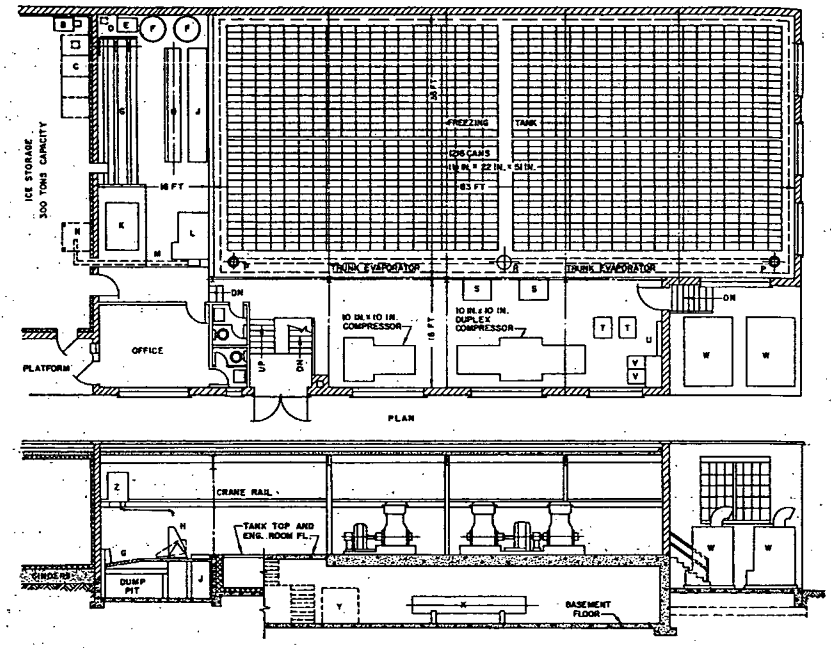

B. *Ice crusher* C. *Sized ice bin* D. *Snow chute* E. *Core pump* F. *Filters* G. *Dump conveyor* H. *Can dump* J. *Dip tank* K. *Scoring machine* L. *Ice cube machine* M. *Cube conveyor* N. *Cube bin* P. *Agitators* R. *Accumulator* S. *Blowers* T. *M-G Sets* U. *Panel board* V. *Starting panels* W. *Evaporative condensers* X. *Ammonia receiver*

Fig. 5 .... Ice Plant Layout

tons daily capacity it is usual for one man on the shift to operate the plant in this same manner, except that he gets some help from a day operator who assists in all duties, particularly for core pumping, filling, scoring and plant maintenance. The arrangement of the plant equipment and its design is important to enable accomplishing these ends without hardship. The type of equipment used, the convenient proximity of all equipment in a small level area, and mechanical assists from conveyors, are all important (Fig. 5).

The use of automatic controls and alarm devices in the plant promote economy and safety. The controls consist of high and low pressure alarms or controls, ammonia flow or level controls, high side liquid seals, alarms on motor starters, oil pressure lines, and bearings; and agitator stoppage alarms.

WATER TREATMENTS

Can water supplies should be filtered in open wood or steel pressure-type *sand* or *quartz filters.* All water lines must be galvanized. Periodic soaking and washing of the whole filtering and water line system with heavy soda ash treatment is a salutary method for cleaning and removing discoloration causes in the ice and serves for unknown reasons as an inhibitor against their recurrence for a time.

Water treatment to render water more suitable for ice quality freezing must frequently be used. Undesirable water qualities can result in ice poor as to color, residues, and tendencies to shatter or crack. All water should be analyzed to determine the benefits of treatment. Water treatment may make agitation unnecessary, or permit freezing at faster rates with extremely cold brines, or both.

REFRIGERATION EQUIPMENT

Single-acting, vertical ammonia compressors are more commonly used in modern plants because they require less operating attention, particularly on lubrication and shaft packing glands, than horizontal types. They are less costly when under 75 ton unit size, occupy less floor area, and require minimum foundations. They possess no advantages over horizontal machines as to pumping efficiency, when both types are fitted with adequate valve areas.

Clearance and capacity control is an essential for economic performance. In lieu of this control the removal of the suction valves from one cylinder will effect a capacity control by that amount; mechanical balance is not affected and rarely electric balance in high speed units.

Condensers finding greatest usage in ice plants are shell-and-tube of both vertical open and horizontal multi-pass types. Next in order are tubular multi-shell, atmospheric pipe and double-pipe types. Shell-and-tube types are usually proportioned upon a basis of 7 to 10 sq ft of surface per ton of refrigeration.

Evaporative condensers are coming into greater use, but means must be provided to treat the water against scale formation and algae growth. They must be kept well purged and be connected in a manner to insure against their bottling up when arranged in parallel operation. Inherent in them is the tendency to bottle up liquid.

Condensing water supplies are in general secured from *spray cooling ponds,* natural and *mechanical draft towers,* streams and shallow or deep wells. The use of wells is difficult to justify when the pumping power requirements exceed $^1/_7$ hp per ton of maximum daily ice production and the need for spray ponds or towers is indicated.

With spray ponds it appears most economical to operate on a 5 F deg cooling range with a 6 F approach to the summer wet bulb. With natural draft and fan towers, 7½ to 10 F cooling ranges, with a 3 to 4 F deg approach to the wet bulb, are most practical. The use of fan towers, preferably of the induced type, insures tower performance, whether of the filled or spray type, during the worst summer conditions of high humidity and air stillness. Practice indicates that a plant operates best with a single pump for summer duty, and another of half that capacity, for winter service. With ponds or towers, pumping heads should not exceed 50 to 55 ft.

Water capacity, refrigerating load and the water temperature rise through the condensers bear the approximate relationship of 30 gal degrees per ton of refrigeration. A determination of two of the three factors readily establishes the third:

$$\frac{(g)\ (R)}{30} = T$$

where

g = rate of water circulation, gallons per minute.

R = temperature difference between water entering and leaving the condenser, Fahrenheit degrees.

T = load, tons of refrigeration.

The constant 30 is based upon 250 Btu being abstracted from the condenser per ton of refrigeration. While an approximation reasonably close for average ice plant operating conditions, a closer determination of the heat abstracted by the condenser can be secured from the *ammonia Mollier chart* covering the actual operating pressures.

PLANT ECONOMIES

In general, well designed simple compression plants of 12 cans per ton and 70 F initial can water, will provide ice at 50 kwh per ton for low pressure air systems, as against 53 with high pressure systems. Winter operation reflects a similar comparison of 40 and 45 kwh per ton. The maximum kw demand in low pressure plants will lie between 2.0 and 2.3, and for high pressure plants between 2.3 and 2.5. The power for auxiliaries in low pressure plants will be about 15 percent of the total power consumption as against 19 percent for high pressure plants.

Power consumption will include a day storage of four to six times the maximum daily capacity with some ice stacked or tiered. Power for scoring ice, cubing and sizing is not included.

Two back-pressure operations will effect additional economics of about 6 kwh per ton in summer and 3 to 4 kwh per ton in winter.

Compound operation, together with high back pressure operation, may effect economies over simple compression of 10 to 12 kwh per ton for summer operation and 6 to 7 kwh per ton in winter. The justification for compound compression is determined by comparisons involving factors of plant size, investment, power rates, seasonal load factors and labor rates.

ICE STORAGES

Day storages should accommodate the full production for 3 days with ice held on end, based upon 13 sq ft per ton. When added storage is required, provisions for stacking on edge up to 6 cakes high, with a portable tiering machine, is practicable. The minimum storage height to allow below ceiling coils is 7 ft.

Where more storage is desirable, season storages are built adjacent to the day storage at the same or lower floor level. The day storage in such instance can be halved in size. For best operation season storages should be limited to 30 ft height. Whole ice cakes are stored on edge with the first layer held off the floor, preferably on 3 × 6 in. timbers on edge, two under each ice cake. This arrangement promotes cold air circulation over the floor. Ice is stored at least 8 in. from the side walls, cake to cake whether scored or unscored. If the floor area is extensive, it is practical to allow a spacing lane of at least 8 in. for air circulation on the column center line up through the stack. Ice is preferably stacked to such a height as to leave a clearance of not less than 2 ft under the ceiling coils. The storage capacity of a room is based on 50 sq ft per ton for the entire room content volume. This allowance usually provides ample air circulating clearances, elevator area and space for cooling coils.

Insulation in day storages and season storages is based upon maintaining a 24 to 28 F room temperature.

Direct expansion piping using 2 in. pipes on 10 and 12 in. centers is usual for cooling. With suction pressure of 22 psig ammonia, 1 ft of 2 in. pipe per 18 to 22 cu ft of storage volume is usual. The coils are divided over the ceiling area in flat banks with one expansion valve for 800 to 1200 lineal ft of coil. Control of the coils by thermostatic expansion valves is desirable. It is advisable to keep the coils within 30 in. of the roof deck in order to prevent ceiling sweat and drip. In very large season storages, 2000 to 8000 ton capacity, the coils frequently are arranged in double tiers with 8 to 10 pipe-high coils along the walls near the ceiling. In some arrangements the ceiling coils are connected to a horizontal large diameter accumulator for flooded float valve controlled operation.

It is advisable to provide *hot* gas connections to all storage coils for defrosting. A ½ in. line from the top of the receiver will suffice in most instances. A refrigerant charging connection in the storage room liquid feed line is convenient.

When the storage suction is on the main plant suction, it is necessary to hold the plant suction down to insure proper storage refrigeration. This is an expensive operation at times when ice can conveniently be made at high suctions, or when the plant compressors could otherwise be shut down. For these reasons an independent condensing unit is a good investment. With an independent unit, a single coil or large accumulator type evaporator, the high side float control is nearly ideal.

In large day storages the use of a chain conveyor to carry stored ice to the loading platform is imperative. In season storages a 5 to 8-cake capacity freight elevator has advan-