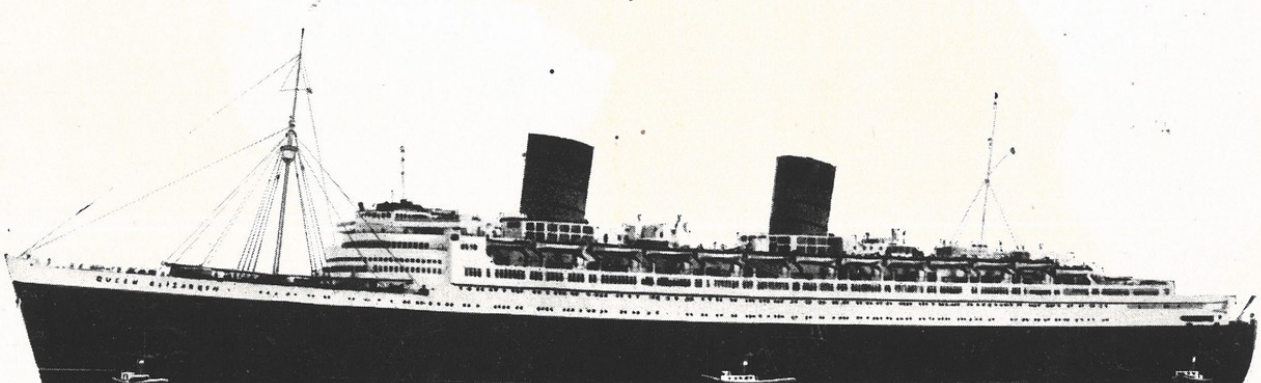
Nickel in
R.M.S. "QUEEN ELIZABETH"



THE MOND NICKEL COMPANY LTD.
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Nickel in R.M.S. "Queen Elizabeth"

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Nickel silver plays a prominent part in the decoration of the Cabin Class Lounge, a corner of which is shown on the left. The lighting fittings, beading to the glass screen and the metalwork of the balustrading are of nickel silver.

BELOW: A view of one of the deck entrances. The panel between the lift doors is sprayed with nickel and phosphor bronze on a dark bronze background. Handrails, balustrades, staircase trim, beading around doors, strip lighting fittings and ventilation grilles are of nickel silver.

By courtesy of George Parnall & Co. Ltd. (Decorative sprayed panel designed by Jan Juta and executed by J. Starkie Gardner Ltd.)

Nickel in R.M.S. "Queen Elizabeth"

The *Queen Elizabeth*, sister ship to the *Queen Mary*, has been designed and built in accordance with the announced policy of the Cunard White Star Company to provide passenger transport of maximum comfort and convenience to a rigid weekly schedule between Southampton and New York. Her size, power, extensive equipment and services testify the length to which her owners have gone to implement this policy.

While her design, constructional details and propelling machinery follow, generally, the marine engineering practice established by the *Queen Mary's* construction, she embodies refinements, derived from continued research and service experience, which establish her as an outstanding achievement in marine engineering of modern times.

In the fields of decorative and architectural art she attains new high standards of modern treatment fully in keeping with the excellence of the hotel services, passenger accommodation and recreational facilities to which they are the setting.

In her construction advantage was taken of the most up-to-date established advances in all constructional fields of art and science. In this publication an attempt is made to show the part played by nickel in these fields as represented by the uses made of nickel and alloys containing nickel in the various departments of the ship.

I. PROPELLING MACHINERY AND AUXILIARIES

In the main propelling machinery and auxiliaries, many of the varied properties provided by nickel-containing materials have been utilised. Structural strength, toughness, heat-, corrosion- and erosion-resistance and bearing qualities have all been provided, and it is interesting to note the variety of functions which these nickel-containing materials fulfil as the thermal energy of the fuel is converted to diverse other forms of energy in the main propelling and auxiliary equipment.

In order to ensure that, despite the vagaries of the North Atlantic weather, the *Queen Elizabeth* might maintain the close schedule desired, and arrive at

terminal ports at stated times, it was found that a shaft horse-power of over 160,000 would be required. This is developed in four sets of Parsons' quadruple-expansion single-reduction geared turbines, each set directly connected by line shafting to a propeller. The steam for these turbines and the auxiliary generating sets is provided by twelve Yarrow-type, side-fired, oil-burning boilers, working at a pressure of 425 lb. per square inch and a final steam temperature of 750° F. For many of the applications required throughout all this equipment, from the pumps feeding fuel oil and water to the boilers to the pinions driving the propeller shafts, nickel-containing alloys have been used.

Oil-Burning Installation

The oil-burning equipment is of the Wallsend-Howden pressure system. The oil is pumped by eight Stothert and Pitt pumps, each capable of an output of 20,000 lb. of fuel oil per hour. Each pump is driven by a 12 h.p. Laurence Scott motor running at speeds varying from 1,500–750 r.p.m. through a high-efficiency worm reduction gear, which reduces this speed to 270 r.p.m. To withstand the heavy loads imposed upon them, these worm gears are made from a 3 per cent. nickel case-hardened steel, advantage being taken of the superior properties of core strength and toughness, without loss of case hardness or wearing properties, which result from additions of nickel to the normal case-hardening carbon steel. Air for combustion is directed by air director vanes which, since they must withstand intense radiated heat, have been made of a heat-resisting steel containing high percentages of nickel and chromium.

Feed Pumps

The feed water is pumped through the I.P. and H.P. pre-heaters to the feed regulators and boilers by means of Weir multi-stage turbine-driven centrifugal pumps. There are eight of these pumps, four working and four stand-by, fed with steam at 400 lb. per square inch pressure and superheated to 700° F. Many important components of both turbines and pumps are in nickel-containing alloys. Monel, a 70/30 nickel-copper corrosion- and erosion-resisting alloy, has been used in the pump turbines for the steam stop-valve seats, throttle valves, pressure-governing piston and steam strainers, while the turbine blading is manufactured in nickel-chromium heat- and corrosion-resisting steel containing 16 per cent. of chromium and 10 per cent. of nickel. In accordance with established engineering practice for components requiring high strength and toughness without sacrifice of ductility, combined with superior resistance to alternating stresses, the turbine shaft is in $3\frac{1}{2}$ per cent. nickel-chromium steel heat-treated to a tensile strength of 58–68 tons per square inch. The pump itself is of the ring section type, and the impellers and diffusers are of Monel.

The admission of feed water from the pump and pre-heaters to the boilers is controlled by Weir "Robot" type regulators of which there are twenty-four.

These regulators, in which the wearing liners and all parts subject to erosion are of nickel-bearing corrosion-resisting steel, are float operated and utilise Monel ball floats. Float liners and needle valves are in high tensile corrosion-resisting steel containing about 18 per cent. chromium and 2 per cent. nickel, and main valve seats in austenitic corrosion-resisting steel containing 18 per cent. chromium and 8 per cent. nickel. The main valve and main feed check valves are in a 35–40 per cent. nickel bronze.

The boilers are also fitted with Weir low level and oil fuel control gear arranged to close the fuel supply to the burners when the water level reaches a pre-determined low level. The floats in these are of Monel, and all wearing parts are in 18 per cent. chromium, 2 per cent. nickel corrosion-resisting steel. This steel combines with a high degree of corrosion-resistance the ability to be hardened and tempered to high levels of tensile strength, hardness and wear-resistance.

Steam Lines and Valves

As mentioned above, the boilers generate steam at a pressure of 425 lb. per square inch and a final temperature of 750° F. This superheated steam is carried to the turbines and auxiliaries in pipes bolted together with high-tensile nickel-chromium-molybdenum steel bolts, and it is controlled at the boiler and various other positions in the steam pipe lines by valves, components of which are in corrosion-resisting steels and nickel bronze of compositions varied according to the severity of the service conditions to which they are exposed.

The spring-loaded safety valves, bulkhead emergency valves and cross-connection valves were designed and made by Cockburns Ltd., and the internal components of the boiler stop valves and manoeuvring valves were also designed and made by this firm.

There are in all fifty-six spring-loaded safety valves. Of these the twelve triple safety valves on the superheaters and the twelve single safety valves on the saturated steam drums have lids and seats in 33 per cent. nickel bronze, and spindles of corrosion-resisting steel. The remainder, four double safety valves, are fitted to the auxiliary steam boilers, and, not being subjected to such severe conditions, have seats and lids of a nickel bronze with a lower nickel content.

The twelve boiler stop valves, six bulkhead emergency valves and two cross-connection valves, also the eight manoeuvring valves which distribute steam to the turbines, have spindles of corrosion-resisting steel, valve seats of corrosion-resisting steel or 33 per cent. nickel bronze and other internal components of these materials or of Monel.

Monel and bronzes containing a high percentage of nickel are favoured by manufacturers in view of their excellent resistance to corrosion and erosion by water and steam. Furthermore, such alloys retain a large measure of their normal strength and hardness at steam temperatures.

Turbines

Each of the four propelling units consists of a H.P., 1st and 2nd I.P. and L.P. turbine, each turbine driving a separate pinion engaging with the main gear wheel which is in turn coupled to the forward end of the propeller shafting. In these turbines, full use is made of the high-strength corrosion-resisting alloy steels. The nozzle partition plates of the H.P. and L.P. astern turbines were manufactured in Staybrite corrosion- and heat-resisting steel, containing 18 per cent. chromium and 8 per cent. nickel. The gear pinions driven by all these turbines were forged from $3\frac{1}{2}$ per cent. nickel steel.

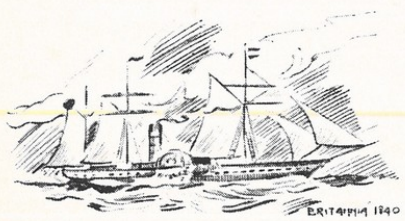
Condensing System

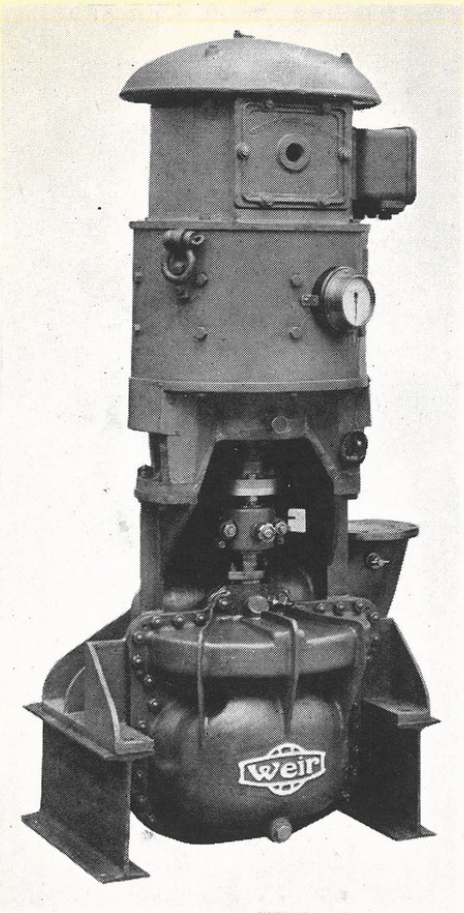
The four main turbine units on the *Queen Elizabeth* with the various auxiliaries are arranged to operate on the Weir closed circuit feed system. In this system no opportunity is presented for the feed water to come into contact with the atmosphere. The complete system comprises the feed pumps, feed heaters and feed control valves mentioned above, Weir regenerative condensers, motor-driven extraction pumps, air ejectors and drain coolers.

Each set of the main turbine propelling units is served by a Weir regenerative-type condenser. The condensers were built by John Brown & Co. Ltd., and the condenser tubes, as in the *Queen Mary*, are of solid drawn 70/30 cupro-nickel. There are 13,780 tubes in each condenser, and the total weight of tubes and ferrules in the main condensers is approximately 162 tons.

The condensate is extracted from the well of the condensers by Weir Lo-Hed electrically driven two-stage centrifugal pumps, eight in number—four working and four stand-by. The motors are of 45 to 55 b.h.p., with a speed range of 850 to 1,250 r.p.m. The pump impellers are of cast Monel, with spindles of the 18 per cent. chromium, 2 per cent. nickel type corrosion-resisting steel, advantage being taken of the high strength and excellent bearing properties of this steel, combined with marked resistance to galvanic corrosion when in contact with dissimilar metals.

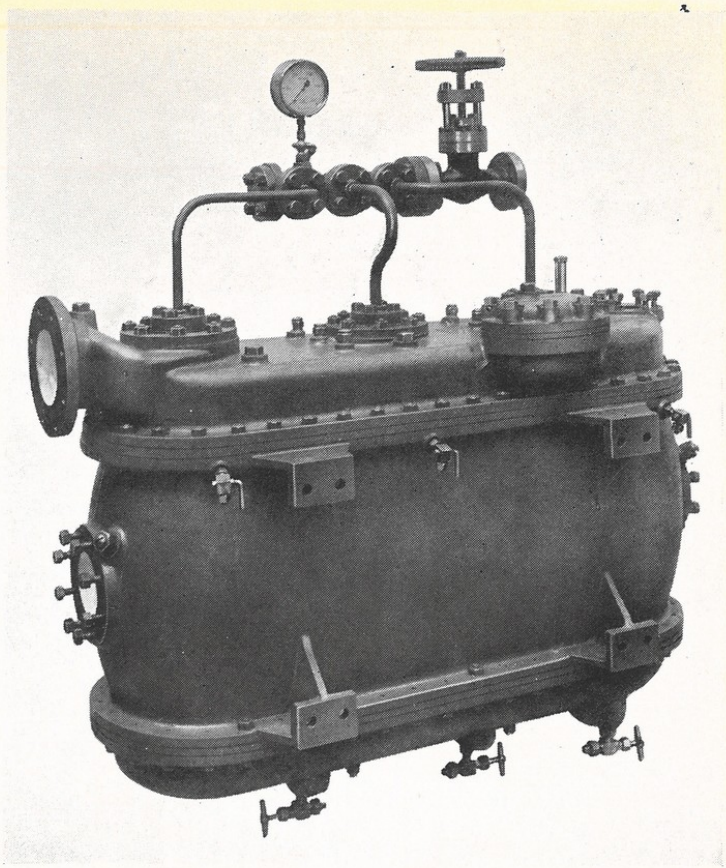
Two sets of Weir three-stage steam-jet air ejectors evacuate the air and non-condensable gases from each condenser. The steam nozzles for each stage are of Monel and are supplied with steam at 250 lb. per square inch and 650° F. The cooler tubes are of 70/30 copper-nickel alloy. The condensate from each of the condensers passes through a drain cooler receiving the drains from a L.P. feed heater. The cooling surface of these drain coolers consists of solid drawn cupro-nickel tubes. From the drain coolers the condensate passes to the L.P. feed heaters of a straight tube type, which are on the suction side of the feed pumps. The heat-transfer tubes in the L.P., I.P. and H.P. feed heaters are also in 70/30 cupro-nickel tubing.





Condenser extraction pump fitted with Monel impellers.

By courtesy of G. & J. Weir Ltd.

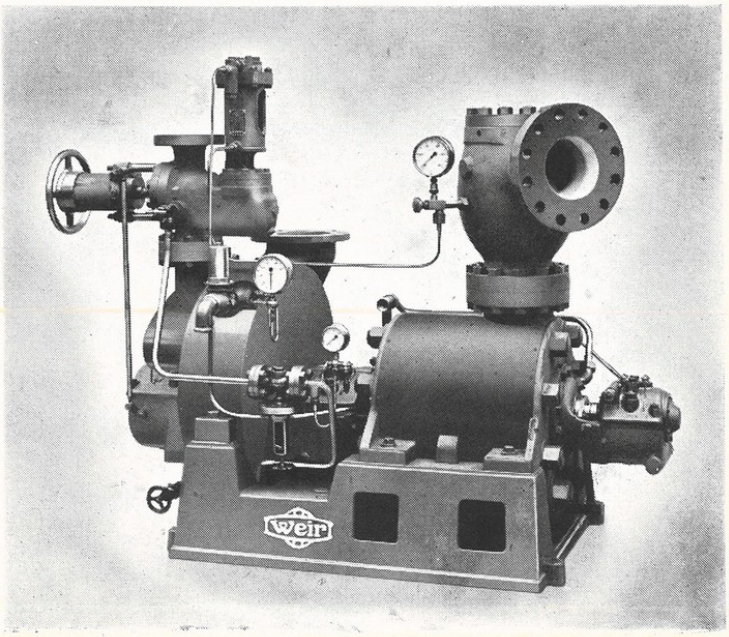


A three-stage air ejector in which the steam nozzles and strainers are of Monel, and the cooler tubes of 70/30 cupro-nickel.

By courtesy of G. & J. Weir Ltd.

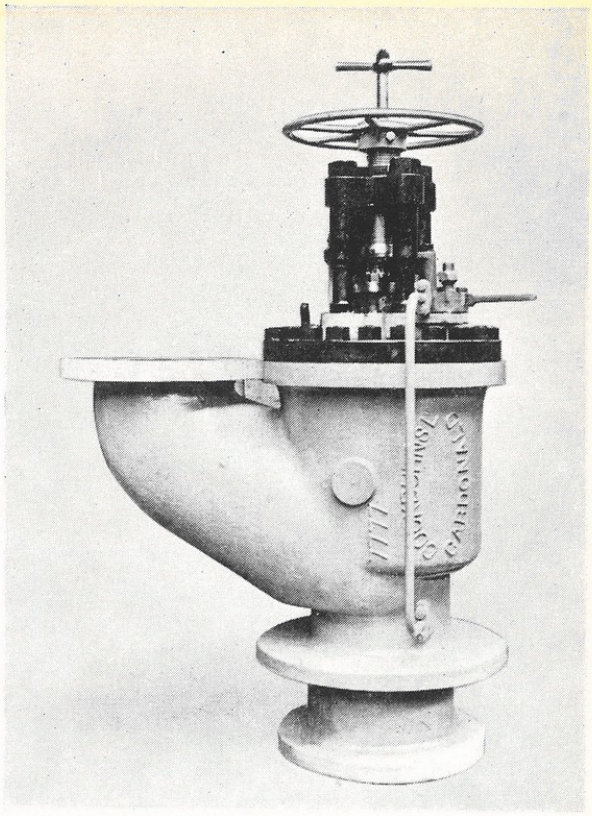
A turbo-feed pump with Monel valve parts, steam strainers, impellers and diffusers. The turbine blading is of nickel-chromium, corrosion-resisting steel and the shaft of nickel-chromium steel.

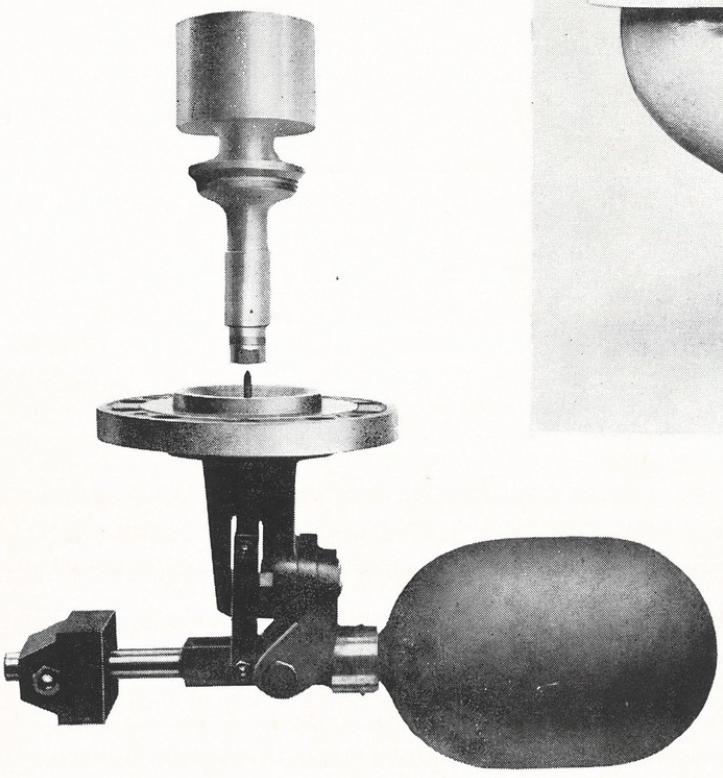
By courtesy of G. & J. Weir Ltd.



RIGHT: One of the sixteen-inch bulkhead valves equipped with nickel-bronze valve parts.

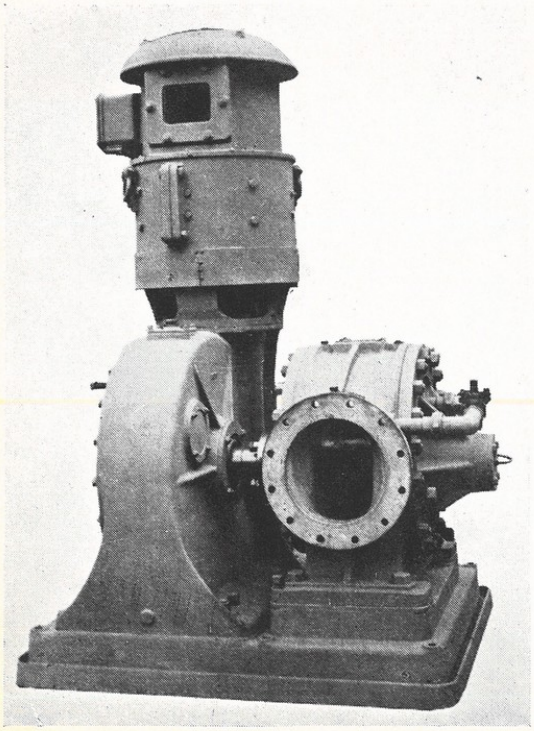
By courtesy of Cockburns Ltd.





ABOVE: Weir Robot boiler feed regulator controlling the admission of feed water to the boilers. The float is of Monel, and the float levers, needle valves and seats of nickel-chromium corrosion-resisting steel.

By courtesy of G. & J. Weir Ltd.



LEFT: The worms in the fuel transfer and trim pumps are of 3 per cent. nickel case-hardened steel.

By courtesy of Stothert & Pitt Ltd.

Miscellaneous Auxiliaries

Further applications of nickel-containing materials are found among the many important auxiliaries essential for the efficient working of the main machinery or the well-being of the ship.

Prominent among these are the Parry soot blowers, which keep the surfaces of the generating, superheater and air heater tubes clean and efficient. The nozzles of these blowers, of which there are 168, have to withstand the high temperatures and erosion of steam and have been made in a heat-resisting steel containing 25 per cent. chromium and 20 per cent. nickel. This steel is also used for the wall box ends in the blowers and for the small nozzles screwed into the nozzle pipes of the air heater blowers.

Also of importance are the superheater tube spacer supports and attachment bolts. For these a heat-resisting nickel-chromium-iron alloy containing approximately 55 per cent. of nickel has been used, the high nickel content in combination with chromium ensuring adequate strength at the high service temperatures, with resistance to the hot and highly oxidising furnace gases with which they are in contact.

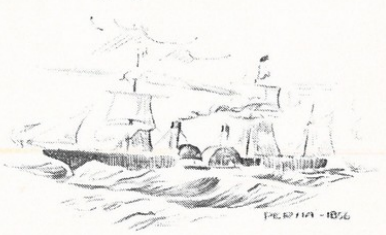
Other important auxiliaries are the "Centrex" self-priming type bilge and ballast pumps built by Drysdale & Co. Ltd., which incorporate Monel impellers and 37 per cent. nickel-bronze bearing rings, and the condenser cooling water and lubricating oil pumps, which embody Monel and nickel alloy steel components.

II. ELECTRICAL EQUIPMENT

With the exception of the main propelling machinery, the turbo-driven feed pumps and some uses of steam heating for cooking, the *Queen Elizabeth* is virtually an all-electric ship. All other propelling machinery auxiliaries, steering gear, deck machinery, anchoring and mooring equipment are electrically operated, as are the hotel and allied services, such as the ventilating system, cooking ranges, dumb waiters and passenger and service lifts.

Throughout all these services nickel and alloys containing nickel have been extensively used. Their widely varied applications are too numerous to detail here; the following remarks will therefore be confined primarily to the more prominent uses of nickel-containing materials in the electrical equipment.

The electrical power for all these services is supplied by four B.T.H. turbo-generators, each having a normal rating of 2,200 kw. at 225 volts, giving a total output of 8,800 kw., sufficient to supply the total electrical demands of a small town.

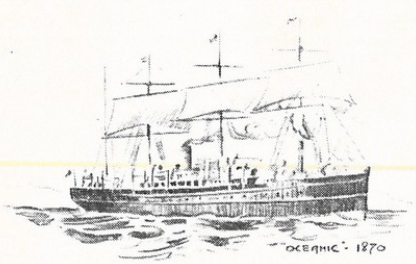


The use of nickel in the generator turbines follows closely on the lines described earlier for the main turbines of the propelling machinery. Thus, the spindles of the high-pressure and turbine stop valves, controlling steam supplied at 390 lb. per sq. in. and 730° F., are of high-tensile corrosion-resistant steel, containing 18 per cent. chromium with 2 per cent. nickel. The oil-cooling tubes, condenser tubes and ferrules are in 70/30 cupro-nickel alloy, and the pinions and pinion shafts of the reduction gear are in nickel-alloy steel. The first-stage blading is in "Stayblade", a heat-resisting chromium-nickel steel of the 18 per cent. chromium, 8 per cent. nickel type. An interesting use of nickel and nickel-bronze, not previously referred to, is for the prevention of steam leakage. In order to ensure maximum operating efficiency and to ensure steam "tightness", the turbine shaft glands and diaphragm packings are in nickel-bronze and the high-pressure joint rings are of corrugated nickel. The selection of these materials is based on their good erosion- and corrosion-resistance against super-heated steam.

The generators themselves are fitted, in all, with eight straight-line pattern shunt field regulators, manufactured by the Cressall Manufacturing Co. Ltd. The resistance elements in these regulators are made from "Ferry" resistance tape. "Ferry", a nickel-copper alloy containing approximately 44 per cent. nickel, has the highest specific resistance of the alloys in the nickel-copper series, an extremely low temperature coefficient of electrical resistance, and is particularly resistant to the action of marine atmospheres, properties which make it particularly suitable for use in marine electrical applications.

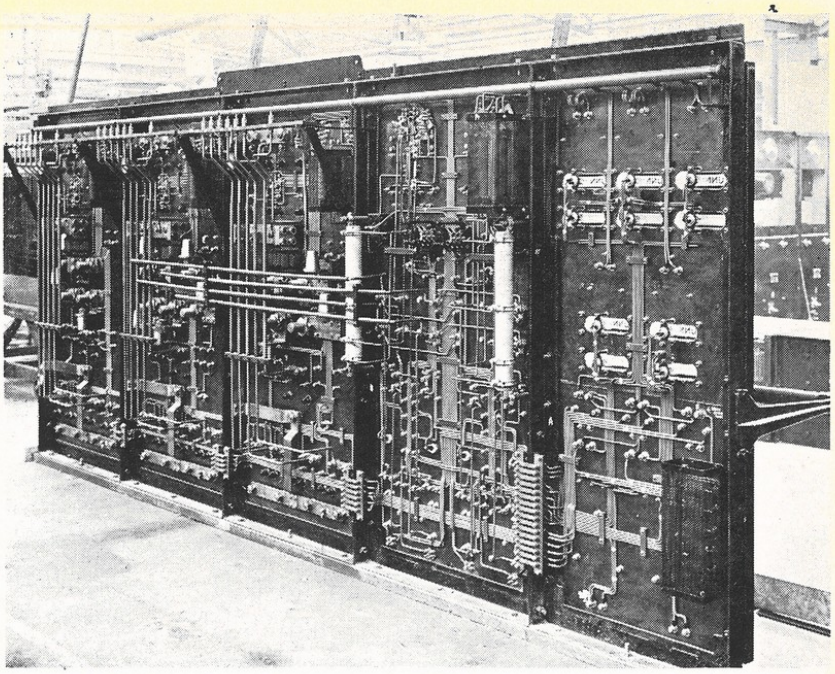
The major part of the energy generated is used in providing power for hotel services and auxiliary machinery described elsewhere in this publication. The extent of the use of electric motors is illustrated by the fact that there are over 650 of them, varying in size from $\frac{1}{4}$ to over 300 h.p., with a total of over 19,000 h.p. Over 500 of the control units for these motors, which include every type of D.C. starter, were made by Allen West & Co. Ltd., and "Ferry" was again used for all resistances. A corrosion-resisting steel containing 8 per cent. of nickel was used for bearing pins in the automatic contactor units and other items, it being essential that these components be free from corrosion and free-moving under all conditions.

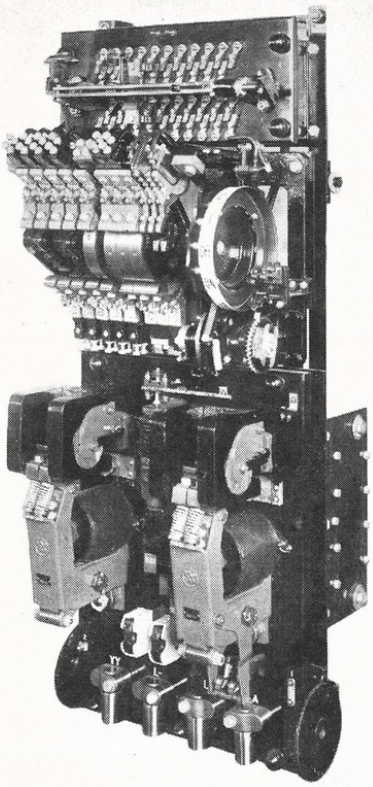
The network of communications in the ship is an electrical system, complete in itself but requiring only small power for its operation despite its importance. A comprehensive system of communication is obviously essential for the efficient working of the ship, convenience of passengers, and safety in emergencies. Each of these requirements is adequately catered for in the *Queen Elizabeth*. This may be instanced by the telephone system installed by the General Electric Co. Ltd., the extensive engine-room telegraphs by Siemens Brothers & Co. Ltd., and the radio equipment



RIGHT: The back of the motor control switchboard for the steering gear drive showing the banks of resistances and tubular resistances, all of which are wound with Ferry, nickel-copper alloy. The starting resistances for the main 250 h.p. motors are mounted away from the switchboard and are of the unbreakable grid type with grids of nickel-copper alloy sheet.

By courtesy of Brookhirst Switchgear Ltd.



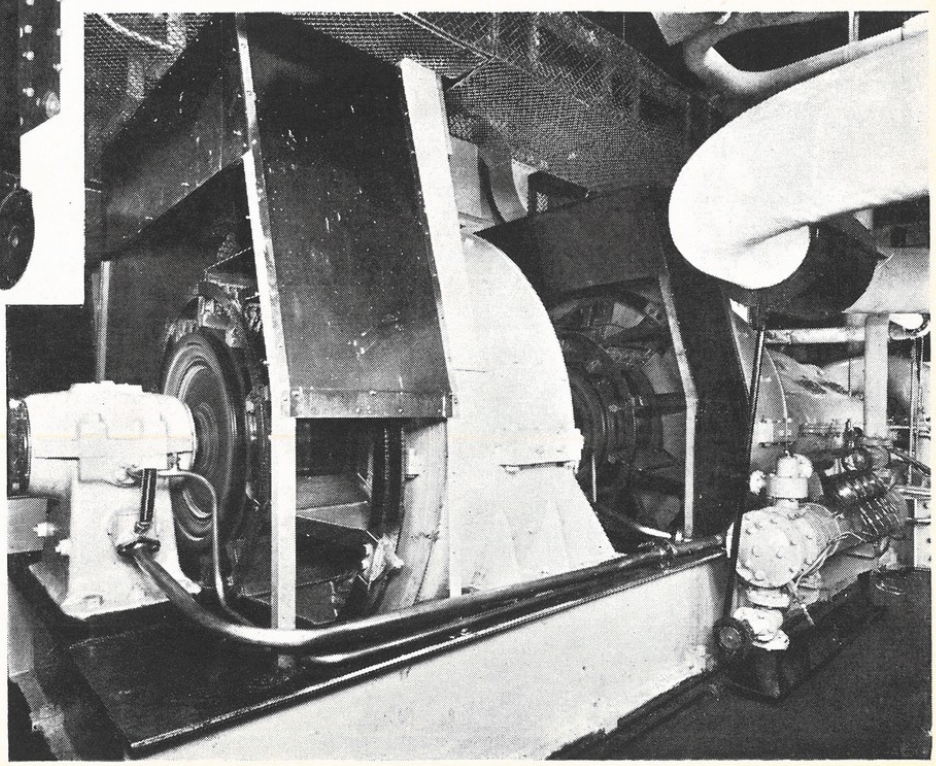


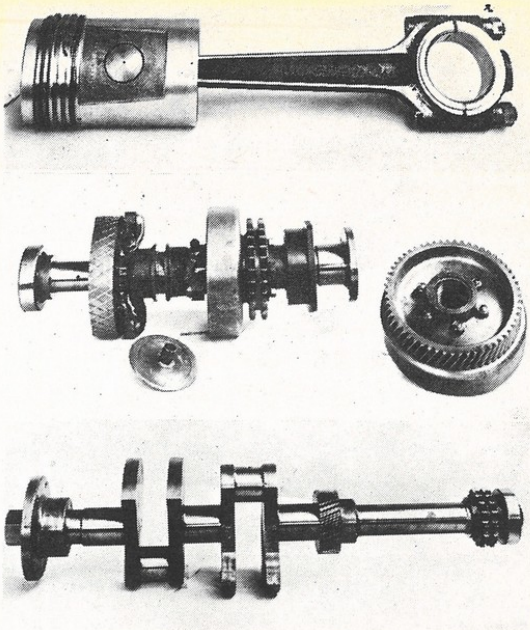
BELOW: Power is generated by four B.T.H. turbo-generators, which utilise a number of nickel alloys. H.P. and turbine stop-valve spindles are of nickel-chromium corrosion-resisting steel, oil-cooling tubes, condenser tubes and ferrules of 70/30 cupro-nickel, pinions and pinion shafts of the reduction gear of nickel alloy steel, corrugated joint rings of nickel, and shaft glands and diaphragm packings of nickel-bronze. The first-stage blading is of "Stayblade" heat- and corrosion-resisting nickel-chromium steel.

By courtesy of British Thomson-Houston Co. Ltd.

ABOVE: In this large hand-operated control, the bearing pins of the contactor and mechanism are of nickel-chromium corrosion resisting steel, and the resistance units (only the framework of which is shown in this view) are wound with Ferry.

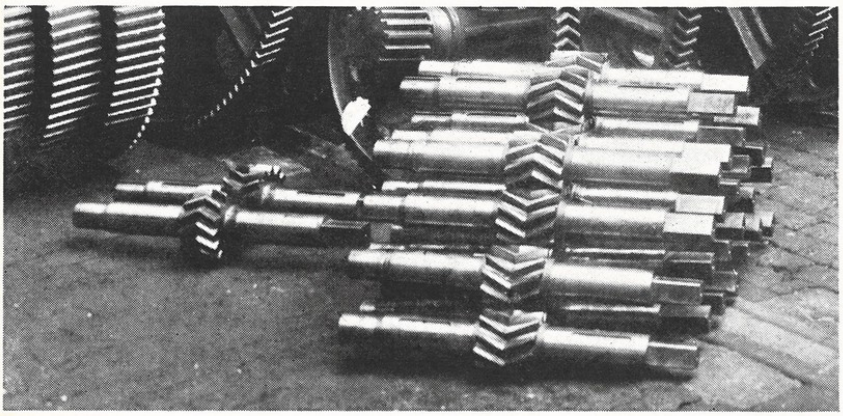
By courtesy of Allen West & Co. Ltd.





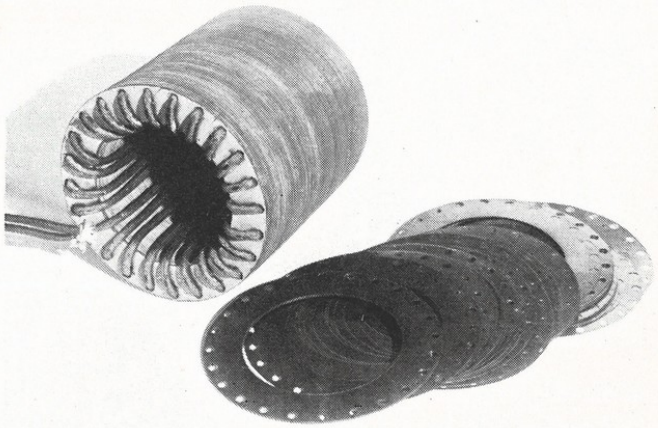
RIGHT: Some examples of the use of nickel alloys in the lifeboat engines. The reverse gear expanding member in the clutch assembly is of 2 per cent. nickel cast iron, the crankshaft of 1 per cent. nickel steel, the connecting rod and cap of $3\frac{1}{2}$ per cent. nickel steel and the connecting rod bolts of 3 per cent. nickel steel.

By courtesy of John I. Thornycroft & Co. Ltd.



LEFT: These 3 per cent. nickel steel pinions are part of the mechanism operating the lifeboat davits.

By courtesy of Keighley Gear Co.



ABOVE: One of the magnetostriction oscillators used in the "Hughes Recording Echo Sounder" and a stack of the thin nickel stampings from which these oscillators are constructed.

By courtesy of Henry Hughes & Son Ltd.

LEFT: The Sperry Gyroscope Mark XIV Master Compass, employs nickel alloys for a number of components (see page 14).

By courtesy of Sperry Gyroscope Co. Ltd.

by the International Marine Radio Co. Ltd. These are only three of the many and complex systems provided, all of which utilise nickel-containing alloys, including nickel-copper resistance alloys, nickel alloy magnets and nickel-copper-zinc electrical contacts.

In the telephone system there are 500 telephones and 585 lines, with an appropriately large switchboard. First-class passengers are provided with a telephone at their bedside, by which they can be linked to any ship or shore station. Throughout this system nickel silver containing 18 per cent. nickel has been used for the contact springs. The same alloy has been used for the contact springs in the engine-room telegraphs. The nickel silver selected for this purpose possesses corrosion-resistance, excellent spring qualities and low contact resistance. This latter property is particularly important where nickel silver to nickel silver contact is used without intermediary contact points of special metals.

The wireless equipment is of the latest type, including the radio-telephone system referred to above, the radar installations, and other equipment used for navigation or communication. In this equipment, among the nickel-containing materials used are nickel silver for contact springs and nickel wire, mesh or foil for valve components. Nickel plating is used to protect components against corrosion.

A complete list of the uses of nickel and alloys of nickel in the electrical and communication equipment would be as lengthy as a list of the circuits themselves, but the few examples given above will illustrate the extent and nature of the use of such materials.

III. NAVIGATIONAL AND SAFETY EQUIPMENT

The advances in design and technique, indicated elsewhere in this publication, which have been incorporated in the machinery and hotel services of the *Queen Elizabeth* have not outstripped the improvements and additions made to the navigational and safety equipment. Radar, wireless direction-finding, depth-sounding, standard compass, sextant, chronometer, lifeboats, emergency generators, etc., all assist in ensuring that the Atlantic crossing is made in as short a time and as safely as possible.

As in the case of the electrical equipment, the navigational and safety equipment is so extensive that only a selection of examples of the use of nickel or nickel-containing alloys can be described and illustrated.

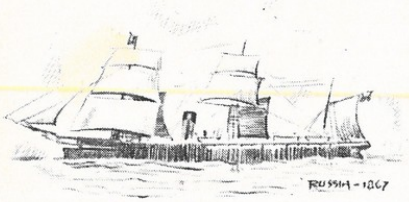
One of the most interesting of the navigational aids is the Gyro Compass and Gyro Pilot. This consists of two complete Sperry Gyro Compass installations with the usual accessories, including repeaters and course recorder,

and also a Sperry self-synchronous automatic pilot. Steering by gyroscopic means, utilising the earth's rotation as the controlling factor, has introduced a degree of accuracy which would not have been believed possible in the early days of ship navigation. The fact that the gyroscopic compass is non-magnetic in its operation and is not affected by extraneous influences, together with the fact that by its means steering can be made automatic, has contributed in no small measure to increased safety and efficiency at sea.

In the Sperry Gyro Compass equipment the properties of various nickel alloys have been used to obtain the maximum possible reliability. Outstanding instances of this are the use of a high-tensile nickel-chromium-molybdenum steel shaft for the 55 lb. rotor, which is the heart of the instrument; of Monel for the bodies of the contactors, which, by means of tungsten contacts, carry current to certain components in one of the compasses; of nickel for the anodes in the valves of the follow-up system of the second compass; and of nickel silver for the speed-corrector scale, the slip rings which carry current to the rotors and other components, and for the contact rings of the automatic pilot. All bright parts of the equipment are nickel plated.

The automatic pilot and hand-steering gear control the rudder through hydraulic rams. In the rudder itself, which weighs 140 tons, use has been made of corrosion-resisting 18 per cent. chromium, 8 per cent. nickel steel bolts and nuts, while for the rudder pintle bushes the 18 per cent. chromium, 2 per cent. nickel steel is used. The rudder is hydraulically operated, the flow of oil to the rams being controlled by hydraulically operated valves. The power for the rams is developed in 285 h.p., and that for the valves in 4 h.p. electric motors driving hydraulic pumps. The control gear for these motors was manufactured by Brookhirst Switchgear Ltd. The starting resistances which are of the unbreakable grid type, mounted away from the switchboard, are in nickel-copper alloy, and the control resistances on the switchboard are of "Ferry", the 44 per cent. nickel-copper resistance alloy.

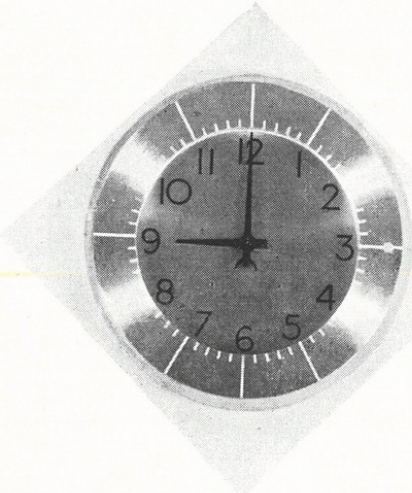
Another interesting and modern navigational aid, which utilises a magnetic property of pure nickel, is the Hughes Recording Echo Sounder. This is fitted in the chart room of the *Queen Elizabeth* and employs transmitting and receiving elements of pure nickel. These sound resonators or oscillators are fitted in tanks welded inside the hull of the vessel near the keel. The transmitter sends out a short pulse of sound waves, which is echoed back from the ocean bed and picked up by the receiver. The recording apparatus measures the time taken for the sound to go down and return, and presents it as a depth measurement on a slowly moving band of paper.



The method used to produce sound vibrations in the water, which although highly efficient

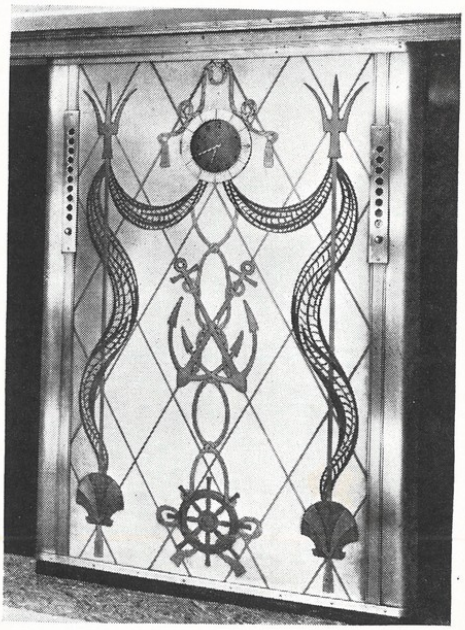
Main Hall on the Promenade Deck showing extensive use of nickel silver for decorative metalwork. The handrail, balustrading and trim to the staircase, the balustrading to the gallery, beadings to the columns and panelling, ceiling lighting fittings and metal trim to the plant tubs are all of nickel silver.

By courtesy of Bath Cabinet Makers & Artcraft Ltd., and George Parnall & Co. Ltd.



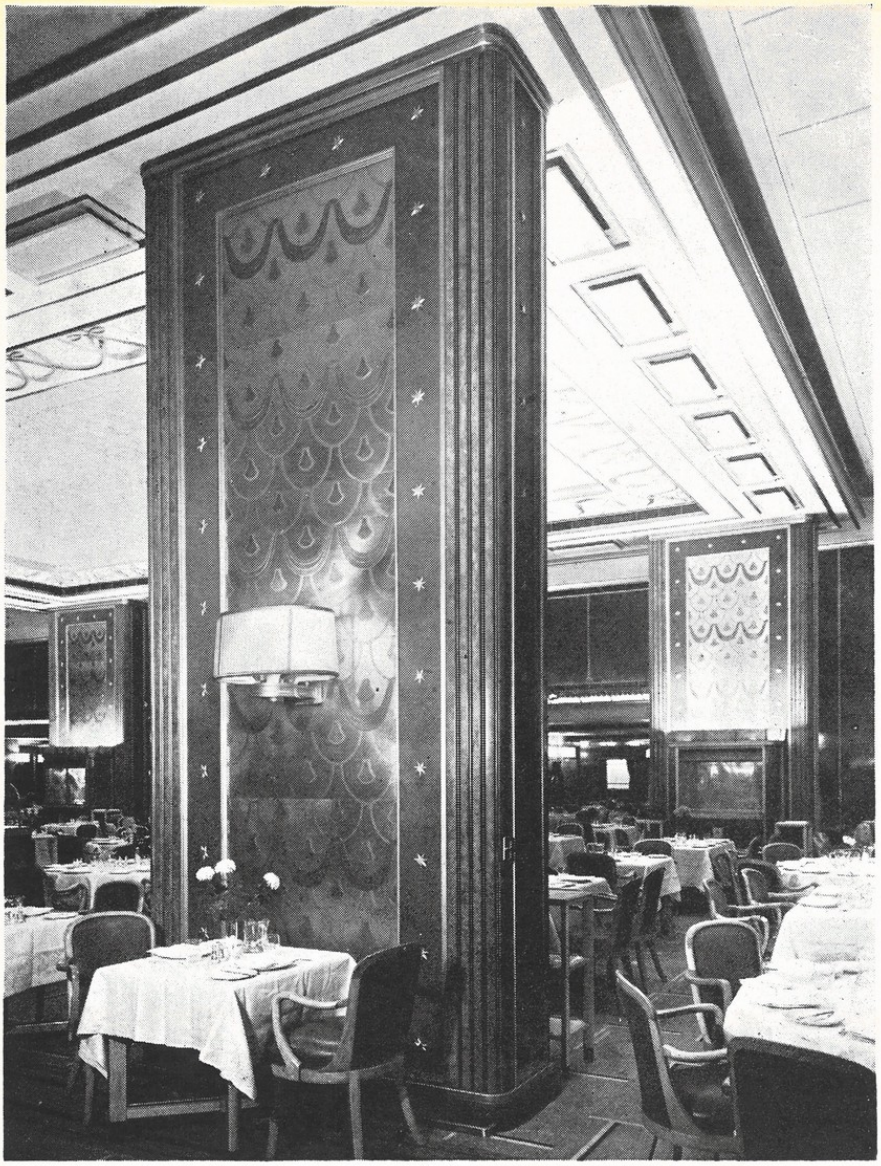
Clock face in nickel silver.

By courtesy of Thomas Mercer Ltd.



A decorative metallised panel sprayed with nickel and phosphor bronze on a dark bronze background to the design of Jan Juta.

By courtesy of J. Starkie Gardner Ltd.



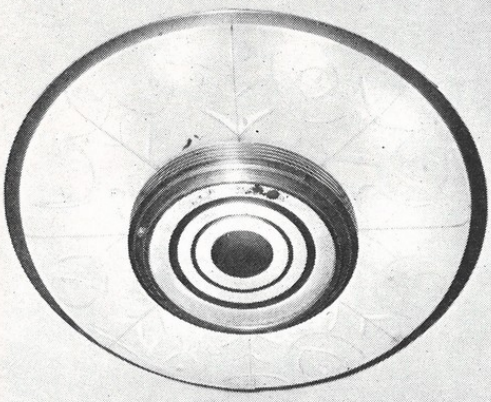
LEFT: A view of the First Class Main Dining Room. The decorative metallised panels, designed by Jan Juta, are of bronze sprayed with nickel, phosphor bronze and stainless steel.

By courtesy of J. Starkie Gardner Ltd.

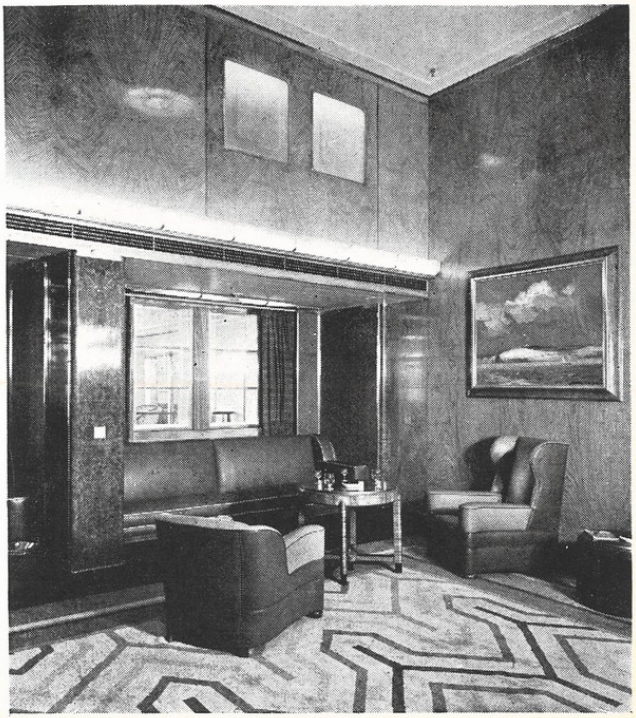
BELOW: Cabin Class Dining Room. Nickel silver is used for the lighting fittings, door furniture, mirror frames, terminal collars to columns and beading to the strip lighting. The dumb waiter tops and safety ridges are of Monel and the splash backs of nickel silver.

By courtesy of G. T. Rackstraw Ltd.

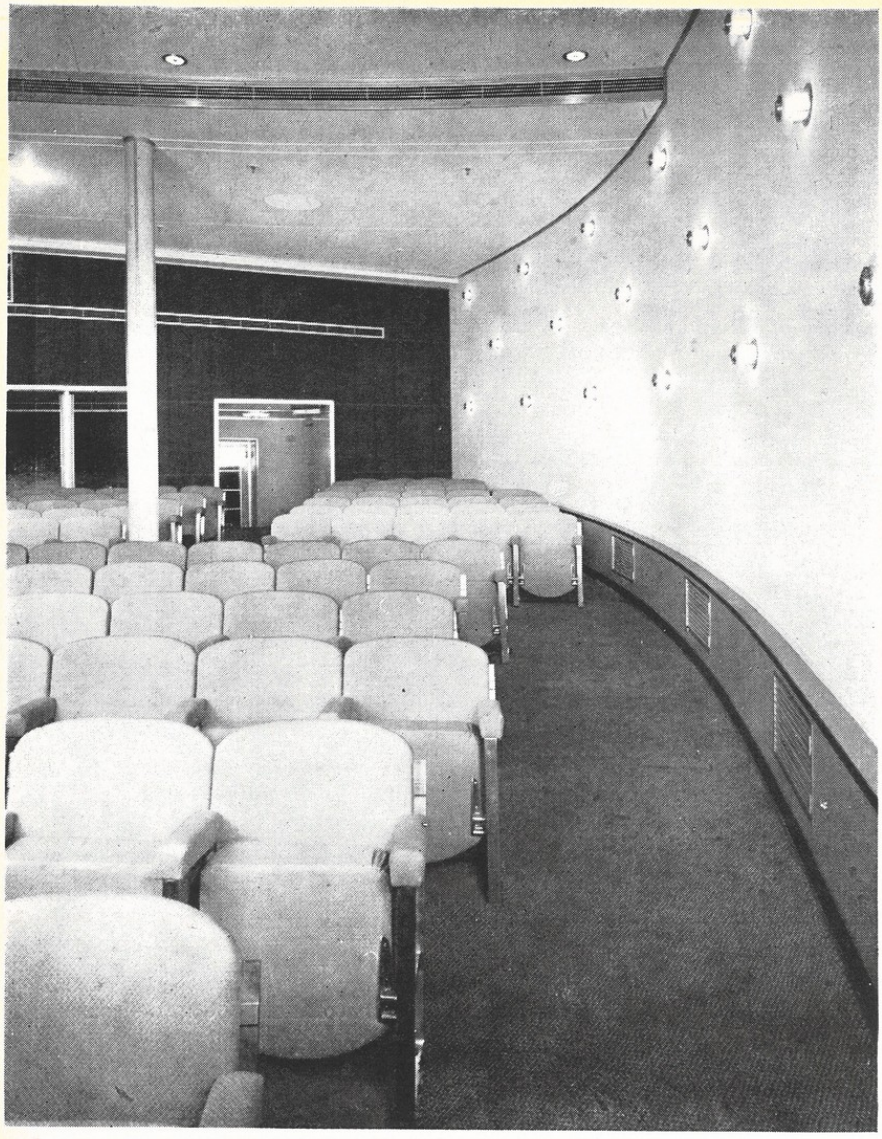
First Class Smoke Room. Use is made of nickel silver as an enrichment to fine wood panelling and columns, for air vents, strip lighting fittings and window framing. One of the nickel silver ceiling lights is shown on the left.
By courtesy of Waring & Gillow (1932) *Ltd.*



By courtesy of British Thomson-Houston Co. Ltd.

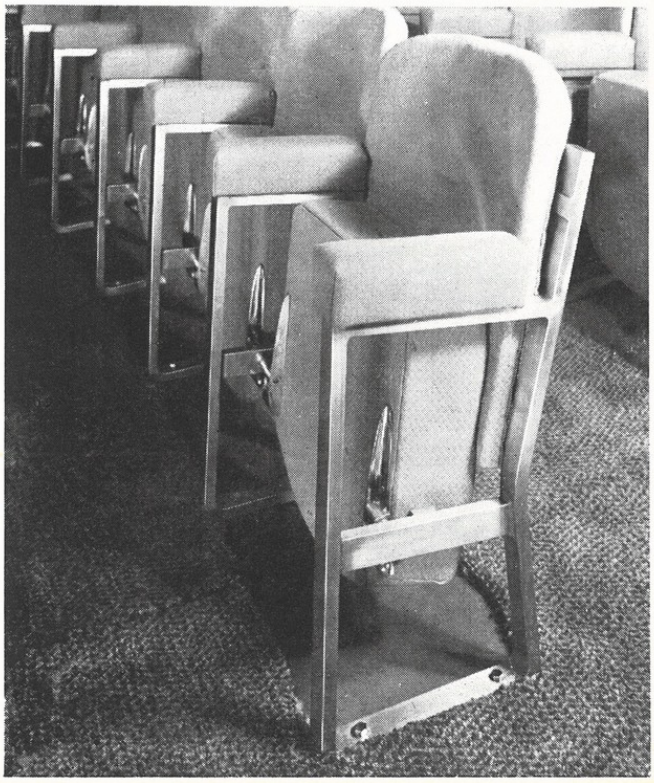


A corner of the First Class Smoke Room showing nickel silver beading to the picture frame, columns and lighting fittings and the nickel silver window frames and ventilation grilles.



A view of the First Class Cinema and Theatre with seating accommodation for some 380 passengers. The supporting standards for the seating are built up from solid-drawn rectangular nickel silver tube. The bracket supports for the underside are of cast nickel silver. The upholstery is carried out in red fabric.

By courtesy of J. Starkie Gardner Ltd.



is remarkably simple, depends on magnetostriction. Magnetostriction is the property possessed by certain metals of expanding and contracting when subjected to the influence of a varying magnetic field. Nickel is one of the best examples of the few metals with this property. Nickel contracts in an increasing and expands in a decreasing magnetic field.

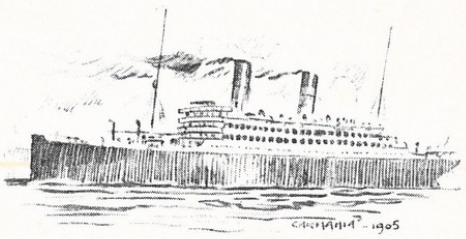
The magnetostriction oscillators are constructed in the form of hollow cylinders, built up from thin circular nickel stampings, through which a few turns of wire are wound to convey the magnetising current. The tanks in which the oscillators are suspended are kept permanently filled with water, yet the packs require no attention and no anti-corrosive treatment other than an initial dipping in insulating varnish.

Despite all the precautions and skill of builders, owners and crew, emergencies may arise and must be allowed for, from a simple electrical failure to an emergency which necessitates abandoning the ship. The regulations laid down by the Board of Trade, Lloyd's Register of Shipping, and other responsible bodies governing the safety of passengers and ships, have been more than fully complied with.

The ship has been divided into 140 water-tight compartments, the doors in the bulkheads directly controllable from the bridge and the entrance to the turbo-generator room. Indicators have been fitted on the bridge which enable the Commander to see the position of every door in the ship.

Twenty-six lifeboats are installed, each capable of carrying more passengers than the original Cunarder *Britannia*. These lifeboats are motor-driven by high-speed Thornycroft diesel engines, in which full use has been made of the strength and reliability of nickel steels. The connecting rods and caps are in $3\frac{1}{2}$ per cent. nickel steel, and the bolts in 3 per cent. nickel steel. The crankshafts are in 1 per cent. nickel steel, and the reverse gear expanding members in 2 per cent. nickel cast iron. The davit gear, by Samuel Taylor & Sons, which enables the lowering of the boats to be controlled by one man, employs certain gears and pinions manufactured in 3 per cent. nickel steel.

Apart from major emergencies necessitating the abandonment of the ship, provision is made for minor breakdowns, as instanced by the emergency battery for the low-voltage (25 v.) electrical system supplying power for the call bells and indicators, intercommunication telephones, electric clocks, etc. The battery was supplied by Nife Batteries Ltd., and is of the nickel-alkaline type consisting of two units, each of 120 Ah. and comprising nineteen cells. These batteries require no attention whilst not in use and, as there is no loss of charge when the batteries are standing idle, there is no upkeep cost.



Similarly, provision is made in case of failure of the main turbo-generator. In this case two 75 kw. 220 v. diesel-driven generating sets have been provided, situated on one of the upper decks. The two diesel engines were supplied by Associated British Oil Engines Ltd. Each has six cylinders and develops 133 b.h.p. In these engines extensive use has been made of 3 per cent. nickel steel for such components as camshafts, intermediate and crankshaft gears, fuel-pump driving shafts, engine-studs and bolts for cylinder heads, cylinder casings and connecting rods.

IV. PASSENGER ACCOMMODATION

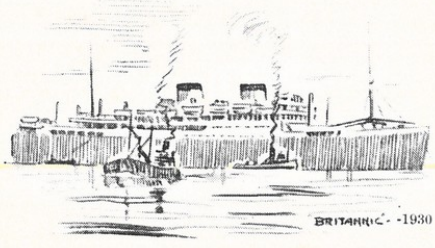
Prominent among the many striking features of the First-class, Cabin and Tourist accommodation provided, is the sense of spaciousness, combined with evidence of attention to detail planning to ensure that no service or amenity is lacking which might meet the needs, or contribute to the comfort or convenience of the passengers. In addition to private suites, staterooms and cabins and the 35 public rooms, the extensive service and recreational facilities provided include theatre, cinemas, shopping centre, gymnasia, nurseries, bank, hospital, Turkish bath, swimming pool, travellers' bureau and garage.

Decoration

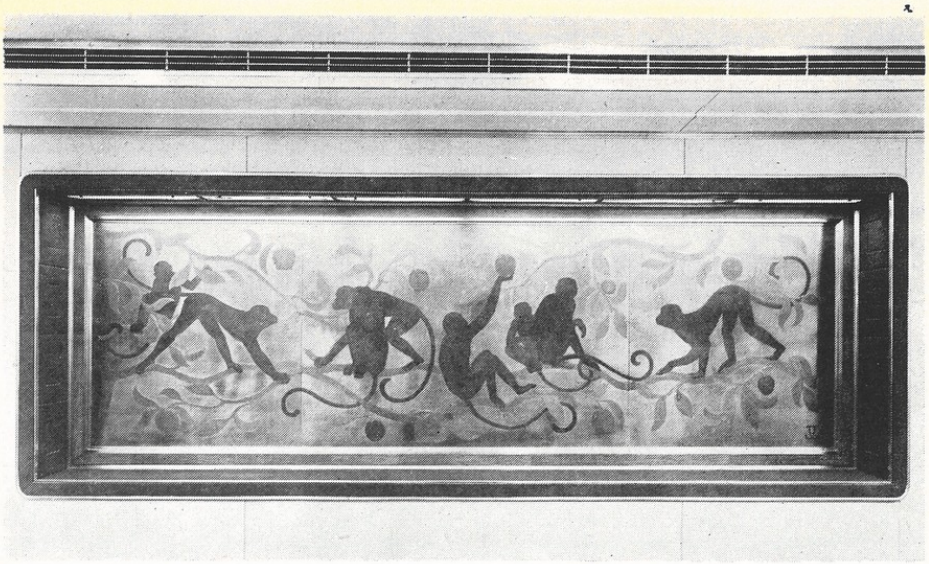
The most striking visible application of nickel is undoubtedly in the decorative setting in which these services and amenities are enjoyed, where the decor, combining, in a modern restrained style, dignity with architectural lightness, attains standards in artistic expression and execution fully in keeping with the achievements in naval architecture and marine engineering in other departments of the ship.

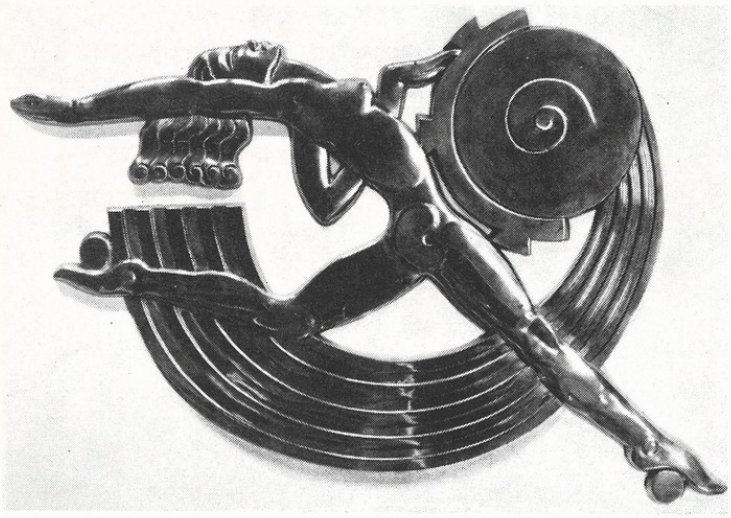
In the following paragraphs an attempt will be made to outline the role played by nickel-containing materials in decorative construction. This is also illustrated in the photographs reproduced, showing views of some of the public rooms, passenger-space, and decorative details.

As in her sister ship *Queen Mary*, the white nickel-copper-zinc alloys (better known as nickel silver or "silver bronze") have been very extensively used in the various decorative schemes adopted throughout the passenger accommodation of the *Queen Elizabeth*. This is quite in accordance with modern practice in architectural decorative work, both afloat and ashore, as the pleasing silver-white finish obtainable in both cast and varied wrought forms of nickel silver,



RIGHT: A decorative panel in one of the private dining rooms. The panel, designed by Jan Juta, has been metallised with nickel, phosphor bronze and stainless steel.

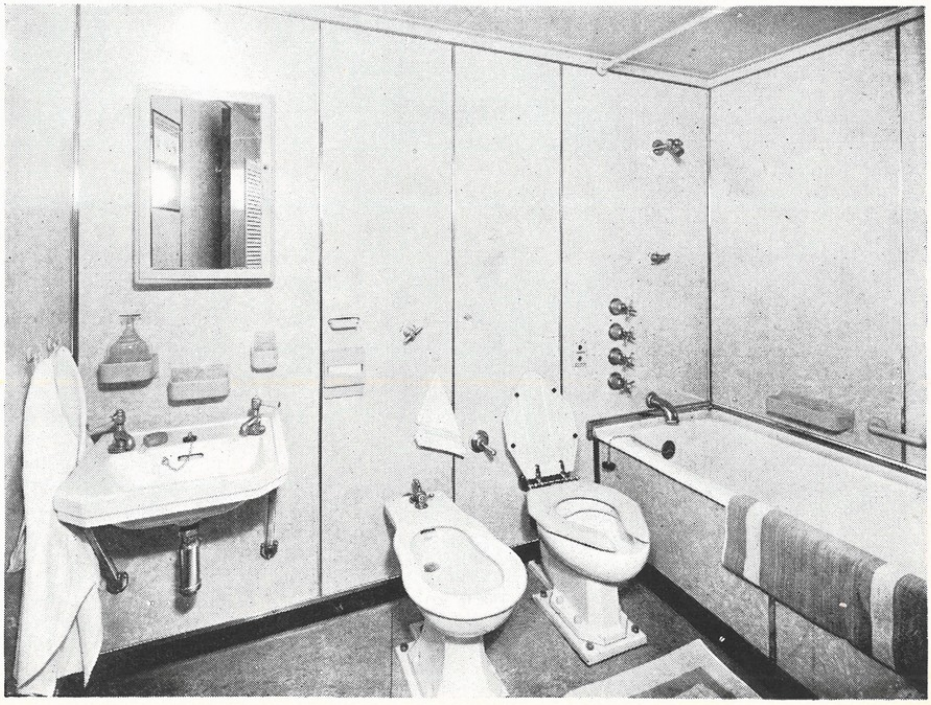




LEFT: A decorative motif, one of a set of nine in the Cabin Class Smoking Room symbolising various materials used in the construction of the ship. The one illustrated is of 20 per cent. nickel silver. Sculptor - Norman J. Forrest.

RIGHT: Sanitary fittings of Shanks's "Aconite" (20 per cent. nickel silver) are used throughout the ship. This view of one of the bathrooms illustrates the range of fittings involved. The bath rim beading and metal strips over the wall panelling joints are of Staybrite corrosion-resisting steel.

By courtesy of Shanks & Co. Ltd.

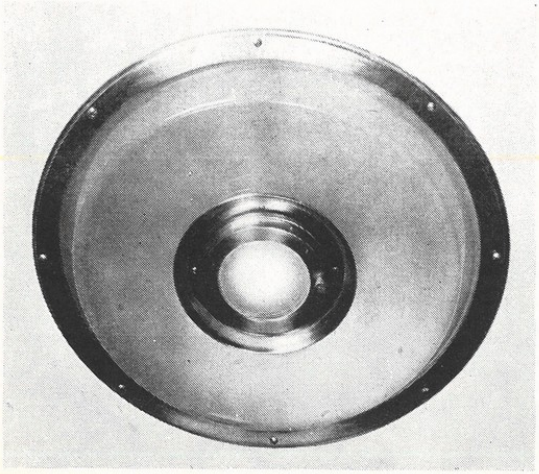


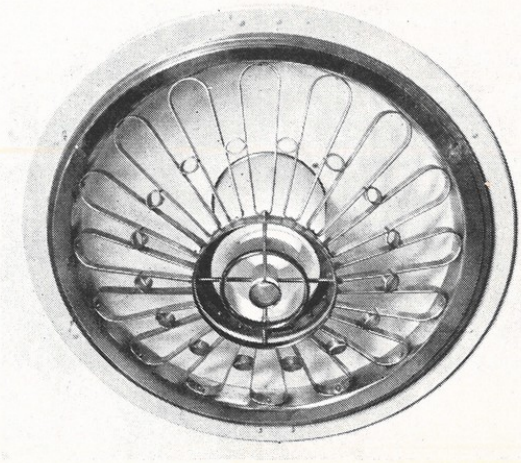
LEFT: First Class Cocktail Lounge in which nickel silver is used for the decorative balustrading, bar fittings, metal trim of bar and beading to columns. The handrail round the front is of cupro-nickel.

By courtesy of Trollope & Sons (London) Ltd.

RIGHT: A corner of the First Class Cocktail Lounge showing the nickel silver balustrading, door and window framing, door furniture and clock rim.

BELOW: Two types of ceiling light executed in nickel silver.



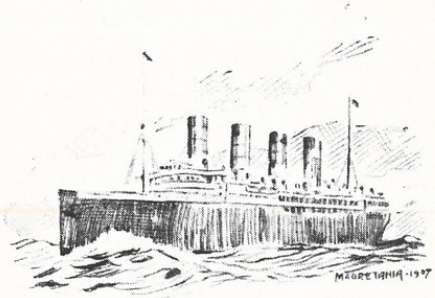


in association with the very desirable characteristic of ease of maintenance even in marine atmospheres, ensures a strong position for these alloys in modern decorative materials.

In the *Queen Elizabeth* full use has been made of the aesthetic appeal created by blending the soft silver "satin" or "matte" finishes obtainable on nickel silver with the rich variegated colourings of Empire woods, tapestries, coloured leathers, plastics and glass. At the same time this alloy has the advantage of ability to withstand the service demands of arduous usage on such details as door furniture, kicking plates, luggage strip in halls and passageways, and handrails and balustrades on staircases. The extensive decorative use of nickel silver is probably best illustrated by reference to the various views given of passenger accommodation, including as it does, decorative beadings and mouldings, window-frames, metalwork of lighting fittings, jardinieres, columns, screens and panels, clock-faces, frames for decorative features and mirrors, ventilation and ornamental plaques, bureau-grilles, shop fronts and numerous minor furnishings, such as fittings of writing-tables and theatre seat- and door-furnishings.

In certain of the public rooms and passenger spaces the extensive decorative metalwork is entirely in nickel silver. Views of some of these, the First-class Main Staircase, Hall and Entrances, First-class Smoke Room, Cabin Main Lounge and Dining Room, are given. Reference, for example, to the view of the Cabin Main Lounge will indicate how extensively is the metalwork used for such items as wall and ceiling lighting fittings, air-conditioning extract plaques in ceiling, collars at top and bottom of columns, panel beading, balustrading to platform, coupled columns and jardinieres, false windows, window-frames and sliding sashes, map-feature framing, writing-table fittings, clock-cases, door-furniture, etc.

In addition to the decorative application, nickel has played a varied and important part in the equipment and installations contributing to passenger service, comfort and entertainment. Certain of the more important of these applications have been referred to in the sections of this publication dealing with electrical installations and catering equipment. It is, however, obviously impossible to detail all the varied requirements which have been met by nickel-containing alloys for small detail components throughout the extensive services provided. They range from the high electrical, heat and scaling resistance of the 80/20 nickel-chromium wire constituting the heating elements of the modern convection-type Thermovent cabin heating installations, to the special physical, electrical and chemical properties of the many nickel alloy components in bedside telephone installations, steward-call system and radio broadcasting system throughout the passenger accommodation.



Special Decorative Effects

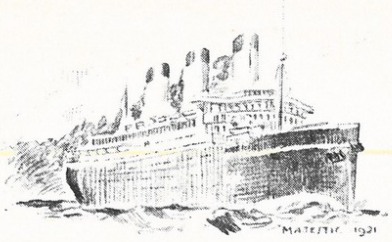
Among the many works of art and special decorative effects contributed by artists of international repute, the series of nine bas reliefs designed by Norman Forrest and located in the Cabin Smoke Room calls for particular reference. These illustrate the materials used in the construction of the ship, and the media used include steel, copper, nickel silver, bronze, aluminium, lead, wood, rubber and glass. Each panel embodies a motif illustrating the origin and use of the material used, and an impression of the excellence of artistry and technique involved is given in the photographic reproduction of the panel in this series depicting white metal.

Of particular interest, also, are the several examples of the modern technique of decorative metallising or metal spraying through stencils. In this work, sprayed metal is the medium of expression, the varied colours desired being obtained by selection of suitable metals, such as nickel, copper, Monel, phosphor bronze and stainless steel. It will be appreciated that only those metals having artistically pleasing appearance, permanence of colour and lustre, and freedom from corrosion in marine atmospheres, are acceptable. It is significant that in the excellent example of this technique—the Monkey Panel in the After Dining Room (port)—executed by J. Starkie Gardner Ltd., sprayed nickel is used in contrast with sprayed phosphor bronze and stainless steel on a background panel of nickel silver.

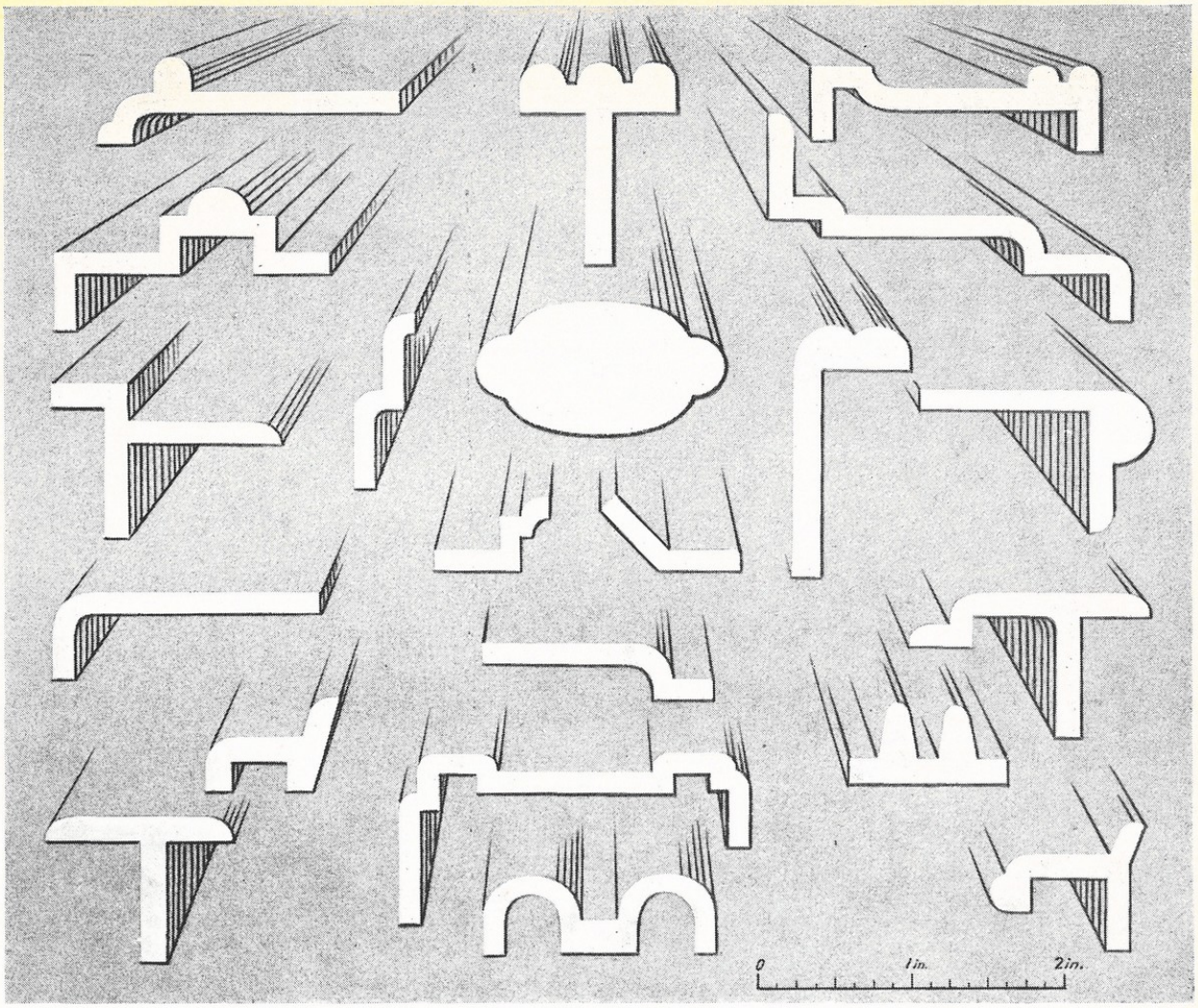
Further examples of this craft, also by J. Starkie Gardner Ltd., are the decorative metallised panels of various design on "A", "B", "R" and Main Decks, in which sprayed nickel and nickel silver contrast with sprayed phosphor bronze on a dark bronze background, and the decorative panels between pillars in the First-Class Restaurant. Here again, sprayed nickel, in combination with phosphor bronze and stainless steel, is employed to convey the artistic expression desired. Decorative nickel spraying has also been used as a finish to the supporting columns in the Cabin Cocktail Bar.

Service Experience

The splendid war services of *Queen Elizabeth* and *Queen Mary* are too well known to require recapitulation here. It is of interest, and appropriate in this section, to refer to the service experience with those nickel silver fittings which remained in these ships during their service as troop carriers. We are indebted to Delta Metal Co. Ltd. for permission to reproduce the following extract from a report prepared on the metalwork of these ships as a preliminary to refitting:

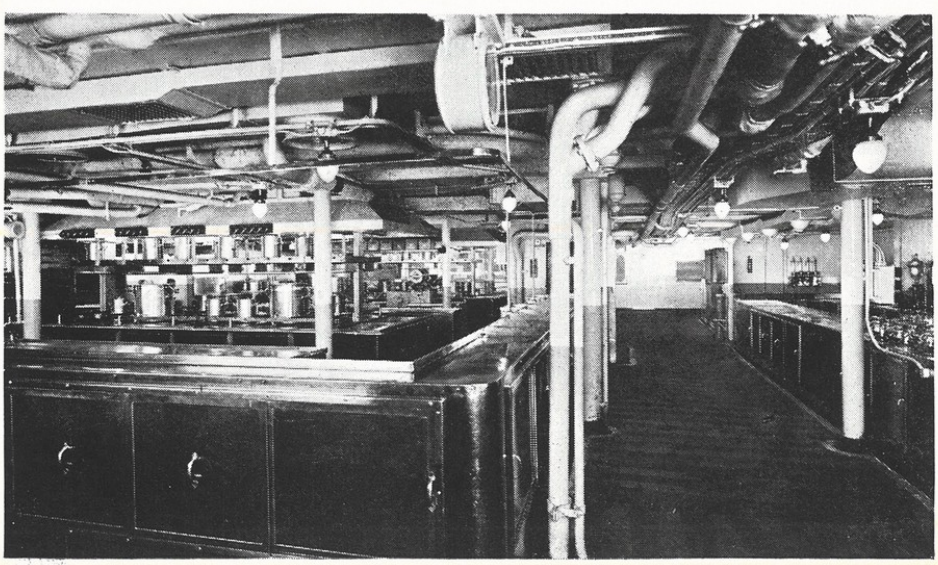


You will, I am sure, be gratified to hear that Delta No. 2 Silver Bronze has stood up very well to the exceptionally hard testing time of the war years where 15,000 *troops*



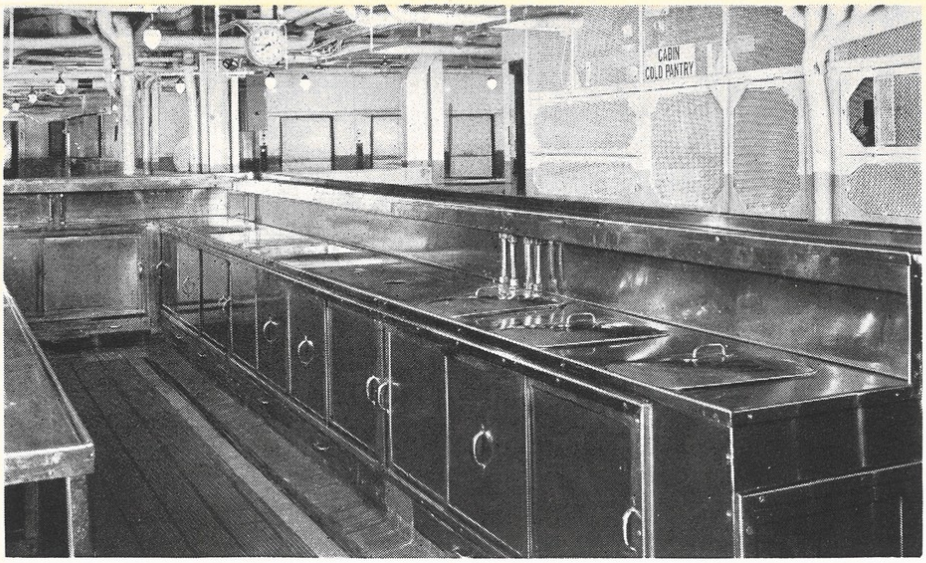
Some of the nickel silver sections used in the public rooms.

By courtesy of the Delta Metal Co. Ltd.



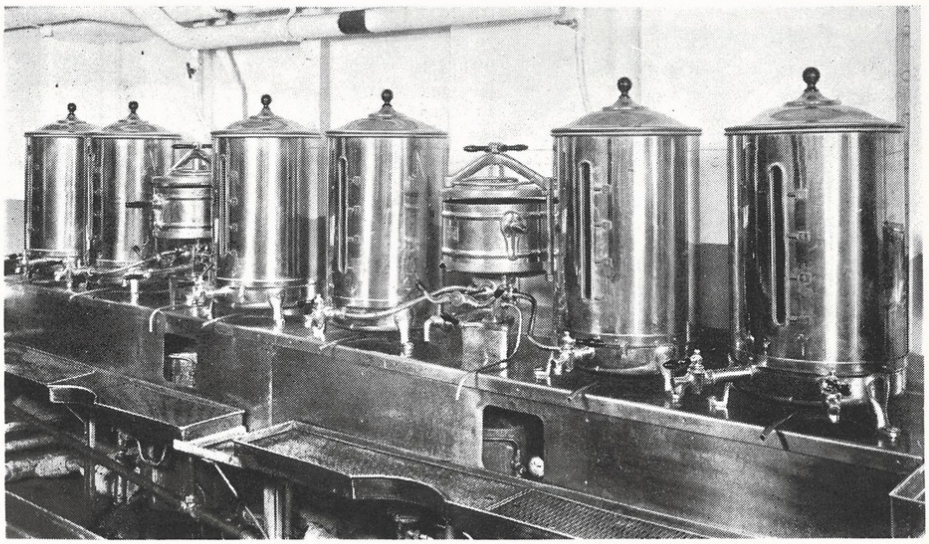
Staybrite corrosion-resisting steel is used extensively in the kitchens.

By courtesy of Henry Wilson & Co. Ltd.



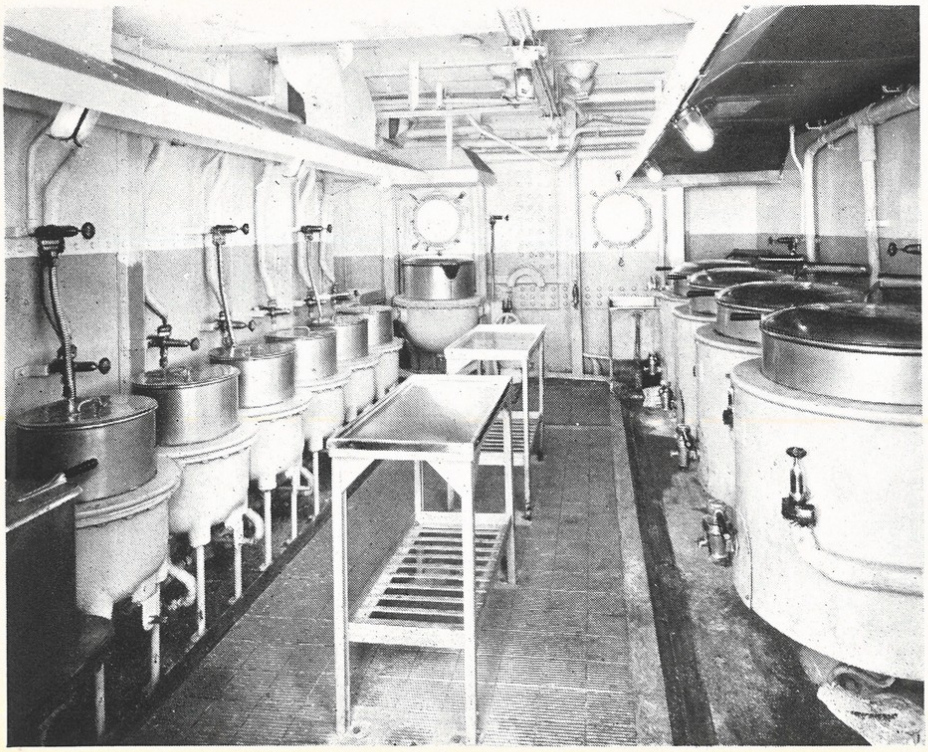
LEFT: Part of the Cabin Class Kitchen, showing a steam-heated hotpress in Staybrite corrosion-resisting steel, with Bainmarie tanks of Monel.

By courtesy of Henry Wilson & Co. Ltd.



RIGHT: Coffee making machines of Monel.

By courtesy of W. M. Still & Sons Ltd.



LEFT: Steam kitchen showing steam-jacketed stock pots on the right with nickel inner bodies and covers, Staybrite covered tables in the centre and steam-jacketed vegetable boilers on the left with nickel linings, covers and vegetable baskets.

By courtesy of Henry Wilson & Co. Ltd.

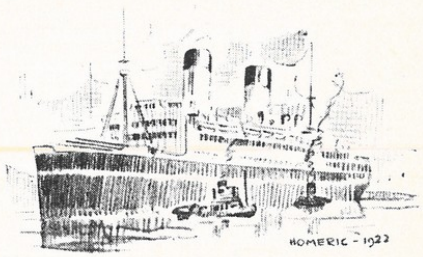
have been carried nearly every trip, so that every cabin has been used as was never intended. In spite of this, doors and windows being opened and closed goodness knows how many times, baggage of all sorts and conditions being banged against the Delta No. 2 Silver Bronze door joints, and feet shod in army boots kicking against them—the metal today is as good as when it was put in, and will only have to be cleaned "in situ", and this applies equally to the "Queen Elizabeth" so far as this vessel was fitted out.

Sanitary Fittings

The sanitary installation is of considerable technical interest, in that it embodies the latest and best plumbing practice as used in many modern hotels and public buildings of Europe and America. The system is based on the "one pipe" system originally evolved for the owners in conjunction with the London School of Hygiene and Tropical Medicine for the *Queen Mary*, and it has been fully proved during the passenger and war service of this ship.

This is no place to discuss the many and varied problems involved or the manner in which each was solved, but some idea of the complexity of the system can be readily appreciated by examination of the lavish provision of toilet facilities, which is one of the main features of the passenger accommodation. Practically all first- and cabin-class staterooms and cabins have private bathrooms or toilets attached, and these contain sanitary equipment and fittings of the most up-to-date type and design, including plunge and shower baths for hot or cold, fresh or salt water, wash basins and W.C.s. Generous provision of these facilities is also a feature of the tourist accommodation. It is of interest that, in accordance with the modern conception of sanitary installations, 20 per cent. nickel silver was used throughout for all exposed metalwork of the system, including fittings for showers, bath supplies, wastes, lavatories, plug chains, towel-rails and wall flanges. The suitability and economy of nickel silver for such services has been established by extensive experience and is based upon consideration of decorative appeal and ability to harmonise with the many and varied multi-coloured decorative bathroom schemes. Ease of cleaning, combined with solid whiteness throughout, thereby eliminating any danger of removal of protective coatings by abrasive or chemical cleaning agents, coupled with resistance to corrosion by humid or marine atmospheres are further practical considerations enhancing the attraction of this material for bathroom- and toilet-fittings.

In association with these properties, the availability of nickel silver either as castings or in such wrought forms as bar, sheet, springs, tubing or varied sections, wire and assembly details, such as nuts and bolts, enhances its suitability as a material for all sanitary purposes.



The extensive use of Staybrite corrosion-resisting steel strip drawn on brass and wood cores over the joints in the bathroom panelling also deserves reference.

V. CATERING EQUIPMENT

The spacious planning and lavish equipment of the catering department of the *Queen Elizabeth* clearly demonstrates the owners' appreciation that the impressions of their voyage retained by transatlantic travellers are strongly influenced by the cuisine provided. To maintain the acknowledged high reputation which the company has established in this sphere and to provide some ten thousand meals daily, the planning and equipping of the kitchens and complementary service have been based on skilful combination of catering experience with the provision of the most up-to-date food handling and cooking equipment.

In the manufacture of this equipment, extensive use has naturally been made of the modern culinary materials nickel, Monel and corrosion-resisting steel. These materials have long been established in the food handling and processing industries by reason of their ability to meet the exacting requirements of resistance to chemical attack by food, ease of cleaning, pleasing appearance, long life and ability to withstand service usage.

'Staybrite' corrosion-resisting steel has been particularly widely used, and all sinks, table and dresser tops, and general trim of cooking ranges, ovens, hot presses, cupboards and dish-washing machines have been executed in this material, bright and dull polish finishes being used to provide an effective contrast. In actual contact with foodstuffs and beverages, nickel and Monel have mainly been used and nickel-chromium resistance alloy has been universally adopted in the Wilson-B.T.H. Torribar electrical heating elements fitted to ranges, ovens, hot plates, water and coffee boilers. Use has also been made of nickel steels and nickel cast irons for the refrigerating equipment, while table ware and cutlery are almost all in heavily silver-plated nickel silver.

It is obviously impracticable in a publication of this nature to refer to all the detailed applications of these materials throughout the complex kitchen installation of a liner equipped on the scale of the *Queen Elizabeth*. Accordingly reference will be confined to typical applications in some of the main items of equipment as detailed below.

Main Cooking Utensils

All the main cooking utensils used are of solid nickel plated on the outside with copper to improve heat conductivity.

Vegetable Boilers

The steam-jacketed vegetable boilers have linings and covers of polished nickel, with perforated pure nickel baskets to hold the vegetables.

Stock Pots

Three of the stock pots, of American manufacture installed during the war, are manufactured in corrosion-resisting steel. The remaining twenty steam-jacketed stock pots are nickel-lined and are fitted with polished nickel covers.

Bainmarie Tanks

The bainmarie tanks for use with the hot presses are constructed in Monel: those used in conjunction with the electric ranges are in corrosion-resisting steels. For both the tureens used are of nickel.

Fish Fryers

The fish fryers have corrosion-resisting steel fat pans and drainers with pure nickel wire baskets.

Water Boilers, Coffee and Milk Urns

All the many water boilers, coffee and milk urns distributed throughout the various kitchens and service pantries are in Monel, and Monel is similarly used in the various sets of coffee-making apparatus installed in the main kitchens.

Torribar Heating Elements

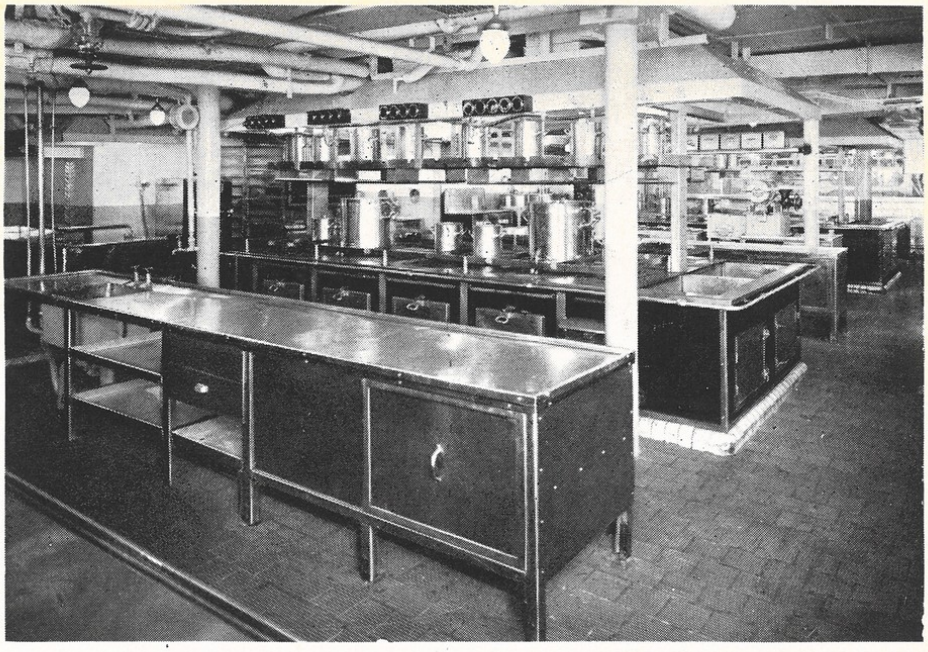
These electrical resistance heating units, which are of particularly robust construction as befits their heavy and constant service duty, consist of a helix of 80/20 nickel-chromium resistance wire inside, but insulated from, a corrosion-resisting steel tube. Leads and terminals are of nickel. For hot-plate applications these elements are cast integrally with the iron plates, while in the ovens they are supported by stainless steel racks on either side of the cooking space.

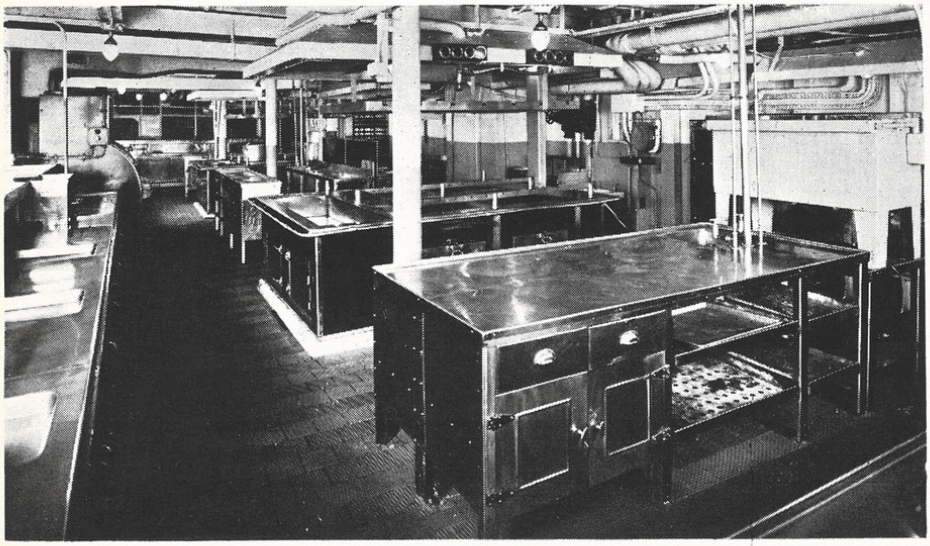
Refrigerating Equipment

The main carbon dioxide refrigerator compressor is fitted with $3\frac{1}{2}$ per cent. nickel steel compressor rods to meet the service requirements of moderately high tensile strength with maximum toughness and ability to take and maintain a high-polished surface. In the subsidiary Freon and methyl chloride compressors, cylinder blocks, cylinder head and crank cases are in 1·5 per cent. nickel cast iron to ensure pressure-tightness and wear-resistance combined with good machinability.

Table Ware and Cutlery

Practically all the table-ware, hollow-ware and cutlery, much of which is specially designed for use on the ship, is in heavily silver-plated nickel silver, mainly of the 15 per cent. nickel variety. Some idea of the extent of the use of this material can be judged by the fact that, excluding spoons and forks, items such as teapots, salvers, vegetable dishes, entrée dishes and cruets number around 21,600.



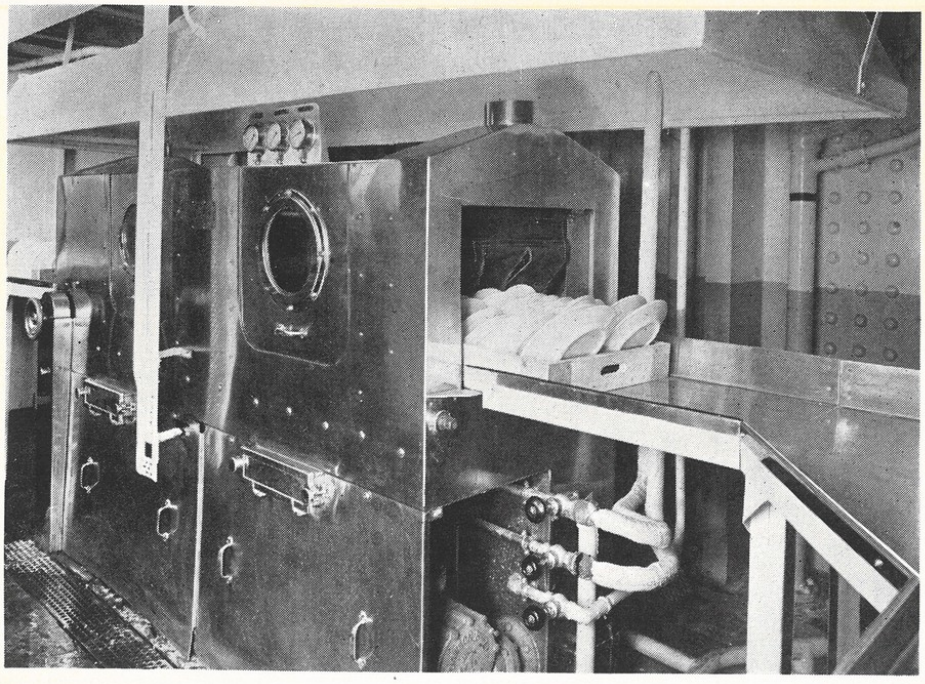


LEFT & ABOVE: General views of kitchens showing solid nickel cooking utensils and very extensive use of Staybrite corrosion-resisting steel for tables and dressers, range tops, handrails, sinks and general trim.

By courtesy of Henry Wilson & Co. Ltd.

RIGHT: View of charcoal grill showing extensive use of Staybrite corrosion-resisting steel.

By courtesy of Henry Wilson & Co. Ltd.

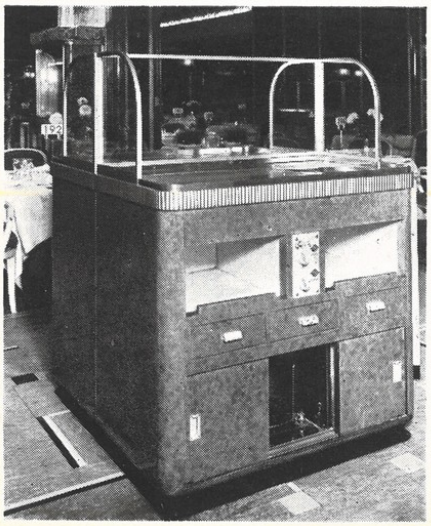


LEFT: One of the dish-washing machines sheathed in Staybrite corrosion-resisting steel.

By courtesy of Dawson Bros.

RIGHT: A large number of Monel boilers are used throughout the ship for heating water, milk, etc.

By courtesy of Henry Wilson & Co. Ltd.



LEFT: A dumb waiter in one of the Dining Rooms in which Monel is used for the hot cupboard and hotplate surround.

By courtesy of H. H. Martyn Ltd.

RIGHT: A fish fryer in one of the kitchens, fitted with stainless steel pans and drainers and nickel wire baskets.

By courtesy of Henry Wilson & Co. Ltd.

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Accles & Pollock Ltd.
Associated British Oil Engines Ltd.
Bath Cabinet Makers & Artcraft Ltd.
British Thomson Houston Co. Ltd.
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Allen West & Co. Ltd.
Henry Wiggin & Co. Ltd.
Henry Wilson & Co. Ltd.
Worcester Brass Co. Ltd., The

THE CUNARD WHITE STAR LINER R.M.S. "QUEEN ELIZABETH"

Builders	John Brown & Co. Ltd., Clydebank
Contract signed	October 6th, 1936
Keel laid	December, 1936
Launched	September 27th, 1938, by Her Majesty Queen Elizabeth
Maiden voyage	March 2nd, 1940
First passenger sailing	October 16th, 1946
Service	Southampton–New York

Dimensions and Figures

Gross tonnage		83,673
Length		1,031 ft.
Width		118 „
Length of promenade deck		724 „
Height of keel to superstructure		135 „
No. of decks		14
No. of public rooms		35
No. of passengers: First Class	822	
Cabin	668	
Tourist	798	
Total		2,288
No. of meals served per day		10,000

War Service

Miles steamed on war service	492,635
Service personnel carried	811,324
No. of meals served	22,015,764

Propelling Machinery

Type: Quadruple screw Parsons' reaction single reduction geared turbines.
Number of turbines in each set—Four. H.P. 1st I.P., 2nd I.P. and L.P.
Total shaft horsepower over 160,000.

Boiler Equipment

Type of boiler	Yarrow side-fired oil fuel
No. of boiler rooms	Four
No. of boilers	Twelve
Designed working pressure	425 lb. per sq. in.
Final steam temperature	750° F.

Generating Sets

Four sets 2,200 kw.	225 volt. B.T.H. geared turbo-dynamos
Total output	8,800 kw.
Speed of turbines	4,500 r.p.m.
Speed of generators	600 r.p.m.
Steam pressure	390 lb. per sq. in.
Steam temperature	730° F.

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