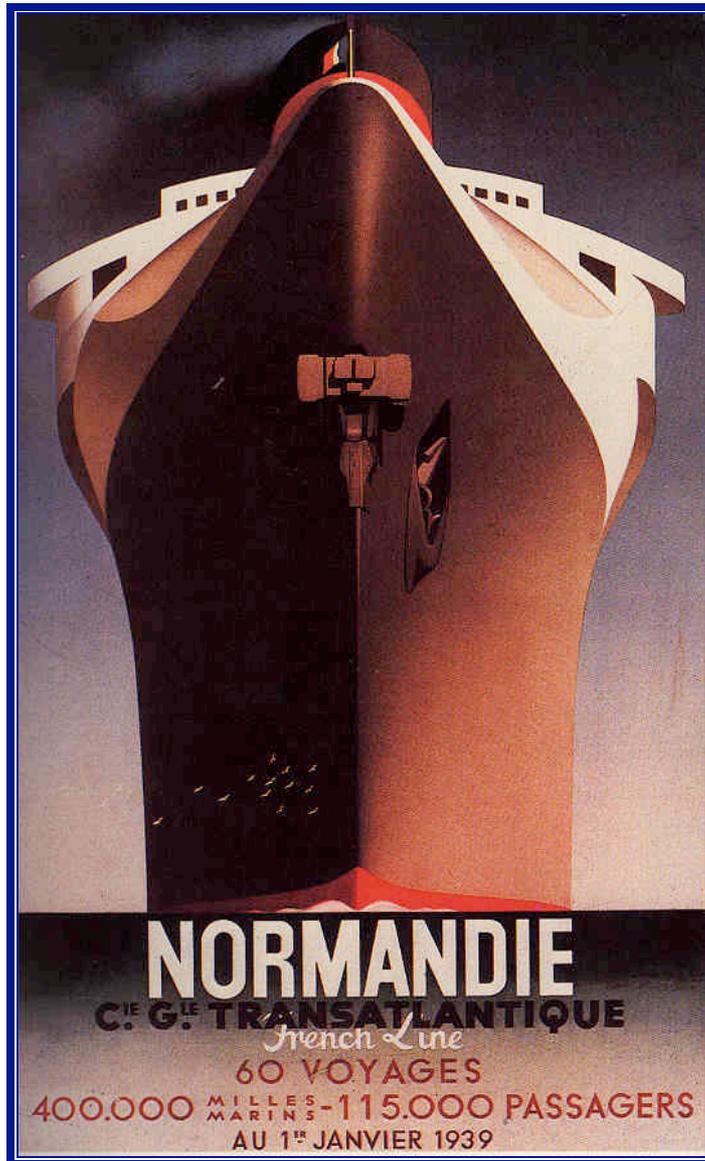


MARINE AIR CONDITIONING



From Carrier Engineering Company
Documents in the Heritage Group Collection

The text is taken from Section 3.5 of
the electronic book “Manufacturing the Weather”
available on this web site

MARINE AIR CONDITIONING

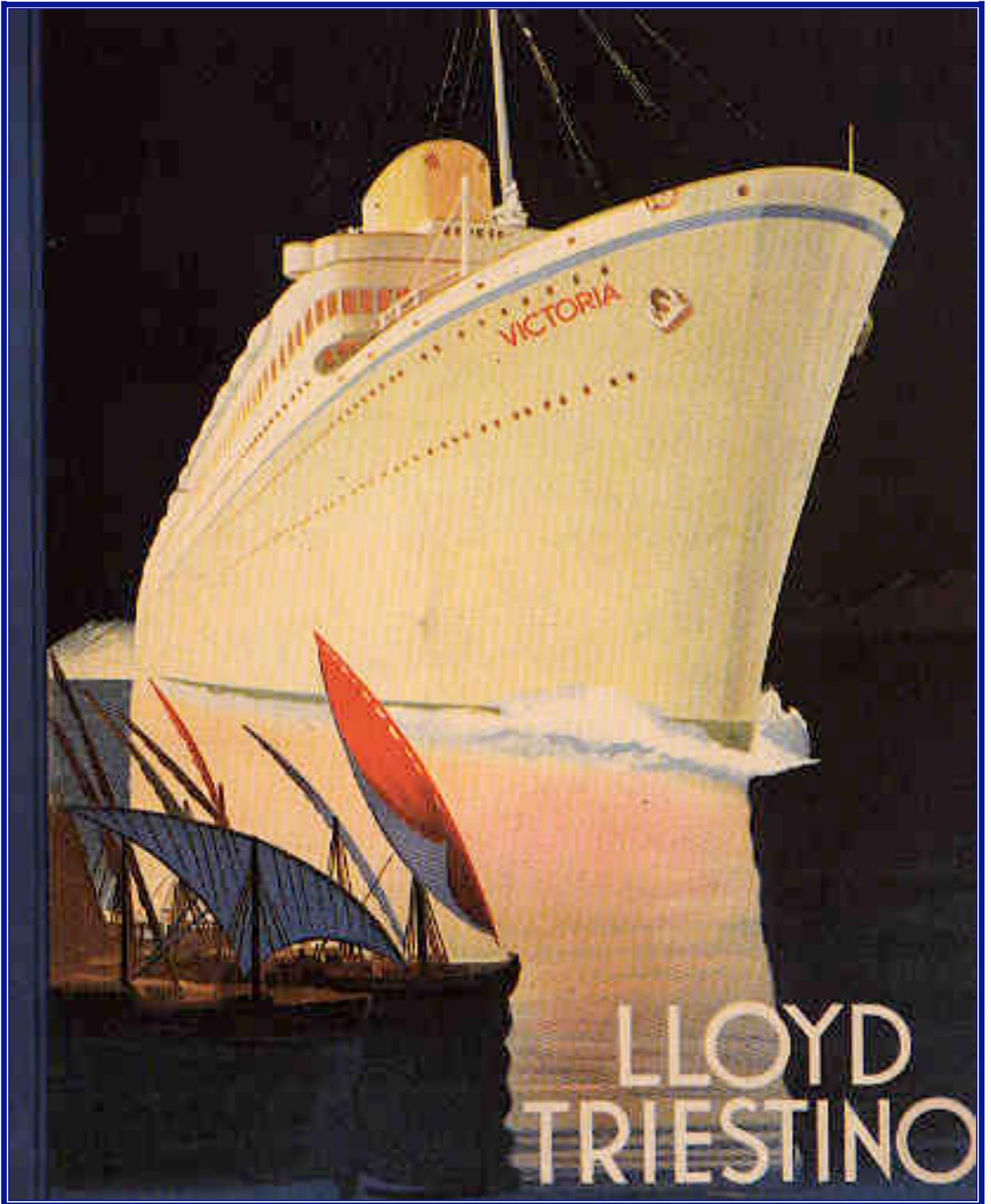
The artificial ventilation of ships can be traced back to the use of bellows in the 1740s by Sir Martin Triewald in Sweden and then by the Rev Stephen Hales in England. It has been reported that Dr John Gorrie of Florida attempted to use his cold air machine for shipboard refrigeration around 1873 but was unsuccessful. Whether or not this was for space cooling is unclear. Refrigeration on ships was initially used to keep cargoes of meat chilled on long voyages, This was attempted from about 1875, but the first real success is usually attributed to the system on the SS "Strathleven" in 1880, using a Bell-Colman cold air machine [11/175]. From the 1890s, elaborate mechanical ventilation systems came into use for passenger comfort. In 1908, the Thermotank Ventilating Company of Glasgow provided elaborate heating and ventilating systems on the "Lusitania" and "Mauretania" [11/527]. Similar systems became commonplace on new luxury liners.

Early in 1924, Willis Carrier adapted his centrifugal refrigerating machine for use in the engine room of the American Navy warship USS "Arkanas". As a precaution, in a confined space, he intended the use of trichloroethylene as the refrigerant, rather than dielene. This was approved by the Navy and the machine was duly built, but the Navy decided it should be installed in the USS "Wyoming." This special 2-stage unit of 95 TR, installed in late 1925, became the first ship equipped with a centrifugal refrigerating machine. But Willis Carrier wanted a more suitable refrigerant and in 1926 he filed patent claims using methylene chloride as a refrigerant, and gave it the name "Carrene." This refrigerant doubled the cooling capacity of the existing centrifugal (doubling the horsepower also) and greatly improved its competitiveness against reciprocating machines [FAC, 74-5]

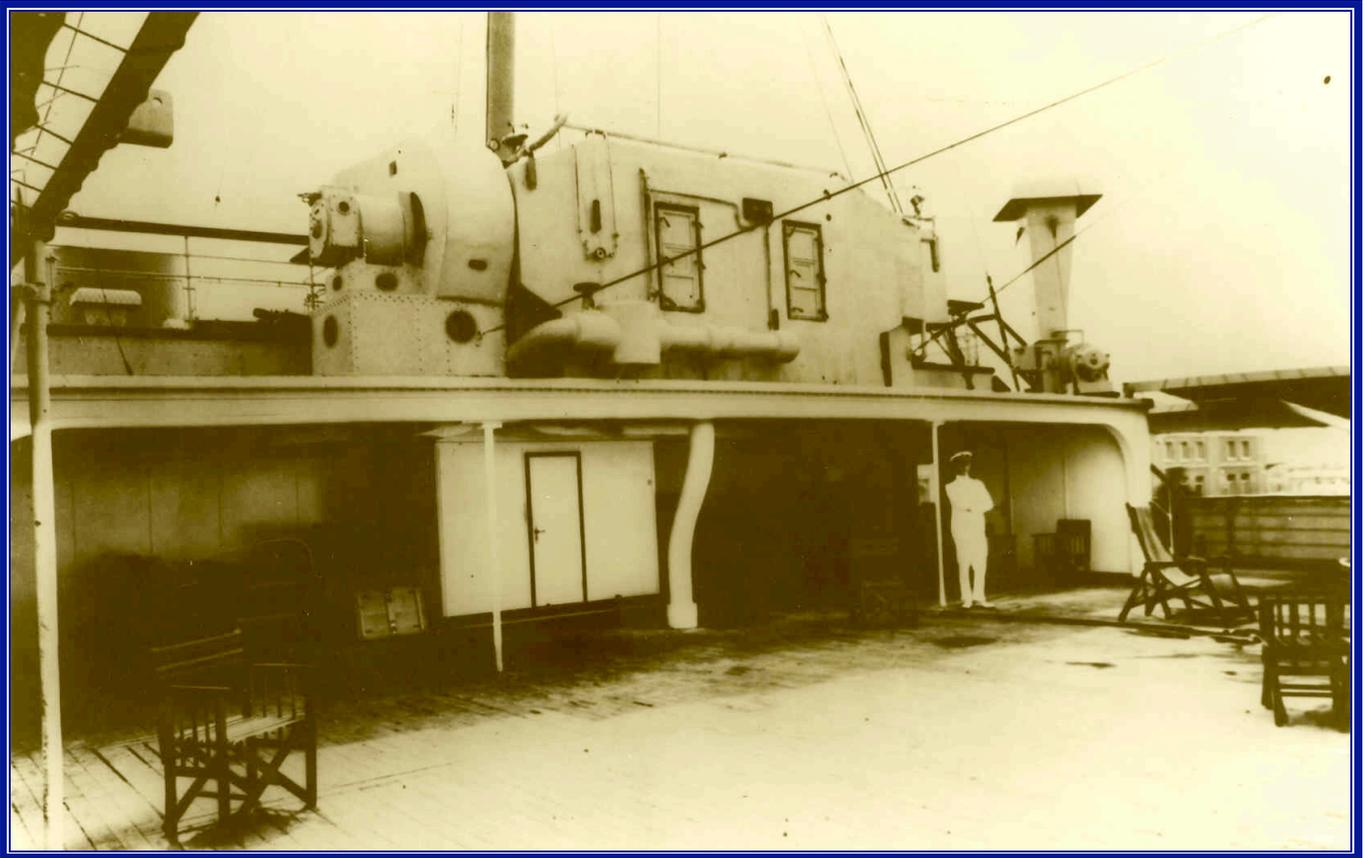


Battleship USS Wyoming 1912, 27,200 tons

In 1930, C L Sainty and Archie Heard of CEC sailed back from the States carrying the drawings for the first air conditioning installation to be made in a passenger liner, the MV "Victoria" of the Lloyd-Triestino line. The system included full air conditioning for the dining saloons and six luxury cabins. The cabins were treated by means of local units (which would later be called induction units), supplied by small, high velocity conditioned fresh air ducts -a forerunner of the Carrier Weathermaster system [11/538].



MV Victoria 1930



Air conditioning plant on M V Victoria 1930



Air conditioned Dining Room M V Victoria 1930

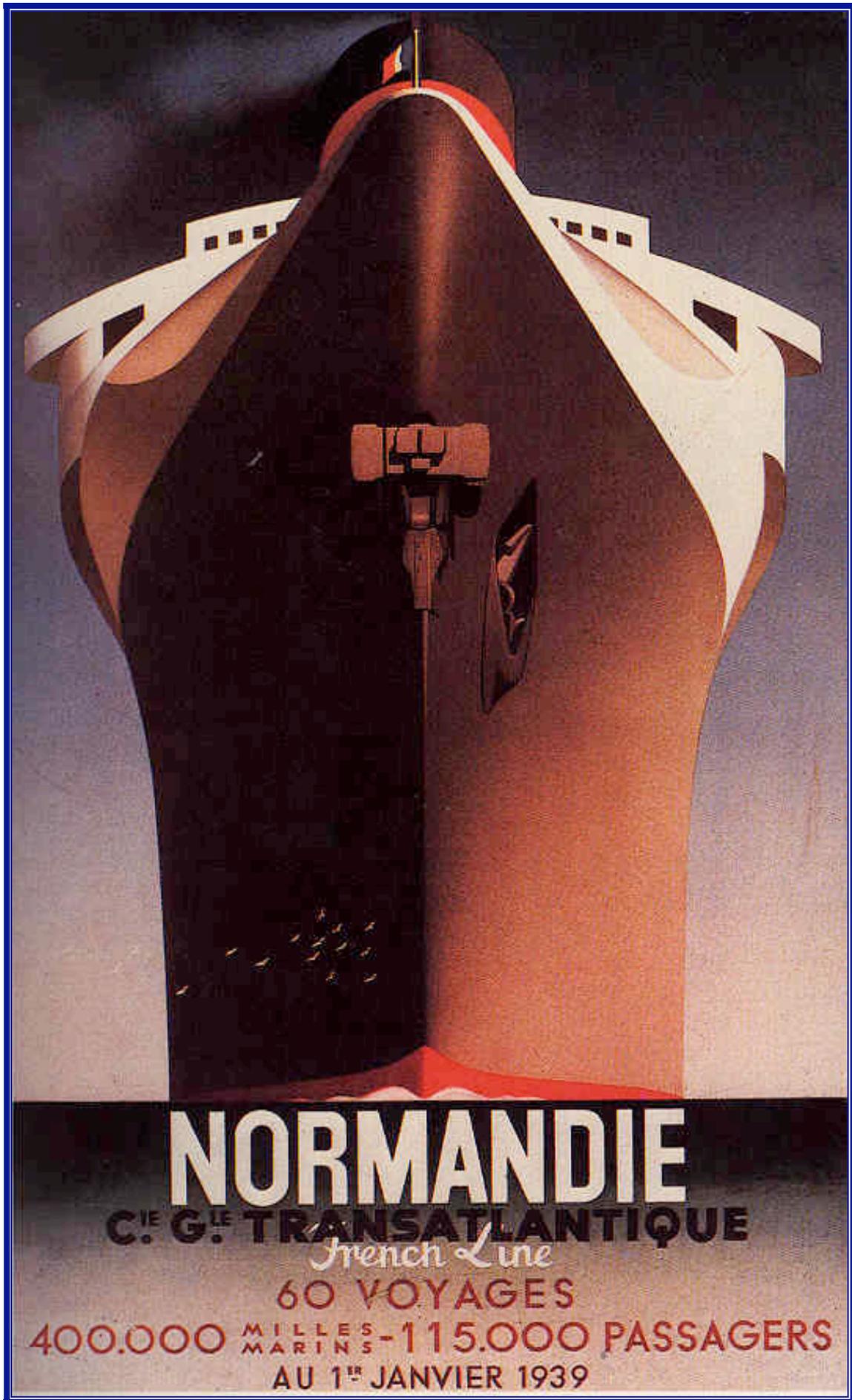
After the "Victoria" CEC was engaged with a long sequence of ships in which the public rooms were all fully air conditioned, together with a few luxury cabins. These included the "Orion" (1935, Orient Line, 23,350 tons, 665 ft long) and "Orcades" (Orient Line); the "Strathmore," "Stratheden," and "Strathallan" (all P & O); and the "Normandie" (1935, French Line, 79,280 tons, 1028 ft). The "Normandie" was the first liner, air conditioned in 1936, to be fitted by CEC with a centrifugal refrigeration machine [11/538]. This was a 5-stage compressor with Carrene-1 as the refrigerant, rated at 174 TR driven by a 225 hp DC variable speed motor and gears. (In 1935, a 140 TR Carrier centrifugal had been installed on the "Koan Maru" for the Imperial Railway Steamship Company of Japan) [11/534].

Table 1. Installations of Centrifugal Refrigerating Machines on Shipboard

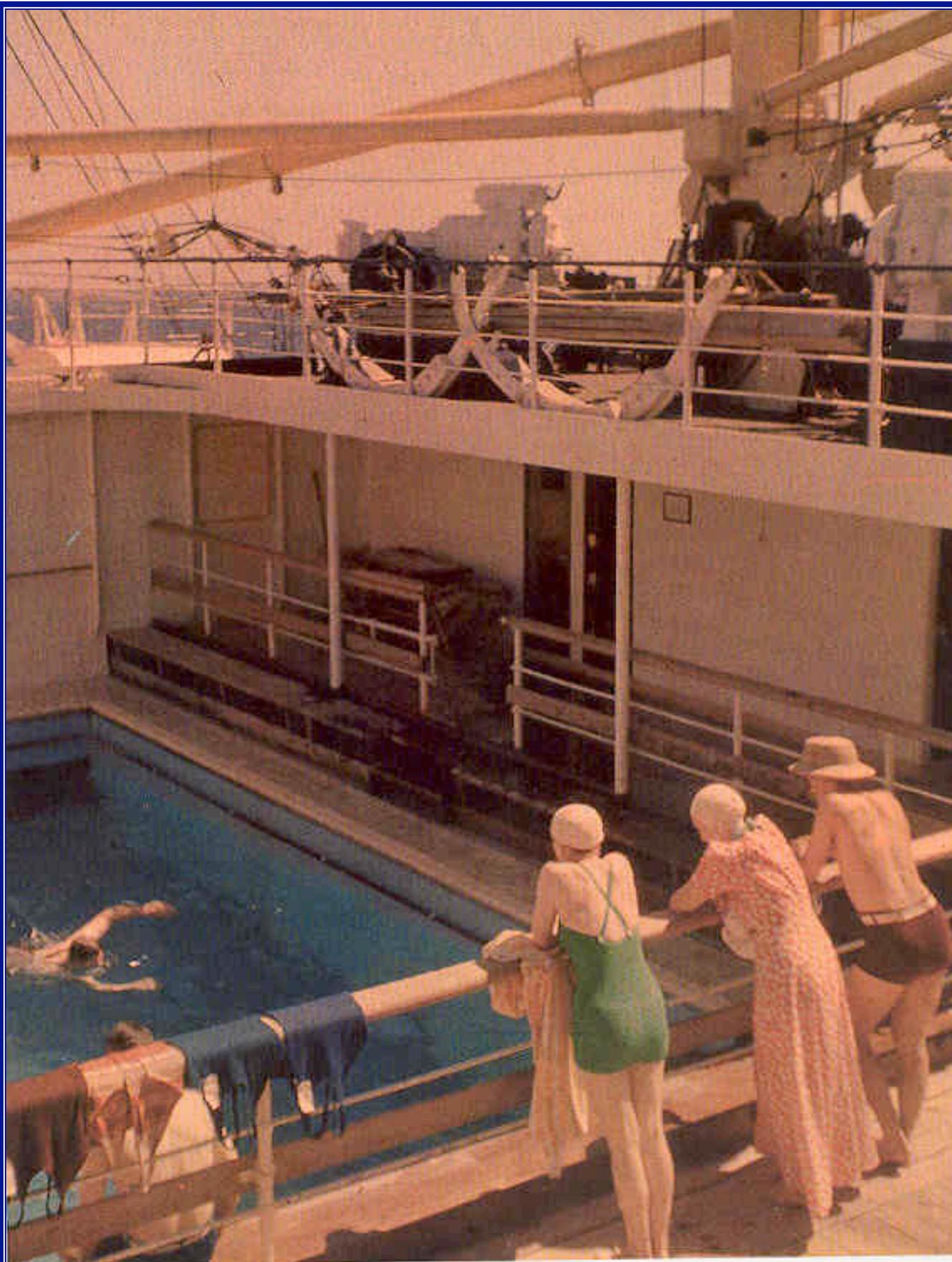
Year	Vessel	Owner	Rating, tons	No. of stages of compression	Refrigerant	Drive	Hp	Service
1935	Koan Maru	Imperial Railway Steamship Co. of Japan	140	3	Carrene #2 (F-11)	DC variable speed motor & gears	150	(Air cond.) Chill water
1936	Normandie	French Line	174	5	Carrene #1 (Ch ₂ Cl ₂)	DC variable speed motor & gears	225	(Air cond.) Chill water
1938	Nieuw Amsterdam	Holland-American Line	(2) Comp. ea. 131	3	Carrene #2 (F-11)	DC variable speed motor & gears	150	(Air cond.) Chill water
1942 to 1945	Tauelae C-2 Cargo	U.S.M.C.	(2) Comp. ea. 175	3	Carrene #2 (F-11)	Condensing turbine	325	(Cargo refig.) 15 F compartment temp. brine
1945	Six C-3 Cargo	American President Line	(2) Comp. each Low temp. 55 High temp. 100	4	Carrene #2 (F-11)	Condensing turbine	250	(Cargo ref.) -10 to +55 F compart. temp. brine
1946	Del Norte Del Sud Del Mar	Mississippi Shipping Co.	120	2	Carrene #2 (F-11)	Non-condensing turbine	125	(Air cond.) Chill water
1947	President Cleveland	American President Line	(2) Comp. each 150	2	Carrene #2 (F-11)	Non-condensing turbine	160	(Air cond.) Chill water
**	President Wilson					*440 v 60 cycle, 3 ph, ac motor & gears	150	
**	Lurline	Matson Navig. Co.	(2) Comp. each 250	2	Carrene #2 (F-11)	Condensing turbine	280	(Air cond.) Chill water

*One compressor turbine driven, one compressor motor driven on each ship.
** Now under construction.

From Heating, Piping, Air Conditioning, 1947 (?)



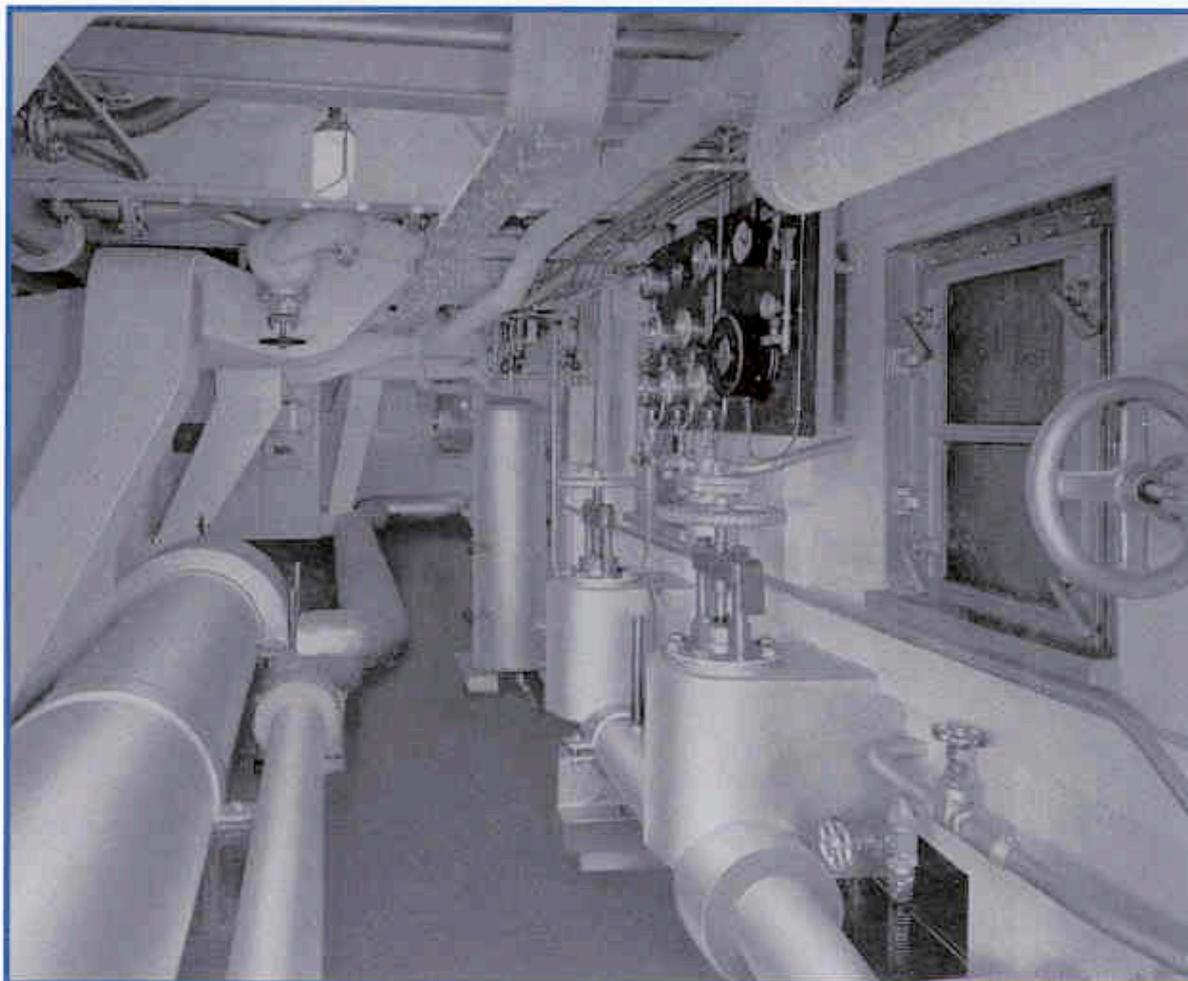
Normandie 1935, 79,300 tons, 1030 x 118 feet, C G Transatlantique



"Morning Bathe" on the *Strathmore*, circa 1937, by Agnes B. Warburg. Warburg's photograph shows the open bathing pool on C deck. The luxurious *Strathmore*, built and engined by Vickers-Armstrong, captured the Blue Riband of the passage from Mediterranean ports to India on her maiden voyage.

SS STRATHEDEN

First Class Dining Room air conditioned
in 1937 by Carrier Eng, UK



Air conditioning plant serving Dining Room



SS Stratheden

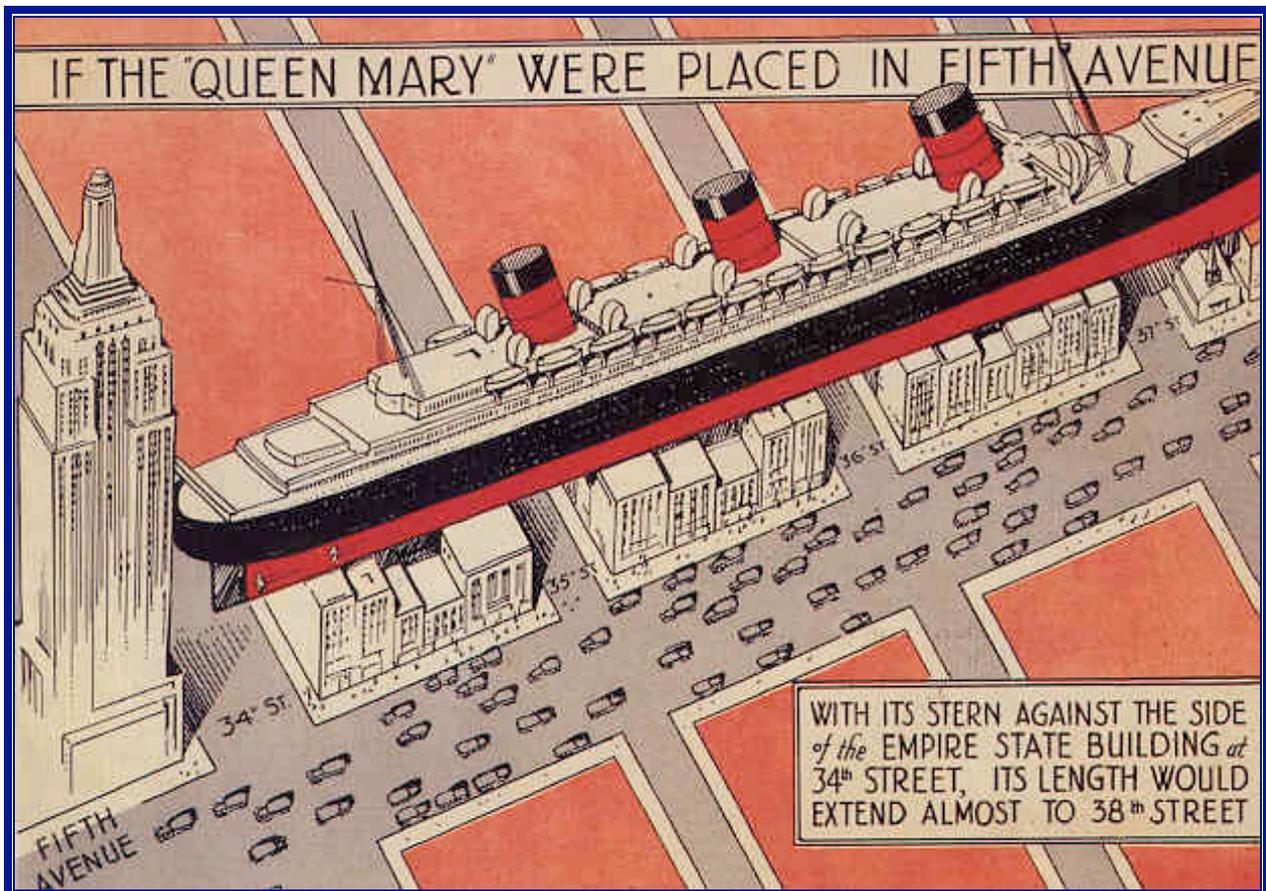
First Class
Dining Room



In 1936, CEC provided air conditioning for the RMS "Queen Mary" (Cunard White Star, 80,744 tons, 1018 ft). At this time air conditioning was limited to public spaces: the Main Dining Room, First Class Lounge, Tourist Dining Room and First Class Hairdresser's Shop. In 1938, the air conditioning for the "Nieuw Amsterdam" (Holland America Line, 36,287 tons, 758 ft) incorporated 2 x 175 TR centrifugal machines. A CEC listing of marine projects [6/502] shows that as the 1930s came to a close, the company was also involved with the RMS "Queen Elizabeth" and the second SS "Mauretania" (both for Cunard White Star), and with the MV "Dominion Monarch" (Shaw, Savill & Albion).



R M S Queen Mary 1936, 80,750 tons, 975 x 118 feet, Cunard White Star





*America this year
by
R.M.S. "Queen Mary"*



**Cunard
White Star**

In the “Mauretania” (1939, 35,750 tons, 772 ft) six CEC plants served the Cabin Dining Room, Grand Hall, Tourist Dining Cabin, Tourist Lounge and Tourist Cinema. The biggest installation at this time was for the “Queen Elizabeth” (1940, 83,673 tons, 1031 ft). Twelve plants served the Public Rooms: Cabin Restaurant, Tourist Dining Saloon, Tourist Lounge, Cabin Smoke Room, Theatre, Salon, Cabin Lounge, Writing Room, Studio and Hairdressing Saloon.



Mauretania II 1939, 35,750 tons, 772 x 90 feet, Cunard

With the outbreak of World War II, the air conditioning of luxury liners gave way to the provision of air conditioning in the vital areas of warships, eg. radar rooms, with work on a variety of Light Fleet Cruisers, and air and sea rescue ships [11/538]. The CEC war-effort “at sea” extended to many non-air conditioning manufacturing activities: Catalina and Sunderland sea-plane refuelling craft, air-crew ferry vessels, marine fuel transfer pumping systems, and air-crew rescue buoys [11/541].

After the War, the first installation of marine air conditioning continued the pre-war pattern of applying these comfort facilities only to public spaces. In 1947, CEC provided air conditioning for the relatively small, first post-war Cunard White Star liner, the “Media” (13,350 tons, 531 ft). This was followed in 1948 by the “Parthia” with 3 plants serving the Dining Saloons, Lounge, Cinema, Cocktail Bar, Smoke Room, Long Gallery, Drawing Room and Writing Room.

16 CEC plants were installed in the “Caronia” (Cunard White Star, 34,200 tons, 715 ft), completed in 1949. These served the Aft Dining Saloon, Official’s Dining Saloon, Theatre, Verandah Cafe, First Class Smoke Room, Library & Writing Room, Garden Lounge Bar, Cabin Lounge, Forward Restaurant & Private Dining Saloons, First Class Lounge, First Class Hairdressing Saloons, Cabin Smoke Room, Hospital General Wards, Operating Theatre, Infectious Wards, Cabin Hairdressing Saloon, Gymnasium and Medicinal Bath Cubicles. Though the air conditioning was extensive, it did not extend to the Passenger Cabins.

When C L Sainty resigned from the company, Groom decided to forgo future marine work and Heard recalls that CEC interests were more or less handed over to Winsor Engineering of Glasgow. However, when later, the Admiralty indicated they would like to keep CEC as a competitor to Thermotank, the position changed. Archie Heard was able to negotiate cost plus contracts for the new Hermes Class aircraft carriers (“Centaur,” “Bulwark,” “Albion” and “Hermes”). This resuscitated marine work leading to contracts for the “Empress of Canada” (1961, CPR Line, 27,300 tons, 650 ft), the “Northern Star” (1962, Shaw, Savill & Albion, 24,750 tons, 650 ft), and then the “QE2” (1968, Cunard, 65,850 tons, 963 ft). [11/538].

The “Empress of Canada” had Carrier Centrifugals and was the first liner to be fitted with the CEC “Marinair” high velocity, all-air, air conditioning system [11/525]. The “Northern Star” incorporated many refinements found advantageous during seven years of round the world service by her earlier sister ship “Southern Cross,” and was air conditioned throughout by the CEC “Marinair” high velocity system. In addition to the 13- Public Rooms, air conditioning was provided for all passenger cabins as well as the accommodation of the officers and crew. CEC provided 67 separate air conditioning plants in conjunction with 3-electric motor-driven Carrier centrifugal water-chilling refrigeration machines of 1020 TR total capacity [11/R97]. Advertising by Carrier Ross Engineering indicates the establishment of a Marine Air Conditioning Division under their banner (although Haden were using the name CAC Marine for the same company in 1977), with a project listing from 1960 onwards through to 1985 [9/542]. This list includes HMS “Bulwark” (1960), HMS “Albion” (1961), “Empress of Canada,” “Northern Star” and the “QE2” mentioned above. The great majority of the air conditioning work carried out by Carrier Ross over the next 25-year period was for Fast Patrol Boats for Vosper, later Vosper Thornycroft, for navies of countries all around the world. They also worked on a destroyer, numerous frigates and corvettes, as well as ammunition carriers and landing ships.

The air conditioning of the “QE” proved to be a difficult contract. Cunard favoured Thermotank, and were hesitant about the CEC “Marinair” high velocity air system which didn’t use the traditional heating and cooling water valves for individual cabin control. They also expressed concern over service arrangements when in port. So CEC joined forces with Winsor Engineering to quote as joint venture. The first design for a liner, codenamed Q3, proved to be uneconomic.

At this stage CEC considered the chances of winning the contract for the modified ship Q4 to be poor. However, Carrier-Winsor came up with a new design concept, which they managed to keep secret from the competition. Their proposal was to concentrate all the major plant rooms on one deck. These centralised services, simplified maintenance and operation, released space to the interior designers, reduced weight at high level, and was cheaper. It secured the order. [11/539].



The QE2 on sea trials 1968, 65,863 tons, 963 x 105 feet, Cunard

The details of the “QE2”, its accommodation, the boilers, the air conditioning, and all of the complex mechanical and electrical systems that were necessary in a modern passenger liner at that time, have been described elsewhere [“Queen Elizabeth 2,” *The Steam & Heating Engineer*, May & June 1969].

These articles record that Winsor was in fact the Winsor Engineering Division of Stone-Platt Scotland Ltd. The “Marinair” system as used provided a high velocity, constant volume single duct arrangement to distribute cooled air to terminal reheat units. Supply air was delivered through an acoustically treated diffuser developed for the “QE2” and called “Carmline.” The centralisation of all the air conditioning plants on one deck reduced the total number required from a possible 75 to 34, allowing them to be accommodated in only 10 plant rooms on No.3 deck. The extract plants were located in 4 other plantrooms on the top deck. The total supply air volume totalled 518, 000 ft³/min. The cooling load was handled by 3 Carrier centrifugal machines with a total capacity of 2050 TR, each machine being driven through speed-increasing gears by a 700 hp motor.

Archie Heard described the completion and trials of the “QE2” as disastrous [11/540]. The workmen used the air conditioning ducts as receptacles for all kinds of rubbish. Even a large coil of one-inch rope had been jammed inside a chilled water main. The ship was still unfinished when the trials began and suffered from engine troubles. Carrier-Winsor had their own share of problems. The chilled water system kept draining itself, until it was discovered that someone had connected the sprinkler system into it. There was an initial unfavourable reaction to the air conditioning from Cunard who expected the usual draughts and noise, and had to be convinced all was working satisfactorily. However, these and the usual commissioning difficulties pale into insignificance compared with the boiler and turbine problems so widely reported by the media.

In 1970-1, Carrier Ross air conditioned eight SRN6 hovercrafts for a British Hovercraft order to Saudi Arabia. During the 1980s, air conditioning of hovercraft was carried out for owners in Mexico, Hong Kong, Singapore and Kuwait. Passenger vessels included the MV “Copenhagen” (1975, Nordline of Denmark), the “Stella Polaris” (1978, Kuwait National Hotels) and two passenger ferries (1984, Hong Kong Hi-Speed Ferries).



Santa Paula 1958, 15,350 tons, 584 x 84 feet, Grace Line (later Stella Polaris)

Another document [11/529] reveals that the P & O liner “Chusan” (built 1950, 24,200 tons, 673 ft) was converted to full air conditioning; that the “Copenhagen” was renamed “Odessa” and passed into Russian ownership; that the “Stella Polaris” was formerly the American cruise liner “Santa Paula” (built 1958 for Grace Line of New York, 15,350 tons, 584 ft) and was to be permanently berthed in Kuwait to be used as a hotel. Also upgraded by CEC in 1959 was the third “Himalaya” (built 1949, P & O, 27,955 tons) [11/527]. Both the “Chusan” and “Himalaya” had Carrier centrifugal refrigeration.

CARRIER ROSS ENGINEERING

Marine Air Conditioning Division — Projects Completed

	Vessels		Owners	Shipyard
1960	H.M.S. "Bulwark"		Admiralty	H.M. Dockyard, Portsmouth
1961	"Empress of Canada"		Canadian Pacific	Vickers-Armstrong
1961	M.Y. "Ivara"		Shell Tankers	Vosper, Portsmouth
1961	H.M.S. "Albion"		Admiralty	H.M. Dockyard
1962	"Northern Star"		Shaw Savill Line	Vickers-Armstrong
1962	Fast Patrol Boat	2 off	Royal Malayan Navy	Vosper, Portsmouth
1962	"Remeura"		New Zealand S.S.Co.	Alex Stephens
1962	H.M.S. "Victorious"		Admiralty	H.M. Dockyard
1963	Fast Patrol Boat	4 off	Royal Malayan Navy	Vosper, Portsmouth
1963	Corvettes	2 off	Ghana Navy	Vosper, Portsmouth
1964	Fast Patrol Boat	4 off	Royal Malayan Navy	Vosper, Portsmouth
1965	Fast Patrol Boat	2 off	Govt. of Trinidad & Tobago	Vosper, Portsmouth
1965	Fast Patrol Boat	3 off	Kenyan Navy	Vosper, Portsmouth
1966-67	Fast Patrol Boat	10 off	Royal Malayan Navy	Vosper, Portsmouth
1967	Fast Patrol Boat	2 off	Royal Malayan Navy	Vosper, Portsmouth
1968	Fast Patrol Boat	2 off	Royal Malayan Navy	Vosper, Portsmouth
1969	RMS "Queen Elizabeth II"		Cunard Line	U.C.S., Clydebank
1969	I.I.N.S. "Artemiz" Destroyer		Imperial Iranian Navy	Vosper Thornycroft
1970	Fast Patrol Boat	3 off	Republic of Singapore	Vosper Thornycroft
1970-71	SRN6 Hovercrafts	8 off	Saudi Arabia	British Hovercraft
1971	I.I.N.S. Frigates	2 off	Imperial Iranian Navy	Vosper Thornycroft
1971	Fast Patrol Boat	2 off	Trinidad & Tobago	Vosper Thornycroft
1971	Fast Patrol Boat	3 off	Republic of Singapore	Vosper Thornycroft
1971	Fast Patrol Boat	2 off	Government of Panama	Vosper Thornycroft
1972	I.I.N.S. Frigates	2 off	Imperial Iranian Navy	Vosper Thornycroft
1972	L.N.S. "Dat Assawari" Frigate		Libyan Navy	Vosper Thornycroft
1972	N.N.S. Corvettes	2 off	Nigerian Navy	Vosper Thornycroft
1972	Fast Patrol Boat	1 off	Royal Navy	Vosper Thornycroft
1973	T.S.M.Y. "Stilvi"		Greek Owner	Camper Nicholson
1974	T.S.M.Y. "Araminta III"		British Owner	Camper Nicholson
1974	Fast Patrol Boat	2 off	Venezuelan Navy	Vosper Thornycroft
1974	Fast Patrol Boat	1 off	Royal Brunei Regiment	Vosper Thornycroft
1975	Fast Patrol Boat	4 off	Venezuelan Navy	Vosper Thornycroft
1975	Fast Patrol Boat	2 off	Abu Dhabi Defence Force	Vosper Thornycroft
1975	Fast Patrol Boat	2 off	Qatar Sea Arm	Vosper Thornycroft

**Carrier Ross —
Conditioning the
Marine Environment**

	Vessels		Owners	Shipyard
1975	Fast Patrol Boat	2 off	Royal Brunei Regiment	Vosper, Singapore
1975	M.V. "Copenhagen"		Nordline, Denmark	Vickers Shipbuilding
1975	Fast Patrol Boat	1 off	Kenyan Navy	Brooke Marine
1976	31m Fast Patrol Boat	4 off	Abu Dhabi Defence Force	Vosper Thornycroft
1976	31m Fast Patrol Boat	4 off	Qatar Sea Arm	Vosper Thornycroft
1976	Fast Patrol Boat	2 off	Nigerian Navy	Brooke Marine
1976	T.S.M.Y. "Northwind"			Camper/Greece
1977	Fast Patrol Boat	2 off	Nigerian Navy	Brooke Marine
1977	Fast Patrol Boat	2 off	Tunisian Navy	Vosper Thornycroft
1977	31m Fast Patrol Boat	1 off	Guyana Navy	Vosper Thornycroft
1977	T.S.M.Y. "Al Fath"		Greek Owner	Camper/Greece
1978	31m Fast Patrol Boat		Bahamas Navy	Vosper Thornycroft
1978	Corvettes	2 off	Nigerian Navy	Vosper Thornycroft
1978	T.S.M.Y. "Cleopatra A"		Mid East Owner	Camper/Las Palmas
1978	"Stella Polaris" Passenger Liner		Kuwait National Hotels	Victor Lenac/Riyeka
1978	Tankers	2 off	Iranian Navy	Karachi Shipyard
1979	Ammo Carriers	2 off	Iranian Navy	Karachi Shipyard
1979	33m H.M.C.C. "Searcher" Patrol Craft		H.M. Customs & Excise	Brooke Marine
1980	Cargo Carriers	3 off	Iranian Navy	Karachi Shipyard
1980	52m Fast Patrol Boat	1 off	Egyptian Navy	Vosper Thornycroft
1980	33m H.M.C.C. "Seeker" Patrol Craft		H.M. Customs & Excise	Brooke Marine
1981	52m Fast Patrol Boat	1 off	Egyptian Navy	Vosper Thornycroft
1981	52m Fast Patrol Boat	2 off	Egyptian Navy	Vosper Thornycroft
1981	38m Fast Patrol Boat	1 off	Barbadian Navy	Brooke Marine
1981	31m Patrol Craft	6 off	Suez Canal Co.	Timsah/Ismailla
1981	18m HM218 Hovercraft	4 off	Mexican Owner	Vosper Hovermarine
1982	52m Fast Patrol Boat	2 off	Egyptian Navy	Vosper Thornycroft
1982	23m Shrimp Boats	2 off	Barbadian Owner	Swan Hunter, Trinidad
1982	M.Y. "Lina II"		Greek Owner	Camper/Hamburg
1982	56m Fast Patrol Boat	1 off	Sultanate of Oman Navy	Vosper Thornycroft
1983	27m H.M. 527 Hovercraft	4 off	Hong Kong Owner	Vosper Hovermarine
1983	18m H.M. 218 Hovercraft	5 off	Shell, Singapore	Vosper Hovermarine
1983	93m Landing Ship	2 off	Algerian Navy	Brooke Marine
1984	93m Landing Ship	1 off	Sultanate of Oman Navy	Brooke Marine
1984	56m Fast Patrol Craft	2 off	Sultanate of Oman Navy	Vosper Thornycroft
1984	21m H.M. 221 Hovercraft		Gray Mackenzie	Vosper Hovermarine
1984	700 Passenger Ferries	2 off	Hong Kong Hi-Speed Ferries	Vosper Thornycroft
1984	18m H.M. 218 Hovercraft	4 off	Overseas Owners	Vosper Hovermarine
1984	18m H.M. 218 Hovercraft	2 off	Kuwait Owner	Vosper Hovermarine
1985	56m Fast Patrol Craft	2 off	Kenyan Navy	Vosper Thornycroft
1985	42m M.Y. "Brave Goose"		British Owner	Tough Bros.

**Carrier Ross —
Conditioning the
Marine Environment**

**CARRIER ROSS
ENGINEERING**

Carrier Ross Engineering Limited
Carross House, Sternhold Avenue,
London SW2 4PH.
Tel: 01-674 9833. Telex 291 182.

