the ducts and the ducts are screened to prevent birds and rodents from closing the air passages with nests. A further objection in food plants is the possibility of insects infesting the ducts and other sources of contamination.

COLD STORAGE DOORS

The type and usage of cold storage doors for cold storage plants has generally changed as the practice of lift truck operation and palletized storage has gained acceptance.

The trend is to use fewer doors of more refined development with resultant higher costs. The doors are often of the automatic type with electric heated gaskets and necessary safety devices.

Frequently, short vestibules are used in combination with warming pipes or electric heaters in the floor wearing slabs, to avoid floor ice and water, a hazard in all forms of traffic.

The selection and application of cold storage doors are a fundamental part of cold storage warehouse design since this selection has a strong bearing on the overall economy of warehouse operation. The importance of the proper selection cannot be overemphasized. Manufacturers offer all types supplied with the proper thickness of insulation for the use intended. Doors used only for personnel cause few problems. In general, a personnel door 3 ft wide by 6½ ft high of one of the basic types, designed for the temperatures and humidity involved, is entirely adequate.

The proper selection for use in heavy traffic doorways should provide:

1. Maximum traffic capacity.
2. Minimum loss of refrigeration.
3. Minimum maintenance.

The achievement of these goals has led to the use of fewer but more efficient doors, which are larger and motor operated. This is being done not only in new construction but also in the renovation of older buildings.

Five basic types of doors are shown in Fig. 5.

Swing or slide. A door with hinges on the right hand side, when facing the side on which the operating hardware is mounted, is right hand swing. If a door slides to the right to open, it is a right slide door. Left hand is the reverse in either case.

Metal or plastic cladding. Modern usage requires the maintenance of the thermal efficiency of any door by light metal cladding or the use of a reinforced plastic skin. Areas of abuse must be further protected by heavy metal, either partial or full height.

Heat. To prevent ice formation with subsequent faulty door operation, doors are available with provision of automatic electrical heat not only in the sides, head and sill of door or door frame but also in switches and cover hoods of power operated units. The use of such heating elements is a necessity on all four edges of double acting doors in low temperature rooms. Care should be exercised to use safe devices meeting electrical codes or having underwriter's marker.

Floor guards and bumpers. The use of power operated doors makes it mandatory that complete abuse protection be provided. Bumpers embedded in the floor back and front of the wall and on each side of the passageway are invaluable in preserving the life of the door. Floor guards placed correctly protect sliding doors from traffic damage. Typical protection is illustrated in Fig. 6.

Buck and anchorages. It is impossible to get good operation without good buck provisions. The recommendations of the door manufacturers should be coordinated with the wall construction by the engineer.

Door size. A hinged insulated door opening should provide at least 12 in. clearance on both sides of a pallet. Thus 6 ft should be the minimum size for a 48 in. pallet load. Double-acting doors should be 8 ft in width. Specific conditions at a particular doorway can require variations from this recommendation. See Fig. 6. There is a growing tendency to use 10 ft as the standard height in order to accommodate all varieties of high stacking lift trucks.

Sill. The most frequently used, and most feasible, sill is concrete to minimize the rise at the door sill. A thermal break should be provided in the floor slab at or near plane of front of wall.

Power doors. Modern warehouse design and usage dictates the selection of horizontal sliding doors when electric operation is provided. The fastest operation, and safest design, is the two leaf bi-parting unit, which reduces opening and closing time to a minimum. Since leading edges of both leaves are equipped with safety edges, maximum protection is provided for personnel, doors, trucks and product. The door is out of the way when open, and can be given ideal protection from damage at all times.