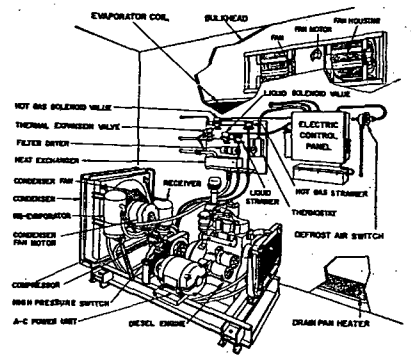

Fig. 4 .... Typical Refrigeration Components for Mechanical Refrigerator Cars

An electric control panel is usually provided and contains motor starters, control relays, time delay relay, and the necessary fuse and terminal blocks for the system. It may also have a heating contactor for the evaporator coil heaters and pilot lights to indicate whether the system is operating in the *cool* or *defrost* cycle. A motor starting control panel and an electric temperature control which controls the operation of the refrigeration equipment are also provided. The temperature controller is actuated by a thermostat bulb located in the return air stream and operates the system to provide either refrigeration or heating.

The elaborate electronic type thermostat is giving way to a simpler, more durable mechanical type which operates independently of an electric power source and hence is less subject to purely electrical failures.[10]

The defrost cycle is usually controlled by an automatic timer or by a defrost air switch (which is energized when the differential air pressure across the evaporator coil reaches a predetermined value) and is terminated by a thermostat which limits the coil temperature.

The electric-drive mechanical refrigeration systems are equipped with a plug-receptacle which makes it possible to shut the engine down and operate the system from a standby electric power source. Standby operation has been used while correcting engine difficulties and where the engine noise or exhaust fumes might be objectionable.

Fuel for the internal combustion engine is usually carried in two interconnected fuel tanks located under the car floor. The total fuel tank capacity for diesel engine driven systems varies from 300 to 650 gal with nearly 90 percent of the mechanical cars having 400 to 500 gal. For the systems having spark ignition engines, two tanks having a total capacity of 130 gal are used with diesel fuel and a single tank of about 180 gal capacity (located in the machinery compartment end of the car) is used with propane fuel.

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CHAPTER 57

MARINE AND AIR TRANSPORT

MARINE CARGO REFRIGERATION: Built-In Refrigerators, Refrigeration System, Components, Distribution of Refrigeration, Specifications, Load Calculations, Container Vans; REFRIGERATED SHIP'S STORES: Commodity and Storage Areas, Design Fundamentals, Construction, Methods of Refrigeration, Inland Water and Harbor Vessels; FISHING BOATS: American Practice, Refrigeration with Ice, Mechanical Refrigeration, Tuna Seiners, Tuna Clippers, Mother Ships and Factory Vessels; AIR TRANSPORT: Air Cargo, Equipment and Cargo Volume, Perishable Commodity Requirements, Ground Handling, Transit Refrigeration

THIS chapter will discuss the use of refrigeration in: (1) marine cargo transport, (2) ship's stores, (3) fishing boats, and (4) air transport.

PART I: MARINE CARGO REFRIGERATION

To offset increased costs and lowered production at marine terminals, the shipping industry has developed new methods of handling cargo. Principally, the increased use of various sizes of cargo containers has effected savings, mostly by providing quicker turn-about of the vessels.

Containerization of cargo is affected by many variables, including length of voyage, usability of containers on homebound voyages, sequence of ports-of-call, and availability of handling facilities on shore. Some dry cargo cannot be handled in containers due to weight and dimensional limitations. However, most refrigerated cargo can be containerized, within the limits imposed by the variables. The need for controlled atmospheric environments for perishable produce imposes additional limitations over those for dry cargo.

By economic analyses, demonstration, and the testing of traffic and labor tolerances, the shipping industry is determining the extent to which containerization can be applied.

A few companies have utilized containers for refrigerated cargo where returns appeared favorable, but it is the consensus that much development work is yet to be done. There will never be a total displacement of the ship's built-in cargo refrigerator for such services as that provided by passenger ships, logistic supply ships, the all-refrigerated fruit carrier, and special service vessels, which will continue to require the insulation and refrigeration of the principal structural compartments of a ship. Containers may be carried within a ship's refrigerated hold.

In view of the fact that containerized services as well as the break-bulk or individual package type of operation must be accommodated, this section will discuss the physical and mechanical aspects of both types of facilities.

Mechanical refrigeration had its beginning on board ship, and the early concept involved dry-bulb temperature considerations only, with little information on optimum storage conditions for perishables. The subsequent development of criteria for cold storage by warehouse operators and food technologists has now made such guides available to the marine carrier. The shipping industry has been slow to retreat from the dry-bulb temperature concept. Typical specifications prepared by naval architects and design agencies have required a trial trip demonstration of carrying temperatures in empty rooms. Usual precedure calls for an observation of temperature rise with idle machinery and little regard to the climatic or seasonal environment of the vessel during the test. There has been no requirement for heat exchange apparatus characteristics which will produce desirable high relative humidities. On the contrary, there has developed the concept that marine transport is an interim operation likened to that of highway transport. Marine transport is basically an interim operation between pre-shipment storage of indeterminate duration and early distribution at destination ports, but frequently the voyage period is equal to or even exceeds the full high quality life of many perishables being transported. Good design therefore requires that the shoreside criteria be applied to the floating cold storage plant. The specifications and design should call for characteristics of facilities that will approach these criteria under typical conditions at sea.

New guides are being formulated for frozen foods in the form of codes with which American ships in intra-state services may have to comply. The frozen food industry and representatives of governmental agencies have sought to eliminate faulty distribution practices by such codes. They will demand zero *product* temperatures in transport, a condition not easily attained by the facilities that in the past have been considered adequate for marine services. Even though the shipping industry may not be affected directly by these codes, such standards will be expected from the ships by the shipper and consignee.

BUILT-IN REFRIGERATORS

Arrangement and Utility

The location and arrangement of the compartments within the hull, as well as the subdivision of the insulated enclosures, should reflect, if possible, the trade in which the vessel will serve. The volume of trade, the scheduling of ports of call, and the efficient and speedy handling of produce with minimum exposures are all factors that will influence these arrangements.

The arrangement should allow perishables to be the last cargo loaded and the first to be discharged.

Limitations of dimension and arrangement will be found in