electrically operated equipment, which may remain inactive during periods while in port when heating to about 50 F will be required.

Storerooms and Cargo Spaces

The ventilation provided for these spaces depends on the type of vessel, location of space, and nature of cargo.

Ventilation is required for all closed spaces. Even if ventilation is not necessary to preserve the stores or cargo, it is required to prevent the accumulation of toxic or combustible gases and odors. One air change in 15 to 30 min is common practice, except where inflammable liquids or proximity to hot spaces requires additional ventilation. Mechanical supply and natural exhaust are usually used. However, where inflammable gases may exist, natural supply and mechanical exhaust are provided.

Many ships are fitted with dehumidification facilities for eliminating damage to the dry cargo by preventing condensation and dampness. The dehumidification load consists of moisture removed from the ventilation air passed through the dehumidifier, plus the moisture on, or given off by, the cargo, packaging, dunnage, battens, and other materials in the ship's holds. The most severe outside condition requires a moisture removal of 90 grains (140–50) per pound of dry air, with 88 F cooling water. The largest cargo ships are provided with equipment for removing about 250 lb of water per hour.

The dehumidification systems generally utilize silica gel or lithium chloride with inhibitor. (See Chapter 37). In most cases central drying equipment is provided. On large passenger ships consideration is given to the use of two dehumidifying units, because the cargo-carrying spaces are usually concentrated at the extreme ends of the vessel. A simple duct system distributes the dry air to the hold supply ventilation system. These ventilation systems use outside air when weather conditions are favorable. Recirculation and dehumidification are used only when necessary, *i.e.*, when the weather dew-point approaches or exceeds the temperature in the hold. Two control stations are generally provided, one in machinery space and one in chart or wheelhouse. These stations are arranged so that either may change the cargo conditioning system controls from use of outside air to use of conditioned air.

AIR CONDITIONED SPACE TREATMENT FOR SHIPS

The application of air conditioning to new American passenger ships is well established. All passenger staterooms, except steerage and third class, are usually air conditioned. This includes staterooms for ship's personnel and offices within conditioned passenger areas. Third class staterooms are air conditioned on some ships, depending on the particular trade. Theaters, lounges, smoking rooms, beauty shops, barber shops and similar closed public spaces are usually air conditioned.

All messrooms, recreation rooms, officers' offices, crew's inboard rooms, and those having fixed portlights are usually air conditioned on passenger vessels. The treatment depends on the requirements of the operator and the proposed itinerary of the vessel.

SHIP SYSTEMS AND CONTROLS

The types of comfort conditioning systems used to date generally have followed conventional lines, except for those serving staterooms, offices, and similar small spaces. Large public spaces are fitted with individual

systems which supply dehumidified and cooled air during the cooling cycle, and warm air during the heating cycle. In many cases these rooms are fitted with large glass windows and doors, and require direct radiation to offset the downdraft which would occur in cold weather. Finned-tube radiation running the full length of the glass area is commonly used for this purpose. Introduction of warm air at the sill, in lieu of direct radiation, is also used.

Systems serving most public spaces are designed to provide all outside air as long as the refrigeration load is less than the capacity of the cooling equipment. Many central systems are simplified by using 100 percent outside air all-year-round. The important problem in ship air conditioning concerns the treatment of the small spaces such as passenger staterooms, offices, and crew quarters. Low headroom, congested quarters, double berths, and unsymmetric arrangements make each space a problem in air distribution and treatment.

The simplest system used for small spaces consists of a central filter bank, supply fan, preheater, and cooling and dehumidifying coil. The preheater steam valve and cooling coil water valve are controlled in sequence by a duct thermostat, in the fan discharge, set to maintain a constant outlet air temperature. Zone reheaters are provided to take care of variations in heating loads. The reheater steam valve is controlled by a sub-master thermostat at the reheater outlet. Control of room temperature is obtained by operating manual dampers in the air supply to the space. A recirculation exhaust fan is frequently provided, and operates in conjunction with automatic dampers to utilize the maximum quantity of outside air consistent with capacity of the cooling coils.

One system utilizes the same central supply equipment and recirculation exhaust system as the one just described, except that zone reheaters are replaced by individual space hot water reheaters. Each reheater is provided with a control valve, controlled by room thermostat. Generally, a forced circulation single pipe hot water system is used. This system is generally used for staterooms and small spaces devoted to first and second class passengers. The average total air per person is about 60 cfm, and average outside air per person is about 18 cfm.

A third system, used to a limited extent, is similar to the system just described, except that each room is provided with an induction unit (floor type where possible) which reheats the primary air supply. Control of heating coil in the induction unit is the same as noted for the system described in the previous paragraph. The average primary air supply is about 40 cfm per person. Recirculation is not always used. The amount of induced air varies with unit design.

A fourth less common arrangement is similar, but makes use of hot water in the induction unit in winter and cold water in the induction unit in summer. Control of the valve on the unit is obtained by use of a summer-winter type thermostat. The unit is provided with drip pan and drain piping to remove condensation. No recirculation is used.

On cargo ships, tankers and vessels not carrying passengers or not having air conditioning, heating of crews' spaces and officers' staterooms is usually obtained through a central system having filters, preheaters and reheaters. A minimum temperature of air leaving the preheater is controlled by a duct thermostat. The reheater is controlled by a sub-master discharge-duct thermostat, reset by outside master control. Relationship between sub-master and master control (wherein discharge temperature is raised as